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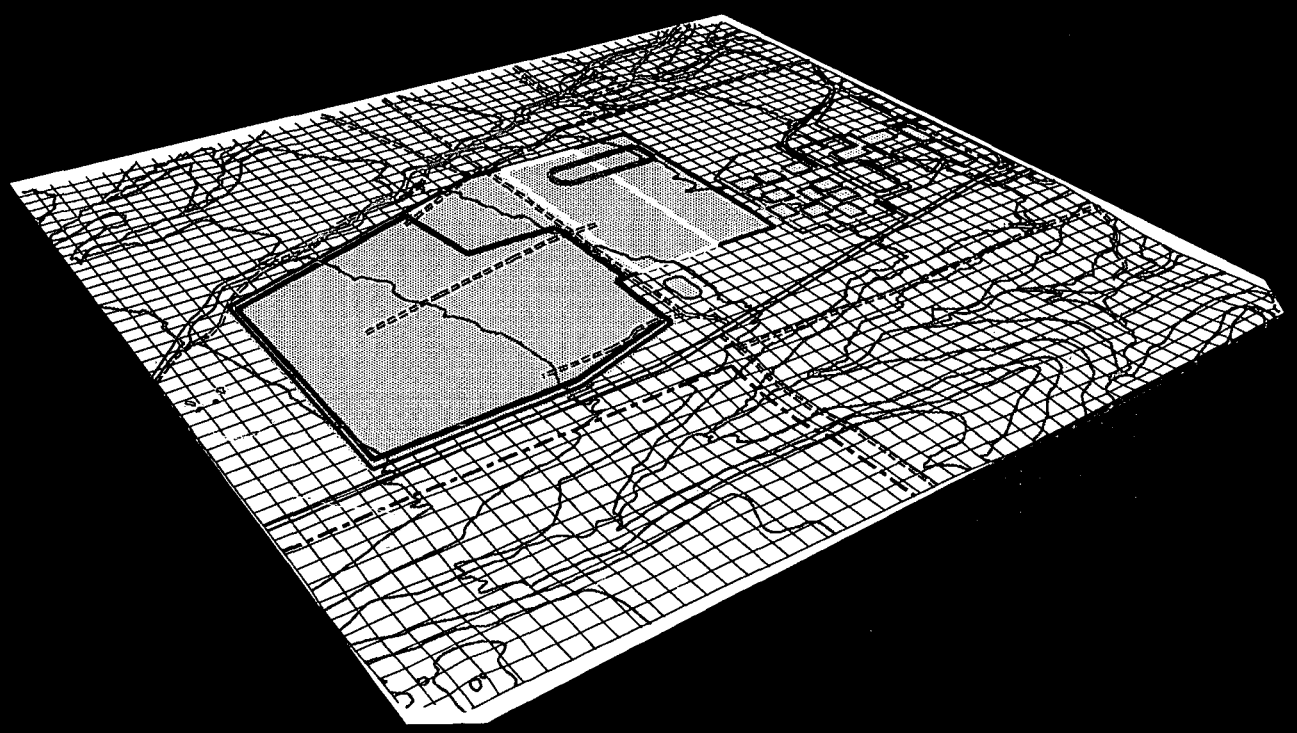
Operable Unit 11
Combined Phases RFI/RI Report
for the
Rocky Flats Environmental Technology Site

Final Report
June 1995



U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

ADMIN RECORD

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Comment Responses on Draft
Operable Unit 11 Combined Phases RFI/RI Report
June 1, 1995

Comments from Colorado Department of Public Health and Environment

Comment Reference

(1) Section 2.2. The first bullet mentions 52 surficial soil samples, while on the next page (Section 2.2.1.1) and elsewhere (e.g., Section 4.4), the text refers to 53 surficial soil samples.

The first bullet in Section 2.2 has been corrected to reference 53 surficial soil samples.

(2) Section 4.5.4. This section begins by stating that the presence of VOCs "is considered significant to the identification of potential contaminants." The second paragraph, however, seems to imply that because the presence of VOCs may not have originated from spray activities, VOCs should not be included as PCOCs. If the primary argument for not including the specified VOCs as PCOCs is their potential as laboratory contaminants, then information such as laboratory blank data would help to validate this argument.

The first paragraph of Section 4.5.4 has been reworded to more accurately reflect the author's point. The primary argument for not including the specified VOCs as PCOCs is related to their distribution, concentrations, and depositional history at OU11. Their frequent occurrence as laboratory contaminants is supporting evidence.

The following comments address DOE's comment responses on the Draft Letter Report.

(3) Comment #14. A comparison with Front Range soils is too general and not site-specific enough to be useful. A comparison with site-specific background soils is the only valid comparison given the variability in composition of Front Range soils. Whether or not a substance is included in the range of Front Range normal values should only be used as a supplementary piece of evidence, not a determinant.

While DOE feels the comparison to Front Range soils is a valid comparison and was appropriately used as supporting evidence, the reference has been removed. Arsenic and lead have not been included as PCOCs in soils based on distributions and concentrations at OU11, rather than comparisons to other Front Range soils.

(4) Comment #15. EPA's *Risk Assessment Guidance for Superfund* (RAGS) recommends using total contaminant values rather filtered or dissolved contaminant values when assessing risk because of the potential to underestimate chemical concentrations in water from an unfiltered tap (RAGS Part A, pp. 6-27). DOE's use of dissolved values to suggest there would be no risk from arsenic exposure to water from Well 4986 is inappropriate.

DOE is aware of the RAGS recommendation to use total rather than dissolved values when assessing risk because of the potential to underestimate concentrations. Unfortunately, only dissolved values are available for well 4986 since February 1993. The dissolved values were reviewed for this well because it is the information available. The dissolved values consistently reported as "nondetections" for every sample since February 1993, coupled with the observation that only five percent of all groundwater samples exceed the background UTL and that no exceedance in well 4986 has been more than one tenth of a µg/l above the UTL, provided a weight of evidence by which to conclude that the arsenic detections in well 4986 are not reflective of contamination. Additionally, DOE would like to point out that, while acknowledging the RAGS recommendation, the CDPHE Conservative Screen Process and identification of PCOCs for which the dissolved values have been used as supporting evidence is not the risk assessment process referred to by EPA in RAGS.

(5a) Comment #16. If a chemical was found in concentrations that exceed UTLs or RBCs, then it is irrelevant whether or not the chemical is historically or spatially related to spray activities as a source. The argument that specific chemicals do not appear to be spatially related to spray activities may have some validity as supplemental evidence when used in conjunction with primary arguments, but its repeated use seems to emphasize the point.

The spatial relationship of chemical detections at OU11 was used, as per Gilbert Methodology, in conjunction with temporal distribution, concentrations at the site, and the conceptual model (transport mechanisms) to distinguish contamination from "noise" in the data set. The spatial distribution discussions have been reworded in the text as appropriate to emphasize the combinations of evidence.

(5b) It also appears that DOE has ignored the presence of a chemical in one medium if it can reasonably argue that it could be eliminated in another. DOE legitimately argues that lead is not a contaminant in ground water, but then uses the Front Range soils comparison and the lack of association with spray activities to inappropriately eliminate this metal as a PCOC in surface soils. Lead should remain a PCOC for surficial soil given the lack of information.

Lead was not considered a PCOC for surficial soil primarily because the maximum concentration (sample SS102894) of 82.9 mg/kg was compared to the

residential screening level of 400 mg/kg and determined insignificant. This comparison was coupled with the percentage of detections, distribution, and concentrations in OU11 to make the decision that lead was not a PCOC.

(5c) DOE has not provided sufficient data for us to independently review for some chemicals that were eliminated as PCOCs. For example, comment responses state that copper in surficial soils exceeded the UTL once, but that it was associated with "a sample location with several associated metals reflective of natural occurrences." Which metals were these and what is the evidence that they are naturally occurring?

The single occurrence of copper in SS140194 was associated with detections of antimony, lead and silver. DOE's evidence for determining this occurrence as naturally occurring was focused primarily on the concentrations of these associated metals. Statistical comparisons could not be completed for antimony and silver because they were not detected in the background data set. However, both metals were detected at the site at levels below the background detection limit and substantially below the PRG and the EPA residential screening level. Antimony occurred in the sample at 3 mg/kg, the PRG is 110 mg/kg, and the residential screening level is 31 mg/kg. Silver occurred in the sample at 0.6 mg/kg, the PRG is 1370 mg/kg, and the residential screening level is 390 mg/kg. Copper and lead did occur in background so statistical comparisons were completed. The single copper occurrence of 88.1 mg/kg exceeded the UTL of 30 mg/kg but falls well below the PRG of 11,000 mg/kg and the residential screening level of 2,900 mg/kg. Lead occurred at 56.3 mg/kg compared to a UTL of 62 mg/kg and a residential screening level of 400 mg/kg.

(5d) DOE has also eliminated certain chemicals as PCOCs using the mistaken concept that because evidence of plumes does not exist, these chemicals can not be considered PCOCs. This concept ignores the possibility of localized areas of contamination or hot spots. It is in appropriate to eliminate a chemical even though it may appear in only one well or sample site. For example, DOE had legitimate reasons for considering that Well 5086 is not actually contaminated with manganese. However, the elimination of manganese as a PCOC has not been adequately justified since ground water from Wells B411289 and 46292 also exceeded the background UTL. Similarly, the presence of vanadium in Well 5286, PCE in Well B410789, and toluene in Well 50394 have not been sufficiently justified.

DOE did not ignore the possibility of localized contamination or hot spots in the development of the PCOC list or the RFI/RI report. The CDPHE process employed to identify PCOCs includes a comparison to UTLs in addition to the statistical comparisons. This UTL comparison identifies any occurrences at anomolously high concentrations that may not be identified as statistically significant. Every analyte reporting an exceedance of a UTL was further considered and reviewed for inclusion as a PCOC. Those reviews and resultant decisions are included in Appendix D of the letter report.

Specifically, manganese in wells B411289 and 46292 were initially (at well installation) reported at values exceeding the UTL. Both wells have shown continuously diminishing concentrations of manganese and have reported no detections exceeding the UTL since 1993. Figure 1 and 2 are the time series plots for these wells which graphically document the diminishing values.

The presence of vanadium in well 5286 was not included in the statistical comparisons for OU11 because it is an upgradient well, not associated with the OU and not in the OU11 data set. It was mentioned in the text merely as a frame of reference for vanadium concentrations in unimpacted wells. The text has been reworded to clarify the intent of the discussion. PCE in well B410789 has been plotted in a time series plot, included as Figure 3. As this figure demonstrates, the detection of PCE is associated with a change in laboratory detection limits. The single confirmed detection was reported at the detection limit, and the subsequent sample was a "U"-qualified result and therefore did not confirm the detection. This evidence in conjunction with the lack of recurrent detections at any other location in the OU11 area support the conclusion that PCE is not a PCOC. The toluene detection in well 50394 could not be verified because subsequent sampling results are not yet available. However, the detection of .2 µg/L was "J" qualified (so it is not a confirmed detection) and below the PRG. Subsequent samples from this well will be reviewed as they are available to confirm the conclusion.

(6a) Comment #17. The response to this comment is inadequate. Both the Division and EPA requested to see the comparison of laboratory contaminants and laboratory blank values in order to see whether the "5-times" or "10-times" rules recommended in RAGS (pp. 5-16) had been met. This specific comparison could not be found, even though the comment response states it "is presented in Section 2.3 of the RI Report." DOE then used professional judgment to eliminate several organic chemicals as PCOCs, maintaining that they are laboratory contaminants.

DOE agrees that an OU11-specific comparison of the "10-times blank" guidance for common laboratory contaminants such as bis(2-ethylhexyl)phthalate would strengthen the general comparison of OU11 data and QA/QC data presented in Table D-3. However, the majority of the OU11 ground water data was collected as part of the Rocky Flats sitewide monitoring program, in which QA/QC blanks are collected and analyzed for each sitewide sample batch (which may represent several OUs) and are not reported in RFEDS as specific to an OU.

(6b) The chemical eliminated by this professional judgment which is of greatest concern is bis(2-ethylhexyl)phthalate (or di-octylphthalate). As shown in Table 3 of the Comment Responses, the maximum concentrations of this contaminant found in OU 11 ground water exceeds the carcinogenic RBC by more than 4 times. Given the fact that DOE has and still does use this chemical on-site, that it is likely that it could have been released into the air, that it is present in concentrations that exceed

the carcinogenic RBC, and that it occurs in concentrations greater than what RAGS recommends can legitimately be attributed to laboratory contamination, bis(2-ethylhexyl)phthalate should be retained as a PCOC.

DOE presented the information in the previous comment response that the maximum concentration of bis(2-ethylhexyl)phthalate in ground water is four times the RBC. Since the RBC is based on a 1E-06 screening risk level, this maximum (and the rest of the data set below this value) is not indicative of health impacts. DOE feels that the preponderance of evidence, including very low concentrations of the same magnitude of reported detection limits, lack of temporal trends in ground water analyses, ubiquitous presence in samples and blanks sitewide, widespread use of phthalate ester plasticizers in commercial products, and potential introduction during field activities does not support the inclusion of bis(2-ethylhexyl)phthalate as a PCOC.

Figure 1
TIME SERIES PLOT

MANGANESE
B411289

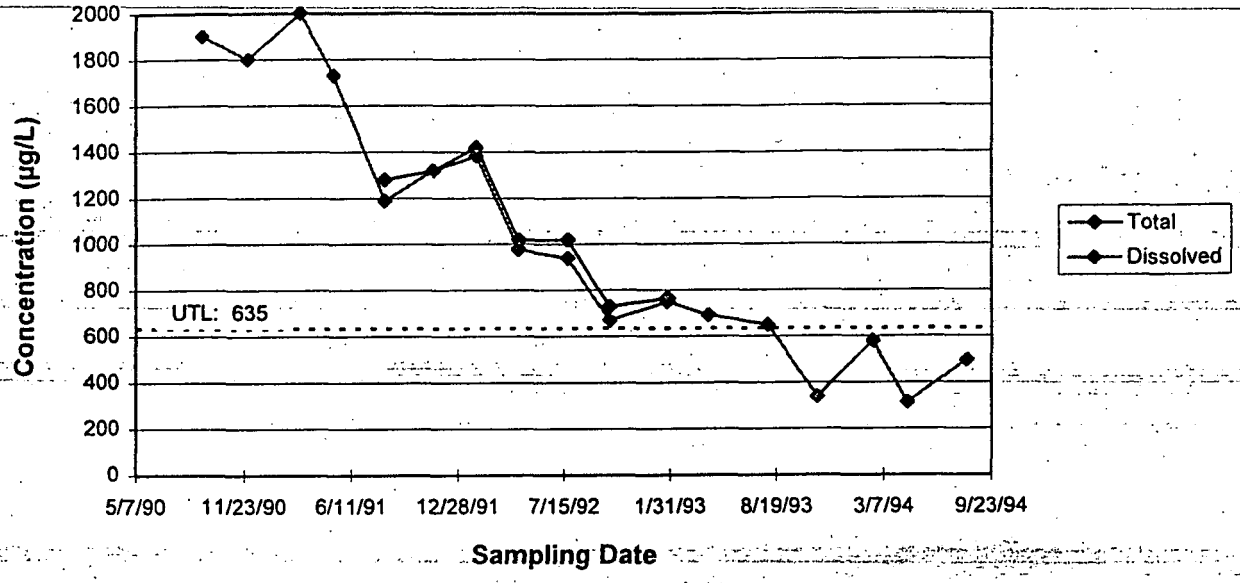

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Figure 2
TIME SERIES PLOT

MANGANESE
46292

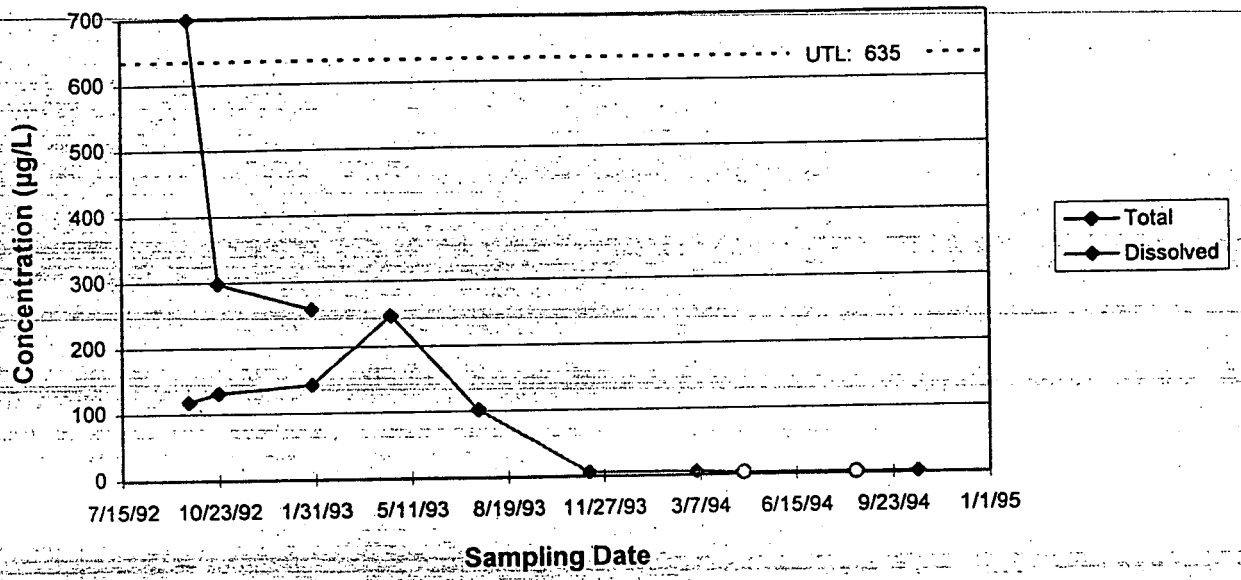

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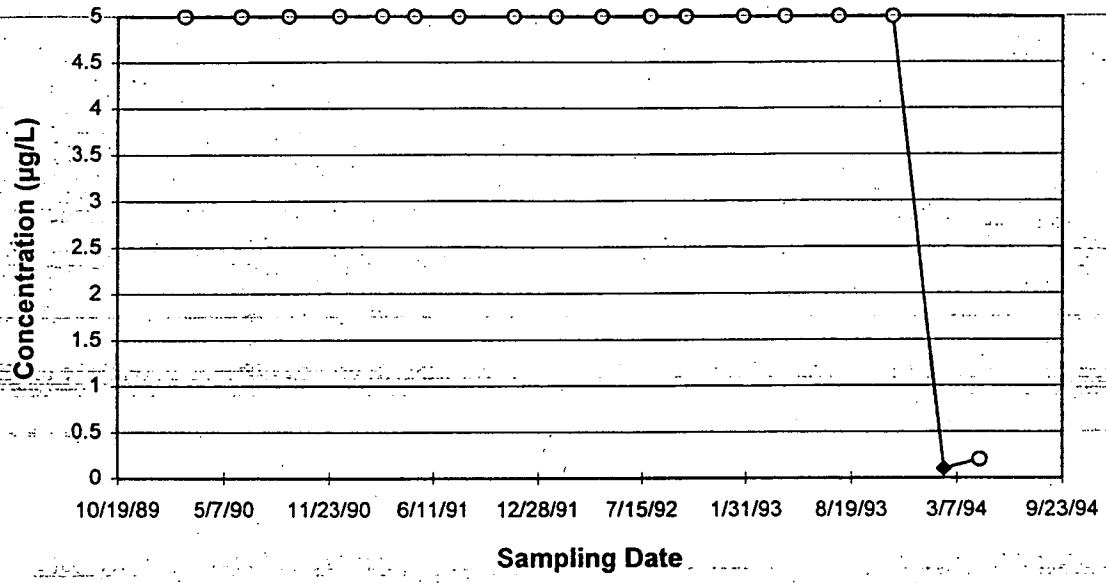
Figure 3
TIME SERIES PLOT

TOTAL TETRACHLOROETHENE
B410789



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Operable Unit 11 Combined Phases RFI/RI Report for the Rocky Flats Environmental Technology Site

Final Report

June 1995

Prepared for:

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado 80402

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EG&G ROCKY FLATS

Executive Summary

The combined phases Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) for Operable Unit (OU) 11 at the Rocky Flats Environmental Technology Site (RFETS) was conducted to satisfy the requirements of RCRA; the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); and the Colorado Hazardous Waste Act, as mandated by the Interagency Agreement (IAG) dated January 22, 1991. The performance of the combined phases RFI/RI and the preparation of this report has been guided by the OU 11 Technical Memorandum—Revised Field Sampling Plan and Data Quality Objectives (FSP TM) dated June 1994.

OU 11 consists of one individual hazardous substance site (IHSS), IHSS 168, located on the west end of RFETS. In complying with the requirements of the IAG as they apply to OU 11, both RCRA and CERCLA concerns are addressed in this document. This document presents both the activities and the results of the OU 11 field investigations and provides the decision basis for recommending whether further action is required at the OU.

The general objectives of the RFI/RI are to:

1. Characterize the nature and extent of contamination associated with OU 11,
2. Identify if perched ground-water conditions are present at OU 11, and
3. Quantify if OU 11 currently poses risk to human health or the environment.

The specific objectives of the OU 11 combined phases RFI/RI site investigation, as presented in Table 2.1-1 of the FSP TM, are:

1. Determine if contamination exists in the vadose zone and/or ground water,
2. Determine if contamination exists in surficial soils, and
3. Assess current ecological conditions.

Activities performed as part of the field investigations include collection and analysis of surficial soil samples, completion of a high-purity germanium survey, collection and analysis of subsurface geologic materials (referred to as vadose zone soils in the OU 11 FSP TM), installation of ground-water monitoring wells in both perched and regional ground-water systems, collection and analysis of water samples from these wells, a survey of current ecological conditions, and comparison of conditions to reference area conditions.

The combined phases (combined Phase I and II) RFI/RI was conducted in accordance with the approved FSP TM, the sitewide Quality Assurance Project Plan (QAPjP), and EG&G Rocky Flats, Inc. (EG&G) Standard Operating Procedures (SOPs). Data quality

objectives (DQOs) were established in the FSP TM to qualitatively and quantitatively evaluate the usability of the data in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. Based on the specific numerical PARCC objectives set out in the FSP TM, as well as the qualitative goals of the investigation program, the DQOs were met by the combined phases RFI/RI. The data were judged of sufficient quality to support the required decision process.

A baseline risk assessment was not performed for OU 11 in conjunction with this RFI/RI. The Colorado Department of Public Health and Environment (CDPHE) Conservative Screen process, as agreed to by the U.S. Department of Energy (DOE), CDPHE, and the U.S. Environmental Protection Agency (EPA), directs that a baseline risk assessment be completed if the risk-based concentration (RBC) ratio sum is greater than one. At OU 11, the RBC ratio sum is less than one, indicating that a baseline risk assessment is not appropriate because no further action is necessary for the site. This Conservative Screen process is presented in Section 6 and Appendix D of this report in lieu of the risk assessment.

Based on the results of the combined phases RFI/RI activities, the following conclusions have been drawn:

1. **The requirements of the IAG and the OU 11 FSP TM have been met and are documented in this Final Combined Phases RFI/RI Report.**

   Sections 1 and 2 present a detailed evaluation of the requirements of the IAG and the OU 11 FSP TM. Table 2.1-1 lists the specific requirements and references the sections in this report that address the requirements.

2. **The DQOs specified in the FSP TM have been met.**

   Section 2.3 presents the DQOs for the combined phases investigation and compares the results of the investigation against the specific OU 11 DQO and PARCC criteria.

3. **Perched ground water is present at OU 11, on a very localized scale.**

   The results of the combined phases investigation presented in Section 3 indicate that a zone of variable saturation exists in the alluvium above the regional ground-water table at OU 11. Variable saturation can be equated to a very localized "perching" of ground water. There is no evidence from this investigation supporting contamination in the perched system.

4. **The following potential contaminants of concern (PCOCs) have been identified at OU 11:**

Media	Analyte
surficial soils	nitrate/nitrite americium-241 plutonium-239,240
subsurface geologic materials	tritium nitrate/nitrite
ground water	none

Section 4 of this report presents the nature and extent of contamination at OU 11, including methodology for background comparisons, PCOC identification, and source characterization. Section 6 and Appendix D summarize the results of the statistical tests, geochemical analyses, and professional judgment process undertaken to identify PCOCs at the site. This process was implemented at OU 11 utilizing methodology agreed to by DOE, CDPHE, and EPA. Section 6 and Appendix D also present results of the CDPHE risk-based conservative screen for OU 11.

5. **There is no evidence to indicate the existence of an imminent threat of a release of hazardous or radioactive constituents from OU 11 to the environment.**

Sampling results presented in Section 4, reviewed relative to the site hydrogeologic conceptual model presented in Section 3 and the fate and transport mechanisms presented in Section 5, show that current conditions at OU 11 are highly unlikely to result in releases to the environment.

6. **There is no current or imminent threat at OU 11 under present or projected land uses.**

Based on the CDPHE Conservative Screen process presented in Appendix D and the evaluation of the concentrations and distributions of PCOCs presented in Section 4, OU 11 poses minimal, if any, health risks, assuming long-term residential exposure. The carcinogenic and non-carcinogenic ratio sums are less than 1. By CDPHE criteria, this warrants no further action consideration, pending evaluation of potential risk from dermal exposure. The risk at OU 11 from dermal exposure is also minimal, as documented in Appendix D. The investigations at OU 11 identified no remediation requirements or imminent health threats.

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List of Acronyms and Abbreviations

BRA	baseline risk assessment
BSCP	Background Soils Characterization Project
C	Celsius
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm/sec	centimeters per second
cm^3/g	cubic centimeters per gram
CRDL	contract-required detection limit
DIL	dilution
DOE	U.S. Department of Energy
DQO	data quality objective
EcMP	Ecological Monitoring Program
ECOC	ecological contaminant of concern
EE	environmental evaluation
EG&G	EG&G Rocky Flats, Inc.
EMD	Environmental Management Department
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERA	ecological risk assessment
ERAM	ecological risk assessment methodology
F	Fahrenheit

FSP TM	Technical Memorandum—Revised Field Sampling Plan and Data Quality Objectives
ft bgs	feet below ground surface
ft/ft	feet per foot
ft/yr	feet per year
FWHM	full width at half maximum
g/mol	grams per mole
GC/MS	gas chromatography/mass spectrometry
GFAA	graphite furnace atomic absorption
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
HI	hazard index
HPGe	high-purity germanium
HQ	hazard quotient
IAEA	International Atomic Energy Agency
IAG	Interagency Agreement
IDL	instrument detection limit
IHSS	individual hazardous substance site
ITS	interceptor trench system
K_d	distribution coefficient
kg	kilograms
km	kilometers
kW h/m^2	kilowatt hours per square meters
LANL	Los Alamos National Laboratory
LHSU	lower hydrostratigraphic unit
mb	millibars

MDL	method detection limit
meq Na/100 g	milliequivalents of sodium per 100 grams
mg/kg	milligrams per kilogram
mph	miles per hour
MS	matrix spike
MSD	matrix spike duplicate
msl	mean sea level
NA	not applicable/not available
NCP	National Oil and Hazardous Substances Contingency Plan
ND	not determined
NOAEL	no-observed-adverse-effects-level
NR-WP	not required - work plan
OU	operable unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCE	tetrachloroethene
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PCOC	potential contaminant of concern
PPRG	programmatic risk-based preliminary remediation goal
PVC	polyvinyl chloride
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
Qrf	Rocky Flats Alluvium
R	retardation factor

RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
REP	replicate
REX	re-extraction
RFEDS	Rocky Flats Environmental Database System
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RPD	relative percent difference
SCS	Soil Conservation Service
SEPs	Solar Evaporation Ponds
SOP	standard operating procedure
STP	Sewage Treatment Plant
SVOC	semivolatile organic compound
TAL	target analyte list
TCE	trichloroethene
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TIC	tentatively identified compound
TOC	total organic carbon
TRG	target
TSS	total suspended solids
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
UHSU	upper hydrostratigraphic unit

USCS	Unified Soil Classification System
UTL	upper tolerance limit
$UTL_{99/99}$	upper tolerance interval of the 99th percentile at the 99-percent confidence level
VOC	volatile organic compound
WSF	West Spray Field
Wxbrclst	weathered bedrock claystone

1. Introduction

This document summarizes the activities performed during the combined phases (combined Phase I and II) field investigation at Operable Unit (OU) 11, the West Spray Field (WSF), of the Rocky Flats Environmental Technology Site (RFETS) and presents the results of the investigation. The field investigation was performed to comply with the Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requirements for field investigations. This document presents the nature and extent of contamination in potentially affected media at OU 11, including soils, ground water, sediments, air, and biota. This document also discusses contaminant fate and transport and presents an assessment of risk. The assessment of risk identifies the risk to human health and the environment to support decisions regarding future actions at OU 11.

The investigation summarized in this report is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies, remedial/corrective actions, and justifications for no further action currently in progress at RFETS. These investigations are being performed pursuant to a compliance agreement between the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Colorado Department of Public Health and Environment (CDPHE). The agreement consolidates RCRA and CERCLA issues into a scheduled, sequential environmental restoration (ER) program.

As part of the ER program, a two-phased field investigation was required at the WSF. The two-phased approach was consolidated into a "combined phases" investigation by mutual agreement among the three parties. The combined phases approach was documented in the work plan titled Technical Memorandum—Revised Field Sampling Plan and Data Quality Objectives, dated June 13, 1994 (FSP TM) (EG&G, 1994a). This RCRA Facility Investigation/Remedial Investigation (RFI/RI) report summarizes the implementation of the FSP TM and presents the results of the field investigations at OU 11.

1.1 Purpose of the Report

The purpose of the field investigations at OU 11, as stated in Section 1.1 of the FSP TM, is to determine the risk to human health and the environment to support a final action decision. The purpose of this report is to document and summarize the data obtained during the field investigations as well as data collected from previous OU 11 and sitewide investigations; draw conclusions about the nature, extent, fate and transport of contaminants; and finally, quantify the potential risks at the site.

The field investigations were based on the data quality objectives (DQOs) designed to support an evaluation of the risk to human health and the environment. This document presents potential contaminants of concern (PCOCs) identified through the field investigations and quantifies the risk posed by those PCOCs.

1.2 Site Background

RFETS is a government-owned, contractor-operated facility, which is part of the nationwide nuclear weapons complex. RFETS is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver. From 1951 until January 1992, the plant mission, as a nuclear weapons research, development, and production facility, was to fabricate weapons components from plutonium, uranium, beryllium, and stainless steel. Research was conducted in metallurgy, machining, remote engineering, and physics. Both storage and disposal of operations-related wastes occurred at the site. The current mission at RFETS is environmental restoration and waste management.

1.2.1 Description of the West Spray Field, OU 11

The WSF, shown on Figure 1.2-1, is an area of approximately 105.1 undeveloped acres located on the west side of RFETS. The WSF was identified as a hazardous waste management unit regulated by RCRA in 1986 because it was known to have received water containing hazardous constituents from the Solar Evaporation Ponds (SEPs). The 1991 agreement among EPA, CDPHE, and DOE outlined the activities to be undertaken to characterize the potentially impacted media at OU 11 and the schedule for characterization activities. OU 11 includes one individual hazardous substance site (IHSS), IHSS 168. The boundaries for the OU and the IHSS are identical.

1.2.2 History of the West Spray Field, OU 11

Between April 1982 and October 1985, three areas of the WSF were used for periodic spray application of excess liquids pumped from SEPs 207-B North and 207-B Center as a means of evaporating wastewater (DOE, 1992a). When the storage capacity of one of the ponds was reached, the liquids were pumped to the spray field via an above-ground pipeline for land application. Pond 207-B North was used as a repository for shallow ground water collected on the northeast side of the plant in an interceptor trench system (ITS). The ITS collects ground water and seepage downgradient from the SEPs and the footing drains for Buildings 771 and 774. Pond 207-B Center was primarily a repository for effluent from the Sewage Treatment Plant (STP); however, some liquid from the ITS was transferred from Pond 207-B North to Pond 207-B Center. The ponds and the ITS are shown on Figure 1.2-1, Location Map. The areas of spray application are shown and numbered on Figure 1.2-2.

Liquids from Pond 207-B North were primarily applied to spray area 1. Liquids from Pond 207-B Center were applied to all three application areas. The volume of liquid applied to the WSF from Pond 207-B North and Pond 207-B Center was approximately 9 million and 57 million gallons, respectively (Rockwell International, 1988a).

Aerial photos indicate a fourth area east and slightly north of the WSF received limited spray applications between April 1982 and October 1982. Construction of Buildings 130 and 131 began near this area in October 1982, ending all spraying in the area and disturbing all soils in this spray area. This fourth area received relatively minor spray applications, and the original soils are no longer intact.

Spray application was conducted using several different techniques. Initially, moving spray irrigation lines, mounted on metal wheels, were used. These portable lines were replaced with fixed lines or stationary impulse heads. Area 1 was approximately 35.6 acres in size, with three fixed spray lines. Each of the lines had an average length of 1,524 feet and a spray width of 80 feet. Area 2 covered approximately 2.5 acres, with one fixed line trending north-south. Area 3 was approximately 3.2 acres in size. A spray impulse head with a maximum spray radius of 100 feet was used in Area 3. Aerial photos indicate that this head was moved on an east-west trend periodically.

1.2.3 Previous Site Investigations

Previous investigations conducted specifically at the WSF are limited to two soil sampling programs conducted in 1986 and 1988. Several sitewide programs have included collection of data from the WSF area. These studies include the following:

- The sitewide ground-water monitoring program, implemented in 1986 and conducted quarterly
- Gamma surveys, including aerial gamma conducted in 1989 and high-purity germanium (HPGe) gamma conducted in 1993
- A seismic study, performed in 1992 during the Geologic Characterization Data Acquisition Plan (one line in the WSF area)

The above studies and their results were briefly summarized in the OU 11 FSP TM. The data from all these studies were used to design the field investigation and develop the FSP TM. Because many of these data were not validated, or were not specific to OU 11, the data from previous site investigations have been used in this RFI/RI report only as supporting documentation and not for definitive characterization or decision-making purposes.

1.3 OU 11 Combined Phases RFI/RI Report Organization

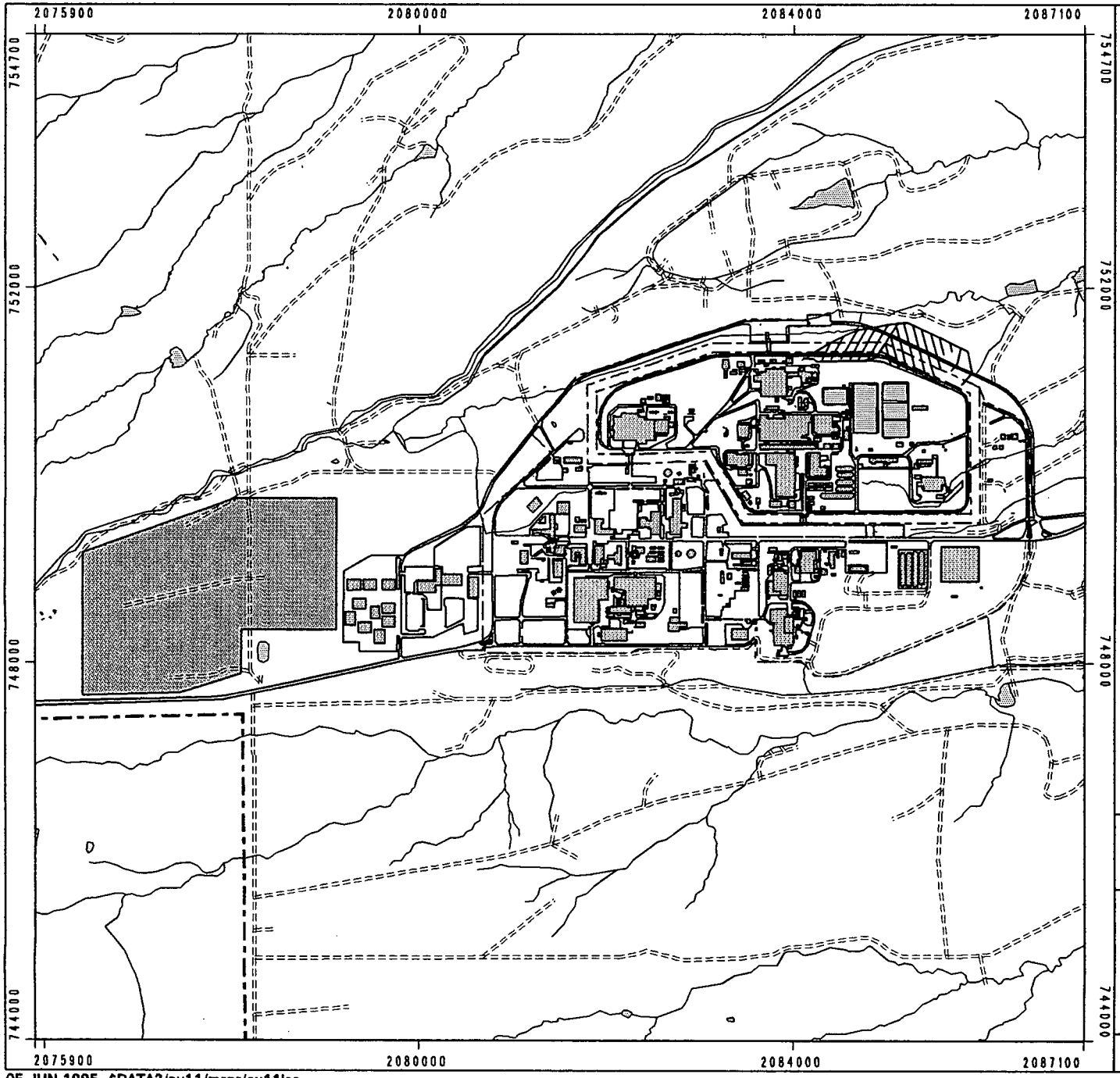
Following EPA's suggested format for RFI/RI reports, this document is presented in eight sections. This first section introduces the report, including the purpose, a description of the site, and a brief summary of the site history and previous site investigations. Section 2 summarizes the field investigations and is organized by physical media, such as soils and ground water. Section 3 presents the physical characteristics of the site.

The nature and extent of the contamination are presented in Section 4. This section begins with the comparison criteria for identification as a "potential contaminant," followed by the analytical results and plots of areas identified as potentially impacted. Section 5, which discusses contaminant fate and transport, presents potential migration pathways and transport processes for the potential contaminants identified in Section 4. Section 5 also presents and uses the physical and chemical characteristics of the contaminants to identify potentially impacted media and migration routes.

The risk assessment, Section 6, consists of two components. The first is a characterization of the potential risks to humans posed by the contaminants identified in the field investigations and the PCOC ranking process. The second component of Section 6 is an evaluation of the current and potential impacts to the ecological system from the identified contaminants and identification of potential receptors.

Section 7 summarizes all findings of the field investigation and subsequent data evaluation and presents the recommendations for acceptable closure of the WSF site. Section 8 presents the references used in generating this report.

Supporting data for this report are presented in the appendices. Included in the appendices are the OU 11 borehole logs, well construction diagrams, data quality review, CDPHE Conservative Screen Final Letter Report, and ecological measurement endpoints and data files.



EXPLANATION

- Interceptor Trench System
- Streams and Drainages
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers

Scale = 1 : 19200
1 inch = 1600 feet

800 0 1600ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Location Map

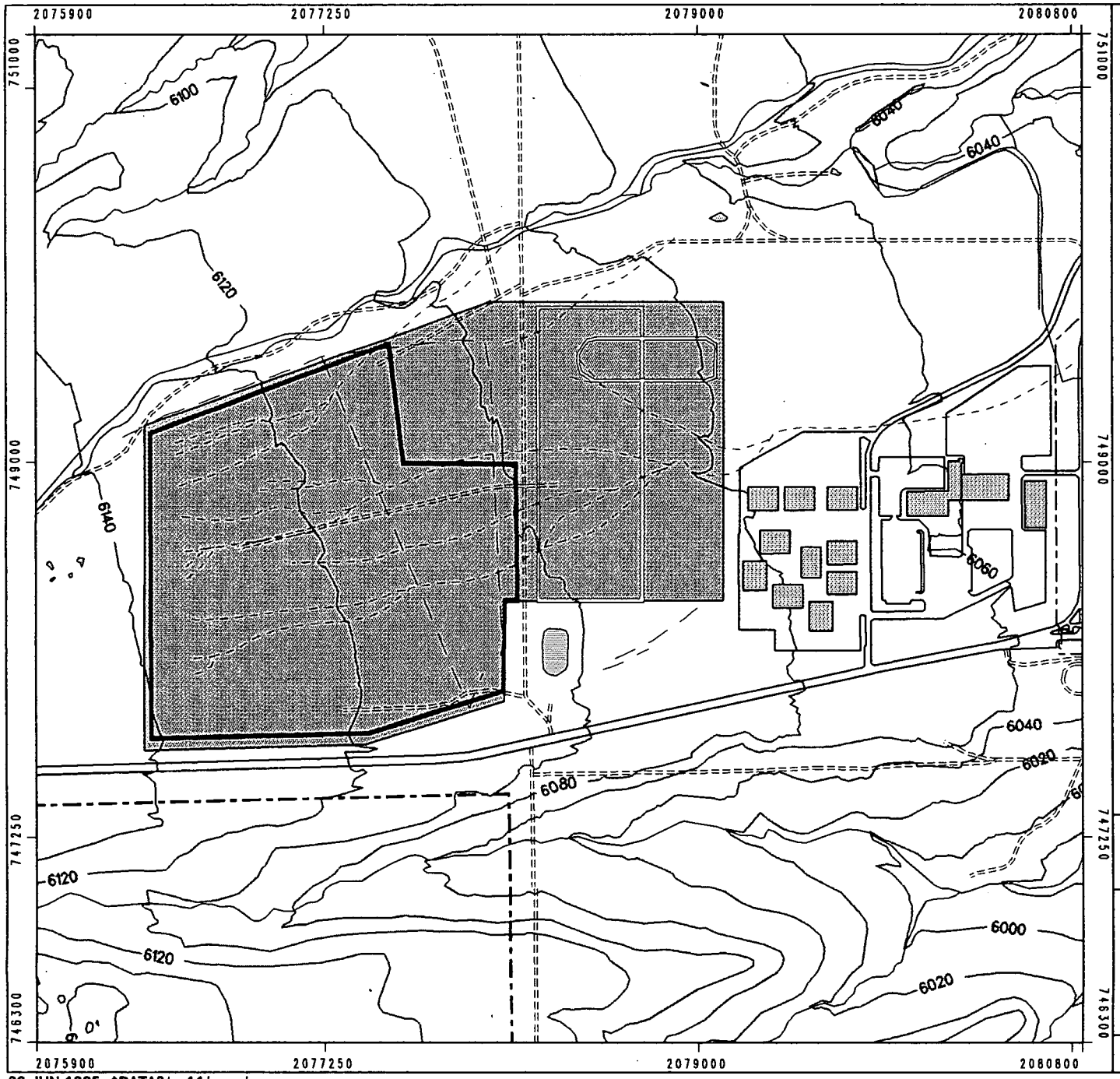
Final Combined Phases
RFI/RI Report

Operable Unit 11

June 1995

Figure 1.2-1

05-JUN-1995 $DATA2/ou11/maps/ou11loc



EXPLANATION

- Spray Area 1
- Spray Area 2
- Spray Area 3
- Spray-Induced Drainage
- Manmade Drainage
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

DATA SOURCE:
Buildings, roads, and fences provided by
Facilities Engineer, EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by
United States Geological Survey - (date unknown).

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Areas of Spray Application

Final Combined Phases
RFI/RI Report

Operable Unit 11

June 1995

Figure 1.2-2

02-JUN-1995 $DATA2/ou11/maps/spray

2. OU 11 Field Investigations

As stated in Section 1, information on historical site activities and previous environmental investigations revealed that environmental concerns exist at the WSF. These environmental concerns relate to the potential for contamination in three media: (1) surficial soils, (2) subsurface geologic materials (referred to as vadose zone soils in the OU 11 FSP TM), and (3) perched ground water. Potential ecological impacts were assessed in conjunction with the media investigations. This section summarizes the field investigation activities that were conducted to investigate these environmental concerns. Rationale for the sampling and analyses performed, quality assurance/quality control (QA/QC) procedures implemented to ensure that the results are scientifically defensible, and an evaluation of the usability of data collected are included in the discussion.

2.1 Site Investigation Objectives

The first step employed in this site investigation involved development of DQOs. DQOs were designed to ensure that the data collected would support quantification of the risk posed by environmental concerns at the WSF. These DQOs and the approaches proposed for achieving them are presented in the OU 11 FSP TM (EG&G, 1994a). This revised field sampling plan was approved by EPA and CDPHE on June 15, 1994. The DQOs and proposed approaches are as follows:

- Determine if contamination exists in surficial soils
  - Obtain recent HPGe gamma survey data and 1989 aerial gamma survey data
  - Collect and analyze surficial soil samples

- Determine if contamination exists in the vadose zone and ground water
  - Collect and analyze subsurface geologic material samples from borehole cores
  - Install monitoring wells to collect and analyze perched ground water, if appropriate
  - Drill to saturated zone if perched water does not exist

- Assess current ecological conditions
  - Compare current conditions to background
  - Determine the absence or presence of adverse impacts to the ecology

All proposed activities were implemented. In many cases, implemented activities exceeded proposed activities, further improving the knowledge gained from the investigation. Table 2.1-1 summarizes proposed activities and completed activities.

2.2 Investigation Activities

The field investigation was conducted between June 16 and October 26, 1994. Activities performed include the following:

- **Collection and analysis of 53 surficial soil samples** to investigate potential surficial soil contamination.
- **HPGe gamma surveys** to further screen gamma activities in surficial soils.
- **Collection and analysis of subsurface geologic materials from 15 boreholes** to characterize potential contamination and to identify potential shallow isolated saturated zones (perched ground water).
- **Construction and development of 15 monitoring wells** designed to allow potential contamination and ground-water flow in shallow saturated zones to be characterized. These wells were installed in the aforementioned boreholes. Eight of the wells were screened to intercept ground water in potential shallow isolated saturated zones. Seven wells were screened to intercept ground water in the upper (perched) portion of the water table aquifer.
- **Collection and analysis of potentiometric surface information and ground-water samples** to characterize vertical and horizontal hydraulic communication and the nature and extent of potential ground-water contamination.
- **Ecologic field surveys** to enhance existing ecologic information and to determine any ecological impacts to the site.
- **Downhole geophysical logging**, including neutron, natural gamma, density, and electromagnetic readings to support the interpretation of lithology and hydraulics.
- **Collection of slug test data and water-level data** in newly installed monitoring wells over a 10-week period to provide information about water flow within the saturated zones.

Because standing surface water is not present in the WSF, surface-water samples were not collected. Background data for storm events is available, but data comparability between storm water and surface water is questionable. The lack of surface water at the site renders surface water an insignificant, and unmeasureable, pathway for any potential contamination.

Similarly, air sampling was not conducted because (1) spray activities at the WSF were ceased in 1985, (2) vegetation covers spray areas, and (3) current activities do not involve resuspension of soils. Air is also deemed an insignificant pathway for any contamination.

The purpose of the following sections is to discuss field activities conducted to support the DQOs as delineated in the OU 11 FSP TM. The activities include surficial soil, ecologic, geologic, and ground-water investigations. Table 2.2-1 summarizes the specific samples required of these investigations and presents a comparison of the required number of samples with the actual number of samples collected.

2.2.1 Surficial Soil Investigations

The surficial soil investigations involved a surficial soil sampling program and an HPGe gamma survey.

2.2.1.1 Surficial Soil Sampling Program

The surficial soil sampling program was conducted in June and July, 1994, and involved collection and analysis of 53 surficial soil samples (see Figure 2.2-1). These samples were collected predominantly from locations that represented the greatest potential for contamination, such as discharge channels, spray contact areas, areas of vegetation imbalance (stress or enhancement), and pipeline junctures. These locations were determined by field reconnaissance and review of historical information, including aerial photographs.

Samples were collected using a modified "Rocky Flats Method" in accordance with EG&G Rocky Flats, Inc. (EG&G) Geotechnical Standard Operating Procedure (SOP) GT.08, Surface Soil Sampling (EG&G, 1992a). Use of this method allowed consistency to be maintained with other RFETS surficial soil sampling programs, particularly the 1994 Background Surficial Soil Survey. The resulting data support a comparison between the areas with the highest likelihood of contamination in the WSF and agency-approved data for background concentrations in surficial soils.

The surficial soil samples were analyzed to address the spray water constituents that could be expected to be retained in surficial soils, specifically radionuclides, metals, and nitrate. Although volatile and semivolatile organic constituents were also present in the spray water, the volatile properties of these compounds combined with the application method (spraying) make it highly unlikely for the compounds to be retained in the surficial soils.

Each sample location was surveyed before and after sampling. Along with soil samples, duplicate soil and equipment rinse water samples were taken in accordance with the frequency required in Section 5 of the FSP TM (EG&G, 1994a). This frequency is one duplicate sample for every 10 soil samples taken and one equipment rinse for every 20 soil samples taken. Soil samples were containerized and shipped following the procedures outlined in the Field Operations SOP FO.13, Containerization, Preserving, Handling and Shipping of Soil and Water Samples (EG&G, 1992a). Rinsate water

samples were containerized, preserved, and shipped following SOP FO.13 and the OU 11 FSP TM. Shipments were accompanied by a chain of custody. Data contained in each chain of custody was entered into the Rocky Flats Environmental Database System (RFEDS) via the Datacap program to track samples. QA/QC samples are summarized in the data usability section of this report.

2.2.1.2 *High-Purity Germanium Gamma Survey*

The HPGe gamma survey was designed to confirm and supplement previously conducted gamma surveys at the WSF. The previous gamma surveys included an aerial survey conducted in 1989 and a ground-based survey performed in 1993. These surveys indicated that gamma exposure rates at the WSF are lower than those measured on plant site and other surrounding areas.

The HPGe survey was conducted by EG&G Environmental Measurements and involved 158 measurement locations (see Figure 2.2-2). Figure 2.2-2 not only shows the coverage of the HPGe survey but also presents contour isopleths of the survey results. The contours represent the gamma exposure at the WSF.

2.2.2 Ecological Investigations

The assessment of the ecological effects and risks associated with the WSF resulting from RFETS activities follows EPA guidance (EPA, 1992a). As part of that guidance, data acquisition, verification, and monitoring occurred interactively with problem formulation, analysis (i.e., characterization of exposure and ecological effects), and risk characterization. Existing ecological data relevant to OU 11 are described below and support the risk characterization presented in Section 6 of this report. All ecological sampling followed EG&G Ecology SOPs.

Under the EG&G Ecological Monitoring Program (EcMP), EG&G has conducted extensive sampling that is relevant and applicable to the environmental evaluation (EE) for OU 11. Additionally, the conditions at OU 11 were appropriate to combine the EE study with an evaluation of the EcMP methodology. That is, the EcMP sampling and analysis methods have been difficult to evaluate, given the scarcity of the ecological impacts associated with RFETS activities. Many of the EcMP endpoints should be very sensitive to the historic conditions at OU 11, specifically the effects of the addition of water and nitrate to the terrestrial ecosystem. Sampling at OU 11 provided the mutually beneficial opportunity to evaluate the EcMP methods and add to the state of the art EE at OU 11.

2.2.2.1 *Terrestrial Ecosystem Sampling for OU 11 EE*

Samples for the OU 11 EE were collected from spray areas, non-spray areas, and reference areas. Within those areas, 5-meter-by-5-meter grids were sampled for vegetation, small mammals, and insects. Vegetation sampling included cover transects and production quadrants, following Ecology SOP EE.10, Vegetation Sampling (EG&G, 1992a). Terrestrial arthropods were collected by sweep netting in all grids of each area, following Ecology SOP EE.09, Terrestrial Arthropod Sampling (EG&G 1992a). Samples are in secure storage awaiting possible identification and enumeration as indicated by the problem formulation. One bird transect was also inventoried, following Ecology SOP EE.07, Bird Sampling (EG&G, 1992a).

Trapping for small mammals was conducted in four grids per area, following Ecology SOP EE.06, Small Mammal Sampling (EG&G, 1992a). To expand the relevance of the small mammal data collected, trapping was done for three nights so that results would be comparable with extensive reference data collected under the EcMP. Small mammals collected include deer mice (*Peromyscus maniculatus*) and meadow voles (*Microtus pennsylanicus*). Large mammals observed include coyote (*Canis latrans*), mule deer (*Odocoileus heminus*), and desert cottontail (*Sylvilagus audubonii*).

Vegetation tissue samples were collected by quadrant from all grids within each area. Samples of selected species (*Poa compressa*, *Artemesia ludoviciana*, *Ambrosia psylostachya*, and *Andropogon geradii*) are in storage in Building T891G at RFETS in a locked room, in custody-sealed boxes, in paper bags, holding the dried vegetation at room temperature. Tissue samples are awaiting possible analysis as indicated by the problem formulation.

2.2.2.2 *Aquatic Ecosystem Sampling for OU 11 EE*

The only permanent surface water monitoring station with a potential aquatic receptor ecosystem directly downgradient from OU 11 is SW-128. This impoundment principally receives runoff from parking lots and may be influenced by OU 11 only during runoff events. In support of the OU 11 EE, one qualitative benthic macroinvertebrate sample each was collected from surface water monitoring station SW-128 and Lindsay Pond, following Ecology SOP EE.02, Aquatic Invertebrate Sampling (EG&G, 1992a). The samples contained a diverse array of 17 and 29 species, respectively.

The following preliminary data have been collected or formulated as a result of sample collection in direct support of the OU 11 EE:

- Small mammal capture data
- Vegetation production summaries and calculations

- Vegetation production plot summary forms
- Vegetation cover transect summary forms
- Vegetation belt transect summaries and calculations
- Relative abundance survey summary
- Species list of macrobenthic organisms

2.2.2.3 *Terrestrial Ecosystem Sampling for EcMP*

The EcMP is a DOE-mandated program to determine long-term ecological endpoints, exposure values, and effects at RFETS (DOE Order 5400.1, DOE Order 5440.1E, 43 Code of Federal Regulations [CFR] Part 11, 40 CFR Part 300 Subparts E and G, and 10 CFR Part 384). Field operations for this program began in 1993, focusing on the testing of methodologies, experimental designs, sample scheduling, and program operations, all of which had been approved by the DOE Rocky Flats Field Office. Soil sampling at OU 11 was conducted in September of 1993.

The EcMP initially had been divided into five modules:

- Aquatic Ecology
- Terrestrial Vegetation, including cover, richness, density, production and litter biomass values, and tissue analysis
- Ecosystem Functions, including background soil physical/chemical measurements, microbial carbon and nitrogen pools, and potential rates of carbon and nitrogen transformations
- Soil Invertebrate Analysis
- Small Mammal Population Dynamics

Many of the ecological endpoints used in the EcMP are still in a state of development for adaptation to monitoring functions, but the endpoints chosen have been reviewed by an independent team of western university research experts (i.e., Rocky Mountain Universities Consortium, Denver Research Institute, University of Denver) and DOE's ecological consultant (Dr. Beverly Ausmus-Ramsey). There is consensus that "best available technology" is being used.

Much of the 1993 EcMP ecosystem sampling took place in the Buffer Zone to define ecological attributes of reference areas. EcMP personnel recognized that the nitrogen treatment in the OU 11 area provided a unique opportunity to examine the feasibility and sensitivity of many program variables. Because many ecological measurements are affected by both carbon and nitrogen flows and pools, if impacts are indeed detectable, one would expect to find them in an area of heavy nitrogen application (OU 11).

Therefore, several EcMP measurements were taken in OU 11. Data that are currently available have been used to support the OU 11 EE as appropriate.

2.2.3 Geologic Investigations

Geologic investigations involved a drilling program designed to collect subsurface geologic material samples to determine the nature and extent of contamination in the vadose zone. This information also focused the field investigation through the observational approach. Field observations were used to determine the locations and construction of new monitoring wells and to provide lithologic information to support development of hydrologic and geologic site conceptual models. Specific activities supporting the geologic investigations included drilling, core logging, and subsurface geologic material sampling.

2.2.3.1 Drilling

Ten boreholes were proposed in the OU 11 FSP TM. Geologic conditions encountered in the field resulted in actual drilling of 17 boreholes (see Figure 2.2-3). Fifteen of these boreholes were then developed into ground-water monitoring wells in support of the hydrogeological investigations; the other two boreholes were abandoned. Borehole locations were chosen to meet the guidelines presented in the OU 11 FSP TM (EG&G, 1994a). These guidelines included drilling:

- in irrigation sub-basins or areas that received the highest volumes of spray waters,
- near existing water table wells where nitrate levels were anomalously elevated (although still below drinking water standards),
- near existing or abandoned wells where potential shallow saturated zones were encountered during drilling, and
- within surface water runoff areas.

Borehole drilling and completion details are summarized in Table 2.2-2. Boreholes were drilled using the innovative Resonant Sonic™ drilling technology. This technology was used because of several reported advantages over conventional drilling technologies (Westinghouse, 1993 and undated). These advantages include (1) an improved ability to penetrate cobbly material, which is common in the Rocky Flats Alluvium; (2) increased recovery of sample core from this material; and (3) reduction of volumes of drill waste. Resonant Sonic™ technology achieved these goals by providing consistently high core recovery and reducing the amount of drill cuttings. The volume of cuttings generated was estimated at less than 50 percent of the volume associated with conventional hollow-stem auger drilling techniques, based on a

comparison between the two methods of footage drilled and volume of cuttings generated.

Drilling was conducted in accordance with Geotechnical SOP GT.04, Rotary Drilling and Rock Coring (EG&G, 1992a). Continuous core samples were collected from all locations using a 3.75-inch inside diameter, 5-foot-long core barrel. A 6.5-inch-diameter outer casing was drilled to a depth of 4 feet at each location to hold the borehole open. Drilling was halted when a moist zone was identified. This determination was made using Speedy Soil Moisture Tester® readings and borehole lithology results. When the soil tester registered moisture in a 2-foot interval, the borehole was allowed to stand open for one to several days to observe if free water would be produced. If an open borehole produced at least 0.3 feet of free water, a monitoring well was installed. The interval to be screened was determined by evaluation of lithology and moisture content encountered during drilling. After determining the water level and appropriate screen interval at each well, the outer casing was driven to the total depth of the well, creating a 7-inch-outside-diameter borehole. The well was then installed inside the outer drill casing. Well installations are discussed in Section 2.2.4.

Drill cuttings from all locations were containerized in 30-gallon drums in accordance with Field Operations SOP FO.08, Handling of Drilling Fluids and Cuttings (EG&G, 1992a). Characterization of the drum contents is based on analytical results of the borehole samples corresponding to the drill cuttings in the drums. For those borehole depth intervals not sampled, drill cuttings were composited and analyzed to characterize drum contents. Drums were moved to a 90-day RCRA storage area at RFETS within 24 hours of filling.

2.2.3.2 *Core Logging*

Continuous core samples were collected from all 17 borehole drilling and monitoring well installation locations. Preliminary core descriptions were completed in the field by the rig geologist, and all core not used for analytical sampling was boxed at the site. Wooden blocks were labeled and placed in the core boxes to mark the beginning and ending depth for each box, as well as the beginning of each drilling interval, and to represent sections of no recovery or sections used for chemical analysis. After being returned to the field trailer, these cores were photographed and described in detail in accordance with Geotechnical SOP GT.01, Logging Alluvial and Bedrock Material (EG&G, 1992a). Logging involved detailed lithologic descriptions including grain-size distributions, grain shape and angularity, mineralogy, and moisture content. Lithology and moisture information were used to determine the design of the monitoring wells subsequently installed at the WSF. Borehole logs are presented in Appendix A.

2.2.3.3 Subsurface Geologic Material Sampling

Subsurface geologic material samples were collected at 2-foot increments to a depth of 12 feet and 6-foot increments below 12 feet. Drill casing was typically advanced in 2- or 3-foot runs. Clay zones were sampled discretely when encountered. When saturation was reached, borehole sampling ceased. Two types of samples were collected: (1) 3-inch-long discrete samples collected in stainless-steel sleeves for volatile organic compound (VOC) analyses and (2) 2- or 6-foot composite samples collected from the core barrel for all other analyses. When difficult drilling conditions were encountered, the drill stem was rotated and resonated. Rotation required removing the internal core barrel to avoid damage. In these limited cases, core was obtained from the outer casing by resonating the geologic material onto a polyvinyl chloride (PVC) tray.

Once at the surface, the core barrel was immediately opened. The stainless-steel sleeve containing the VOC sample was removed from the barrel, and its exposed ends were covered with sheets of Teflon® and capped. The capped sample was classified, labeled, recorded, bagged, and placed in a cooler chilled to 4° Celsius (C) with blue ice. The remaining core was peeled with a stainless-steel putty knife to remove any surficial material smeared onto the outside of the core. Core material was then placed in a clean stainless-steel bowl and homogenized. The homogenized sample was then placed in the appropriate sample containers and chilled to 4°C if required. Typically, less than half the core in each barrel was removed for the composite sample, and the remainder was preserved in a core box for logging. Borehole samples were containerized, preserved, handled, and shipped in accordance with Field Operations SOP FO.13, Containerization, Preserving, Handling and Shipping of Soil and Water Samples (EG&G, 1992a). Field duplicates and equipment rinse QC samples were collected along with the original borehole soil samples following the QC sampling frequency guidelines in the FSP TM (EG&G, 1994a). The results of the QC sampling program are presented in the data quality section of this report (Section 2.3.1).

All sampling equipment was decontaminated in the field between samples in accordance with Field Operations SOP FO.03, General Equipment Decontamination (EG&G, 1992a). All downhole drilling equipment was decontaminated in the field with a steam cleaner after removal from the ground. The drill rig was completely decontaminated before entering and upon departing IHSS 168, according to Field Operations SOP F0.04, Heavy Equipment Decontamination (EG&G, 1992a). These decontamination activities ensured that constituents were not spread between borehole locations or between sample intervals at each borehole.

2.2.4 Ground-Water Investigations

Ground-water investigations involved installation, development, potentiometric surface measurement, and sampling of monitoring wells. These activities were designed to determine site-specific concentrations of analytes—and their potential movement—in alluvial ground water.

2.2.4.1 Well Installation

As indicated in the OU 11 FSP TM (EG&G, 1994a), the primary intent of the 10 proposed monitoring wells was to characterize water quality in upper hydrostratigraphic unit (UHSU) ground water. Well construction diagrams are presented in Appendix B.

Of the 15 wells installed, seven encountered moisture and lithologic conditions that suggested the potential for existence of perched water: 50294, 50494, 50694, 50794, 50894, 50994, and 51594 (see Figure 2.2-3). These wells were screened in the "perched" or variably saturated zone as per the FSP TM.

One of the wells (50494) did not immediately produce water despite soil moisture readings, lithologic data, and screen-depth intervals that were similar to those at other wells that exhibited some ground water. Consequently, a supplementary well (51694) was installed 10 feet south of well 50494 to investigate the potential for perched water at deeper intervals. However, moist conditions were not identified in the deeper intervals, so well 51694 was completed as a water table monitoring well. Well 50494 did eventually begin producing water after standing open for more than two weeks.

Well 51594 is also a supplementary well that was installed to screen an interval that produced free water in adjacent borehole 50594. Borehole 50594 was not completed as a well. Well 51594 eventually developed a water column of 0.7 feet at a depth of 18 feet, after standing open for a week.

Of the remaining seven wells, six were installed in the water table aquifer because moisture readings and lithologic data encountered during drilling did not reflect potential perched conditions: 50194, 50394, 51094, 51194, 51294, and 51494. Two of these wells (51194 and 51294) are supplementary wells installed to investigate an area outside the eastern portion of OU 11 that received sporadic spraying. This area of spraying was identified and investigated following a review of recently located aerial photographs.

The fifteenth well (51794) is a supplementary well installed to serve as a piezometer to determine if the water levels measured at well 50794 represent confined conditions. (Water levels in well 50794 were approximately 4 feet below ground surface

approximately 24 hours after well completion, despite drilling through "dry" geologic materials down to a depth of 16 feet.)

2.2.4.2 *Well Development*

Monitoring wells were developed to provide physically and chemically representative ground-water samples. Newly installed monitoring wells were developed before ground-water sampling was undertaken. Two wells (51694 and 50494) were dry and, therefore, were not developed during the combined phases field investigation. These wells were later developed as part of the sitewide ground water monitoring program. The data available from these wells has been utilized in this report.

Well development was performed in accordance with Groundwater SOP GW.02, Well Development (EG&G, 1992a). Well development equipment was decontaminated before and after each use in accordance with Field Operations SOP FO.03, General Equipment Decontamination, (EG&G, 1992a) and stored in clean plastic bags between use. Water level and total depth were measured at each well to determine the volume of water in the well casing. The minimum volume of water to be purged from each well was calculated according to guidelines in Groundwater SOP GW.02 (EG&G, 1992a). In accordance with this procedure, the volume of purge water is a minimum of five times the initial well casing volume of water.

During development, water was slowly evacuated from the wells using a Teflon® bailer and/or an inertial pump. Purge water was emptied in a graduated 5-gallon bucket to measure the amount of water removed and then transferred to a holding tank for proper disposal. Purge and decontamination water were handled in accordance with Field Operations SOPs FO.05, Handling of Purge and Development Water, and FO.07, Handling of Decontamination Water and Wash Water (EG&G, 1992a). Field parameters including pH, temperature, specific conductance, and turbidity were measured following the procedures outlined in Groundwater SOP GW.05, Field Measurement of Groundwater Field Parameters (EG&G, 1992a). Parameters were measured at regular intervals at least once for each well casing volume purged. Estimated recharge rates were measured for low-yielding wells in accordance with Groundwater SOP GW.01, Water Level Measurements in Wells and Piezometers (EG&G, 1992a).

As per SOP GW.02, Well Development, a well was considered fully developed when all of the following conditions were met: (1) a minimum of five casing volumes of water were removed; (2) field parameter measurements of pH, temperature, specific conductance, and turbidity had stabilized over three consecutive readings (readings taken for each casing volume removed); and (3) the purged water became free of suspended sediment. Wells that dewatered during development activities were

revisited a number of times over several days in order to remove the required volume of water.

2.2.4.3 *Potentiometric Surface Measurements*

Static water-elevation measurements were obtained through the month of November 1994 on a daily basis to characterize potentiometric surfaces and hydraulic communication within and between the various water-bearing zones. The well network used for water-elevation measurements consists of the 15 newly installed wells (including one piezometer). Pressure transducers and data loggers were installed in all the wells for this purpose. Historic well data were used to supplement this recent data in development of potentiometric surface maps presented in Section 3 of this report.

2.2.4.4 *Ground-Water Sampling*

Ground-water samples were collected in accordance with the OU 11 FSP TM and Groundwater SOPs GW.06, Groundwater Sampling, and GW.01, Water Level Measurements in Wells and Piezometers (EG&G, 1992a). Water-level and total-depth measurements were taken to determine the volume of water in the well casing. The data were used to calculate the casing and purge volumes. Standing water was purged from the well with a Teflon® bailer. A minimum of three well casing volumes was purged to ensure that the sample was representative of the ground water in the formation. Six of the wells produced sufficient water to collect a full suite of samples. Nine of the wells had slow recharge rates and resulted in collection of partial ground-water sample suites. Table 2.2-1 summarizes the ground-water samples collected.

Radionuclide screen samples were collected from the purge water. Field parameters, including conductivity, pH, temperature, dissolved oxygen, and turbidity, were measured from an aliquot of the first bailer of water in accordance with Groundwater SOP GW.05, Field Measurement of Groundwater Field Parameters (EG&G, 1992a). Conductivity, pH, and temperature were measured for every half-casing volume of water removed from the well. Turbidity and dissolved oxygen were measured a second time during well purging; the sample chosen for the second measurement was determined by professional judgment of the field crew.

If the well dewatered while purging, a final set of conductivity, pH, temperature, turbidity, and alkalinity parameters was measured before collecting ground-water samples. A well was considered dewatered when the water level required longer than 30 minutes to recover to at least 90 percent of the static water level. Well purging was considered complete when one of the following conditions was met: (1) three casing volumes had been purged and the field parameter measurements had stabilized (measurements were within 10 percent of each other) or (2) the well dewatered. Purge and decontamination water were handled in accordance with Field Operations SOPs

FO.05, Handling of Purge and Development Water, and F0.07, Handling of Decontamination Water and Wash Water (EG&G, 1992a).

After completion of well purging, ground-water samples were collected using a Teflon® bailer. VOC samples were collected from the first bailer of water. The bailer was equipped with a bottom-decanting control valve to transfer the sample to the container. Unfiltered samples were transferred directly from the bailer to the containers using the bottom-emptying valve. Samples for dissolved analytes were transferred to a stainless-steel bucket and filtered using a peristaltic pump equipped with a disposable 0.45-micron filter. The disposable filter was attached to the decontaminated sample delivery line so that filtered samples could be transferred directly to the appropriate containers. All sampling equipment was decontaminated between locations in accordance with Field Operations SOP FO.03, General Equipment Decontamination (EG&G, 1992a).

2.3 Data Quality and Usability

DQOs and their measurement criteria for the OU 11 RFI/RI are specified in the OU 11 FSP TM (EG&G, 1994a). Specification of these objectives ensures that sample-collection and analytical methods used provide appropriate data to characterize the site and describe the nature and extent of contamination.

The primary QA assurance objective for analytical data is to ensure that data generated are of documented quality and are defensible for the intended data uses. To meet this objective, appropriate steps were taken to ensure that the OU 11 data are (1) of known quantitative significance in terms of precision and accuracy at levels appropriate for the intended data use, (2) representative of actual physical and chemical conditions, (3) comparable to previous data, and (4) complete to the extent that conclusions can be made and supported. The quality of the OU 11 data was evaluated for usability in accordance with EG&G Administrative Procedure 2-G32-ER-ADM-08.02, Evaluation of ERM Data for Usability in Final Reports (ADM-08.02) (EG&G, 1991a) and is described in Section 2.3.1.

Data usability describes what data can be used, how and why it is used, and when and where it can be used. Different types of data and data from various sources may vary in quality and, thus, in their usability. Absolute criteria regarding whether data can be used or not do not exist for all circumstances. Data usability for the OU 11 RFI/RI was determined by the data-quality needs and documentation of the field sampling, laboratory, and QA/QC protocols; usability is discussed in Section 2.3.2.

2.3.1 Data Quality

OU 11 RFI/RI field activities were conducted in accordance with the OU 11 FSP TM (EG&G, 1994a), the Sitewide Quality Assurance Project Plan (QAPjP) (EG&G, 1990a and 1991b), and SOPs (EG&G, 1992a).

2.3.1.1 Field Quality-Control Sampling

Field QC samples provide information to assess sampling and analysis precision and to identify potential biases in analytical data resulting from cross contamination during sampling or during sample transport and storage. At OU 11, QC samples were collected concurrently with real samples of surficial soils and subsurface geologic materials. Table 2.3-1 presents the required frequency of QC sample collection (as stipulated in the FSP TM), and Table 2.3-2 summarizes the actual QC samples collected during surficial-soil and subsurface geologic material sampling.

The OU 11 ground-water monitoring wells generally produced low volumes of water, and with the exception of wells 5086 and 46292, QC samples were not collected from these wells during the OU 11 RFI/RI. To evaluate the quality and general usability of ground-water data collected during the OU 11 RFI/RI, analytical results for QC samples collected with ground-water samples from 1990 to 1994 were reviewed, as presented in the Groundwater Geochemistry Report (EG&G, 1995a). These data were collected in conjunction with the sitewide ground-water monitoring program at RFETS and include analytical results for metals, radionuclides, semivolatile organic compounds (SVOCs), VOCs, water-quality parameters, and field measurements (e.g., dissolved oxygen, water temperature, specific conductivity, and pH). The OU 11 RFI/RI samples were collected as part of the sitewide program, so review of the sitewide QC data is relevant.

The types of field QC samples collected include field duplicates, equipment rinses, trip blanks, and field blanks. Field duplicates provided additional sample volume for a duplicate laboratory analysis. Duplicate samples were collected at the same time as the real samples, using the same procedures and the same types of containers. They were also preserved in the same manner and submitted for the identical suite of analyses required for the real samples. These results, when compared to analytical results for the real samples, assessed the precision of both the field sampling methods and analytical procedures.

Equipment rinses were collected upon completion of decontamination procedures to evaluate whether or not decontamination activities were adequate to prevent cross contamination. Equipment rinses were obtained by pouring distilled water on decontaminated sample-collection equipment. The rinsate was collected and submitted for the same analyses as the real samples.

Trip blanks and field blanks were collected to provide information on the potential for contamination during sample collection and transport. Trip blanks consisting of distilled water were prepared either by the sampling team or the analytical laboratory and accompanied each shipment of samples for VOC analysis. Trip blanks were collected during sampling of subsurface geologic materials and ground water. Analysis of these blanks provided information about possible contamination by VOCs or any problems associated with sample shipment, handling, or storage.

Field blanks of distilled water, preserved (as appropriate) according to the applicable preservation requirements, were prepared by the sampling team and were used to provide an indication of any contamination introduced during field sampling.

2.3.1.2 *Laboratory Qualifiers and Validation Codes*

Two types of qualifiers are used to describe data: laboratory qualifiers and validation codes. Laboratory qualifiers are applied by the laboratory following analysis and provide useful information on the quality of measurement values. Validation codes are determined by an independent review of laboratory QC records.

Laboratory Qualifiers

Environmental samples were analyzed using EPA Contract Laboratory Program (CLP) procedures and other well-established analytical methods identified in the General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G, 1991c). All laboratory analyses for target analyte list (TAL) metals and target compound list (TCL) organic compounds were performed using EPA CLP procedures. Methods for non-CLP analytes, including major ions and radionuclides, were based on the EPA methods specified in the GRRASP.

Laboratory qualifiers are defined in Table 2.3-3.

Validation Codes

EPA CLP methods and data-validation protocols (EG&G, 1991c; EPA, 1988a and 1988b) were used in the validation process for these data. Because EPA guidelines for validating non-CLP analytes are not currently available, non-CLP data were validated by an independent subcontractor in accordance with guidelines developed by the Rocky Flats EMD. These non-CLP guidelines are based on EPA validation protocol and are modified for non-CLP analytical methods. Data were validated at EPA Level IV or the equivalent for non-CLP analyses.

Laboratory QA/QC results, including laboratory control-sample analyses, were reported to the data validation subcontractor and were reviewed to evaluate the precision and

accuracy of laboratory analyses. After reviewing laboratory QC results, the data validation subcontractor qualified data as necessary.

OU 11 data were validated as either (1) V = valid and usable without qualification, (2) A = acceptable for use with qualification, (3) JA = acceptable as estimated result, (4) Y = in validation process, (5) R = rejected and thus unacceptable for use, or (6) Z = validation not required or performed. Table 2.3-4 presents a definition of the validation codes.

Valid or acceptable data met the following objective standards, where applicable:

- Analytical methods were followed (primary validation criteria).
- Acceptance criteria were achieved.
- Sufficient numbers and types of QC samples were analyzed.
- QC limits were achieved (primary validation criteria).
- Compounds and analytes were correctly identified (primary validation criteria).
- Equipment and instrumentation calibration criteria were achieved (primary validation criteria).
- Sample holding times were met.

Data that were acceptable with qualifications met most, but not all, of the above-listed standards. At a minimum, all of the primary validation criteria were achieved within acceptable limits. Rejected data failed to meet primary validation criteria. Rejected data were not included in the working database for the OU 11 RFI/RI (refer to Section 2.3.1.3). Data qualified as V, JA, or A were considered of equal utility and were included in the working database.

Table 2.3-5 presents a summary of the validation status for OU 11 data extracted from RFEDS on December 21, 1994. Approximately 79 percent of all results have been validated. The percentage validated based on the total number of results varies by medium and analyte group. The percentage of data validated by medium varies from 78 percent for subsurface geologic materials to 89 percent for ground water. The percentage of data validated by analyte group varies from 0 percent for radionuclides in surficial soils to 100 percent for metals and VOCs in ground water.

2.3.1.3 Data Review and Cleanup

Data collected during the OU 11 RFI/RI, sitewide ground-water monitoring program, and background characterization programs were received in electronic format from RFEDS and systematically reviewed and organized to achieve a standard format for each record. Identical data-cleanup routines were used to format data from the site and from the background locations. These routines are based in part from guidance received from EG&G (EG&G, 1994b). The OU 11 data-cleanup routines are briefly summarized below.

Site data used in this report were extracted from RFEDS on December 21, 1994. In addition to the analytical data from environmental samples, RFEDS data includes information such as field QC samples and analytical results for sample dilutions. All water-level and field measurements were also provided by RFEDS; these data were stored separately from the analytical data. RFEDS contains all validated and unvalidated results. Prior to data evaluation, the database was edited and made internally consistent by the following steps:

1. Records reported with undefined units, laboratory qualifiers, or validation codes; blank results or unit fields; and non-radionuclide results equal to zero were researched. If a resolution was not possible, these records were labeled as unusable.

2. Tentatively identified compound (TIC) records were labeled based on a result type or secondary result type of "TIC," or laboratory qualifier of "A" or "N."

3. RFEDS assigned "Z" to the following sample records:

   - Samples analyzed at onsite laboratories

   - Geophysical samples

   - Sample numbers starting with NP (for National Pollutant Discharge Elimination System) or VW (for surveillance surface water)

   - All laboratory QA records that are typically stored in a separate RFEDS database

   - Records with a blank result field and information in the laboratory disposition field

   Records assigned a validation code of "Z" were removed from the database.

4. Result values were converted to consistent units of measurement for each group of analytes of each media type.

Matrix	Analytical Group	Units
Soil	Metals and Water-Quality Parameters	mg/kg
	Radionuclides	pCi/g
	VOCs and SVOCs	µg/kg
Water	Radionuclides	pCi/L
	All other analytical groups	µg/L

Where:

mg/kg = milligrams per kilogram

pCi/g = picocuries per gram

µg/kg = micrograms per kilogram

pCi/L = picocuries per liter

µg/L = micrograms per liter

5. A usability category was assigned based on validation codes and laboratory qualifiers. Table 2.3-6 presents the usability categories.

6. Results that indicated detection of an analyte and results that indicated nondetections were labeled. Metals, water-quality parameters, VOC, and SVOC records with laboratory qualifiers of U, UC, UE, UJ, UN, UW, and UX were labeled "nondetections." All records for radionuclides were labeled "detections" regardless of laboratory qualifier.

7. The reported detection limit was checked against the contract-required detection limit (CRDL) specified in the GRRASP. If these two values were equal, the value stored in the result field was used as the instrument detection limit (IDL) for metals or the method detection limit (MDL) for SVOC and VOC records.

An internally consistent database of supportable data, with standardized units of measurement, was developed using these cleanup steps. Detection and nondetection criteria, quantity summaries, validation status, and usability status of the records were compiled from this database.

The following additional formatting steps were performed to produce the final "project" database for OU 11:

1. TIC records and records for analytes not included on the list of target analytes in the OU 11 FSP TM were removed.

2. Records labeled as unusable or rejected were removed.

3. Location descriptions and hydrostratigraphic and geologic unit labels were added to each record for use in aggregating comparable data.

The end result was the project database from which all data used in site characterization, risk assessment, and data-quality evaluations were extracted. Two separate files, the "working" database (real-sample results) and the QC database (QC-sample results), were created from the project database as follows:

1. Real records having usability categories of VALID, ESTIMATE, and BLNK/Y VAL were copied to the Real or "RI" database.

2. Records of real and duplicate sample pairs were identified and copied to the QC database. Records for field blanks, trip blanks, and equipment rinses were also copied to the QC database.

For each of these databases, duplicate records were identified and researched to determine which record to use based on the result type (for example, TRG [target], DIL [dilution], REP [replicate], REX [re-extraction]), laboratory qualifier, and validation code. Records not used were removed and stored. The following criteria were used iteratively to identify the most accurate record:

1. If none of the records was validated, the TRG record was kept and the other(s) was removed.

2. If one record was validated and the other(s) was not, the validated record was kept and the other(s) was removed.

3. If more than one record was validated, the record with the highest "rank" in the validation code hierarchy was kept and the other(s) was removed.

Validation Code Hierarchy	
V	Highest
A,JA	Second Highest
Y,blank	Third Highest

4. If the records had the same validation code, the record with highest concentration (to be most conservative) was kept and the other(s) was removed.

Data from the working database were used to perform statistical comparisons of site data to background data and to evaluate the nature and extent of contamination. Data from the QC database were used to describe the quality of data collected for the combined phases RFI/RI in terms of data-quality indicators.

OU 11 data used in background comparisons were extracted from RFEDS in December 1994 and January 1995. These data are from locations identical to those used in the Background Geochemical Characterization Report (DOE, 1993), except that some records previously identified as unusable due to missing information had been updated. The updated records are more complete and therefore could be included in the database used to calculate summary statistics for background media. The background data were subject to the same cleanup routines as the data collected at OU 11.

Prior to performing statistical comparisons, data from the working database were systematically reviewed to identify records for nondetections. A new result value was assigned to the nondetection records for use in statistical summaries or comparison tests. In statistical summaries (mean, standard deviation, etc.), this value is either one-half the reported detection limit when the IDL or MDL is reported or it is one-half the result when the CRDL is reported (EG&G, 1994b). In the statistical comparison tests this value is the reported detection limit (Gilbert, 1993).

2.3.1.4 Data-Quality Indicators

Data quality is assessed in terms of the precision, accuracy, representativeness, completeness and comparability (PARCC) parameters. PARCC parameters apply to both laboratory and field data.

Precision is a measure of the reproducibility of analytical results. Accuracy is a measure of how closely a measurement of concentration corresponds to the actual concentration in a sample. Representativeness is a qualitative measure of how well data meet the project goal of representing true background concentrations. Completeness is a measure of the amount of valid data derived from the sampling program. Comparability expresses the extent to which data collected over a period of years and/or by different methods can be considered to be equivalent.

Table 2.3-7 presents a summary of the PARCC parameter QC criteria for each media sampled. A detailed discussion of each PARCC parameter and an evaluation of the OU 11 data quality is included as Appendix C. A summary of the data quality is presented below.

2.3.1.5 Summary of Data Quality by Media

Data quality for surficial soils, subsurface geologic materials, and ground water is summarized below.

Surficial Soils

Precision for most analytes in surficial soils is good, even though it can be difficult to achieve reproducibility in soil samples because of the heterogeneity of the matrix. Based on the precision analysis, results for antimony, copper, molybdenum, nickel, selenium, thallium, and tin have been qualified as estimated results. Results for all radionuclides have also been qualified as estimated results, indicating that precision was poor for these analytes particularly at levels near the minimum detectable activity. Nitrate/nitrite results were also qualified as estimated based on the results of the precision analysis.

Accuracy of the surficial-soil data was evaluated by reviewing the detection limits reported by the laboratory and the CRDLs specified in the GRRASP. All CRDLs were within the range of detection limits reported or were higher. This indicates that accuracy of the analytical method and the specific instruments used in the laboratory was very good. Laboratory qualifiers and validation codes also provide information on accuracy and were considered when assigning usability to individual results.

Representativeness is good. Although several metals were detected in equipment rinses, the majority are major-ion constituents of natural water and most likely originated in the distilled water used to rinse sampling equipment. Lead and zinc were also detected infrequently and at low concentrations.

Completeness of surficial-soil sampling activities at OU 11 exceeded 100 percent because additional samples were collected to address potential impacts downgradient of the site, including pipeline junctions, channels, and a newly identified spray area. Analytical completeness is also very good. Of the total results available as of December 21, 1994, approximately 86 percent of soil sample results have been validated (including 62 percent valid, 19 percent acceptable, and 5 percent remaining). Approximately 100 percent of the surficial-soil data is considered usable.

Comparability of OU 11 RFI/RI data to historical data has been ensured by the use of an approved work plan (EG&G, 1994a), standard analytical protocols (EG&G, 1991c), and approved SOPs (EG&G, 1992a).

Subsurface Geologic Materials

Precision for analytes in subsurface geologic materials is generally very good, with the following exceptions. Based on the precision analysis, results for aluminum, arsenic, chromium, cobalt, copper, lead, lithium, manganese, molybdenum, and nickel have been qualified as estimated results. Reproducibility among radionuclides is generally poor, particularly at levels near the minimum detectable activity. Results for all radionuclides have been qualified as estimated results. All SVOCs met the precision requirements, with the exception of di-n-butyl phthalate; results for this analyte have been qualified as estimated. Results for nitrate/nitrite were also qualified as estimated.

Accuracy for the subsurface geologic material samples, as evaluated by comparing the detection limits reported by the laboratory and the CRDLs, was very good. The majority of CRDLs were within the range of detection limits. Some CRDLs were higher than the detection limits achieved by the laboratory, indicating that the accuracy requirement for the OU 11 subsurface geologic material data was met, as required by the GRRASP. Laboratory qualifiers and validation codes also provided information on accuracy and were considered when assigning usability to individual results.

Representativeness is good. Several metals were detected in the field QC samples; however, most analytes detected in equipment rinses, with the exception of cadmium, lead, and zinc, may have originated in the distilled water used to rinse sampling equipment. These metals occurred infrequently and at low concentrations. One of the 30 equipment rinses collected contained tetrachloroethene (PCE) at a low concentration which should not affect the representativeness. In addition, bis(2-ethylhexyl)phthalate and diethyl phthalate, which are considered common laboratory contaminants, were detected in several equipment rinses. Nitrate/nitrite was also detected in several equipment rinses at low concentrations.

Completeness of subsurface geologic material sampling exceeded 100 percent because seven additional boreholes were drilled. Of the total results available as of December 21, 1994, approximately 78 percent of the subsurface geological material data have been validated (including 63 percent valid, 5 percent acceptable, 1 percent rejected, and 9 percent remaining results). Approximately 98 percent of the subsurface geologic material data is considered usable.

Comparability of the OU 11 RFI/RI subsurface geologic material data to historical data has been ensured by the use of an approved work plan (EG&G, 1994a), standard analytical protocols (EG&G, 1991c), and approved SOPs (EG&G, 1992a).

Ground Water

Based on an assessment of the ground-water QC data collected from 1990 to 1994, precision for the majority of analytes in ground water is fair. The relative percent differences (RPDs) for metals, with the exception of thallium, exceeded the RPD criterion of 20 percent for approximately one-half of all duplicate pairs (EG&G, 1995a). Elevated RPDs were not unusual when analyte concentrations are at or near the detection limit (especially for metals). At OU 11, a majority of results are near the detection limits. For radionuclide analyses, RPDs were highly variable and typically high. Elevated RPDs are associated with low radionuclide activities that are not within the range required to obtain reproducible results. As a result of the low activities of radionuclides in natural waters at RFETS and the poor laboratory precision associated with measuring these activities, analysis of duplicate samples of radionuclides does not provide a reliable measure of sampling precision.

Results for accuracy (i.e., MS recoveries) were not available from RFEDS for review. Without an assessment of accuracy measurements, the possible bias that may be associated with specific data cannot be evaluated.

Representativeness is generally good. The frequency of metals detected in trip and field blanks was relatively high. The most frequently detected analytes included aluminum, calcium, iron, magnesium, sodium, and zinc. Commercial-grade distilled water was used to prepare the blanks and is one likely source for the frequently detected metals. For this reason, analyses of these frequently detected metals in field blanks may not be useful in identifying field or laboratory contamination of real samples. However, the concentrations of most metals detected in the blanks and equipment rinses was lower than the EPA CRDL.

Analyses of VOCs in trip-blank or field-blank samples indicated that acetone, carbon disulfide, dichloromethane, methylene chloride, toluene, and 2-butanone were typically present in the blanks. These compounds may have originated from the commercial-grade distilled water used to prepare the blanks; they have also been identified as common laboratory contaminants (EPA, 1988b). In accordance with procedures specified by EPA functional guidelines (EPA, 1988a, 1988b, and 1990), results for analytes detected in blanks may require restating results from associated real samples as undetected. This assessment should be performed during data validation. Until the results of such an assessment are available, the presence of acetone, carbon disulfide, dichloromethane, methylene chloride, toluene, and 2-butanone in a field sample should be considered as potentially resulting from laboratory contamination. At present, these results are considered usable as screening-level data.

Temporal trends in detection frequency of blanks and RPD values are not readily apparent. The types of QC samples collected have changed over time. In most cases, only four years of data were available to make comparisons, and the sample sizes in some of these years were small. There is a tendency, however, toward decreased detection of heavy metals and VOCs in equipment rinses for the period 1990 to 1992.

Completeness of OU 11 ground-water monitoring well installation exceeded 100 percent. Although 10 wells were planned, 17 wells were completed as directed by field conditions. As of December 21, 1994, completeness of OU 11 ground-water sampling based on analytical group ranged from a high of over 100 percent for anions, cyanide, and water-quality parameters to a low of 60 percent for metals and SVOCs. Analytical completeness is very good. Approximately 89 percent of all ground-water data available have been validated, including 71 percent valid, 3 percent acceptable, 1 percent rejected, and 14 percent remaining results. Approximately 97 percent of the ground-water data is considered usable.

Comparability of the OU 11 RFI/RI ground-water data to historical data has been ensured by the use of an approved work plan (EG&G, 1994a), standard analytical protocols (EG&G, 1991c), and approved SOPs (EG&G, 1992a).

2.3.2 Data Usability

The usability of data was evaluated for each media sampled using the laboratory qualifier, the validation code, and the results of the data-quality analysis. The usability of individual records was defined by the laboratory and validation codes. The usability of larger groups of data, such as all records for a specific analyte, was further qualified based on results of the data-quality analysis.

Four usability categories have been defined for the OU 11 data (RFI/RI data and historical data from ground water) based on laboratory qualifiers and validation codes. Table 2.3-6 lists these categories and the qualifiers and codes associated with each one. Fully usable data (category = VALID) include validated records that are not qualified by the laboratory as estimated values. Estimated results (category = ESTIMATE) are those data considered acceptable by the validation code but reported by the laboratory as estimated values based on a variety of QA/QC criteria. Unusable data (category = REJECT) include rejected results and unvalidated records with undefined laboratory qualifiers or qualifiers indicating poor analytical results (such as "E"-qualified organic compound results). The fourth category includes unvalidated records (category = BLNK/Y VAL) that may or may not be qualified by the laboratory. The status of these records remains undetermined at this time, but they have been considered usable as estimated values similar to the estimated-results category.

The percentages of the records for each medium within each usability category are provided in Table 2.3-8. In general, the majority of data reviewed from all media types is fully usable. The percentage of rejected or unusable data varies for each medium. Zero percent of the total surficial-soil results reviewed were rejected. Approximately 2 percent of all subsurface geologic material results were rejected and considered unusable. Specific results based on analytical group ranged from a low of 0 percent for water-quality parameters to a high of 8 percent for radionuclides in subsurface geologic materials. Approximately 3 percent of all ground-water results reviewed were rejected and ranged from a low of 0 percent for SVOCs to a high of 12 percent for total radionuclides. Data in this category were removed from the working database used to describe conditions at OU 11.

Data usability has been assessed for two distinct data sets: (1) historical data collected prior to the RFI/RI and (2) data collected during the OU 11 RFI/RI.

2.3.2.1 *Historical Data*

Historical data for surficial-soil and subsurface geologic material samples collected in 1988 are not considered usable. The surficial soils are not comparable to samples collected at OU 11 in 1994, and they are not comparable to background soil samples. No documentation on 1988 subsurface geologic material sampling is available, and analytical results from these samples were never reviewed for validation. Therefore, they are not comparable to the RFI/RI data and are not considered usable.

Surficial-soil samples collected since January 1992 are considered comparable and valid, and estimated results from these samples are considered fully usable.

Ground-water data collected since January 1990 as part of the sitewide and RCRA ground-water monitoring programs are considered fully usable. Their quality has been assessed; the procedures used for sample collection, preservation, shipping, and analysis are well documented; and analytical data have been validated. All valid and estimated results for ground water are considered usable.

2.3.2.2 *RFI/RI Data*

Data collected during the combined phases RFI/RI have undergone rigorous review and data-quality evaluation. Specific results of the data-quality analysis are summarized in Section 2.3.1.5. Results indicate that data quality is generally good. Therefore, data are usable for the intended purposes of characterizing site physical features and identifying contaminant sources.

As of December 1994, approximately 79 percent of the OU 11 records have been reviewed and evaluated in accordance with EPA procedures for documentation and

validation of Level IV data (Level V data for radiological analyses). The valid and acceptable data (validation codes V, A, and JA) are considered usable for site characterization, human health and environmental risk assessments, remedial alternative evaluation, engineering design and remedial actions, and potential-responsible-party determination (EPA, 1987).

As of December 21, 1994, approximately 21 percent of OU 11 results have not been validated. According to EPA guidance (EPA, 1992b), unvalidated data may be used in risk assessments only qualitatively to identify analytes during preparation of a sampling and analysis plan.

The data used for a baseline risk assessment (BRA) must also meet criteria for the PARCC parameters. As presented in Section 2.3.1, data quality has been assessed for all Level IV and Level V data. For any analyte that did not meet precision goals in more than 50 percent of the sample pairs, that had average RPDs that exceeded the acceptable RPD value, or where the overall precision compliance was below the goal of 85 percent, all of the results reported for that analyte were qualified as estimated results.

Usable data, which includes valid data, estimated data, and data that has not yet been validated, range from 97 percent (ground water) to 100 percent (surficial soils) of the total results (see Table 2.3-8). These percentages indicate that the majority of data meet the data usability needs for addressing the RFI/RI objectives of characterizing the site, evaluating contaminant sources, describing contamination, and evaluating risks to human health.

2.4 Summary

The investigative activities discussed above were designed and implemented to achieve the DQOs developed specifically for the RFI/RI at the WSF. The DQOs were designed to allow quantification of the human health and ecologic risk posed by potential contamination in surficial soils, subsurface geologic materials, and perched ground water. The sample numbers, locations, and analyses completed closely followed those proposed in the agency-approved OU 11 FSP TM. Through the observational approach, when additional data needs became evident during the course of these investigations, additional investigative activities were implemented. Moreover, approved decontamination procedures and documented QA/QC protocol were applied. These activities collectively contributed to the generation of scientifically defensible data that is appropriate for assessing risk and determining future remedial response.

Table 2.1-1
Comparison of Proposed OU 11 RFI/RI Field Activities to Actual Field Activities

Proposed Field Activities	FSP TM Page Reference	Actual Field Activities	RFI/RI Report Reference
• Establish goals for the field investigation. • Evaluate existing data to determine where further investigation is necessary. • Propose a revised scope for the OU 11 field investigation.	1-1 1-1 1-1	• Historical activity records and information from historical investigations were reviewed to determine the environmental concerns at OU 11 and to identify areas and media where data is lacking. • Specific DQOs were developed to ensure that the environmental concerns would be adequately characterized. • The field sampling program incorporated the DQOs in its design. In addition, conditions encountered during the field program initiated additional investigation activities to further enhance the achievement of the DQOs.	Sections 1.0 and 2.0
• Streamline the Phase I and II field investigations into a single, comprehensive effort.	1-1	• The investigation activities for OU 11 were conducted in a single comprehensive effort, which addressed both Phase I and Phase II directives.	Sections 1.0 and 2.0
• Employ the EPA seven-step process to develop DQOs.	2-1	• The EPA seven-step process is outlined in the FSP TM. This process initiated background characterization activities and the DQOs for the resulting field investigation. Moreover, a baseline risk assessment was conducted following EPA and CDPHE protocol.	Sections 1.0, 2.0, 5.0, and 6.0
• Install 10 wells to evaluate potentiometric and geologic information to determine ground-water flow paths in the upper aquifer, in support of assessment of risk.	2-9, 4-11, 4-17	• Fifteen additional wells were installed to investigate the uppermost potential saturation encountered. Water-level and chemical information were collected from these and pre-existing deeper wells. This information was evaluated with respect to vertical and horizontal gradients, the degree of vertical hydraulic communication, and the nature and extent of contamination. This evaluation allowed the fate and transport of contamination to be described. All of this information supports the assessment of risk. • Gamma-ray/neutron geophysical logging was conducted to support lithologic characterization.	Sections 2.0, 3.0, 4.0, 5.0, and 6.0
• Collect and analyze approximately 120 soil samples from 10 boreholes to determine if contamination exists in the vadose zone.	2-9, 4-10, 4-17	• Resonant sonic drilling techniques were used to investigate the vadose zone because of significant improvement in ability to penetrate the alluvium and obtain representative core samples, relative to conventional drilling methods. • Approximately 125 soil samples were collected and analyzed from drill core at 15 boreholes. Samples involved 2-foot composites, collected continuously to 12 feet below ground surface, and 6-foot composites, collected continuously thereafter until potentially saturated conditions were encountered. Chemical analysis of these samples provides detail on nature and extent of contamination at each borehole. • Fifteen monitoring wells were installed in the boreholes to investigate the uppermost potential saturation encountered. Ground-water level measurements and sampling were conducted to determine occurrence of shallow isolated saturated zones and potential contamination within these zones.	Sections 2.0, 3.0, and 4.0

Proposed Field Activities	FSP TM Page Reference	Actual Field Activities	RFI/RI Report Reference
• Conduct HPGe survey, collect and analyze approximately 38 surficial soil samples, and review historical data to determine if contamination exists in surficial soils.	2-9	• HPGe survey was conducted. • Historical data from 1989 aerial gamma survey, the ongoing surface water monitoring program, 1993 HPGe survey, and 1988 test pit study were evaluated. • Surficial soil sampling program, involving approximately 52 sample locations analyzed for radionuclides, metals, and nitrates was completed. This evaluation was statistically compared to background surficial soils to identify contamination.	Sections 2.0, 3.0, 4.0, and 5.0
• Assess current ecological conditions.	2-9	• Data from previous ecological investigations was evaluated to allow comparisons with current information. • Transects and sampling completed, identifying biota (plant, animal, and birds) in OU 11 spray areas, non-spray areas and reference areas.	Sections 2.0, 3.0, 4.0, 5.0, and 6.0
• Optimize the investigation program.	2-12	• Sampling plan for each media was designed to minimize decision errors. Data from previous programs was used qualitatively to optimize sample numbers and locations. • Potential hotspots were identified and addressed. • Minimum acceptance for data usability (90%) was achieved.	Sections 1.0 and 2.0
• Ensure that PARCC parameters were met and are documented.	2-12, 5-1	• Standardized analytical methods and field procedures were employed. These methods and procedures followed EPA - CDPHE approved protocol. • EPA/CDPHE-approved QA/QC samples were collected and analyzed at the agreed-upon frequencies. • Requirements for precision and accuracy were generally achieved[1] • Sample data were comparable to similar data from the same media • Appropriate decontamination procedures were applied to all sample equipment/containers. • Appropriate sample preparation and handling and shipping protocol were implemented.	Section 2.0
• Accomplish field investigation and submit RFI/RI report to EPA/CDPHE by required submittal date.	6-3	RFI/RI report submitted to EPA/CDPHE.	NA

[1] Based on the results of the precision analysis, results for several analytes have been qualified as estimated results (RPD values for these analytes exceeded the acceptable limits for precision [see Appendix C]).

Definitions:

CDPHE	Colorado Department of Public Health and Environment	OU	operable unit
DQOs	data quality objectives	PARCC	precision, accuracy, representativeness, completeness, and comparability
EPA	U.S. Environmental Protection Agency	QA/QC	quality assurance/quality control
FSP TM	Technical Memorandum–Revised Field Sampling Plan and Data Quality Objectives (EG&G, 1994a)	RFI/RI	RCRA Facility Investigation/Remedial Investigation
HPGe	*high purity germanium*	RPD	relative percent difference
NA	not applicable		

Table 2.2-1
Comparison of Proposed to Actual Samples Collected

Media	Analyte Group	Number of Samples per Sampling-Plan Specifications	Number of Samples Collected	Deviation	Justification
Surficial Soils	Metals	38	53	+15	15 additional sampling locations were added to the program to address areas of potential impact downgradient from the IHSS, including one sample added at a pipeline juncture on northern edge of OU, three samples added in channels downgradient of OU, and 11 samples added downgradient in newly identified spray area (agreed upon with agencies prior to sample collection.)
	Radionuclides	38	53	+15	
	Major Ions and Inorganic Parameters	38	53	+15	
Subsurface Geologic Materials	Metals	~120	145	+25	Additional boreholes drilled as directed by field conditions, including two that were added downgradient in newly identified spray area, three additions that were offsets/well pairs due to field conditions, and two that were abandoned because drilling additives were used that were later deemed inappropriate. Despite additional holes, the geologic conditions determined the number of VOC samples collected (depth to saturated material was less than projected to achieve 120 samples).
	Radionuclides	~120	145	+25	
	VOCs	~120	119	-1	
	SVOCs	~120	145	+25	

Media	Analyte Group	Number of Samples per Sampling-Plan Specifications	Number of Samples Collected	Deviation	Justification
Ground Water[1]	Metals	10	6	-4	10 wells were planned and 17 were drilled as determined by field conditions. Additional wells include two that were added downgradient in newly identified spray area, and three additions that were offsets/well pairs due to field conditions. Eight of the wells produced low volumes of water and the priority for sample collection on pg. 4-15 of the OU 11 FSP TM was used. This deviation matches the priorities—SVOCs, VOCs, and metals are lowest priority.
	Radionuclides	10	12	+2	
	VOCs	10	7	-3	
	SVOCs	10	6	-4	
	Anions, Cyanide, and Water-Quality Parameters	10	16	+6	

[1] The number of samples collected are as of December 21, 1994 (date of RFEDS data extraction). All but two wells were eventually sampled (of 17 drilled, one was dry and one was abandoned).

Definitions:

FSP TM Technical Memorandum—Revised Field Sampling Plan and Data Quality Objectives (EG&G, 1994a)

IHSS individual hazardous substance site

OU operable unit

RFEDS Rocky Flats Environmental Database System

SVOCs semivolatile organic compounds

VOCs volatile organic compounds

Table 2.2-2
Drilling and Completion Details
for Boreholes and Wells

Location	Well (W) or Borehole (BH)	Date Completed or Abandoned	Total Depth (feet below ground surface)	Screen Interval (feet below ground surface)
50194	W	7/14/94	99.0	76.7–96.7
50294	W	8/10/94	18.9	7.9–17.9
50394	W	7/27/94	68.8	51.5–66.5
50494	W	7/27/94	26.0	13.7–23.7
50594	BH	6/17/94	18.0	—
50694	W	8/5/94	31.1	14.0–29.0
50794	W	7/22/94	27.0	15.0–25.0
50894	W	8/1/94	29.3	12.0–27.0
50994	W	7/20/94	26.0	15.0–25.0
51094	W	7/7/94	62.0	39.7–59.7
51194	W	8/17/94	54.3	37.0–52.0
51294	W	8/17/94	39.3	22.0–37.0
51394	BH	6/21/94	5.0	—
51494	W	6/30/94	72.7	48.7–68.7
51594	W	8/19/94	24.0	12.0–22.0
51694	W	8/23/94	64.0	47.0–62.0
51794	W	8/23/94	12.0	5.0–10.0

Table 2.3-1
Required Field QC Sample-Collection Frequency

QC Sample	Frequency
Field Duplicate	1 per 10 real samples
Field Blank[1]	1 per shipping container (or a minimum of 1 per 20 samples)
Trip Blank[2]	1 per shipping container carrying samples to be analyzed for VOCs
Equipment Rinse	1 per 20 real samples or 1 per day[3]
Source Water Blanks	1 sample per source
Triplicate Sample (benthic samples)[4]	For each sampling site

Source: EG&G, 1991b and 1994a

[1] For ground water samples

[2] For samples to be analyzed for VOCs.

[3] Whichever is more frequent for each specific sample matrix being collected when non-dedicated equipment is being used.

[4] For samples collected for tissue analysis.

Definitions:

QC quality control

VOCs volatile organic compounds

Table 2.3-2
Field QC Sample-Collection Summary (Collected During OU 11 RFI/RI)

QC Sample Type	Media	
	Surficial Soils	Subsurface Geologic Materials
Real	53	145
Field Duplicate	5	19
Equipment Rinse	3	30
Trip Blank	NR-WP	30
Field Blank	NR-WP	NR-WP
Replicate	NR-WP	NR-WP
Matrix Spike	NR-WP	NR-WP

Definitions:

NR-WP not required-work plan; i.e., not required in accordance with the OU 11 Technical Memorandum—Revised Field Sampling Plan and Data Quality Objectives (EG&G, 1994a)

OU operable unit

QC quality control

RFI/RI RCRA Facility Investigation/Remedial Investigation

Table 2.3-3
Definition of Laboratory Qualifiers

Qualifier	Definition	Include in Data Analysis	Detected ("Hit")	Value for Statistical Analysis
+	Inorganics: correlation coefficient for the matrix spike analysis is less than 0.995 (estimated value)	yes	yes	result
*	Inorganics: duplicate analysis is not within control limits (estimated value)	yes	yes	result
	Organics: outside contract-required QC limits	yes	yes	result
A	Organics: identifies TIC as a suspected aldol condensation product	yes, remove to TIC table	no	not included
B	Inorganics: reported value is less than CRDL but greater than IDL	yes	yes	result
	Organics: warns that analyte also detected in blank	yes	yes	result
	Radionuclides: constituent also detected in associated blank whose concentration was greater than CRDL and/or minimum detectable activity (estimated value)	yes	yes	result
C	Organics: pesticide result confirmed by GC/MS	yes	yes	result
	Radionuclides: presence of high TDS in sample increased minimum detectable activity	yes	yes	result
D	Organics: identified in an analysis at a secondary dilution	yes	yes	result
E	Inorganics: value is an estimate due to interference (estimated value)	yes	yes	result
	Organics: compound exceeded calibration range of instrument, sample must be re-analyzed	no	no	not included
F	Organics: compound off scale (estimated value)	yes	yes	result
	Radionuclides: for alpha spectrometry - FWHM exceeded acceptable limits (estimated value)	yes	yes	result
G	Inorganics: native analyte is greater than 4 times spike added	yes	yes	result
	TOC: dilution result exceeded range of instrument, estimated result	yes	yes	result
H	Radionuclides: sample analysis performed outside of method-specified maximum holding time	yes	yes	result
I	Organics: interference with target peak (estimated value)	yes	yes	result
J	Inorganics: value greater than IDL but control sample analysis not within control limits (estimated value)	yes	yes	result
	Organics: MS data indicate presence of compound but below detection limit (estimated value)	yes	yes	result
JB	Organics: result below detection limit and analyte detected in laboratory blank	yes	no	½ detection limit
K	Result is less than MDL (CRDL) but greater than IDL	yes	yes	result

Qualifier	Definition	Include in Data Analysis	Detected ("Hit")	Value for Statistical Analysis
L	Undefined	no	no	not included
M	Inorganics: duplication injection precision not met (estimated value)	yes	yes	result
N	Inorganics: spiked sample recovery is not within control limits (estimated value)	yes	yes	result
	Organics: compound presumed present (TIC)	yes, remove to TIC table	no	not included
R	Validation code for rejected data entered in lab qualifier field/unusable data	no	no	not included
S	Inorganics: the reported value determined by the method of standard additions	yes	yes	result
T	Compound found in TCLP extract blank and sample	yes	yes	result
U	Organics and inorganics: analyte analyzed but not detected at the quantitation limit	yes	no	½ detection limit
UC	Organics: pesticide result confirmed but below detection limit	yes	no	½ detection limit
UE	Radionuclides: detection limit reported as result	no	no	not included
UJ	Organics: analyzed but not above the detection limit (estimated value)	yes	no	½ detection limit
UN	Inorganics: spiked sample recovery not within control limits and sample result below detection limit	yes	no	½ detection limit
	Organics: compound presumed present but below detection limit	yes, remove to TIC table	no	not included
UW	Inorganics: post-digestion spike for GFAA analysis is out of control limits and sample result is below detection limit	yes	no	½ detection limit
UX		yes	no	½ detection limit
V	Validation code for valid data entered into laboratory qualifier field	yes	yes	result
W	Inorganics: post-digestion spike for GFAA analysis is out of control limits while sample absorbance is less than 50% of spike absorbance	yes	yes	result
X2	Inorganics (pre-1992): detection limit greater than normal, sample matrix interference	yes	yes	result
	Organics (pre-1992): laboratory software flag (combines more than one qualifier) - not defined	no (unless accompanied by a validated result)	no	not included
	Other (OU 11 RFI/RI samples): result by calculation defined in GRRASP	yes	yes	result

Qualifier	Definition	Include in Data Analysis	Detected ("Hit")	Value for Statistical Analysis
Y	Organics: indistinguishable isomer in TIC	yes, remove to TIC table	no	not included
	Radionuclides: chemical yield exceeded acceptable limits (estimated value)	yes	yes	result
Z	Organics: "quest identification, matrix interference of column"	no	no	not included

[1] common laboratory contaminants: 2-butanone, acetone, common phthalate esters, methylene chloride, toluene.

[2] Note on use of X qualifiers: X is defined in the GRRASP as a result determined by calculation not by direct laboratory analysis. Therefore, for samples analyzed during the period that GRRASP has been in effect (since January 1992) the results qualified by an X will be treated as estimated values (similar to J). For historic data, when GRRASP was not used by laboratories, an X qualifier has two definitions. For organics, the X is a flag entered manually by the laboratory, but is not defined in RFEDS. Therefore, organic results qualified by X are not considered usable data, unless a validated result is given. For inorganics, an X qualifier indicates that the detection limit for the analyte is higher than normal due to matrix interference. An inorganic qualified with an X will be treated like a J result. The X qualifier is sometimes also used with other qualifiers (for example, UX, XJ). In these cases the meaning of X depends on the analyte and the date of the analysis.

Definitions:

CRDL	contract-required detection limit
FWHM	full width at half maximum (the width of the distribution at a level that is just half the maximum ordinate of the peak)
GC/MS	gas chromatography/mass spectrometry
GFAA	graphic furnace atomic adsorption
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
IDL	instrument detection limit
MDL	method detection limit
MS	matrix spike
OU	operable unit
QC	quality control
RFEDS	Rocky Flats Environmental Database System
RFI/RI	RCRA Facility Investigation/Remedial Investigation
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TIC	tentatively identified compound
TOC	total organic carbon

Table 2.3-4
Definition of Validation Codes

Code	Definition	Include in Data Analysis
A	Acceptable result, usable with qualification	yes
JA	Acceptable result (for estimated value)	yes
P	Undefined	no
R	Rejected result, unacceptable for use	no
V	Valid result, usable without qualification	yes
Y	Analytical results in validation process	yes
Z	Validation not required or performed	no

Table 2.3-5
Data Validation Summary (as of December 21, 1994)

Media/Analyte Group	Total Number of Results	Number of Valid Results	Number of Acceptable Results	Number of Rejected Results	Number of Unvalidated Results	Number of Remaining Results	% Results Valid[1]	% Results Acceptable[2]	% Results Rejected[3]	% Results Unvalidated[4]	% Results Remaining[5]
Surficial Soils											
Metals, Total	1820	1323	384	1	0	112	73	21	0	0	6
Radionuclides, Total	323	1	0	0	322	0	0	0	0	100	0
Water-Quality Parameters	131	82	38	0	3	8	63	29	0	2	6
TOTAL	2274	1406	422	1	325	120	62	19	0	14	5
Subsurface Geologic Materials											
Metals	5684	3657	1228	16	560	223	64	22	0	10	4
Radionuclides	1143	43	0	0	1100	0	4	0	0	96	0
SVOCs	15953	9663	280	132	4018	1860	61	2	1	25	12
VOCs	6719	5268	97	177	641	536	78	1	3	10	8
Water-Quality Parameters	579	358	35	0	165	21	62	6	0	28	4
TOTAL	30078	18989	1640	325	6484	2640	63	5	1	22	9
Ground Water											
Metals, Dissolved	203	137	37	0	0	29	67	18	0	0	14
Radionuclides, Dissolved	69	40	1	0	28	0	58	1	0	41	0
Radionuclides, Total	78	47	2	1	28	0	60	3	1	36	0
SVOCs	439	386	2	2	12	37	88	0	0	3	8
VOCs	549	402	4	7	0	136	73	1	1	0	25
Water-Quality Parameters, Dissolved	7	0	0	0	7	0	0	0	0	100	0
Water-Quality Parameters, Total	89	4	0	0	83	2	4	0	0	93	2
TOTAL	1434	1016	46	10	158	204	71	3	1	11	14

[1] (Number of valid results/total number of results) * 100; valid results: validation code = V

[2] (Number of acceptable results/total number of results) * 100; acceptable results: validation code = A or JA

[3] (Number of rejected results/total number of results) * 100; rejected results: validation code = R

[4] (Number of unvalidated results/total number of results) * 100; unvalidated results: validation code = Y or blank

[5] (Number of remaining results/total number of results) * 100; remaining results: validation code = Z

Definitions:

SVOCs semivolatile organic compounds

VOCs volatile organic compounds

Table 2.3-6
Usability Categories

Category	Definition	Validation Codes	Laboratory Qualifiers
VALID	Fully usable	A, V	blank, U
ESTIMATE	Usable as estimated result	A, J, V, JA[1]	+, *, B, C, D, E (inorganics), F, G, H, I, J, N, S, UJ, UN, UW, UX, W, X, Y, Z
REJECT	Not valid	B, C, N, P, R, S,	E (organics), L, R, UE (radionuclides)
BLNK/Y VAL	Acceptable or estimated result, no validation code	Y, blank	blank, +, *, B, C, D, E (inorganics), F, G, H, I, J, N, S, U, UJ, UN, UW, UX, W, X, Y, Z

[1] If the validation code is J or JA, then U and blank laboratory qualifiers are considered to be estimates.

Table 2.3-7
PARCC Parameter QC Criteria by Media Sampled

Media	PARCC Parameters				
	Precision[1]	Accuracy	Representativeness	Comparability	Completeness
Surficial Soils	RPD < 35 percent	% Bias < 20 percent	Qualitative	Qualitative	> 90 percent
Subsurface Geologic Materials	RPD < 35 percent	% Bias < 20 percent	Qualitative	Qualitative	> 90 percent
Ground Water	RPD < 20 percent	% Bias < 20 percent	Qualitative	Qualitative	> 90 percent

[1] The most conservative criteria for precision (20 percent for water and 35 percent for soils) from the OU 11 Technical Memorandum—Revised Field Sampling Plan and Data Quality Objectives (EG&G, 1994a) have been chosen for use in assessing data quality.

Definitions:

PARCC precision, accuracy, representativeness, completeness, and comparability; used to assess data quality

QC quality control

RPD relative percent difference

% Bias percent bias; equal to 100-percent recovery

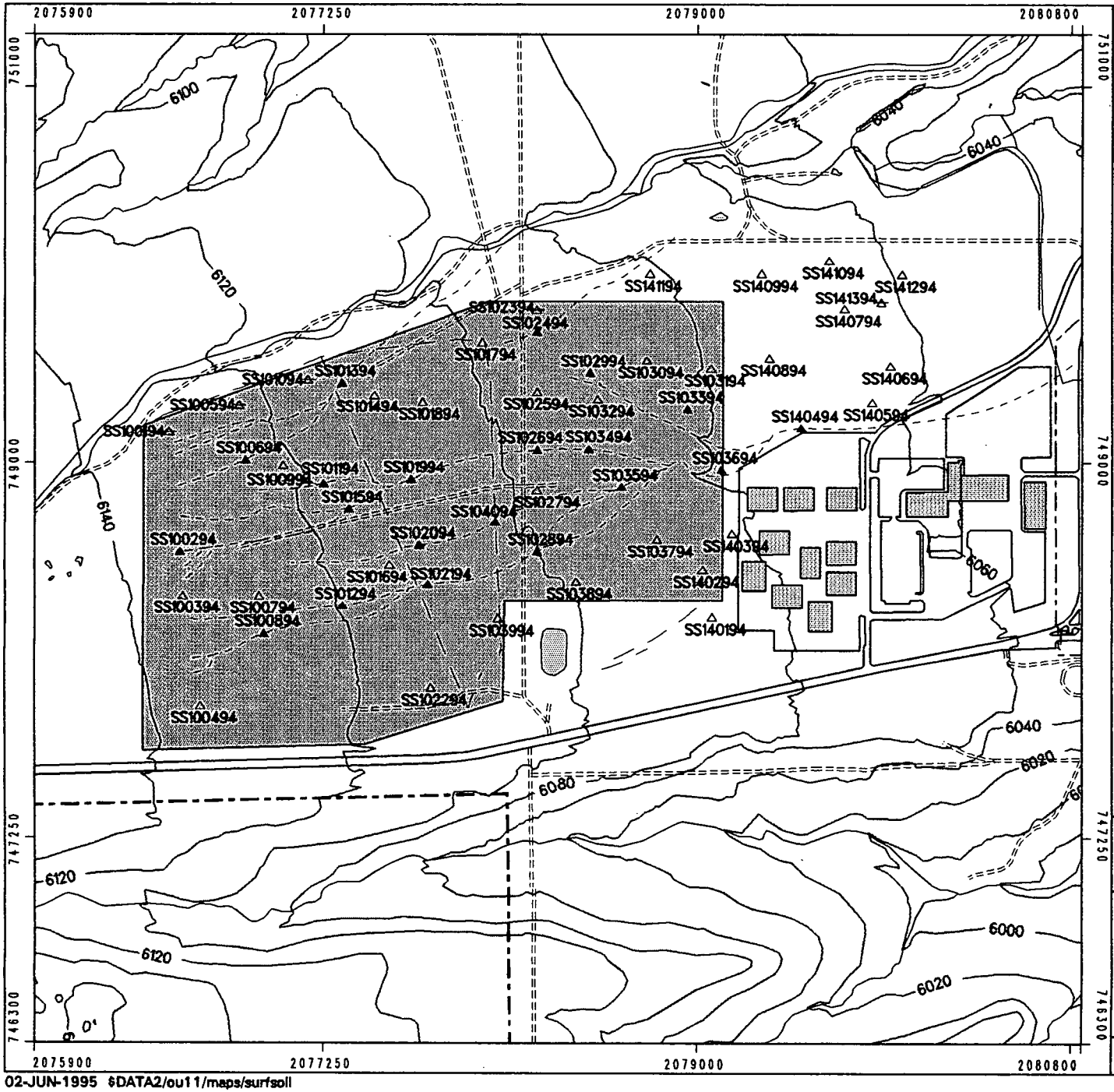
Table 2.3-8
Data Usability by Media Sampled

Media	Analytical Group	Total Results	Valid Results—Fully Usable		Estimated Results—Fully Usable		Unvalidated Results—Usability Not Determined		Total Number Usable Results	Percent Usable Results	Rejected or Unusable Results	
			Number of Results	Percent of Total Results	Number of Results	Percent of Total Results	Number of Results	Percent of Total Results			Number of Results	Percent of Total Results
Surficial Soils	Metals	1708	918	54%	789	46%	0	0%	1707	100%	1	0%
	Radionuclides	296	1	0%	0	0%	295	100%	296	100%	0	0%
	Water-Quality Parameters	123	82	67%	38	31%	3	2%	123	100%	0	0%
	TOTAL	2127	1001	47%	827	39%	298	14%	2126	100%	1	0%
Subsurface Geologic Materials	Metals	7114	3389	48%	3156	44%	533	7%	7078	99%	36	1%
	Radionuclides	1499	312	21%	32	2%	1030	69%	1374	92%	125	8%
	SVOCs	12416	9510	77%	278	2%	2496	20%	12284	99%	132	1%
	VOCs	5863	5007	85%	104	2%	544	9%	5655	96%	208	4%
	Water-Quality Parameters	552	358	65%	35	6%	159	29%	552	100%	0	0%
	TOTAL	27444	18576	68%	3605	13%	4762	17%	26943	98%	501	2%
Ground Water	Metals, Dissolved	7802	4206	54%	2199	28%	1239	16%	7644	98%	158	2%
	Metals, Total	3230	1763	55%	1240	38%	200	6%	3203	99%	27	1%
	Radionuclides, Dissolved	1307	405	31%	668	51%	132	10%	1205	92%	102	8%
	Radionuclides, Total	944	377	40%	352	37%	104	11%	833	88%	111	12%
	SVOCs	640	496	78%	142	22%	0	0%	638	100%	2	0%
	VOCs	8944	7178	80%	487	5%	981	11%	8646	97%	298	3%
	Water-Quality Parameters	574	420	73%	59	10%	72	13%	551	96%	23	4%
	TOTAL	23441	14845	63%	5147	22%	2728	12%	22720	97%	721	3%

Definitions:

SVOCs semivolatile organic compounds

VOCs volatile organic compounds



EXPLANATION

Sample Locations

- ▲ Channel (20)
- △ Non-Channel (28)
- Pipeline Junctures (5)
- Spray-Induced Drainage
- Manmade Drainage
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil Sample Locations

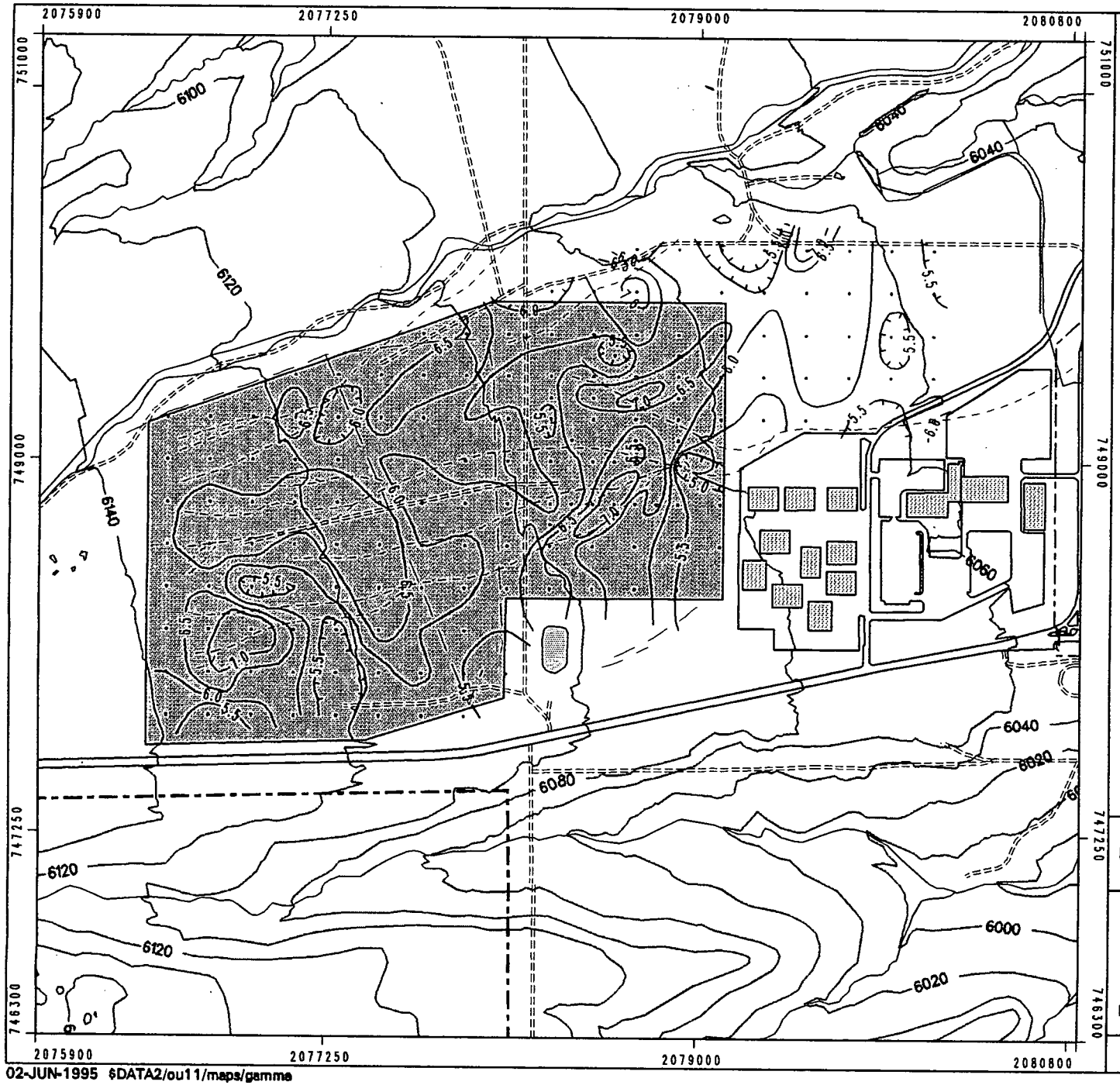
Final Combined Phases RFI/RI Report

Operable Unit 11

June 1995

Figure 2.2-1

02-JUN-1995 $DATA2/ou11/maps/surfsoil



EXPLANATION

- HPGe Location
- HPGe Contours (0.5 uR/h Interval)
- HPGe Contours (decreased value)
- Spray-Induced Drainage
- Manmade Drainage
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

High Purity Germanium Total Gamma Exposure Isopleths

Final Combined Phases RFI/RI Report

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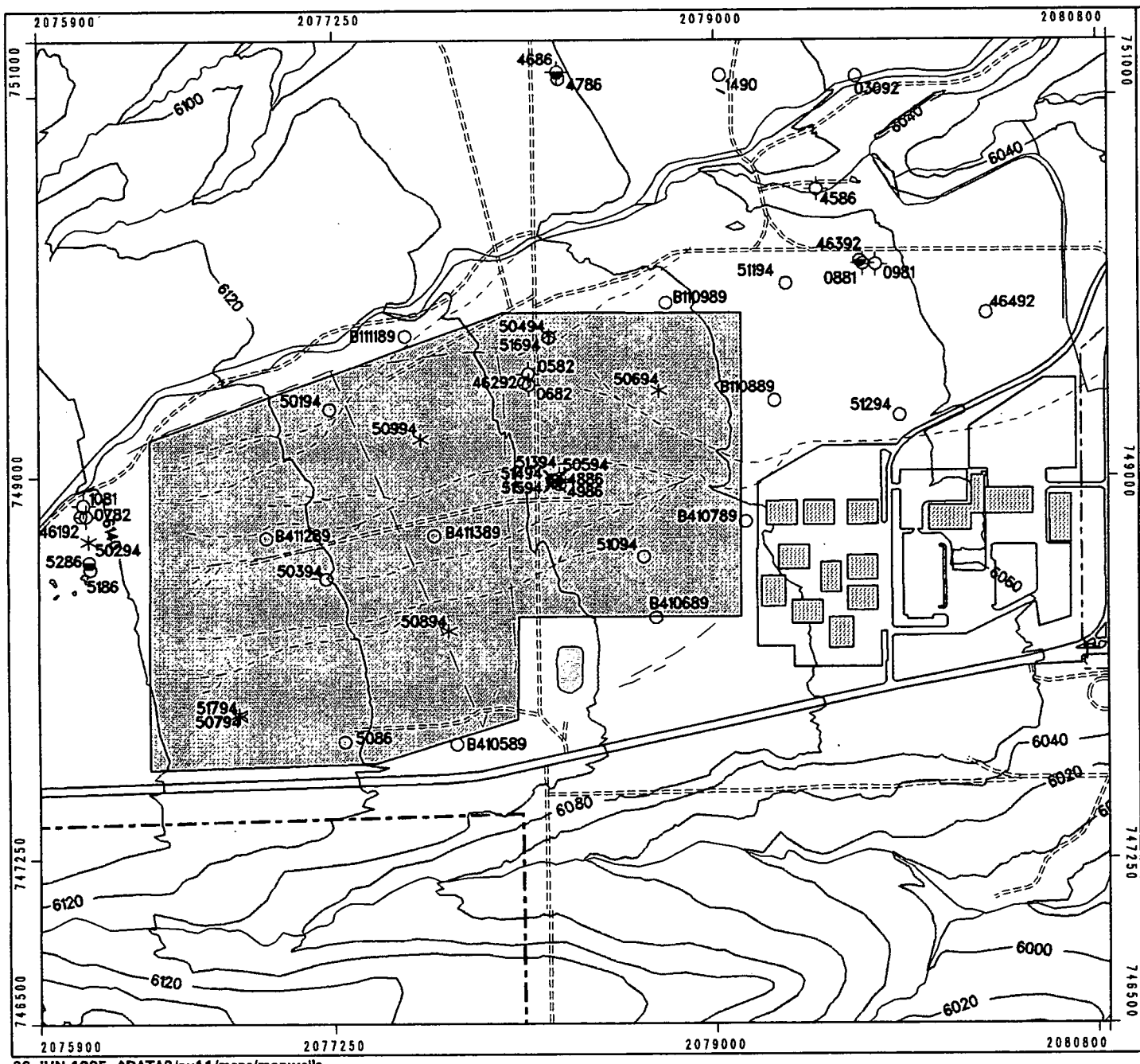
Figure 2.2-2

02-JUN-1995 $DATA2/ou11/maps/gamma



EXPLANATION

- 1994 Borehole
- UHSU-Alluvial Well (Upper Hydrostratigraphic Unit)
- UHSU-Variably Saturated Zone Well
- UHSU-Weathered Bedrock Well
- LHSU-Bedrock Well (Lower Hydrostratigraphic Unit)
- Abandoned Well
- Spray-Induced Drainage
- Manmade Drainage
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Monitoring Well and Borehole Location Map

Final Combined Phases RFI/RI Report

Operable Unit 11

June 1995

Figure 2.2-3

02-JUN-1995 $DATA2/ou11/maps/monwells

3. Physical Characteristics of OU 11

The goal of the OU 11 field investigation was to provide data to characterize the nature, extent, fate, and transport of any spray irrigation-related constituents that may be present. This section presents the physical characteristics of OU 11 as interpreted from the results of the OU 11 field investigation and previous investigations. This description of the OU 11 physical setting provides the framework for evaluating the nature and extent of contamination. Characterization of the site's physical properties allows the environmental media (air, surficial soils, subsurface geologic materials, and ground water) present at OU 11 to be characterized as potential pathways for the fate and transport of contaminants. This characterization guides the risk assessment, which in turn supports the selection of a final action for OU 11.

This physical characterization of OU 11 includes descriptions of surface features, climate, demographics, soils, geology, hydrogeology, and ecology.

3.1 Surface Features

This section includes descriptions of topography, surface water hydrology, and engineered structures at OU 11 and their impacts on and relationship to potentially affected media within OU 11.

3.1.1 Topography

The topography at OU 11 is level, contrasting dramatically with the Front Range to the west and the incised drainages of RFETS to the east. The elevation of OU 11 ranges from approximately 6,140 feet above mean sea level (msl) on the west to approximately 6,080 feet above msl on the east (see Figure 2.2-3).

The Rocky Flats pediment is dissected by several east-northeast-trending streams in many areas of RFETS, but this dissection is not present in OU 11 (see Figure 1.2-1). To the south, Woman Creek has cut a deep (approximately 60 feet) valley. Immediately north of OU 11, Walnut Creek forms a low-relief channel (approximately 5 to 10 feet). Farther north, Rock Creek has cut a valley with approximately 15 to 20 feet of relief. OU 11 is located between the Woman Creek and Walnut Creek drainages in an area of low relief with a gentle 2° eastward slope. Immediately west of OU 11 are a series of quarry pits (the "clay pits") and related mounds. Within OU 11 are several poorly developed, small (1 to 2 feet of relief) irrigation ditches and natural drainages (see Figure 2.2-3).

3.1.2 Surface Water Hydrology

No surface water bodies exist within OU 11. Several surface water impoundments are located nearby—the clay pits to the west, the Raw Water Pond to the southeast, and impoundments to the northeast associated with McKay and Church ditches—all typically containing standing water. However, none of these directly contributes to surface flow at OU 11 or collects surface flow from OU 11.

Occasionally, storm events and snowmelt produce runoff within OU 11 that may flow into the ditches on the north side of OU 11 or Woman Creek on the south side of OU 11. Small channels are evident in aerial photographs taken during spraying activities. These channels are thought to have been enhanced by spray irrigation activities. These channels are no longer visible, with the cessation of spraying in 1985. Storm precipitation and snowmelt that does not collect in channels or infiltrate surficial soils may migrate as slow-moving overland sheet flow. Several site characteristics limit surface runoff, including the slow-moving nature of the flow, low soil permeability, and low infiltration rates. The degree of erosion of surficial soils at OU 11 is also low due to these limiting factors.

3.1.3 Engineered Structures

No buildings or structures exist within OU 11. The closest structures are located to the east in the "Building 130" complex. Closer to OU 11 is the "Trailer 130 complex," comprising several semipermanent trailers. An earthen berm has been constructed along the western side of the Trailer 130 complex on the eastern border of OU 11. Additional earthen berms and ditches have been constructed in and near OU 11 (see Figure 2.2-3). These include shallow irrigation ditches within the OU and the Raw Water Pond and McKay and Church ditches outside OU 11.

3.2 Climate

Climatologic information pertinent to characterizing the nature, extent, fate, and transport of potential contaminants in OU 11 is presented in this section. Climatologic data have been collected at RFETS discontinuously for a number of years. This section summarizes these data describing the climate, precipitation, temperatures, and wind patterns at RFETS.

RFETS is located in a semiarid climate exhibiting wide daily temperature ranges and large seasonal variations. Precipitation is moderate, primarily occurring in the spring. Rocky Flats is also characterized by high-wind events, most frequently in the winter months (EG&G, 1993a). The local climate at RFETS influences ground-water conditions. For example, the amount and frequency of precipitation, combined with air

temperatures and wind conditions, influence evapotranspiration and infiltration characteristics at the site. Detailed climatologic values are summarized below.

Annual precipitation at RFETS is nearly 15.5 inches, including rainfall and snowmelt. Nearly 42 percent of the annual precipitation falls from April through June. Precipitation falls primarily as snow from late October through early April. Summer precipitation results from showers and thunderstorms (EG&G, 1993a). Approximately 36 percent of the precipitation occurs as snowfall (see Table 3.2-1). Monthly total precipitation at RFETS for 1992 and 1993 is shown in Table 3.2-2, and historic mean total precipitation by month for RFETS is shown in Figure 3.2-1.

Characteristic of Colorado's Front Range, temperatures at RFETS are generally moderate, with large diurnal and annual ranges. The thin, dry atmosphere at the 6,000-foot elevation of OU 11 causes wide temperature ranges, with strong daytime warming and nighttime cooling (EG&G, 1993a). Ranges, averages, and extremes in temperature data for RFETS in 1993 are shown in Table 3.2-3. A summary of historic temperature data at RFETS is shown in Table 3.2-4.

High-wind events are common along the Front Range during winter months. RFETS normally experiences several days a year with peak wind gusts exceeding 60 miles per hour (mph); gusts reaching 80 mph or more occur less frequently (EG&G, 1993a). A summary of 1993 wind directions and speed frequencies measured at a 10-meter height at the site is shown in Table 3.2-5. Wind directions are most frequently from the west-southwest through northerly directions. Wind speeds above 18 mph occur primarily with westerly winds and, to a lesser extent, northerly winds (EG&G, 1993a).

Several additional climatological parameters are necessary for a comprehensive climatological characterization of the site. Those additional parameters (mean dew point, mean relative humidity, mean atmospheric pressure, and solar total) are listed in Table 3.2-6. Pan evaporation data for the Denver area indicate that evaporation is greatest during June, July, and August (see Table 3.2-7). Total annual free-water (potential) evaporation averages 45 inches, roughly 2.5 times the annual precipitation. Relative humidities average approximately 46 percent (EG&G, 1993a).

3.3 Demographics

Population, economics, and land use in areas surrounding RFETS are described in a 1989 Rocky Flats vicinity demographics report by DOE (DOE, 1990). This report divides general use of areas within 0 to 10 miles (0 to 16 kilometers [km]) of RFETS into residential, commercial, industrial, parks and open spaces, agricultural and vacant land, and institutional classifications. The study addresses current and future land use near RFETS.

3.3.1 Current Population and Land Use

The majority of residential usage within a 5-mile (8-km) radius of RFETS is located immediately north and southwest of Standley Lake (IHSS 201). Single-family dwellings are located in unincorporated areas immediately east and south of RFETS. Commercial development is concentrated near the residential developments north and southwest of Standley Lake and around the Jefferson County Airport, approximately 3 miles (4.8 km) northeast of RFETS. Industrial land use within 5 miles (8 km) of the site is limited to quarrying and mining operations. Adjacent to OU 11, forming its western boundary, is an active gravel mining operation.

Open space lands are located northeast of RFETS near the city of Broomfield and in small parcels adjoining major drainages and small neighborhood parks in the cities of Westminster and Arvada. Standley Lake is surrounded by Standley Lake Park. Irrigated and nonirrigated croplands, producing primarily wheat and barley, are located northeast of RFETS near the cities of Broomfield, Lafayette, and Louisville; north of RFETS near Louisville and Boulder; and in scattered parcels adjacent to the eastern boundary of the site. Several horse operations and small hay fields are located south of RFETS. The demographics report characterizes much of the vacant land adjacent to RFETS and the reservoirs as rangeland (DOE, 1990).

3.4 Soils

The soils of RFETS were mapped by the Soil Conservation Service (SCS) as part of a soil survey of the Golden, Colorado, area (Price and Amen, 1980). In general, soils at RFETS have formed from alluvial or colluvial deposits of Quaternary age. Soil textures are predominantly loamy with varying amounts of clay, sand, gravel, and cobbles.

The most extensive soils at OU 11 are very cobbly to very stoney sandy loams of the Flatirons series. These soils, which occur on nearly flat slopes (0 to 3 percent), are classified as clayey-skeletal, montmorillonitic, mesic Aridic Paleosols. They are deep, well-drained soils that formed in stoney to gravely and loamy material of the Rocky Flats Alluvium. Consequently, these soils occupy pediment surfaces, high terraces, and upper hillsides. Rock fragments compose 35 to 80 percent of the soil, by volume.

To the north and south of OU 11 in the incised drainages, surficial soils are very cobbly, sandy loams of the Nederland series. These soils are medium to dark brown, loamy, mixed, mesic Aridic Arguisols that formed in cobbly, gravely, and loamy alluvium derived from mixed sources (Rocky Flats Alluvium and undifferentiated Arapahoe and Laramie Formation claystones). These soils cover the surface in areas

where the slope ranges from 15 to 50 percent and exhibit moderate infiltration rates (Price and Amen, 1980).

3.5 Geology

To understand and interpret the data generated during the field investigation, it is necessary to characterize media in which chemicals might reside. Geologic materials of OU 11, including alluvial deposits and bedrock, were studied to determine if chemicals are present as a result of spray operations. Geologic materials in turn influence the ground-water flow, which represents another medium potentially impacted by spray operations.

The geology of OU 11 is the focus of this section, beginning with an overview of the general geologic setting. A description of unconsolidated, alluvial deposits is then presented, followed by a description of bedrock geology of OU 11. This section concludes with a summary of the structural setting of OU 11.

3.5.1 General Geologic Setting

Geologic units underlying RFETS include unconsolidated deposits of Quaternary and Recent ages and Cretaceous and older bedrock units. A geologic map illustrating the distribution of surficial deposits across RFETS is included as Figure 3.5-1. A generalized stratigraphic section for the Rocky Flats area illustrates the vertical sequence of unconsolidated deposits and bedrock (see Figure 3.5-2). For the purposes of this report, only unconsolidated deposits and Upper Cretaceous Arapahoe and Laramie formations are relevant. Deeper formations are of little relevance to this investigation because previous investigations (1991 and 1992 Annual RCRA Groundwater Monitoring Reports) (EG&G, 1992b and 1993b) have concluded that deeper units have not been impacted by activities at RFETS or OU 11.

Surficial deposits at RFETS include alluvium, colluvium, landslide, and artificial fill deposits (see Figure 3.5-1). Alluvial deposits have been mapped in flood plains, stream channels, and terraces along the drainages at RFETS, as well as on the tops of pediment surfaces. These deposits include valley-fill alluvium, undifferentiated alluvium, and Rocky Flats Alluvium. Rocky Flats Alluvium is the only unconsolidated deposit present at OU 11.

Rocky Flats Alluvium was deposited in the early Pleistocene and consists of a series of coalescing alluvial fans which form a blanket of variable thickness that covers the underlying Cretaceous bedrock units. Unit thickness ranges from 100 feet near the apex of the fans, near the western boundary of the Buffer Zone, to less than 10 feet at the depositional limit of the fans, near the eastern boundary of the Buffer Zone (Shroba

and Carrara, 1994). Rocky Flats Alluvium thickness at OU 11 ranges from 30 feet to more than 100 feet. The unit is bisected by the east-flowing drainages.

Unconsolidated deposits unconformably overly Cretaceous bedrock. Upper bedrock units consist of claystones, siltstones, and sandstones of the Upper Cretaceous Arapahoe Formation, Laramie Formation, Fox Hills Sandstone, and Pierre Shale (see Figure 3.5-2). The bedrock surface is irregular due to erosion by alluvial and fluvial processes; bedrock highs are present between the major drainages. The bedrock is weathered to various depths across the site. The extent of this weathering is dependent on the abundance of fractures, presence of root zones, elevation relative to the water table, and proximity to drainages (EG&G, 1995b).

The Arapahoe Formation and Laramie Formation are the uppermost consolidated units at RFETS and the most likely to be impacted by site activities. At OU 11, the Arapahoe Formation is absent and the Laramie Formation subcrops directly beneath unconsolidated deposits.

Depositional environments in the Rocky Flats area during emplacement of the Cretaceous bedrock units were influenced by the Laramide Orogeny and resulting uplift of the adjacent Front Range. The inland Cretaceous Sea regressed during the uplift, causing a progradation of the Pierre prodelta shales and siltstones; the Fox Hills delta-front sandstones; the Laramie delta-plain sandstones, claystones, and coals; and the Arapahoe fluvial conglomerates, sandstones, and claystones (EG&G, 1995b; Weimer, 1973).

The Arapahoe Formation, deposited in fluvial and deltaic environments, is approximately 50 feet thick beneath the central portion of RFETS (EG&G, 1995b). Discontinuous sandstone lenses are common throughout the unit, but the primary rock types within the unit are claystones and siltstones (EG&G, 1992c, 1994c, and 1995b). The Arapahoe Formation is not present at OU 11.

Unconformably underlying the Arapahoe Formation is the Laramie Formation, a thick sequence of claystones with thin coal beds and discontinuous sandstones. The Laramie Formation was deposited in a freshwater delta-plain environment (EG&G, 1991d, 1992c, and 1995b). This unit is subdivided into an upper claystone portion and a lower sandstone portion. The Laramie Formation is 600 to 800 feet thick (EG&G, 1991d, 1992c, and 1995b).

3.5.2 Unconsolidated Deposits at OU 11

The Rocky Flats Alluvium is the only unconsolidated deposit at OU 11. This unit is at its maximum known thickness in OU 11; it is more than 105 feet thick in borehole 50194. The Rocky Flats Alluvium was not fully penetrated in most of the boreholes

drilled during this study. However, the thickness of the unit, and the nature of the contact with the underlying bedrock, has been determined in previous studies (EG&G, 1991d, 1992c, 1992d, 1994c, and 1995b).

The Rocky Flats Alluvium was deposited as an alluvial fan complex by high-energy braided streams and debris flows (EG&G, 1995b) capable of transporting clasts up to boulder size. The bar-and-channel morphologies indicative of this genesis are still visible in some areas to the west (Shroba and Carrara, 1994). At OU 11, this unit is generally composed of poorly sorted gravel, sand, silt, and clay in varying proportions. Gravels are typically subrounded to subangular quartzite, schists, and gneisses. Sands are subrounded to subangular and composed predominantly of quartz with rock fragments. A photograph of a typical occurrence of the Rocky Flats Alluvium is presented as Figure 3.5-3. Clast sizes are typically mixed, but some sorting occurs on a local scale, resulting in gravel- or sand-rich zones and clay-rich lenses. The clay-rich lenses are interpreted as having been derived from suspended fine sediments of lower-energy overbank floodwaters that settled out to form finer-grained deposits. The importance of these clayey lenses to ground-water and solute distribution is discussed in Section 3.6.

Figure 3.5-4 displays the lithologies encountered in several boreholes for two well pairs installed during this field investigation. This figure shows the heterogeneity of the Rocky Flats Alluvium, evident by comparing lithologies at well pairs constructed within 10 feet of one another. From this figure, it is apparent that individual beds of coarser or finer sediments are limited to a few feet in extent. Beds in one borehole correlate poorly with beds in other boreholes, even when closely spaced (visible in well pairs 50494/51694, 51494/51594, and 50794/51794, the lattermost of which is not shown). This heterogeneity is so extreme that stratigraphy of the Rocky Flats Alluvium within one borehole cannot be used to predict stratigraphy 10 feet away. To enable firm correlations, it would be necessary to drill boreholes on a grid that is more closely-spaced than 10 feet, dramatically increasing investigative costs and potential ecological damage while providing little additional information of hydrogeologic value. The heterogeneity results from depositional mechanisms inherent in braided stream and debris flow systems, as well as from incisement of previously deposited fluvial sediment packages by active river systems and subsequent deposition of new or reworked fluvial sediments atop the remains of older sediments.

Artificial fill occurs locally and adjacent to OU 11. Immediately west of the western edge of OU 11, gravel and clay quarrying activities have resulted in the creation of numerous pits (i.e., "clay pits") and related mounds of artificial fill. Roads through OU 11 have been surfaced with quarried (i.e., imported) gravel. On the eastern portions of OU 11 are additional deposits of artificial fill around the Raw Water Pond and the Trailer/Building 130 complex. As discussed in Section 3.1.3, a few shallow,

linear irrigation trenches and berms are scattered over OU 11 (see Figure 2.2-3) and may include minor amounts of artificial fill. No landslide or slump deposits are present in OU 11.

3.5.3 Bedrock Geology of OU 11

Bedrock geology of OU 11 has been characterized in previous documents (DOE, 1991a; EG&G, 1991d, 1992c, 1994c, and 1995b). The nature of the bedrock at OU 11 was not investigated further in this study because the goal was to characterize the geology, hydrology, and geochemistry in the overlying Rocky Flats Alluvium. The following text briefly summarizes previous studies of the bedrock geology.

Geologic logs of boreholes that penetrate bedrock at OU 11 indicate that the uppermost bedrock unit in this area is the Laramie Formation (DOE, 1991a). The absence of the younger Arapahoe Formation, which is present in other areas of RFETS, suggests that this unit was removed through erosion before deposition of the Rocky Flats Alluvium.

Seismic investigations and area mapping have determined the dip of Cretaceous strata along the western edge of OU 11 to be approximately 45° east (EG&G, 1992d). Borehole logs indicate that this dip quickly flattens to approximately 2° in eastern OU 11.

The upper claystone interval of the Laramie Formation has been identified in all wells in OU 11 that penetrate bedrock, but the lower sandstone interval has not been encountered (DOE, 1991a). The upper interval also contains silty claystone, clayey siltstone, and siltstone, all of which have been observed in the OU 11 area. Thin sandstone intervals have been documented at one location (borehole 5286) within 30 feet below the top of the bedrock, but sandstone has not been found subcropping beneath the Rocky Flats Alluvium at OU 11. The claystone that dominates the upper portion of the Laramie Formation is typically poorly indurated, massive to laminated, and silty and may contain iron oxides in the upper portion as a result of weathering. Weathering penetrates over 60 feet into bedrock in some locations (DOE, 1991a; EG&G, 1995b).

Siltstone beds can be found within the upper interval of the Laramie Formation. These beds are often interbedded with claystone intervals and are frequently very clay-rich. Carbonaceous material and coal fragments are frequently present.

Borehole drilling programs have shown that the surface of the bedrock beneath OU 11 is not flat but reflects localized undulation or incisements. Figure 3.5-5 presents the bedrock topography. As at several OUs at RFETS, these undulation features are interpreted as paleochannels. These paleochannels are depositionally related to the overlying alluvium, but evidence of the processes is exhibited in the Cretaceous

bedrock. The north-central portion of the site contains a large paleochannel (see Figure 3.5-5). Borehole 50194, located along the axis of this paleochannel, was drilled to a total depth of 105.5 feet (an elevation of 6,008.9 above msl) without penetrating the top of the bedrock. At the southern end of this feature, bedrock was encountered at an elevation of 6,029.4 feet above msl at borehole 4986. This paleochannel coincides with a monoclinal bedrock fold in the western portion of OU 11.

3.5.4 Structural Geology

Many previous studies have been conducted on the structural setting of RFETS (see EG&G, 1995b for summaries). Several (for example, EG&G, 1990b and 1993c; Kittleson, 1991 and 1992) have identified thrust, backthrust, decollement, and associated faulting within the Pierre Shale and other Cretaceous units in the Rocky Flats and surrounding areas. However, these features have not been identified within OU 11 during any of the investigations.

The Geologic Characterization Report (EG&G, 1995b) does describe seven newly identified potential faults near OU 11, within the Industrial Area and northern and eastern Buffer Zone. These features were identified through stratigraphic correlation and are identified as inferred faults. Offset along these inferred faults is estimated to be 10 to 120 feet. The inferred fault closest to OU 11 ends several hundred feet east, in the Industrial Area, northeast of the Building 130 complex.

A monoclinal bedrock fold, in which the dips of Cretaceous strata flatten from approximately 45° east on the west side of OU 11 to approximately 2° to 3° east within easternmost OU 11, has been identified in previous investigations (EG&G, 1992d). The axial plane of this fold cuts through OU 11 and inclines to the west at approximately 50° to 60°.

The Rocky Flats region has been characterized as tectonically inactive (Dames and Moore, 1981). The Geologic Characterization Report (EG&G, 1995b) concludes that none of the identified faults, including the seven inferred faults, show evidence of displacement in the Recent Epoch (defined as the last 10,000 years).

3.6 Hydrogeology

Ground-water occurrence at OU 11 is characterized by three hydrologic regimes. Consistent with interpretations common at other RFETS OUs, two of the regimes are the UHSU and the lower hydrostratigraphic unit (LHSU). The third flow regime at OU 11 addresses perched ground water discussed in the OU 11 FSP TM (EG&G, 1994a). This flow regime comprises the zone of variable saturation above the water table of the UHSU. This variably saturated zone consists of unsaturated materials (the vadose

zone) and small, isolated zones of perched ground water that exist above the water table.

Fetter (1988) defines a hydrostratigraphic unit as a formation, part of a formation, or a group of formations with similar hydrogeologic characteristics allowing for grouping into aquifers or confining layers. These hydrostratigraphic units comprise geologic units grouped together on the basis of similar hydraulic properties and flow conditions. At RFETS, the LHSU is described as the unweathered bedrock. The UHSU is defined as the unconsolidated deposits, underlying weathered bedrock, and all bedrock sandstones in hydraulic connection with unconsolidated deposits. The zone of variable saturation consists of all units above the water table.

Sections 3.6.1 through 3.6.3 present data collected by historical and recent investigations of each of these flow regimes. These data are integrated into a hydrogeologic conceptual model for OU 11 in Section 3.6.4.

3.6.1 Lower Hydrostratigraphic Unit

The LHSU has been defined as the low-permeability, unweathered bedrock of the Arapahoe and Laramie formations (EG&G, 1994a). Site-specific LHSU data are limited because, while three wells penetrate bedrock, only one well (4886) penetrates the LHSU within OU 11 (Figure 2.2-3). Similar to other OUs at RFETS, however, the LHSU in OU 11 shows no evidence of contamination (EG&G, 1994d). As a result, discussion of the LHSU is brief and presents general characteristics of the LHSU as understood from other investigations at RFETS.

A discussion of the occurrence and distribution of LHSU ground water, LHSU recharge and discharge, and hydraulic properties within the LHSU is presented to provide a conceptual understanding of ground-water conditions within the LHSU.

3.6.1.1 Ground-Water Occurrence and Distribution

Ground water in the LHSU exists within interstitial pore spaces. Fractures can be either confined or unconfined, depending on location. In many cases, however, it is difficult to make this determination because a discrete confining unit is not present. The UHSU is distinguished because of a permeability difference between the UHSU and LHSU rather than the existence of a discrete confining layer.

In general, water levels in wells screened in the LHSU are above the screened interval and are occasionally above the top of bedrock (EG&G, 1995c). The water level in LHSU well 4886 is consistently above the top of bedrock. However, no UHSU weathered bedrock wells are close to well 4886, and therefore, the gradient between the UHSU and LHSU cannot be assessed within OU 11. In most areas of RFETS, a

downward vertical hydraulic gradient exists between the UHSU and LHSU (EG&G, 1995c). Thus, the vertical gradient between the two hydrostratigraphic units at OU 11 is expected to be downward.

Regional ground-water flow in the LHSU is from west to east (EG&G, 1995c). Ground-water flow in the LHSU in OU 11 cannot be specifically characterized because of the limited LHSU data at OU 11. However, the general ground-water flow patterns in the LHSU at OU 11 are likely to be similar to the flow patterns elsewhere at RFETS.

3.6.1.2 Recharge

Recharge to the LHSU can occur directly from precipitation west of OU 11 where bedrock outcrops or as infiltration from the UHSU. In most areas, the vertical gradient between the UHSU and the LHSU is downward, indicating the potential for downward recharge (EG&G, 1995c).

Due to limited potentiometric data in the LHSU, the magnitude of vertical recharge from the UHSU cannot be estimated. However, the low permeability of the LHSU limits recharge from the UHSU. Geochemical information that shows that the UHSU and LHSU ground water have distinct chemistries (EG&G, 1995a) supports this conclusion.

3.6.1.3 Discharge

Water-level elevations in LHSU wells indicate that, in general, the horizontal hydraulic gradient within this unit follows the regional eastward gradient. Thus, LHSU ground water is expected to discharge to the east. Locally, upward gradients from the LHSU to the UHSU exist in stream drainages, and the LHSU may locally discharge to the UHSU in these areas (EG&G, 1995c).

The LHSU may also discharge to the underlying Laramie/Fox Hills aquifer. However, the upper portion of the Laramie Formation is composed predominately of low permeability claystone that forms a confining unit. At RFETS, the upper Laramie unit has been estimated to be 300 to 500 feet thick. This unit limits LHSU discharge into the Laramie/Fox Hills aquifer due to its low permeability and thickness (EG&G, 1995c).

3.6.1.4 Hydraulic Properties

Estimates of saturated hydraulic conductivity were compiled for unweathered bedrock claystones, siltstones, and sandstones as part of the Hydrogeologic Characterization Report (EG&G, 1995c). The geometric mean of hydraulic conductivity values for LHSU claystones, siltstones, and sandstones are 2.48E-07, 1.59E-07, and 5.77E-07

centimeters per second (cm/sec), respectively. These estimates of saturated hydraulic conductivity indicate that LHSU sandstones are only slightly more permeable than LHSU claystones and siltstones. Therefore, flow rates in the LHSU are only marginally affected by changes in lithology (EG&G, 1995c).

3.6.2 Upper Hydrostratigraphic Unit

The UHSU in OU 11 is composed of unconsolidated Rocky Flats Alluvium and weathered bedrock of the Arapahoe and Laramie formations. At RFETS, alluvial deposits and weathered bedrock are hydraulically connected on a larger scale but act as individual sub-units of the UHSU in many areas (EG&G, 1995c). For this reason, the hydrogeology of weathered bedrock and alluvial deposits is presented separately. Because the focus of the field investigation was the alluvium and the potential for perched waters in the alluvium, the discussion of the weathered bedrock is limited to a brief description of weathered bedrock hydrogeology based on previous investigations. The hydrogeology of the UHSU alluvial deposits is then presented in greater detail.

3.6.2.1 Weathered Bedrock

A discussion of the occurrence and distribution of weathered bedrock ground water, weathered bedrock recharge and discharge, and hydraulic properties within weathered bedrock are presented to provide a conceptual understanding of ground-water conditions within weathered bedrock in the UHSU.

Ground-Water Occurrence and Distribution

Ground water within weathered bedrock at RFETS exists under both confined and unconfined conditions. Ground water in weathered bedrock sandstones is locally confined in areas where sandstones are overlain by siltstones and claystones (DOE, 1993). Ground water in weathered bedrock occurs under unconfined conditions in areas where the water levels in the weathered bedrock and alluvial deposits are the same, alluvial deposits are unsaturated, the potentiometric surface of weathered bedrock is below the top of bedrock, or alluvial deposits ground water is perched above the weathered bedrock contact.

Potentiometric Surface

Potentiometric surface maps of weathered bedrock ground water have been constructed for OU 4 (EG&G, 1994c) and OU 7 (EG&G, 1994d). These maps show that the potentiometric surface of weathered bedrock ground water generally resembles the potentiometric surface of ground water within unconsolidated materials but is slightly lower in most areas. Based on the similarities of these potentiometric surfaces in other areas of RFETS, the OU 11 weathered bedrock ground-water flow patterns are

expected to be similar to those of the overlying alluvium (EG&G, 1995c). Thus, ground-water flow is expected to be generally to the east-northeast in weathered bedrock at OU 11.

Recharge

Primary sources of recharge to weathered bedrock are infiltration through unconsolidated deposits and direct recharge at outcrops west of OU 11 (EG&G, 1995c). Factors that influence infiltration from the unconsolidated deposits include vertical hydraulic gradients, the saturated hydraulic conductivity of weathered bedrock, and the presence of an unsaturated zone at the top of bedrock. A previous report (EG&G, 1995c) estimated a vertical hydraulic gradient near OU 11 using wells 5186 and 5286. At this location, the gradient was downward indicating that ground water is flowing from the alluvium into weathered bedrock (EG&G, 1995c).

Discharge

Discharge from weathered bedrock in OU 11 is expected to be primarily to weathered bedrock located downgradient of OU 11. Because of the low permeability of the underlying LHSU, only minor amounts of ground water are expected to discharge to the LHSU. Discharge to the overlying alluvial deposits is not expected because vertical hydraulic gradients are typically downward between weathered bedrock and alluvial deposits.

Hydraulic Properties

Because the OU 11 field investigation focused on ground water in alluvial deposits, no additional hydraulic conductivity data were collected. However, estimates of saturated hydraulic conductivity for weathered bedrock at RFETS were compiled as part of the Hydrogeologic Characterization Report (EG&G, 1995c). The geometric means of hydraulic conductivity values for the weathered bedrock claystones, siltstone, Arapahoe Formation sandstone, and other sandstones are 8.82E-07, 2.88E-05, 7.88E-04, and 3.89E-05 cm/sec, respectively. Weathered claystones exhibit the lowest hydraulic conductivity. Weathered siltstones and "other" sandstones have similar hydraulic conductivities and are more permeable than weathered claystones. The Arapahoe Formation sandstones are the most permeable weathered bedrock unit, but the Arapahoe Formation is not present at OU 11.

3.6.2.2 Alluvial Deposits

Hydrogeology of alluvial deposits in the UHSU was characterized using data describing water levels in monitoring wells, the occurrence and distribution of ground water,

recharge and discharge, hydraulic properties, and flow conditions in the alluvial deposits.

Water Levels

Daily measurements of water levels were made in the newly installed OU 11 monitoring wells from early September to early December of 1994 after well development was complete. Hydrographs constructed from this data can be classified into three categories: (1) wells with slowly increasing water levels, (2) wells with inconsistent fluctuations that correlate with changes in barometric pressure, and (3) wells with slowly decreasing water levels.

Seven of the wells were still recovering from development as of mid-October 1994. For example, Figures 3.6-1 and 3.6-2 show hydrographs for wells 50394 and 50894, respectively. Water levels in both wells continued to rise from early September through mid-October. The curves in both hydrographs eventually flatten indicating that water levels have reached equilibrium. The decrease in water levels between October 19 and October 21 in wells 50394 and 50894 is caused by ground-water sampling performed between October 19 and October 21. Long recovery times in monitoring wells suggest that screened aquifer materials have low transmissivities. Figure 3.6-3 shows the hydrograph for well 50994 which has small inconsistent variations in water level. A comparison of barometric pressure measured at RFETS to OU 11 water levels reveals that water levels change in response to changes in barometric pressure in wells that have recovered (see Figure 3.6-4). Well 50294 (Figure 3.6-5) shows a slight but steady decrease over the measurement period. The explanation for the decreasing water-level elevation is not known.

Ground-water elevations in wells vary significantly over short distances at OU 11. These changes in water elevations coincide with large variations in screen depths between wells. This correlation suggests that wells with shallower screens are producing water from isolated zones above the regional UHSU water table. For example, wells 51494 and 51594 are located adjacent to each other, and depth to water in well 51494 during October 1994 was 35.8 feet lower than in well 51594. The base of the screened intervals in wells 51494 and 51594 are 68.7 and 20 feet below ground surface, respectively. The higher water level and screened interval of well 51594 suggests that well 51594 is producing water from a water-bearing zone perched above the regional UHSU water table.

Ground-Water Occurrence and Distribution

A potentiometric surface map of ground water within UHSU alluvial deposits was constructed for October 1994 (Figure 3.6-6). To construct this map, it was necessary to

determine in which hydrologic regime wells were screened. Table 3.6-1 provides a list of all wells in the greater OU 11 area, the hydrologic regime in which wells were screened, and the rationale for assigning the wells to that regime. Table 3.6-2 provides well construction and water-level information for OU 11 area wells.

In some cases, it was difficult to differentiate between wells screened below the UHSU "regional" water table and wells that produce water but are screened in the variably saturated zone above the UHSU water table. By comparing water levels of these "questionable" wells to water levels in wells with screen bottoms at the top of bedrock, wells could be properly assigned. Water levels in wells screened in the variably saturated zone were generally 30 to 50 feet higher than neighboring wells screened in the UHSU.

The UHSU potentiometric surface map indicates that ground water flows to the east-northeast within OU 11 and to the southeast, toward the Woman Creek drainage, in the area immediately south of OU 11 (Figure 3.6-6).

A map showing the saturated thickness of alluvial deposits during October 1994 was created for the OU 11 area using both new and existing wells. The map was created by subtracting the bedrock surface from the potentiometric surface. The saturated thickness of alluvial deposits during October ranged from over 40 feet to less than 10 feet in the OU 11 area (Figure 3.6-7). The saturated thickness of alluvial deposits varies seasonally with changes in the amount of precipitation; therefore saturated thicknesses are generally greatest in the spring and lowest in the winter (EG&G, 1995c).

Variations in bedrock topography affect the saturated thickness of alluvial deposits. For example, the north-south-trending bedrock channel in OU 11 is also associated with an area of locally increased saturated thickness (Figures 3.5-5 and 3.6-7). Bedrock elevation increases toward the western boundary of OU 11 which results in a decrease in saturated thickness.

Depth to water varies from 70 feet west of OU 11 to 22 feet east of OU 11 (Figure 3.6-8). Depth to water is commonly used as an indicator of recharge and discharge areas. Recharge zones are often associated with areas of greater depth to water, whereas discharge areas are found where depth to water reaches zero. At RFETS, depth to water is greatest in the western portions of the site, including OU 11, which indicates that the area is a recharge zone. Depth to water decreases east of OU 11 in the Industrial Area and in stream drainages that are located immediately south and further north of OU 11 (EG&G, 1995c).

An important source of recharge to the UHSU alluvial deposits in OU 11 is infiltration of precipitation. The stable isotope composition of ground water and water-level fluctuations both indicate that infiltration of precipitation is the primary source of recharge to UHSU materials (EG&G, 1995a). Precipitation averages approximately 16 inches annually at the Rocky Flats site, with the majority of precipitation occurring during April, May, and June (EG&G, 1993a). Most precipitation, however, is lost to runoff and evapotranspiration (EG&G, 1995c).

Discharge of ground water from alluvial deposits at RFETS occurs by a number of different mechanisms. These include transpiration by vegetation, evaporation in the capillary zone, discharge to seeps and ephemeral streams, and infiltration into the underlying weathered bedrock (EG&G, 1995c). As indicated by the potentiometric surface map, discharge from OU 11 alluvial deposits is primarily to alluvial deposits east-northeast (downgradient) of OU 11. Some OU 11 alluvial deposits ground water discharges toward the Woman Creek drainage southeast of OU 11. The downward hydraulic gradient indicated by water levels in wells 5186 and 5286 (Figure 3.6-6) indicates that alluvial deposits ground water also discharges to the underlying weathered bedrock. In the Hydrogeologic Characterization Report (EG&G, 1995c), the vertical hydraulic gradient at this location is estimated to be 0.23 units (downward).

Only very limited amounts of caliche were noted during the drilling of the combined phases boreholes. Therefore, evaporation of ground water in the capillary zone does not appear to be a significant discharge mechanism. Because the water table is deep in OU 11, transpiration of ground water by vegetation is not a mechanism of discharge. No seeps or streams are present within OU 11 and, therefore, are not points of ground-water discharge.

Hydraulic Conductivity

Hydraulic conductivity values for Rocky Flats Alluvium (which is the only alluvial deposit present in OU 11) were estimated from slug tests conducted during the OU 11 field investigation as well as tests conducted during previous investigations. The geometric mean of these tests is 8.51E-06 cm/sec. Results of the slug tests are discussed in greater detail in Section 3.6.3.3.

Ground-Water Flow

Ground water in alluvial deposits generally flows to the east-northeast across OU 11. In southern portions of OU 11, ground water flows to the southeast in alluvial deposits (Figure 3.6-6). Vertical hydraulic gradients indicate that ground water also flows downward from alluvium into weathered bedrock in OU 11.

Using horizontal hydraulic gradients along two flow paths within OU 11, the average hydraulic conductivity, and an assumed effective porosity, average linear ground-water velocities were calculated (Table 3.6-3). Average linear velocities represent the transport of a non-reactive chemical within alluvial ground water. The estimated average linear ground-water velocities in OU 11 alluvium (approximately 30 feet per year [ft/yr]) are in close agreement with velocities calculated in previous reports (EG&G, 1995c).

3.6.3 Zone of Variable Saturation

The OU 11 FSP TM discussed perched ground-water mounds at the WSF (EG&G, 1994a). This hypothesis was based on limited evidence. The limited data directed design of the combined phases investigation. To investigate the occurrence of potentially contaminated, perched ground water in the zone of variable saturation, the OU 11 RFI/RI drilling program was implemented differently than most drilling programs at RFETS.

Most RFETS drilling programs advance boreholes until saturated zones are encountered and then construct wells that screen at least a portion of the identified saturated interval. During the OU 11 drilling program, however, wells were installed across intervals where saturated zones were not immediately obvious (based on near-continuous core samples). The OU 11 wells were installed at points of increased moisture content, despite a lack of apparent saturation, because it was observed that "open" boreholes often accumulated free water after one to several days. ("Open" boreholes were isolated from surface runoff and direct precipitation by leaving the outer drill casing in the hole and covering the opening at the surface.) If an open borehole produced free water within several days, a well was installed. If the borehole did not produce water, it was drilled deeper, and the waiting period was repeated. Thirteen wells were installed in this manner; 12 have subsequently produced water at volumes sufficient for development, sampling, and potentiometric surface monitoring.

The zone of variable saturation refers to depths above the regional water table of the UHSU. In this zone, small, isolated, discontinuous areas of saturated material (perched ground water) occur at depths ranging from 30 to 50 feet above the regional (UHSU) water table. The zone of variable saturation also includes unsaturated materials occurring above the UHSU water table. The zone of variable saturation ranges in thickness from 40 to 70 feet.

A second, unique aspect of the drilling program involved the drilling methodology employed: Resonant Sonic™ technology. This technology was used because conventional technologies (i.e., hollow-stem augering) render it difficult to obtain representative core material from the cobbly Rocky Flats Alluvium. To support the

objective of this project in identifying potentially perched waters, as well as to characterize the chemistry of unsaturated materials, Resonant Sonic™ drilling techniques were used.

Data collected within the zone of variable saturation during the field investigation include water-level data (discussed in Section 3.6.2.2), moisture content and lithologic data, geophysical logs, and aquifer test data. These data were used to identify the occurrence of ground water and estimate hydraulic conductivities.

3.6.3.1 Occurrence of Ground Water

Ground water in the variably saturated zone occurs at relatively shallow depths at OU 11. The depth to ground water within the variably saturated zone ranged from 7 to 19 feet during October 1994 (Table 3.6-2). Ground water in the variably saturated zone was 25 to 46 feet above the regional UHSU water table during the same period. There is no spatial trend to the depth to water in the variably saturated zone; however, the elevation of variably saturated zone ground water above the UHSU water table generally decreases from west to east across OU 11.

Because a correlation between lithology and ground-water occurrence is common in many hydrogeologic systems, special attention was given to lithology and the occurrence of ground water during the field investigation. In most variably saturated materials, water is often perched above less permeable zones such as lenses of clay or silt and preferentially resides in more permeable lithologic units such as sand and gravel. Notable clay lenses were encountered in only three wells in OU 11 (50194, 51094, and 51194). These lenses ranged from approximately 1.5 feet to 4.5 feet thick. After these clay lenses were encountered, the borehole was left open overnight to evaluate the presence of water above the clays. In all three cases, no water entered the hole, indicating that there was no perched water above the clays, and the well was subsequently drilled deeper. Therefore, it is likely that the occurrence of ground water may be controlled by more subtle variations in lithology.

Comparing water-level data to borehole logs generally revealed no obvious relationship between the occurrence of ground water and lithology. Lithologies of unconsolidated materials deposits were classified using the Unified Soil Classification System (USCS), as per EG&G Geotechnical SOP GT.01, Logging Alluvial and Bedrock Material (EG&G, 1992a). However, this classification system did not provide sufficient detail for evaluating subtle changes in lithology that could control the occurrence and distribution of ground water. Therefore, comparisons of percent gravel, sand, clay, and silt to the occurrence of water were also conducted. These comparisons generally indicate that there is no consistent correlation between occurrence of ground water and

gravel, sand, clay, or silt content. For example, Figure 3.6-9 shows that variations in grain size do not appear to be related to the water level in well 50394.

In well 50194, correlation between occurrence of ground water and percent clay and silt is also not clear. There is little variation in clay and silt content in well 50194 with the exception of the two clay layers present at approximately 20 and 83 feet below ground surface (see Figure 3.6-10). There were no indications during drilling that water existed above the clay layer located 20 feet below ground surface. Core directly above the clay layer encountered at 83 feet was described as damp to moist, while the core immediately below this clay layer was described as dry. This distribution of moisture may indicate that water is perched above the clay layer. However, core above the clay layer was moist, not wet, indicating that material above the clay was not saturated. Saturated core was not encountered until 98 feet below ground surface.

As presented in Section 2.2.3, soil moisture measurements were also made during drilling using the Speedy Soil Moisture Tester®. Soil moisture is not directly indicative of a lithologic unit's capacity to produce water because soil moisture content is highly dependent on the grain size of geologic materials. Finer-grained soils retain more moisture as hygroscopic water (Fetter, 1988). However, results of the moisture tests were compared to both moisture noted in the borehole log and occurrence of ground water. Correlation between both of these parameters and soil moisture test results were inconsistent, but the test was useful as a field screening device to guide well completion.

3.6.3.2 Borehole Geophysics

Downhole geophysical measurements were made in wells installed in 1994 and previous to 1994. OU 11 area wells logged with geophysical instruments are listed in Table 3.6-4. In general, findings of the geophysical investigation were (1) geophysical logs correlate poorly with lithology as defined by USCS units or percent of silt and clay, (2) lithology is heterogeneous on a small scale, and (3) geophysical methods do not suggest that water-bearing zones exist above screened intervals.

Geophysical logs are typically used for determining lithology and fluid properties of subsurface materials. During the OU 11 field program, three different downhole tools were used to log wells installed during the combined phases RFI/RI field program and wells installed previously.

Natural gamma and induction resistivity tools were used to evaluate lithology. The count rate measured by the natural gamma tool increases with increasing clay content, and resistivity measured by the induction resistivity tool generally increases with increasing grain size of the formation. The resistivity tool is also affected by water

content. Saturated soils and rocks are generally less resistive than dry geologic materials.

Two active source nuclear logging tools, the neutron and gamma-gamma logs, were also used to evaluate subsurface units. The count rate measured by the neutron log decreases with increasing hydrogen content. Thus, the neutron log primarily responds to the water content of surrounding materials. The count rate measured by the gamma-gamma log decreases with increasing density. All of the boreholes were logged after monitoring wells had been constructed because the boreholes would not stay open uncased. Grout, sand pack, and bentonite all may have differing effects on geophysical logs. In particular, neutron and gamma-gamma logs are influenced by well construction materials.

Correlation between geophysical logs used for lithologic identification (i.e., natural gamma and induction resistivity) and lithologic logs is limited. Variation in resistivity between silty sands and clayey sands is not consistent nor is the correlation between percent silt and clay consistent with measured resistivity. Only units that are predominately clay (>50 percent) are easily identifiable using geophysical logs. Resistivities in these clay units are markedly lower than surrounding material. Figures 3.6-9 and 3.6-10 show geophysical logs, lithologic logs, percent silt and clay, and well construction details for wells 50394 and 50194, respectively. Lower resistivities are measured at 22 and 83 feet in well 50194 corresponding to clays (see Figure 3.6-10). The natural gamma log shows slight increases in count rates across both of these clay layers, but similar count rates are measured at other depths in the well. With the exception of clay layers, variation in resistivity logs does not correlate with either USCS lithology or percent of grain sizes as noted in the borehole log. The resistivity log is responding to subtle variations in lithology and water content that are not evident in the borehole log. Thus, the resistivity log indicates that alluvium is heterogeneous on a scale smaller than the scale at which the core was logged. (The thinnest layers described in the borehole logs are approximately 1 foot thick. However, the resistivity logs show that variations of this same scale occur even within the thicker beds noted in the borehole logs.) In general, the type of resistivity instrument used to log OU 11 boreholes is capable of resolving layers as thin as 1 foot thick. Resolution of the instrument, however, is dependent on resistivity contrast between adjacent layers.

Gamma-gamma and neutron logs were useful for identifying water content of the surrounding materials (see Figures 3.6-9 and 3.6-10). Both logs show decreases in count rate at the water surface, as expected. However, review of the neutron and gamma-gamma logs suggests zones of isolated water were not present above the water level measured in the well. Comparison of these logs to well construction materials shows that they were strongly influenced by the presence of these materials (see Figures 3.6-9 and 3.6-10). The neutron log is sensitive to water contained in grout and

bentonite, and the gamma-gamma log is affected by the density of these materials. Grout and bentonite, therefore, will dampen the response from water contained in the alluvium. Thus, zones of isolated water may exist above the water level measured in wells but cannot be detected due to the effects of well construction on the response of the geophysical log. Although it would be useful to use these logs in open holes, the risk of borehole caving does not permit logging unconsolidated materials in open holes.

3.6.3.3 Hydraulic Conductivity

Slug tests were performed to estimate the hydraulic conductivity of the Rocky Flats Alluvium at OU 11. Both rising and falling slug tests were performed on wells 50194, 50394, 50694, 50794, 50994, 51094, and 51494; bailed slug tests were performed on wells 50294, 50894, 51594, and 51694; and a falling slug test was performed on well 46192. In addition, historic values of hydraulic conductivity in the OU 11 area were taken from the Hydrogeologic Characterization Report (EG&G, 1995c). Calculated hydraulic conductivities range from 8.1E-08 cm/sec to 3.2E-03 cm/sec with an arithmetic mean of 2.2E-04 cm/sec (see Tables 3.6-5 and 3.6-6). A histogram of hydraulic conductivity data is presented in Figure 3.6-11. Hydraulic conductivity values at OU 11 fall within the range of values observed elsewhere at RFETS for Rocky Flats Alluvium (see EG&G, 1995c).

The relationship between hydraulic conductivity and depth was examined by plotting estimates of hydraulic conductivity versus screen midpoint depth (Figure 3.6-12). The figure clearly shows that a wide range of hydraulic conductivities occur at all depths. Thus, there is no correlation between depth and hydraulic conductivity. Figure 3.6-12 also shows that hydraulic conductivities measured in the zone of variable saturation are generally in the same range as those measured in the UHSU alluvial unit.

A factor that potentially influences the accuracy of the aquifer tests is the thickness of the water-producing zone relative to the screen length. In calculating hydraulic conductivities from slug tests, it is assumed that the entire length of the saturated screened interval produces water. However, it is possible, and likely at OU 11, that only a portion of the saturated screened interval produces water. In this case, hydraulic conductivity of the actual water-producing zone is underestimated because the thickness of the water-producing zone is overestimated. Although it is very difficult to assess the occurrence of these conditions, slow recovery rates of some OU 11 wells may suggest that only part of the saturated screen length produces water. Accuracy of slug tests may also have been affected in those wells still recovering from development when the slug tests were performed.

Percent clay and percent clay plus silt were used to evaluate potential correlation between screened lithology and hydraulic conductivity within wells at OU 11.

Weighted mean percent clay and clay plus silt were used during regression analysis, and no correlation was identified. That is, wells screened within similar lithologies do not necessarily exhibit similar hydraulic conductivities. (In some cases, hydraulic conductivity measured in wells screened in similar lithologies differed by four orders of magnitude.)

3.6.4 Conceptual Hydrogeologic Model

Development of the conceptual model of the hydrogeologic system at OU 11 requires the integration and interpretation of information from the OU 11 RFI/RI field program and previous investigations. The section begins by summarizing characteristics of the OU 11 hydrogeologic system and discussing characteristics of the RFI/RI drilling program that are relevant to interpreting hydrogeologic information. Hydrogeologic data are then discussed. Conventional theory on uniform flow is not appropriate in the zone of variable saturation. This conceptual model applies more current theories for non-uniform flow in the zone of variable saturation to the OU 11 hydrogeologic system.

The LHSU is composed of all lithostratigraphic units in unweathered portions of the Arapahoe and upper Laramie formations, except for sandstones subcropping at the alluvial/bedrock unconformity that are in hydraulic connection with the UHSU. No subcropping sandstones have been identified at OU 11. Claystones and siltstones of the Arapahoe and Laramie formations exhibit hydraulic conductivities lower than those of the Rocky Flats Alluvium, resulting in relatively low rates of ground-water movement.

Ground-water movement in unconsolidated materials of the UHSU is generally controlled by topography of the bedrock surface. Bedrock surface at OU 11 generally slopes to the east but is incised by a north-trending channel. As a result, ground water generally flows to the northeast reflecting influence from both the regional and local topography of the bedrock surface. Average horizontal ground-water flow velocities for Rocky Flats Alluvium are estimated at approximately 30 ft/yr. The arithmetic mean of all hydraulic conductivity values of the Rocky Flats Alluvium near the WSF is 2.2E 04 cm/sec. Vertical hydraulic gradients between the Rocky Flats Alluvium and underlying weathered bedrock are understood to be downward within OU 11 (EG&G, 1995c).

The recent drilling program has provided data allowing refinement of the conceptual model of the OU 11 ground-water system, including the following important features:

- Saturated material was rarely observed in drill core from wells installed above the UHSU water table. However, wells screened above the UHSU water table have subsequently produced sufficient water to sample. Therefore, saturated zones must be present above the UHSU water table.

- Moisture in drill core was higher in finer-grained material. However, water levels in wells screened above the UHSU water table do not correlate with moist zones identified in drill core. Furthermore, water levels do not correlate with coarse-grained (higher permeability) zones.

- Potentiometric elevations in wells screened above the UHSU water table vary significantly between wells screened at different depths; in some cases, deeper screened intervals appear to be related to lower potentiometric elevations.

Hydrologic characteristics listed above indicate that zones of saturation exist above the regional (UHSU) water table. These saturated regions do not appear to be controlled by lithology nor do they correlate with a specific depth interval. This would indicate that while perched ground water does exist above the UHSU water table, it is not in the form of a continuous, discrete "mound" of ground water. Rather, these intermittent zones of saturation occur as discontinuous pockets of saturated material whose occurrence is controlled by heterogeneities on a scale not readily discernible.

Preferential flow during infiltration is one mechanism that would promote the formation of isolated, discontinuous regions of perched ground water. The term "preferential flow" describes non-equilibrium behavior where isolated regions preferentially transport moisture through distinct pathways. These distinct, or "preferential," flow pathways often involve non-observable structures (Hill and Parlange, 1972) and can result in the bypassing of large fractions of the soil matrix. Observable heterogeneity, such as that illustrated by the lithologic logs from the newly installed OU 11 wells, tends to further increase the development of preferential flow through unsaturated materials (Helling and Gish, 1991).

Mechanisms for preferential flow typically exist at the pore scale. These mechanisms include (1) flow instabilities formed by variations in hydraulic conductivity, water repellence, and compression of air (Hendrickx and Decker, 1991; Steenhuis and Parlange, 1991) and (2) the presence of macropores which can result from shrinkage and drying cracks, faunal activity (i.e., worm or ant burrows), solution of soil minerals, root channels, lithologic interfaces, and interpedal voids (Fitzpatrick, 1983; Ahuja, *et al.*, 1991). Moreover, preferential flow pathways can be interconnected or, being essentially non-equilibrium processes, can act independently. A conceptual model of the OU 11 hydrologic system is presented in Figure 3.6-13.

Because preferential flow through the zone of variable saturation is gravity driven, preferential flow paths tend to be vertically oriented. Variations to this tendency occur along non-vertical heterogeneities or structural features. Once established, preferential flow paths can persist through subsequent wetting events if residual moisture in the flow path remains elevated relative to the surrounding matrix (Baker and Hillel, 1991). This results from the well-established relationship between hydraulic conductivity and

moisture content, wherein an exponential increase in hydraulic conductivity occurs with increased moisture content (until saturation is reached).

In summary, the hydrologic system above the regional (UHSU) water table is characterized by variable saturation which is not controlled by observable, large-scale features such as a low permeability clay layer. Formation of isolated, discontinuous lenses of perched ground water is promoted by non-uniform flow in unsaturated materials above the UHSU water table. The heterogeneous nature of the unsaturated materials promotes formation of preferential flow pathways during infiltration events. This provides a mechanism for developing saturated zones above the UHSU water table. Because infiltration into unsaturated materials is a transient process, it is likely that existence of these saturated lenses above the UHSU is also transient. However, it is likely that the existence of heterogeneities, not observable on the scale of core logging, promote the formation of saturated lenses in the same general areas during subsequent infiltration events.

3.7 Ecology

Ecological conditions at OU 11, including vegetation, wildlife, and sensitive habitats and endangered species are presented in this section. The observed impact to the ecology from historic spray activities is discussed.

OU 11 is located on an elevated plain on the western side of RFETS, in the Buffer Zone. The Buffer Zone is the area surrounding the Industrial Area of RFETS and is primarily undisturbed by site activities. The Buffer Zone generally supports a wide variety of native plant communities and wildlife. OU 11 is located in a transitional environment known as the Colorado Piedmont. The Colorado Piedmont is an area of dissected topography containing features of the Great Plains Prairie and the Rocky Mountain foothills. Present-day vegetation at OU 11 is dominated by mesic mixed grassland with integrated tall- and short-grass prairie community features.

3.7.1 Vegetation

Mesic mixed grassland is the most prevalent native habitat type at OU 11. Dominant grasses are western wheatgrass, Canada bluegrass, prairie junegrass, and big bluestem. Kentucky bluegrass, little bluestem, crested wheatgrass, sand dropseed, blue grama, and needle-and-thread are also present. The most dominant forbs are diffuse knapweed, Louisiana sage, and Canada thistle. Secondary forbs present include aster, slimflower scurfpea, and klamath weed. Wild rose is the most commonly encountered shrub, and prickly pear is the most common cactus encountered.

To evaluate the effects of the sprayed water and the constituents within the sprayed water (particularly nitrates/nitrites) on the OU 11 vegetation, inventories of vegetation

were completed in 5-meter-by-5-meter grids in spray areas, non-spray areas, and reference areas. These transects evaluated vegetation density and diversity and found that the spray areas showed lower basal coverage than the non-spray and reference areas. Belt transect data suggest this might be a result of the change in species composition resulting from supplemental nitrogen and water additions. Subsequently, production data showed higher plant biomass in spray versus non-spray and reference areas. The data also suggested a much higher litter biomass on the spray areas. The conclusion from this data is that the water and nitrogen supplement has resulted in a greater biomass of large bunch grasses, including little bluestem and big bluestem. These results may be analogous to those from watering and fertilizing a lawn heavily and then withdrawing the external treatments, resulting in less cover but elevated litter and biomass. This data is presented in further detail in the OU 11 FSP TM (EG&G, 1994a).

3.7.2 Wildlife

RFETS in general, and OU 11 specifically, supports a wide variety of wildlife, including large and small mammals, birds, and reptiles. This relatively rich animal community is partly the result of the site's isolation from the increased human activity in the surrounding areas.

The most abundant large mammal is the mule deer, with white-tail deer observed less frequently. Large carnivores present at RFETS, and traversing OU 11, include coyotes, red foxes, gray foxes, striped skunks, long-tailed weasels, badgers, bobcats, and raccoons. Eastern cotton-tail and white-tailed jack rabbits are also present.

Small mammals reported across RFETS include harvest mice, deer mice, meadow voles, thirteen-lined ground squirrels, hispid pocket mice, silky pocket mice, pocket gopher, and the house mouse. More recently, Mexican woodrats, plains and western harvest mice, prairie voles, and both western and meadow jumping mice have been reported at RFETS.

The varied habitats at RFETS support many bird species. The grassland habitats of OU 11 support western meadowlarks, horned larks, vesper sparrows, grasshopper sparrows, western kingbirds, and eastern kingbirds. A lack of trees and open water at OU 11 generally precludes birds that favor those habitats; however, birds of prey have been sighted passing through OU 11. Birds of prey at RFETS include prairie falcons, rough-legged hawks, red-tailed hawks, American kestrels, Swainson's hawk, and northern harriers.

Reptiles present include the bullsnake, yellow-bellied racer, western terrestrial gartersnake, and prairie rattlesnake.

As with the vegetation, surveys were conducted to document relative abundance and diversity of wildlife at OU 11 in sprayed, non-sprayed, and reference areas to identify any impacts. Small mammals were trapped, and large mammals and birds were observed and recorded. Results of these surveys documented no differences between transect locations associated with the spray versus non-spray and reference areas in the relative abundance survey. Breeding bird results suggest higher bird densities at the WSF than at reference areas. The WSF had the highest population of grasshopper sparrows of any location sampled at RFETS. These birds prefer higher stratum grass habitats than other species, and this habitat is common at OU 11. The small mammal capture data were inconclusive due to low numbers of captures in the reference site, the spray areas, and the non-spray areas at OU 11. It is likely that the low numbers of captures were due to the absence of burrowing sites in the upland soils at the WSF. This data is presented and discussed in more detail in the OU 11 FSP TM (EG&G, 1994a).

Overall, the ecological data collected revealed no evidence of adverse biotic effects between the sprayed, non-sprayed, and reference areas investigated at OU 11.

3.7.3 Sensitive Habitats and Endangered Species

A recent report identified four plant species of special concern potentially present at RFETS (EG&G, 1995d). Three of the species have not been identified at RFETS, but the appropriate habitats for the species do exist. All four of the species require habitats that do not exist at OU 11.

Plants include one federally listed threatened species, Ute lady's tresses; one Category 2 species, Colorado butterfly plant; and two species of concern in Colorado, forktip three-awn and toothcup. Ute lady's tresses have been reported a few miles south of the site, and the habitat exists at the site; however, a 1992 survey identified no occurrences at RFETS. Colorado butterfly plant has not been reported at or near the site, but the suitable wetlands habitat does exist at RFETS though not at OU 11. Forktip three-awn was reported along Woman Creek in 1973 and was documented in the same area in 1992. OU 11 does not contain suitable habitat for this plant. Toothcup has been reported in a temporary pool east of Boulder, Colorado, but not at RFETS or OU 11.

Three federally listed endangered wildlife species potentially exist at RFETS but are extremely unlikely inhabitants of OU 11: black-footed ferret, peregrine falcon, and bald eagle. Black-footed ferrets require habitat in and around prairie dog colonies. Neither prairie dog colonies nor black-footed ferrets are known to exist at OU 11. Peregrine falcons may be periodic migrants in the area, but the closest reported nest was 10 km northwest of RFETS in 1991. Though bald eagles have been seen during the winter months at RFETS, no roost areas at RFETS have been located. A lack of trees and

protective coverings at OU 11 renders the site unlikely as a habitat or hunting territory for the bald eagle or the peregrine falcon.

Potential habitat for several Colorado Category 2 wildlife species exists at RFETS but is unlikely to include OU 11 (EG&G, 1995d). Ferruginous hawks have been observed and appear to nest elsewhere but hunt at RFETS. A small number of Baird's sparrows (*Ammodramus bairdii*) have been observed at RFETS, but they are probably migrating and not residents.

Preble's meadow jumping mice have been identified along Woman Creek, Walnut Creek, and Rock Creek. Captured mice were found in a hydrophytic shrubland dominated by sandbar willow and leadplant with lush understory of grasses and forbs. This habitat occurs north of OU 11 along intermittent sections of north Walnut Creek (EG&G, 1995d). However, intense surveys of RFETS in 1992 and 1993 did not identify the species at OU 11.

Table 3.2-1
Precipitation as Snow at the
Rocky Flats Environmental Technology Site

Year	Total Precipitation (inches)	Snow Water Equivalent (inches)	Percent Precipitation as Snow
1964	6.64	2.44	37%
1965	18.87	4.96	26%
1966	11.4	6.25	55%
1967	22.54	4.35	19%
1968	12.71	5.3	42%
1969	24.71	8.13	33%
1970	18.79	5.87	31%
1971	14.3	6.25	44%
1972	14.78	8.82	60%
1973	21.55	7.24	34%
1974	13.77	3.25	24%
1975	12.04	3.4	28%
1976	13.51	5.2	38%
1986	14.47	5.2	36%
1989	15.76	4.12	26%
1990	NA	4.3	NA
1991	NA	3.5	NA
1992	12.33	5.4	44%
1993	12.07	5.2	43%
AVERAGE	15.31	5.22	36%

Definition:

NA not available

Table 3.2-2
Total Precipitation at the
Rocky Flats Environmental Technology Site
1992 and 1993

Month	Total Precipitation 1992 (inches)	Total Precipitation 1993 (inches)
January	0.31	0.13
February	0.02	0.54
March	3.37	1.52
April	0.53	1.45
May	1.53	1.13
June	2.19	1.79
July	1.3	0.48
August	2.97	0.42
September	0.00	1.58
October	0.59	1.41
November	1.25	1.27
December	0.43	0.35
TOTAL	14.49	12.07

Table 3.2-3
Temperature Data for 1993 for the Rocky Flats Environmental Technology Site

Temperature Means (°F)			
Month	High	Low	Average
January	38.3	17.7	28.0
February	32.1	16.7	24.4
March	47.9	28.0	38.0
April	53.5	31.2	42.4
May	64.9	42.4	53.7
June	72.7	48.0	60.4
July	79.7	54.0	66.9
August	75.4	53.6	64.5
September	68.7	49.0	58.9
October	58.9	32.1	45.5
November	45.0	19.7	32.4
December	45.6	20.6	33.1
AVERAGE	56.9	34.4	45.7

Temperature Extremes (°F)				
Month	High	Date(s) Measured	Low	Date(s) Measured
January	56	22, 27	-4	10
February	53	19	-10	16
March	67	25	5	13
April	68	22	22	12
May	82	26	28	1
June	90	15	35	4
July	91	10, 29	49	5, 7
August	87	24	43	30
September	85	11	31	13
October	83	6	1	30
November	64	10	-10	25
December	60	26	-5	22
EXTREME	91	July 10 July 29	-10	February 16 November 25

Definition:

F Fahrenheit

Table 3.2-4
Historic Monthly Temperature Data for the Rocky Flats Environmental Technology Site

Temperature Means (°F)				Temperature Extremes (°F)		
Month	High	Low	Average	Month	High	Low
January	41.1	22.0	31.5	January	69.0	-12.0
February	42.1	23.5	32.8	February	71.0	-10.0
March	48.9	28.1	38.5	March	82.0	-5.0
April	57.7	36.1	46.9	April	80.0	13.0
May	64.4	43.4	53.9	May	89.0	6.0
June	76.1	54.8	65.5	June	99.0	35.0
July	82.2	59.9	71.0	July	102.0	44.0
August	80.0	58.2	69.1	August	97.0	37.9
September	69.7	49.8	59.8	September	91.0	24.0
October	60.6	40.3	50.5	October	83.0	0.0
November	48.6	30.7	39.7	November	71.0	-10.0
December	42.4	24.2	33.3	December	72.0	-8.0
AVERAGE	59.5	39.2	49.4	EXTREME	102	-12

Definition:

F Fahrenheit

Table 3.2-5
Wind Speeds and Directions, 1993, for the Rocky Flats Environmental Technology Site

Month	Wind Speed (mph)[1]	
	Mean	Peak
January	8.5	75
February	6.7	70
March	9.2	50
April	9.3	67
May	7.9	60
June	8.5	58
July	8.9	73
August	7.5	47
September	8.2	58
October	7.6	66
November	9.8	66
December	12.3	82
ANNUAL	8.7	82

[1] As measured at a 10-meter height above the ground

Definition:

mph miles per hour

Wind Direction Frequency[1]	
Direction	Percent
Calm	2.74
N	7.72
NNE	6.13
NE	4.71
ENE	3.61
E	3.55
ESE	3.82
SE	5.35
SSE	5.72
S	5.22
SSW	4.62
SW	5.23
WSW	6.40
W	8.38
WNW	11.67
NW	7.72
NNW	7.42
TOTAL	100

Table 3.2-6
Climatological Data for the
Rocky Flats Environmental Technology Site

Parameter	1993	Long-Term Average
Mean Dew Point (°F)	26.3	30.87
Mean Relative Humidity (%)	41	Not Available
Mean Atmospheric Pressure (mb)	812.3	815.55
Solar Total (kW h/m^2)	165.6	Not Available

Definitions:

F Fahrenheit

kW h/m^2 kilowatt hours per square meters

mb millibars

Table 3.2-7
Approximate Pan Evaporation in Denver
(1931–1960)

Month	Evaporation (cm)
January	0
February	0
March	10
April	17
May	20
June	24
July	29
August	30
September	22
October	14
November	0
December	0
ANNUAL	166

Source: Hazardous Waste Land Treatment, SW-874, U.S. Environmental Protection Agency, Municipal Environmental Research Laboratory, Office of Research and Development, Cincinnati, Ohio, April 1983.

Definition:

cm centimeters

Table 3.6-1
Hydrologic Regime Classification of OU 11 Area Wells

Well Number	Hydrologic Regime	Rationale for Hydrostratigraphic Unit Classification
4686	LHSU	Screened in unweathered bedrock
4786	UHSU-Alluvium	Screen bottom at/near top of bedrock
4886	LHSU	Screened in unweathered bedrock
4986	UHSU-Alluvium	Screen bottom at/near top of bedrock
5086	Not Determined	No well construction information
5186	UHSU-Alluvium	Screen bottom at/near top of bedrock
5286	UHSU-Weathered Bedrock	Screened in weathered bedrock
B110889	UHSU-Alluvium	Screen bottom at/near top of bedrock
B110989	UHSU-Alluvium	Screen bottom at/near top of bedrock
B111189	UHSU-Alluvium	Comparison of water elevation to other wells
B410589	UHSU-Alluvium	Comparison of water elevation to other wells
B410689	UHSU-Alluvium	Comparison of water elevation to other wells
B410789	UHSU-Alluvium	Comparison of water elevation to other wells
B411289	UHSU-Alluvium	Comparison of water elevation to other wells
B411389	UHSU-Alluvium	Comparison of water elevation to other wells
46192	UHSU-Alluvium	Screen bottom at/near top of bedrock
46292	UHSU-Alluvium	Screen bottom at/near top of bedrock
46392	UHSU-Weathered Bedrock	Screened in weathered bedrock
46492	UHSU-Alluvium	Screen bottom at/near top of bedrock
50194	UHSU-Alluvium	Screen bottom 94.7 feet below ground surface
50294	Variably Saturated Zone	Water elevation ~45 feet higher than neighboring wells
50394	UHSU-Alluvium	Comparison of water elevation to other wells
50494	Variably Saturated Zone	This had not produced water as of 10/03/94
50694	Variably Saturated Zone	Water elevation ~30 feet higher than neighboring wells
50794	Variably Saturated Zone	Water elevation ~40 feet higher than neighboring wells
50894	Variably Saturated Zone	Water elevation ~40 feet higher than neighboring wells
50994	Variably Saturated Zone	Water elevation ~40 feet higher than neighboring wells
51094	UHSU-Alluvium	Comparison of water elevation to other wells
51194	UHSU-Alluvium	Comparison of water elevation to other wells
51294	UHSU-Alluvium	Comparison of water elevation to other wells
51494	UHSU-Alluvium	Comparison of water elevation to other wells
51594	Variably Saturated Zone	Water elevation ~40 feet higher than neighboring wells
51694	UHSU-Alluvium	Comparison of water elevation to other wells
51794	Variably Saturated Zone	Water elevation ~50 feet higher than neighboring wells

Definitions:

LHSU lower hydrostratigraphic unit

OU operable unit

UHSU upper hydrostratigraphic unit

Table 3.6-2
OU 11 Area Monitoring Well Construction and Water Levels

Well Number	Hydrologic Regime	Surface Elevation (feet above mean sea level)	Top Screen Depth (feet)	Top Screen Elevation (feet above mean sea level)	Bottom Screen Depth (feet)	Bottom Screen Elevation (feet above mean sea level)	Depth to Water[1] (feet)	Water-Level Elevation (feet above mean sea level)	Date Water Level Measured
4686	LHSU	6082.0	140.3	5941.7	160.8	5921.2	94.6	5987.43	10/03/94
4786	UHSU-Alluvium	6081.9	6.2	6075.7	94.5	5987.4	57.7	6024.2	10/03/94
4886	LHSU	6097.1	192.0	5905.2	207.1	5890.1	60.0	6037.17	10/04/94
4986	UHSU-Alluvium	6097.4	4.1	6093.3	67.6	6029.8	49.9	6047.5	10/04/94
5086	UHSU-Alluvium	6121.0	2.9	6118.1	96.2	6024.9	50.0	6071.05	10/03/94
5186	UHSU-Alluvium	6142.4	4.8	6137.5	79.1	6063.3	62.6	6079.8	10/03/94
5286	UHSU-Weathered Bedrock	6142.1	92.0	6050.1	125.8	6016.3	69.9	6072.28	10/03/94
B110889	UHSU-Alluvium	6075.6	45.3	6030.3	64.8	6010.8	34.6	6041	10/03/94
B110989	UHSU-Alluvium	6082.3	46.1	6036.2	65.6	6016.7	46.9	6035.4	10/04/94
B111189	UHSU-Alluvium	6105.7	53.1	6052.6	72.6	6033.1	56.5	6049.2	10/03/94
B410589	UHSU-Alluvium	6111.8	40.6	6071.3	60.0	6051.8	51.8	6060	10/05/94
B410689	UHSU-Alluvium	6091.7	30.5	6061.2	50.1	6041.7	42.6	6049.1	10/04/94
B410789	UHSU-Alluvium	6082.1	25.5	6056.6	45.0	6037.1	36.9	6045.2	10/04/94
B411289	UHSU-Alluvium	6125.4	48.9	6076.5	68.4	6057.0	60.5	6064.9	10/03/94
B411389	UHSU-Alluvium	6109.5	44.0	6065.5	63.5	6046.0	53.2	6056.3	10/03/94
46192	UHSU-Alluvium	6141.5	57.2	6084.3	77.2	6064.3	70.8	6070.7	10/03/94
46292	UHSU-Alluvium	6095.3	45.5	6049.8	90.5	6004.8	52.9	6042.4	10/04/94
46392	UHSU-Weathered Bedrock	6063.2	64.5	5998.7	79.5	5983.7	31.7	6031.48	10/03/94
46492	UHSU-Alluvium	6054.7	28.2	6026.5	43.2	6011.5	26.1	6028.6	10/03/94
50194	UHSU-Alluvium	6114.4	74.7	6039.7	94.7	6019.7	56.4	6058	10/18/94
50294	Variably Saturated Zone	6142.0	5.9	6136.1	15.9	6126.1	15.8	6126.2	10/19/94
50394	UHSU-Alluvium	6120.3	49.5	6070.8	64.5	6055.8	56.4	6063.9	10/18/94
50494	Variably Saturated Zone	6092.3	11.7	6080.6	21.7	6070.6	dry	dry	10/18/94

Well Number	Hydrologic Regime	Surface Elevation (feet above mean sea level)	Top Screen Depth (feet)	Top Screen Elevation (feet above mean sea level)	Bottom Screen Depth (feet)	Bottom Screen Elevation (feet above mean sea level)	Depth to Water[1] (feet)	Water-Level Elevation (feet above mean sea level)	Date Water Level Measured
50694	Variably Saturated Zone	6085.5	11.8	6073.7	26.8	6058.7	18.5	6067	10/18/94
50794	Variably Saturated Zone	6132.8	13.0	6119.8	23.0	6109.8	7.0	6125.8	10/19/94
50894	Variably Saturated Zone	6111.4	10.0	6101.4	25.0	6086.4	9.5	6101.9	10/19/94
50994	Variably Saturated Zone	6107.6	13.0	6094.6	23.0	6084.6	13.4	6094.2	10/19/94
51094	UHSU-Alluvium	6091.2	37.7	6053.5	57.7	6033.5	42.9	6048.3	10/18/94
51194	UHSU-Alluvium	6071.4	35.0	6036.4	50.0	6021.4	41.7	6033.6	12/2/94
51294	UHSU-Alluvium	6062.8	20.0	6042.8	35.0	6027.8	21.7	6041.1	10/18/94
51494	UHSU-Alluvium	6097.4	48.7	6048.7	68.7	6028.7	49.7	6047.7	10/18/94
51594	Variably Saturated Zone	6097.5	10.0	6087.5	20.0	6077.5	13.9	6083.6	10/18/94
51694	UHSU-Alluvium	6092.5	45.0	6047.5	60.0	6032.5	56.4	6037.3	11/1/94
51794	Variably Saturated Zone	6132.8	3.0	6129.8	8.0	6124.8	8.1	6124.7	10/18/94

1 As measured from ground surface.

Definitions:

LHSU lower hydrostratigraphic unit

OU operable unit

UHSU upper hydrostratigraphic unit

Table 3.6-3
Average Linear Ground-Water Flow Velocity

Flow Path	Horizontal Hydraulic Gradient (ft/ft)	Hydraulic Conductivity (cm/sec)	Effective Porosity	Average Linear Ground-Water Velocity	
				(cm/sec)	(ft/yr)
50394/B110889	0.0129	2.20E-03	0.1	2.84E-04	29
50194/51694	0.014	2.20E-03	0.1	3.08E-04	32

Definitions:

cm/sec centimeters per second

ft/ft feet per foot

ft/yr feet per year

Table 3.6-4
OU 11 Area Wells that were Geophysically Logged

Well Number	
4786	50194
5086	50294
5186	50394
B110889	50494
B110989	50694
B111189	50794
B410589	50894
B410689	50994
B410789	51094
B411289	51194
B411389	51294
46192	51494
46292	51594
46392	51694
46492	51794

Definition:

OU operable unit

Table 3.6-5
Hydraulic Conductivity Data for OU 11 Area Wells

Well Number	Geologic Unit	Hydrostratigraphic Unit	Estimated Hydraulic Conductivity (cm/sec)	Screen Midpoint (ft bgs)
50294	Qrf	Variably Saturated Zone	7.54E-06	10.9
50694	Qrf	Variably Saturated Zone	1.83E-05	19.3
50694	Qrf	Variably Saturated Zone	1.09E-03	19.3
50794	Qrf	Variably Saturated Zone	1.01E-04	18.0
50794	Qrf	Variably Saturated Zone	1.62E-04	18.0
50894	Qrf	Variably Saturated Zone	8.74E-07	17.5
50994	Qrf	Variably Saturated Zone	1.49E-05	18.0
50994	Qrf	Variably Saturated Zone	1.64E-05	18.0
B110889	Qrf	UHSU-Alluvium	3.15E-02	55.2
B110989	Qrf	UHSU-Alluvium	7.50E-03	56.1
B111189	Qrf	UHSU-Alluvium	2.00E-03	63.1
B411289	Qrf	UHSU-Alluvium	1.75E-04	58.6
B411389	Qrf	UHSU-Alluvium	7.75E-04	53.0
46192	Qrf	UHSU-Alluvium	1.01E-06	67.2
46492	Qrf	UHSU-Alluvium	4.73E-06	35.7
50194	Qrf	UHSU-Alluvium	8.74E-04	84.7
50194	Qrf	UHSU-Alluvium	9.00E-04	84.7
50394	Qrf	UHSU-Alluvium	8.08E-07	57.0
51094	Qrf	UHSU-Alluvium	1.86E-03	47.7
51094	Qrf	UHSU-Alluvium	4.65E-03	47.7
51494	Qrf	UHSU-Alluvium	7.91E-05	58.7
51494	Qrf	UHSU-Alluvium	1.41E-04	58.7
51594	Qrf	UHSU-Alluvium	2.49E-06	15.0
51694	Qrf	UHSU-Alluvium	8.45E-07	50.5
4886	Wxbrclst	UHSU-Weathered Bedrock	1.02E-06	197.5
46392	Wxbrclst	UHSU-Weathered Bedrock	2.08E-05	72.0

Definitions:

cm/sec	centimeters per second
ft bgs	feet below ground surface
Qrf	Rocky Flats Alluvium
UHSU	upper hydrostratigraphic unit
Wxbrclst	weathered bedrock claystone

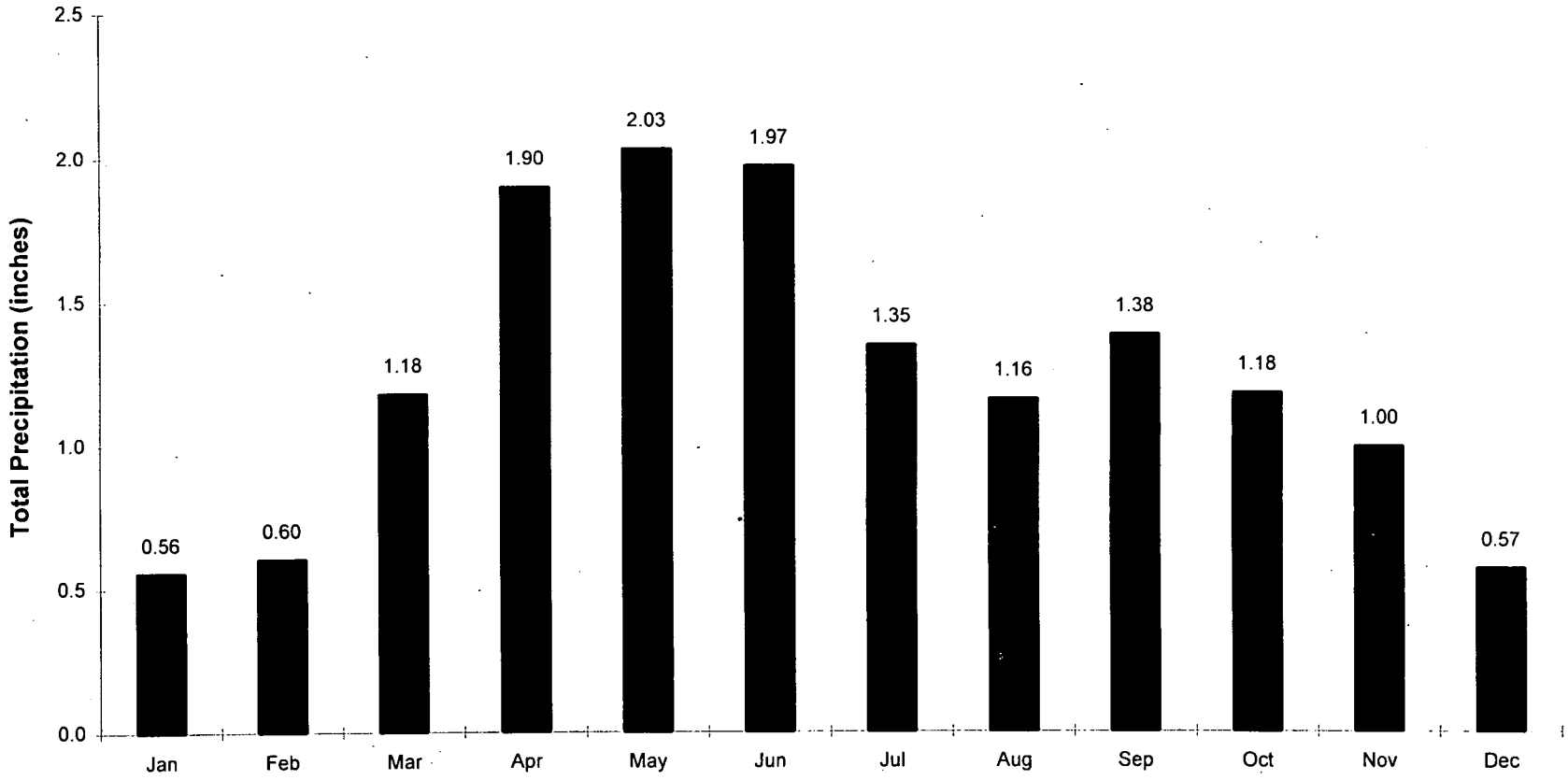
Table 3.6-6
Summary Statistics for OU 11 Area Hydraulic Conductivity Data for Rocky Flats Alluvium

Parameter	Hydraulic Conductivity (cm/sec)
Geometric Mean	8.51E-05
Mean	2.16E-03
Standard Error	1.32E-03
Median	1.21E-04
Mode	0.00E+01
Standard Deviation	6.49E-03
Variance	4.21E-06
Kurtosis	2.02E+02
Skewness	4.38E+01
Range	3.15E-02
Minimum	8.08E-07
Maximum	3.15E-02
Sum	5.19E-02
Count	2.40E+02

Definitions:

cm/sec centimeters per second

OU operable unit



U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

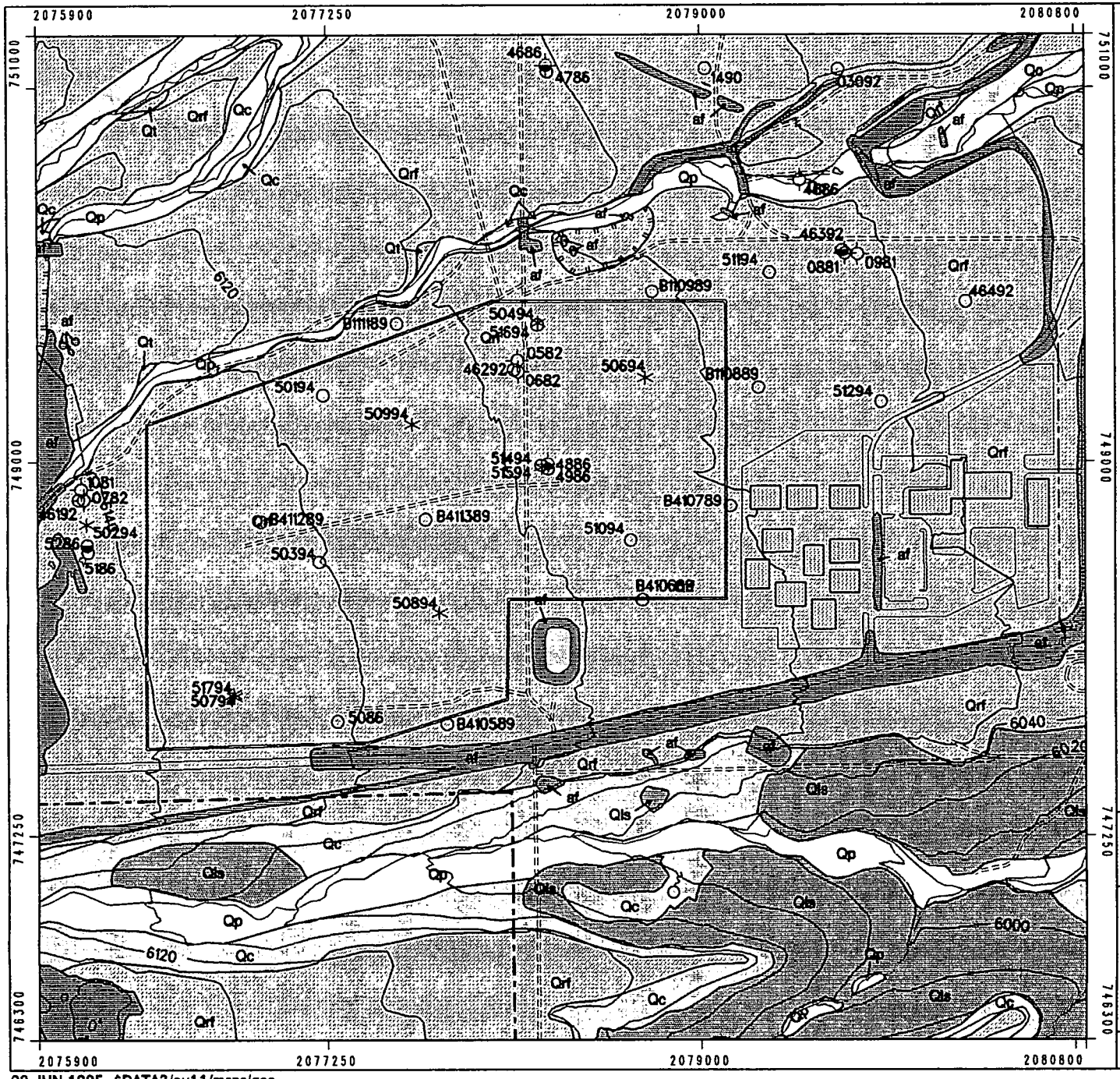
Historic Mean Total Precipitation at the Rocky Flats Environmental Technology Site

Final Combined Phases
RFI/RI Report

Operable Unit 11

June 1995

Figure 3.2-1



EXPLANATION

- UHSU-Alluvial Well (Upper Hydrostratigraphic Unit)
- UHSU-Variably Saturated Zone Well
- UHSU-Weathered Bedrock Well
- LHSU-Bedrock Well (Lower Hydrostratigraphic Unit)
- Abandoned Well
- Lakes and Ponds
- Buildings and Trailers (130 Complex)
- af — Artificial Fill (latest Recent)
- Qp — Piney Creek and Post-Piney Creek Alluvium (Recent)
- Qt — Terrace Alluvium, undivided (late and middle Pleistocene)
- Qs — Slocum Alluvium (middle Pleistocene)
- Qv — Verdos Alluvium (early middle Pleistocene)
- Qrf — Rocky Flats Alluvium (early Pleistocene)
- Qc — Colluvium, undivided (Holocene to middle Pleistocene)
- Qls — Landslide Deposits (Holocene to middle Pleistocene)
- Ka — Arapahoe Formation (Upper Cretaceous)
- Kl — Laramie Formation (Upper Cretaceous)
- Kfh — Fox Hills Sandstone (Upper Cretaceous)

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

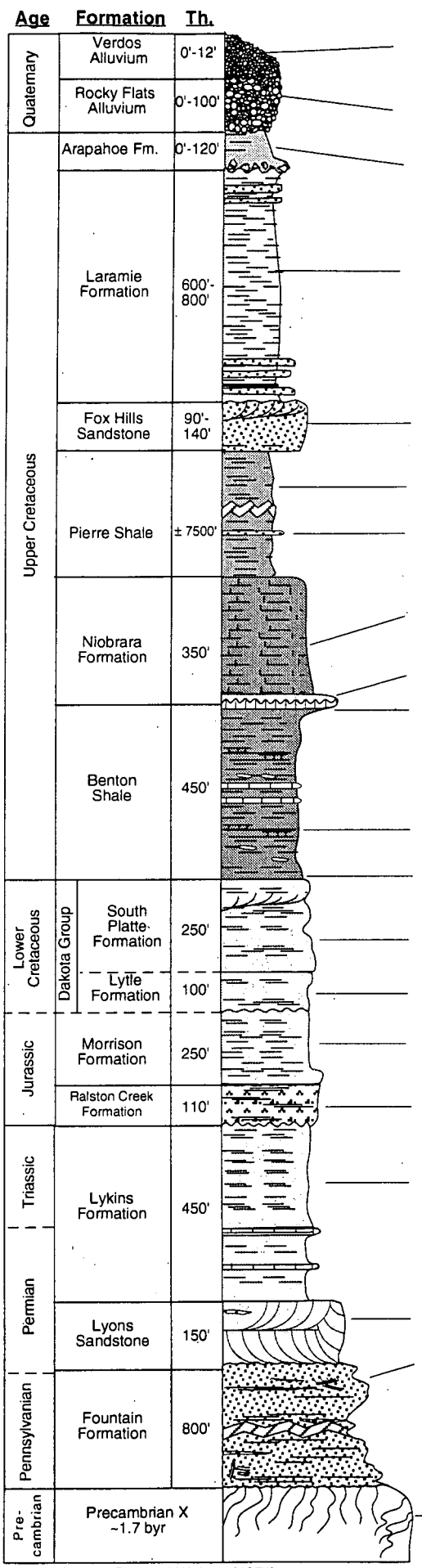
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Map of Surficial Deposits

Final Combined Phases RFI/RI Report — Operable Unit 11

June 1995 — Figure 3.5-1

02-JUN-1995 $DATA2/ou11/maps/geo



Modified from LeRoy and Weimer (1971)

Description

Reddish brown matrix, moderately sorted, sandy pebble gravel and pebbly, silty sand

Reddish brown to yellowish brown matrix, grayish-orange to dark gray, poorly sorted, angular to subrounded, cobbles, coarse gravels, coarse sands and gravelly clays; varying amounts of caliche; aggregate source

Gray to yellowish orange clay stone, sandy clay stone, and clayey sandstone, medium to coarse sandstone and chert pebble conglomerate locally at base

Gray, fine- to medium-grained sandstone and clay stones; thin coal beds mined in lower part

Light olive gray to yellowish brown fine- to medium-grained cross-bedded sandstone, and laminated silty sandstone and shale at base; aquifer east of RFETS

Dark gray, silty bentonitic shale and few thin, silty sandstones

Hygiene Sandstone Member in lower part

Olive gray to dusky yellow, very calcareous shale, thin bentonite, gypsum, and fossiliferous limestone beds

Light gray, dense, fossiliferous limestone

Yellowish gray, sandy fossiliferous limestone

Dark gray shale with bentonite streaks, thin limestones in middle part

Dark gray to black, brittle silty shale

Light gray, fine- to medium-grained cross-bedded sandstone, dark gray clay stone in middle part

Light gray to tan, fine- to coarse-grained, locally conglomeratic sandstone, frequent red and green siltstone interbeds

Gray to greenish-gray to red shale and siltstone, thin limestones in middle part; lenticular sandstones in upper and lower part

Light gray siltstone and light red, silty shale; calcareous; chert nodules and beds

Red siltstone and clay stone with two laminated limestones in lower part

Pinkish-gray, fine- to medium-grained, cross-bedded sandstone; conglomeratic lenses frequent

Red, fine- to coarse-grained sandstone and conglomerate, arkosic, thin, lenticular red siltstones frequent throughout

Gneiss, schist, and small granitic intrusions

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Golden, Colorado

Generalized Stratigraphic Column for the Rocky Flats Area

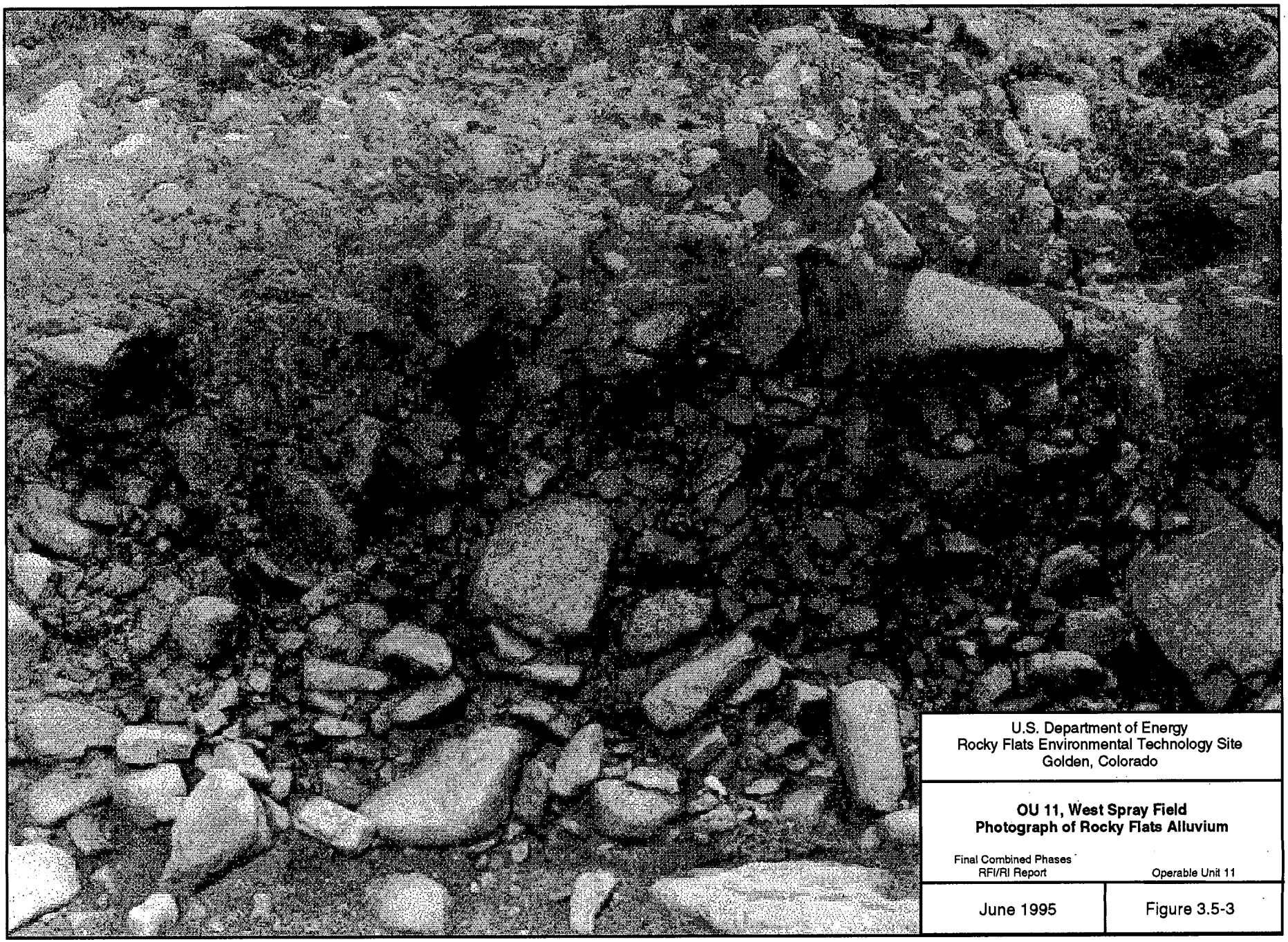
Final Combined Phases RFI/RI Report

Operable Unit 11

June 1995

Figure 3.5-2

G95\ES\Stratigraphy-1975.mdw



U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11, West Spray Field
Photograph of Rocky Flats Alluvium

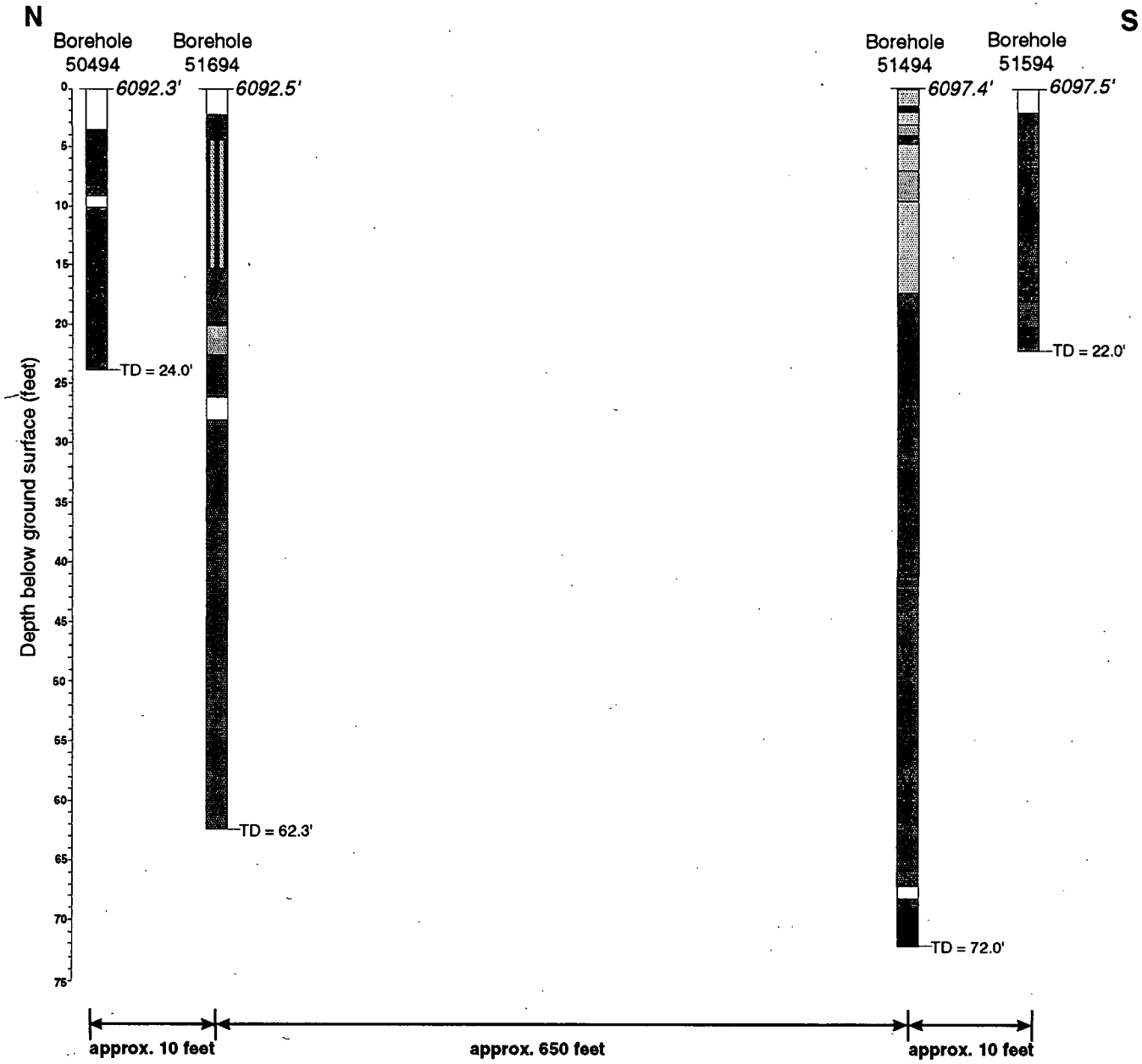
Final Combined Phases
RFI/RI Report

Operable Unit 11

June 1995

Figure 3.5-3

G95\ES\Rocks-OU11.CD



EXPLANATION

Symbol:	USCS Classification:
	GW
	GM
	GC
	SW
	SM
	SC
	CL
	No Recovery
	Bedrock

Color stripes indicate mix of the corresponding USCS classes.

6092.3' - Elevations in feet above mean sea level.

Intervals of no recovery are only shown if greater than 1 foot. Otherwise, interval is split among overlying and underlying USCS classes.

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Lithologies Encountered in Select Well-Pair Boreholes

Final Combined Phases RFI/RI Report

Operable Unit 11

June 1995

Figure 3.5-4

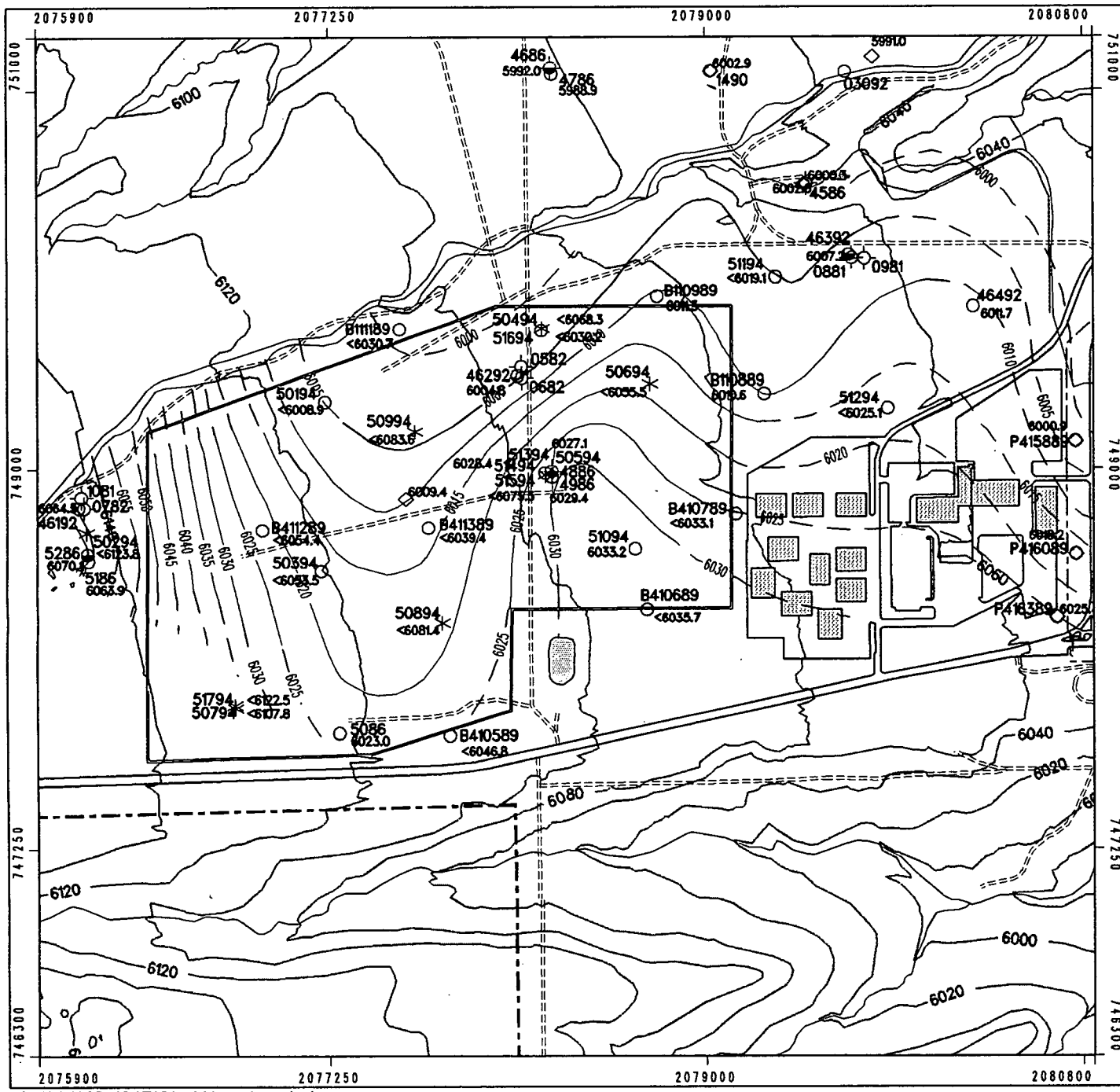
G95\EEC\SELECTED BOREHOLE LOGS\Selected Borehole Logs.ai

Section 4
Tables

Section 5
Tables

Section 6
Tables

Section 6
Figures



EXPLANATION

- UHSU-Alluvial Well (Upper Hydrostratigraphic Unit)
- UHSU-Variably Saturated Zone Well
- UHSU-Weathered Bedrock Well
- LHSU-Bedrock Well (Lower Hydrostratigraphic Unit)
- Abandoned Well
- Top of Bedrock Elevation Contour (5 ft. Interval);
- Dashed Where Inferred
- OU 11 (IHSS 168)
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- Lakes and Ponds
- Buildings

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Top of Bedrock

Final Combined Phases
RFI/RI Report

Operable Unit 11

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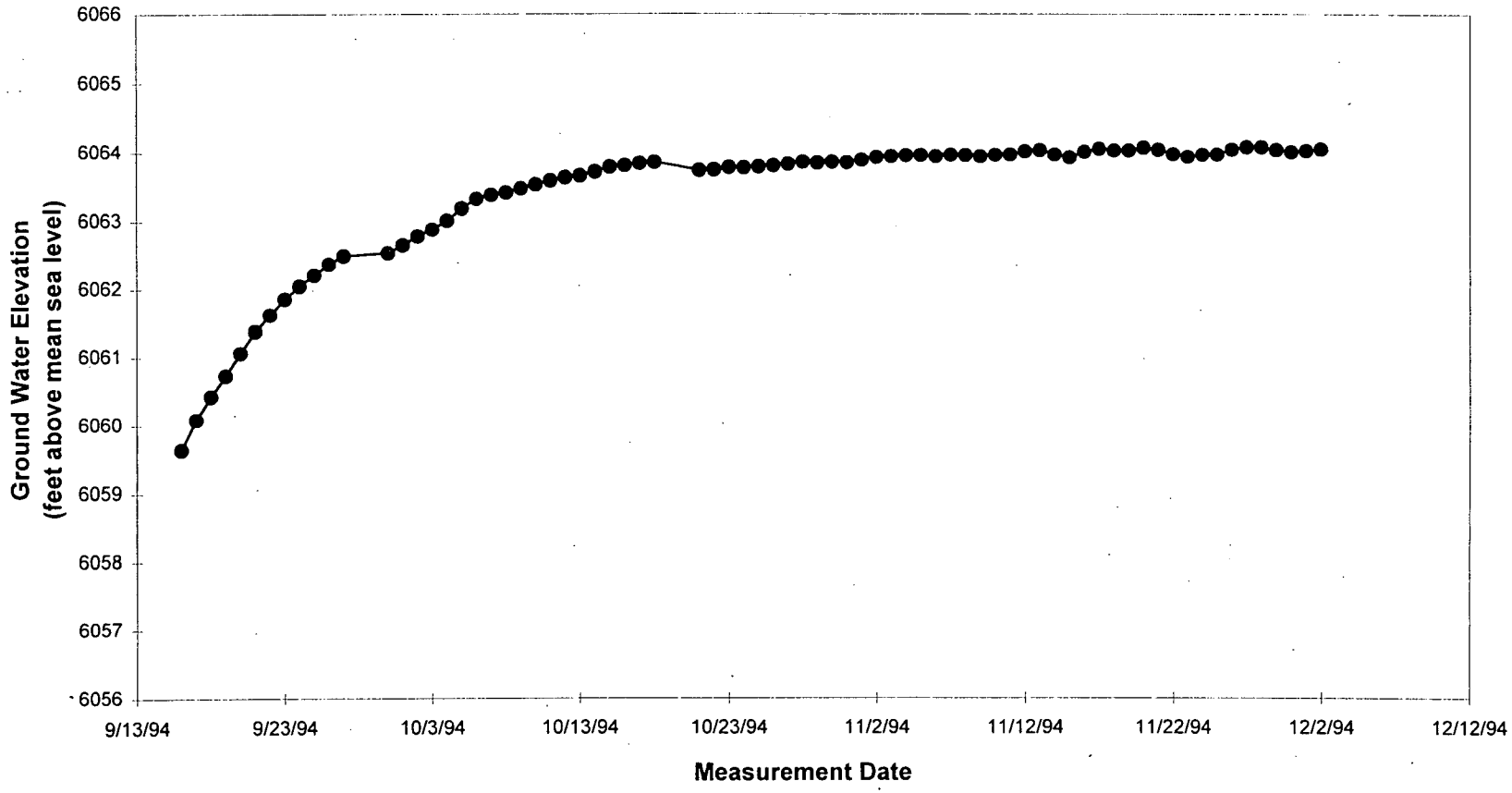
Figure 3.5-5

02-JUN-1995 $DATA2/ou11/maps/mon_bed



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Rocky Flats Environmental Technology Site
Golden, Colorado

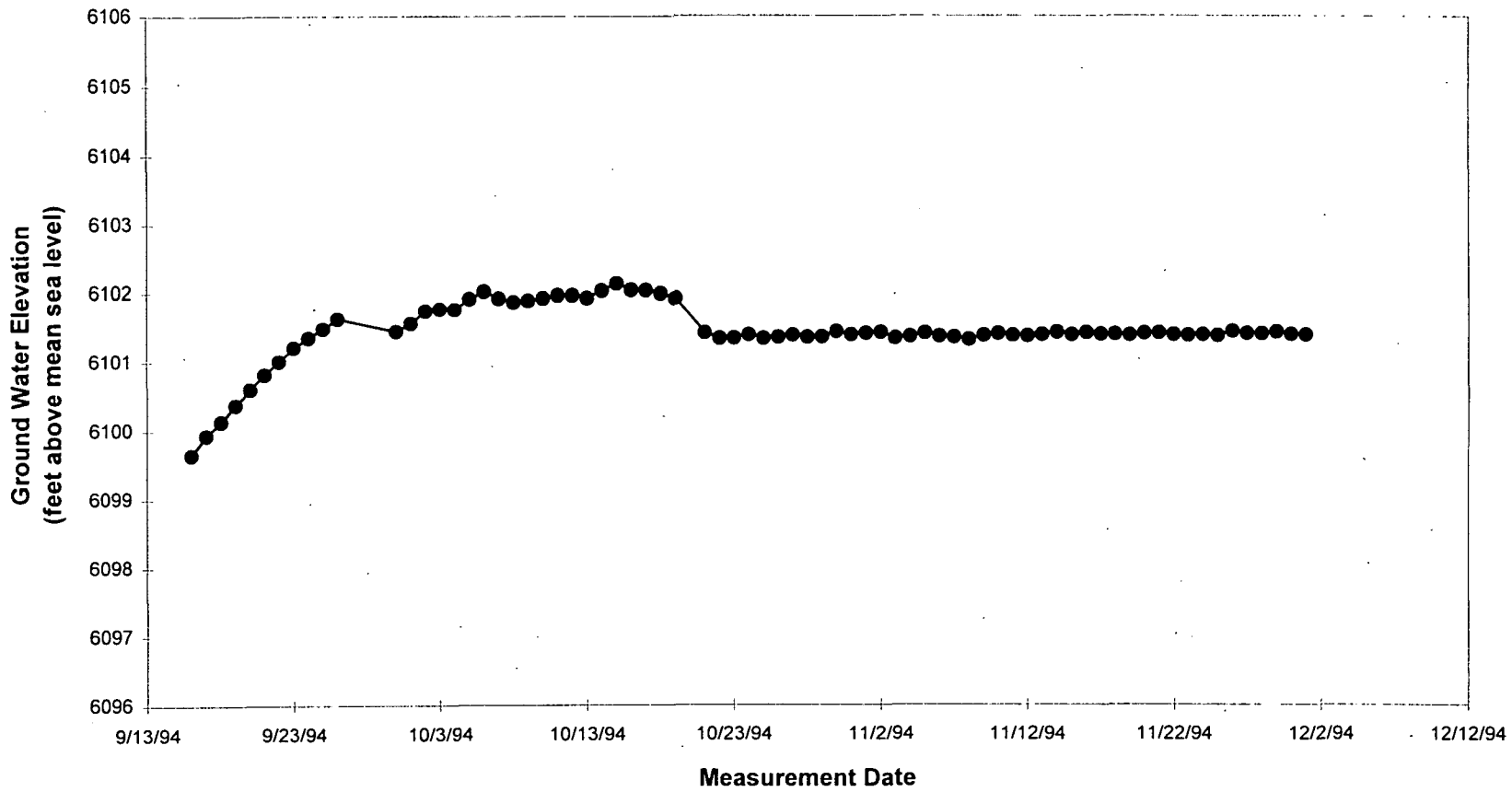
Hydrograph for Well 50394

Final Combined Phases
RFI/RI Report

Operable Unit 11

June 1995

Figure 3.6-1



U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Hydrograph for Well 50894

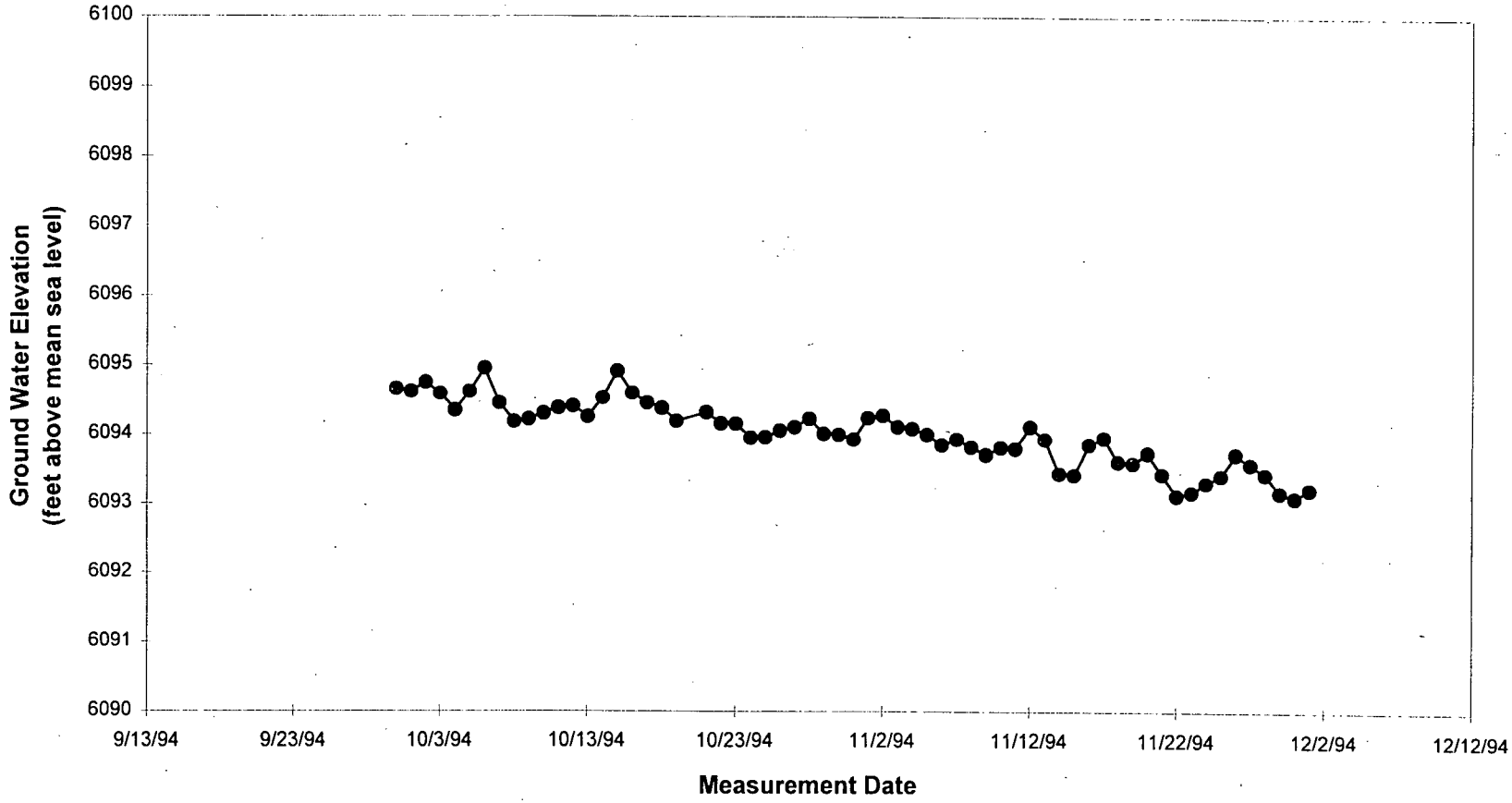
Final Combined Phases
RFI/RI Report

Operable Unit 11

June 1995

Figure 3.6-2

MEP C:\..\OU11HYD.XLS Fig 3 6-2 6/5/95



U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Hydrograph for Well 50994

Final Combined Phases
RFI/RI Report

Operable Unit 11

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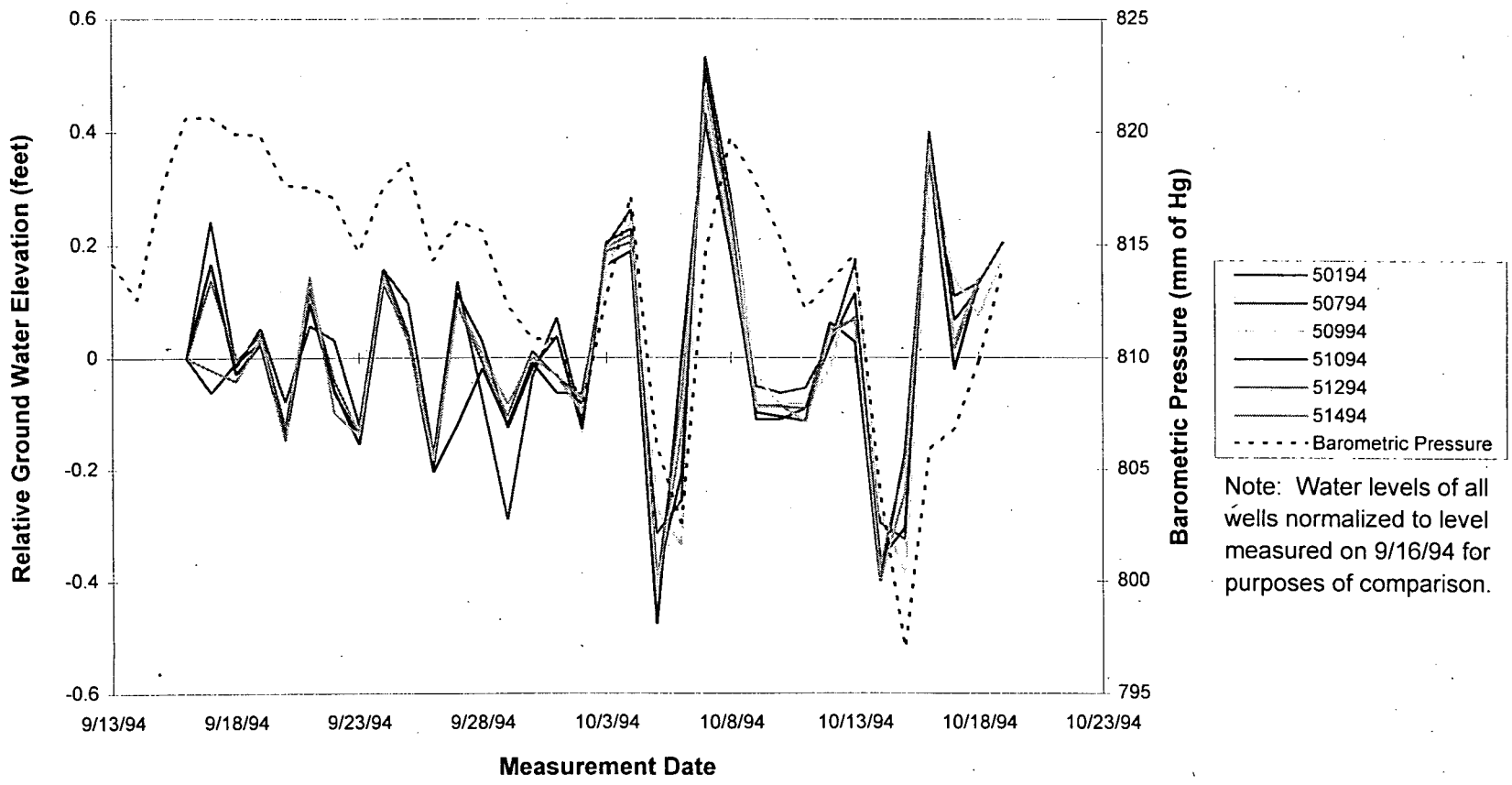
Figure 3.6-3

MEP C:\..\OU11HYD.XLS Fig 3.6-3 6/5/95



Note: Water levels of all wells normalized to level measured on 9/16/94 for purposes of comparison.

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Water Levels of Recovered Wells Compared to Barometric Pressure

Final Combined Phases RFI/RI Report

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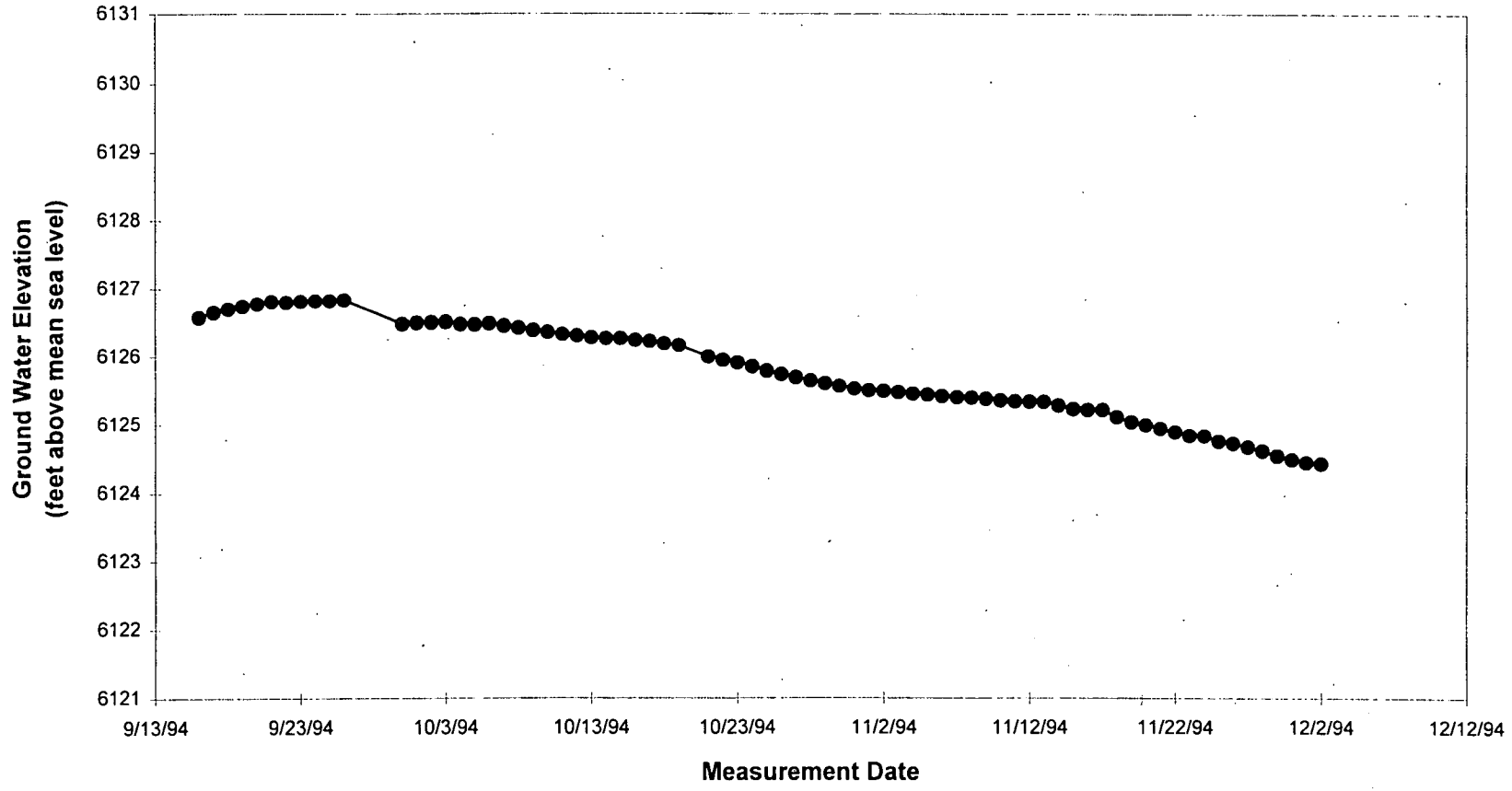
Figure 3.6-4

MEP C:\..\OU11HYD.XLS Fig 3 6-4 6/5/95



U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Hydrograph for Well 50294

Final Combined Phases
RFI/RI Report

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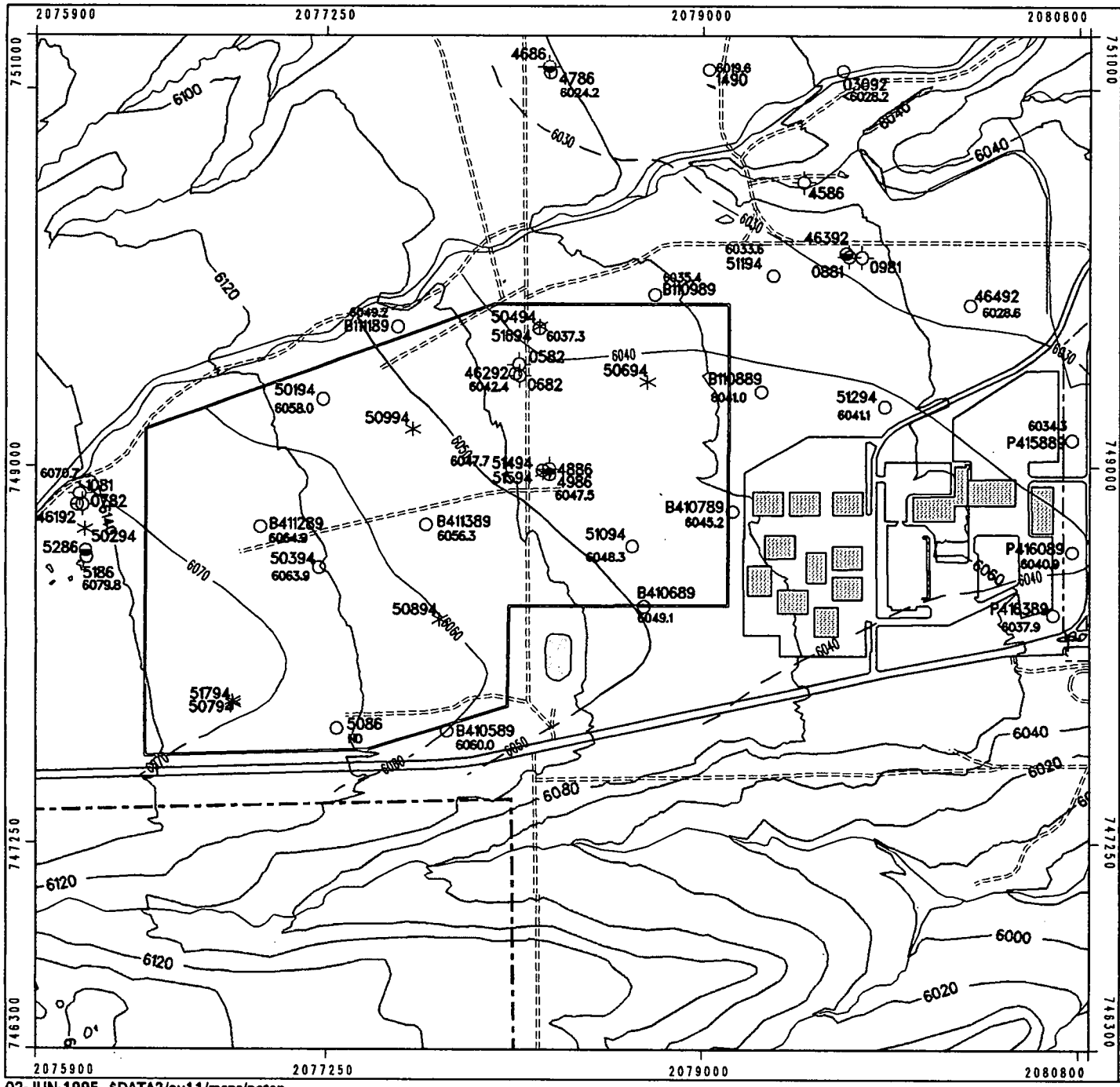
Figure 3.6-5

MEP C:\.\OU11HYD.XLS Fig 3 6-5 6/5/95



EXPLANATION

- UHSU-Alluvial Well (Upper Hydrostratigraphic Unit)
- UHSU-Variably Saturated Zone Well
- UHSU-Weathered Bedrock Well
- LHSU-Bedrock Well (Lower Hydrostratigraphic Unit)
- Abandoned Well
- Water Level Contour (feet above mean sea level)
- (dashed where inferred)
- OU 11 (IHSS 168)
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- Lakes and Ponds
- Buildings

Scale = 1 : 8400
1 inch = 700 feet

250 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Potentiometric Surface October 1994

Final Combined Phases RFI/RI Report

Operable Unit 11

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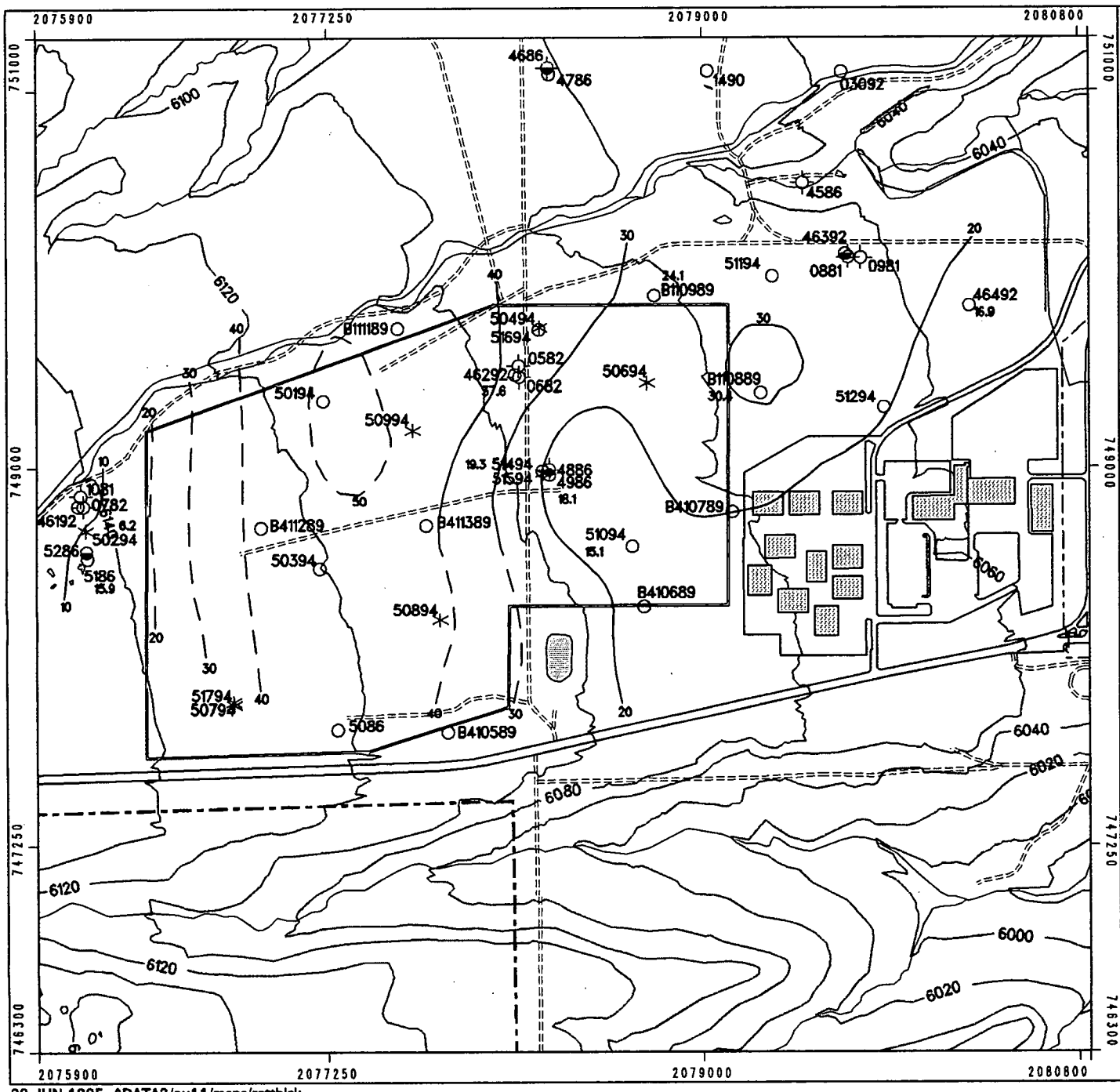
Figure 3.6-6

02-JUN-1995 $DATA2/ou11/maps/poten



EXPLANATION

- UHSU-Alluvial Well (Upper Hydrostratigraphic Unit)
- UHSU-Variably Saturated Zone Well
- UHSU-Weathered Bedrock Well
- LHSU-Bedrock Well (Lower Hydrostratigraphic Unit)
- Abandoned Well
- Saturated Thickness Isopach (in feet)
- Inferred Isopach (in feet)
- OU 11 (IHSS 168)
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- Lakes and Ponds
- Buildings

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Rocky Flats Environmental Technology Site
Golden, Colorado

Saturated Thickness of Rocky Flats Alluvium

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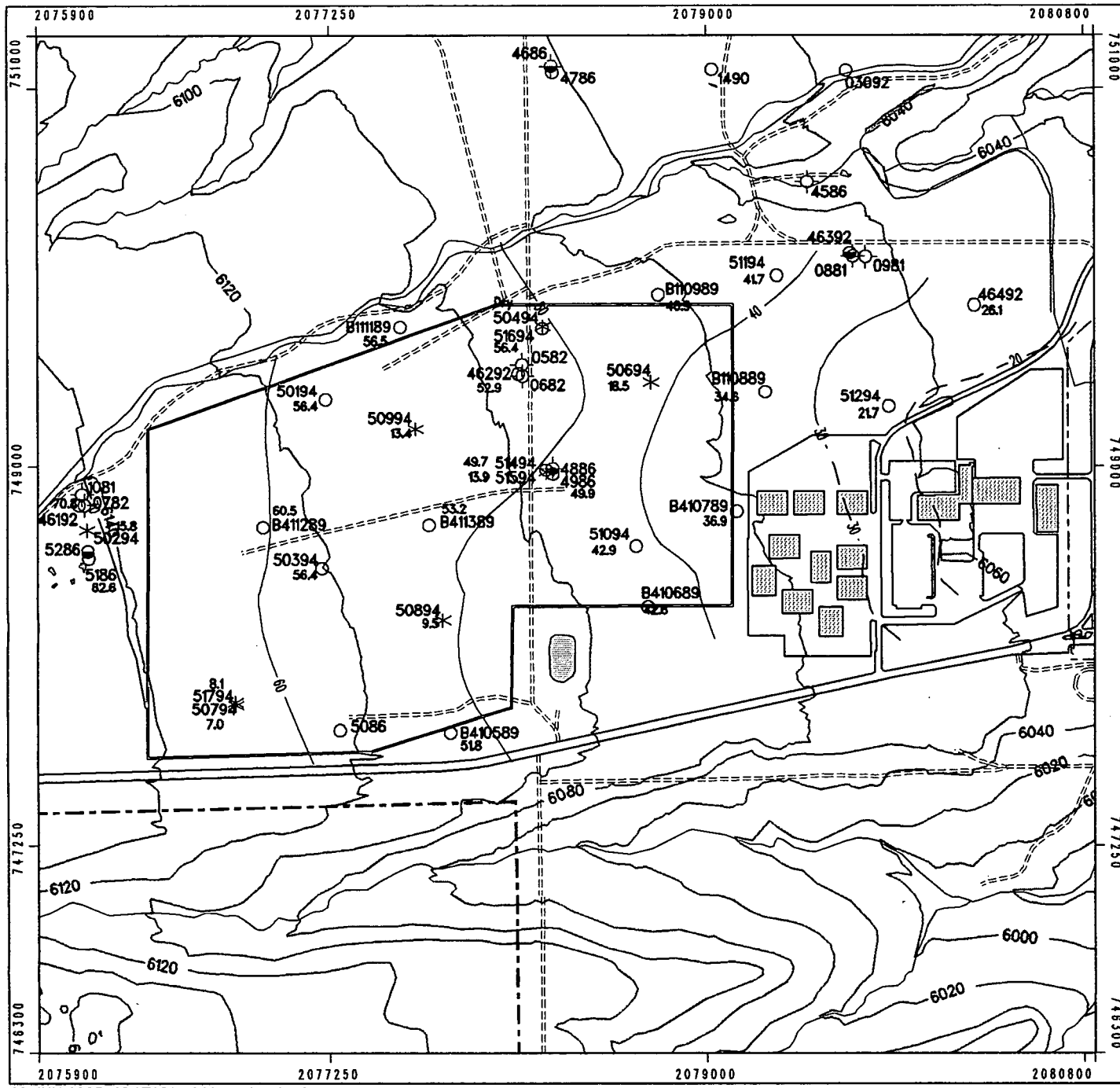
Figure 3.6-7

02-JUN-1995 $DATA2/ou11/maps/satthick



EXPLANATION

- UHSU-Alluvial Well (Upper Hydrostratigraphic Unit)
- UHSU-Variably Saturated Zone Well
- UHSU-Weathered Bedrock Well
- LHSU-Bedrock Well (Lower Hydrostratigraphic Unit)
- Abandoned Well
- Depth to Water Contour (in feet)
- Inferred Contour
- OU 11 (IHSS 168)
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- Lakes and Ponds
- Buildings

NOTE: Data from variably saturated zone wells are posted for completeness but are not contoured.

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Golden, Colorado

Depth to UHSU Water Table

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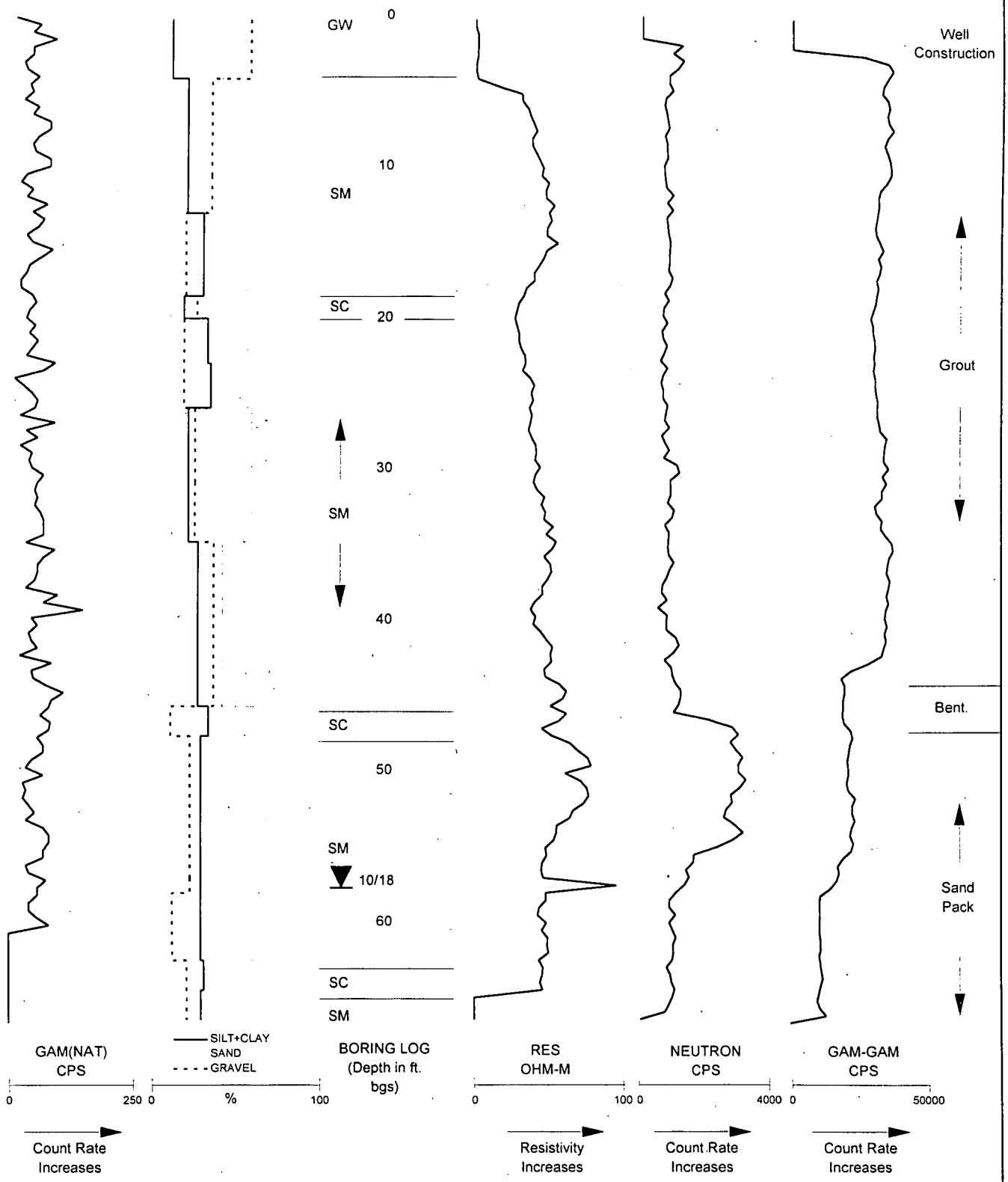
Figure 3.6-8

02-JUN-1995 $DATA2/ou11/maps/gwdepth



Note: Scale is approximate

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Golden, Colorado

Comparison of Geophysical and Borehole Logs for Well 50394

Final Combined Phases
RFI/RI Report
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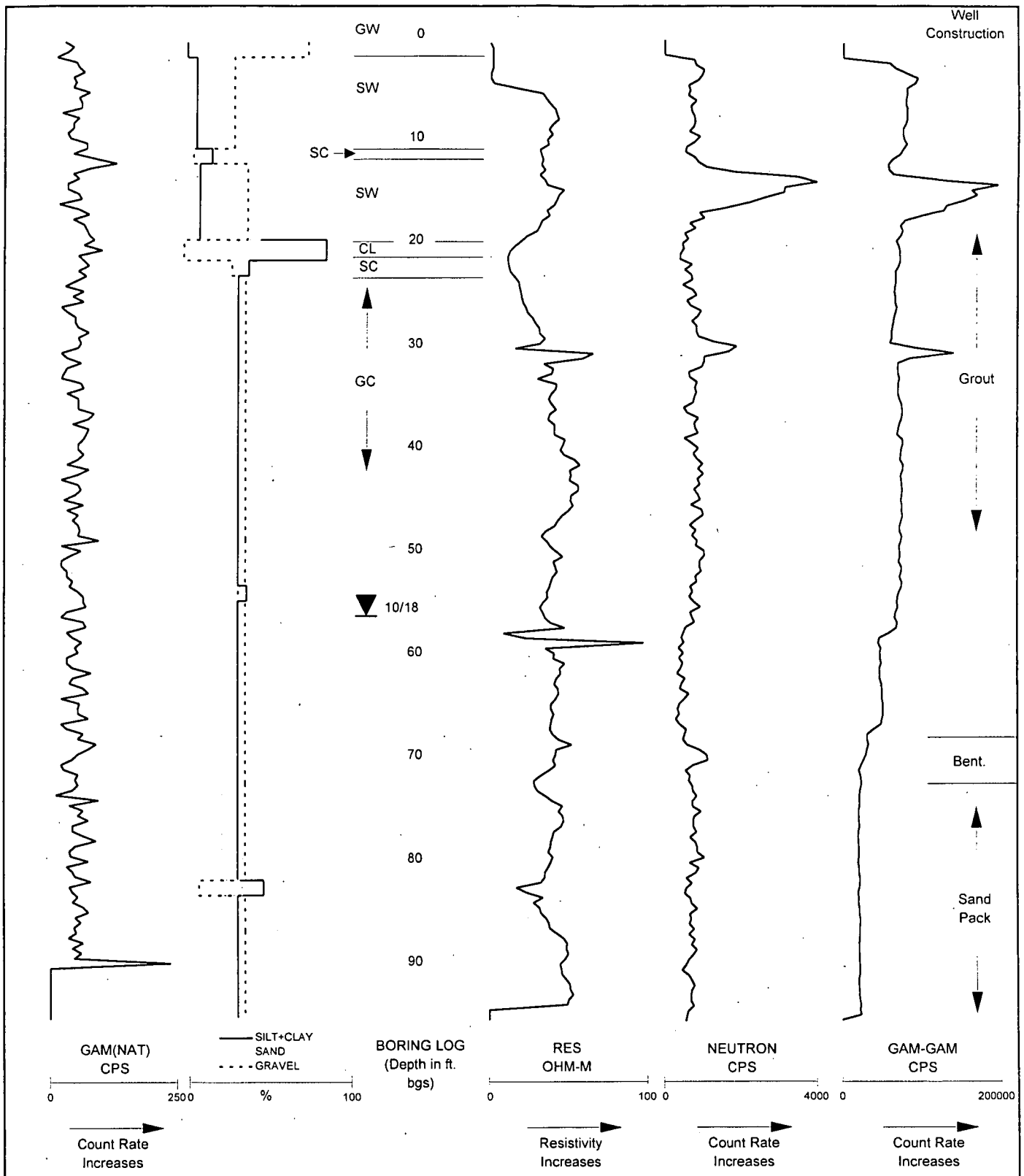
Figure 3.6-9



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Golden, Colorado

Comparison of Geophysical and Borehole Logs for Well 50194

Final Combined Phases
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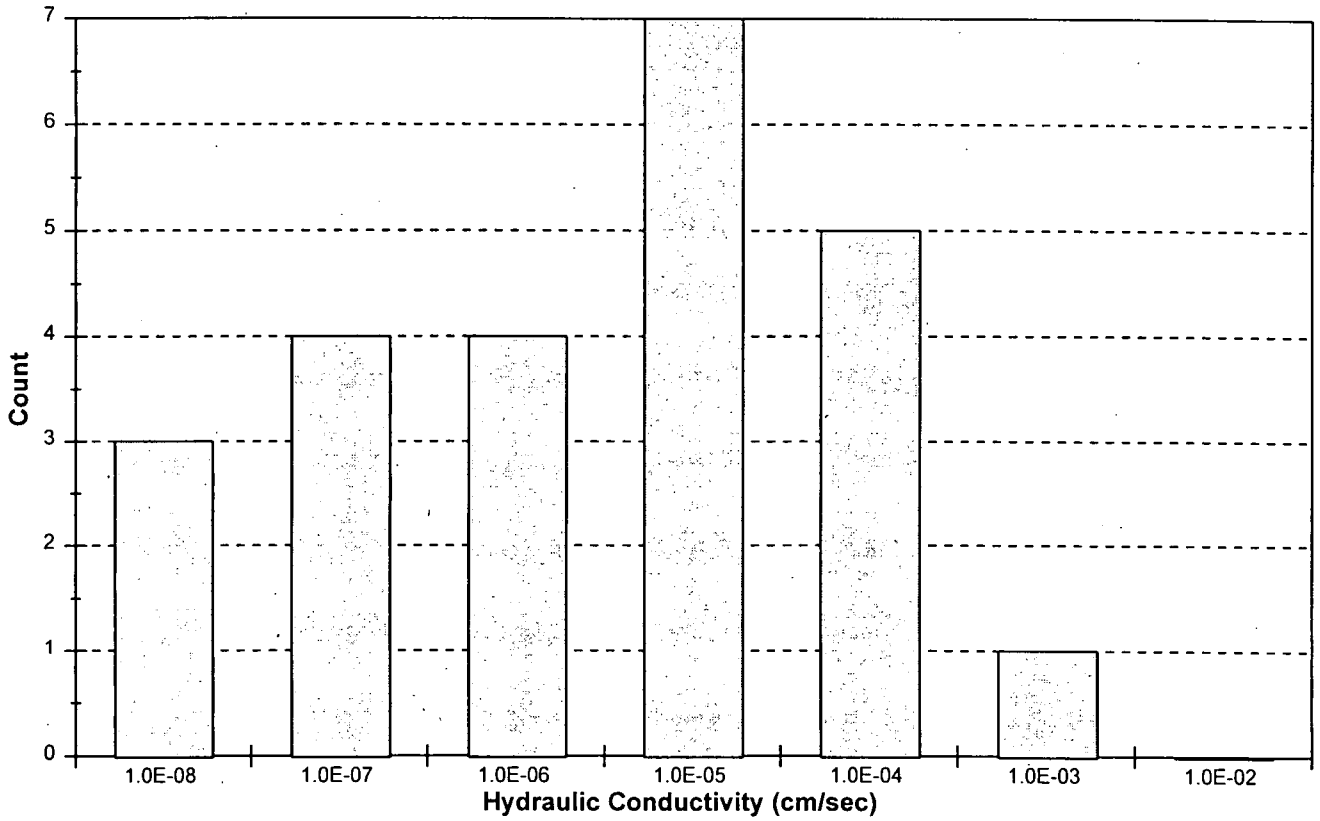
Figure 3.6-10

Note: Scale is approximate

MEP C:\...50194.XLS Fig 3.6-10 6/5/95



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Golden, Colorado

Histogram of OU 11 Hydraulic Conductivity Data

Final Combined Phases
RFI/RI Report

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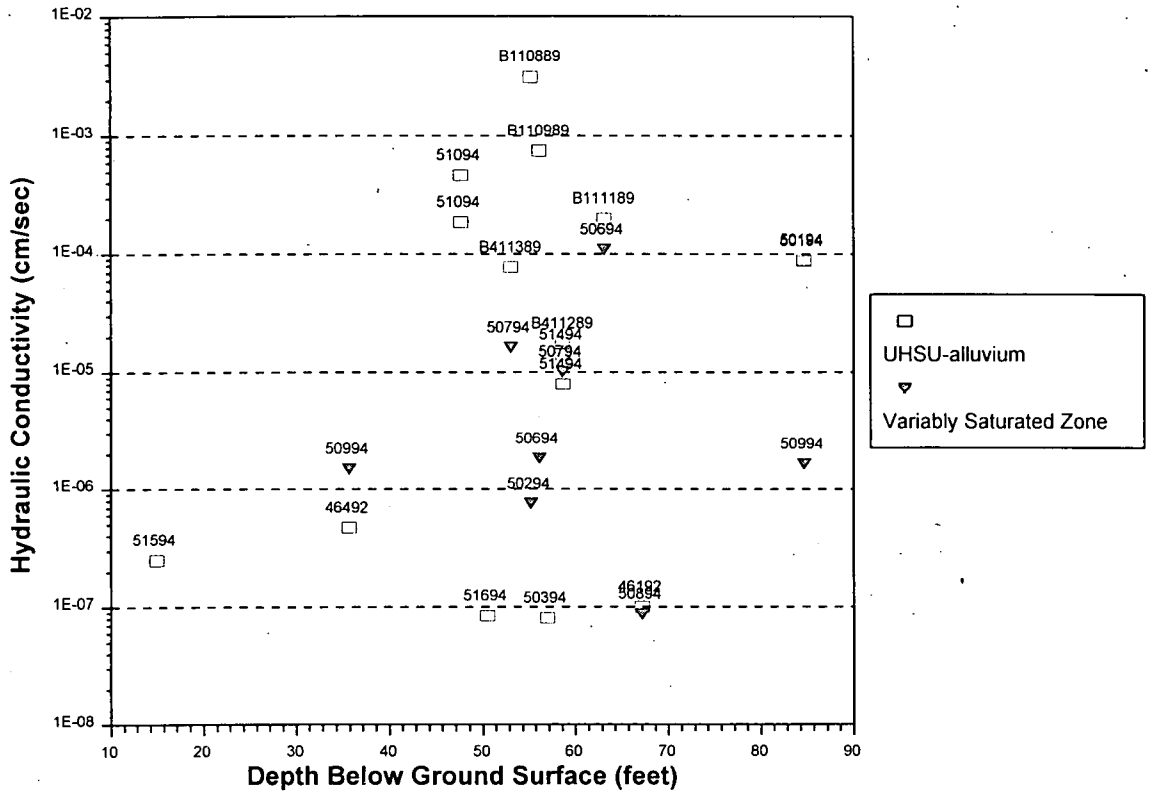
Figure 3.6-11



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Golden, Colorado

Hydraulic Conductivity Versus Screen Midpoint Depth

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RFI/RI Report

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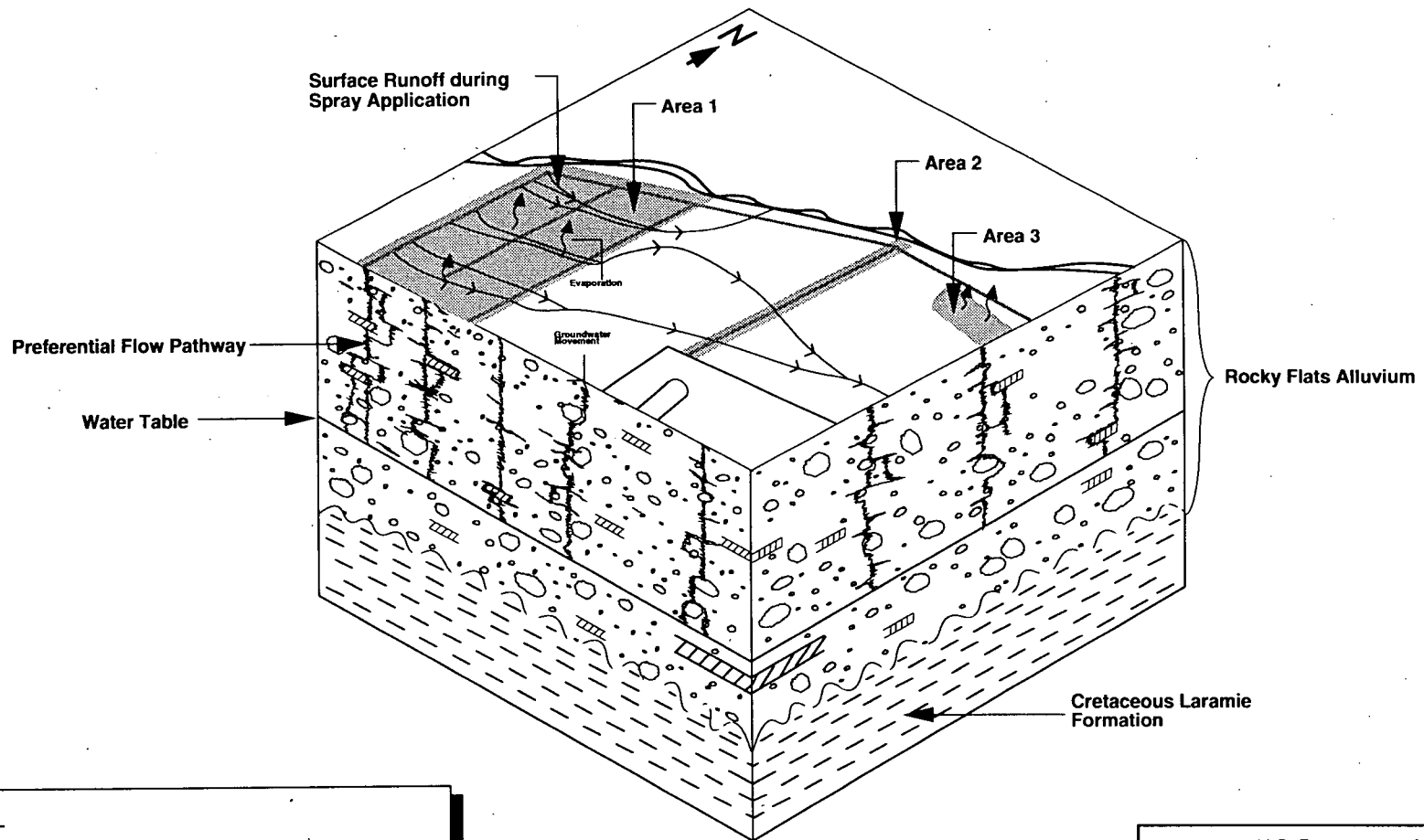
Figure 3.6-12

MEP C:\DOCS\OU11\PLOTS\MEPHYD.XLS Fig 3.6-12 6/5/95



Legend:

- Historical Piping for Spray Application
- Surface Runoff during Spray Application
- Spray Areas
- Semipervious Layers within the Rocky Flats Alluvium
- Alluvial Gravel and Sand
- Bedrock Claystone
- Preferential Flow Pathways

DRAWING NOT TO SCALE

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Golden, Colorado

Conceptual Model of OU 11 Hydrologic System

Final Combined Phases RFI/RI Report

Operable Unit 11

June 1995

Figure 3.6-13

G95\OU11 Block Model.-2509.mdw

4. Nature and Extent of Contamination

The nature and extent of contamination related to sources within OU 11 (IHSS 168) were evaluated by analysis of chemical data from environmental media collected during the combined phases RFI/RI and during ongoing sitewide monitoring programs. Descriptions of contaminant sources for each environmental medium at OU 11 are provided in the following sections and are based on the following information: descriptive summary statistics for each analyte, graphical presentations of concentration data for each analyte, analyte-distribution maps for each analyte, statistical comparisons of chemical concentrations in environmental media from OU 11 to chemical concentrations in environmental media from background locations to identify PCOCs, and qualitative analysis of chemical data to evaluate the spatial and temporal variations in contaminant concentrations.

Statistical data-analysis methods are described in Section 4.1. Summary statistics for each media type and graphical presentations of chemical concentration data are included in the CDPHE Source Area Delineation and Risk-Based Conservative Screen and EPA Area of Concern Delineation Final Letter Report (CDPHE Conservative Screen Final Letter Report), which is included as Appendix D. Results of the statistical-comparison tests are summarized in Section 4.2 and discussed in detail for each media in Sections 4.3 through 4.6.

4.1 Methodology for Background Comparison and PCOC Identification

Analytical data from environmental samples collected during the OU 11 combined phases RFI/RI and from samples collected during sitewide monitoring programs were used to characterize contamination at OU 11. Data from locations discussed in the Background Geochemical Characterization Report (DOE, 1993) provided the background database used for ground water and subsurface geologic materials. Results for background ground-water samples collected from the first quarter of 1990 through the second quarter of 1993 (data used in DOE, 1993) were extracted from RFEDS and compose the background data set. Samples of subsurface geologic materials were collected from background locations in 1991; results for these samples were also obtained from RFEDS. Background surficial soils were not described in the Background Geochemical Characterization Report (DOE, 1993). Background soils were collected and analyzed separately during 1991 and 1992 in support of remedial investigations at OU 1 and OU 2. Soils were collected from 18 locations in the Rock Creek drainage north of the Industrial Area (EG&G, 1994a). Analytical results from these samples were extracted from RFEDS and compose the background-soil data set.

Site and background data sets were subject to the cleanup and evaluation steps presented in Section 2.3, Data Quality and Usability, prior to statistical analysis.

Data from each media type were aggregated in comparable subsets for comparison to background data to meet specific investigation objectives and to identify PCOCs. The rationale for the data aggregation scheme is presented in Section 4.1.1.

Background comparisons were made in two steps. First, qualitative comparisons of site data to background data were made for each media type sampled at OU 11. Histograms and box-and-whisker plots (box plots) for each analyte from each media type were generated for both site and background data. Graphic presentations of the data were used to evaluate the magnitude, range, and distribution of concentrations for each analyte. Histograms and box plots are presented in the CDPHE Conservative Screen Final Letter Report (Appendix D).

Second, chemical concentration data from various media sampled at OU 11 were statistically evaluated to identify analytes present at elevated concentrations relative to concentrations in the same media from background locations. Analytes with elevated concentrations in media from OU 11 were further evaluated for possible PCOC designation (EG&G, 1994e). Possible site contamination was identified by comparison of site data to background data using the statistical and qualitative methods outlined in Statistical Comparisons of Site-to-Background Data in Support of RFI/RI Investigations (EG&G, 1994e). The site-to-background comparison methods, coupled with geochemical analysis, were used to identify inorganic analytes and radionuclide PCOCs. Organic compounds were considered PCOCs if detected in samples from OU 11 at elevated concentrations and if their distribution was geochemically indicative of contamination. The procedures used for statistical analyses and comparisons are described in Section 4.1.2.

4.1.1 Data Aggregation for Background Comparison at OU 11

Chemical concentration data from various environmental media sampled at OU 11 were evaluated with the following two distinct objectives: (1) to identify PCOCs and (2) to describe the nature and extent of contamination. Prior to comparing chemical data from OU 11 to background values, data were aggregated by media. Data aggregation was based on the statistical assumption that all samples within a data set were independent but comparable (i.e., collected and analyzed using the same methods) and represented by a single population characterized by a fixed mean and variance.

Media sampled at OU 11 include surficial soil, subsurface geologic materials, and ground water. Within a given medium, samples were further subdivided by depth, hydrostratigraphic unit, and location relative to IHSS 168 (within or outside) for comparisons with background data. Table 4.1-1 presents the primary groups of data by

media, defines the subdivisions of those groups, and describes the aggregation scheme used to perform statistical comparisons to background data. The rationale for the aggregation approach used for each medium is discussed below.

Surficial soil samples from OU 11 consist of samples collected from two areas: within IHSS 168 and east of IHSS 168. In both of these areas, surficial soil samples were collected from the 0- to 2-inch depth interval. Soil samples from these two areas are comparable to each other and directly comparable to background soils which were also collected from the 0- to 2-inch depth interval. The statistical comparison included all surficial soil samples collected during the combined phases RFI/RI (IHSS 168 and east of IHSS 168). Soils from both the IHSS and adjacent eastern areas were included in the background comparison because of methods used at IHSS 168 to dispose of liquid wastes, which were sprayed over the ground surface.

During the combined phases RFI/RI, subsurface geologic materials were collected from several boreholes within IHSS 168 and two boreholes outside of IHSS 168. Previous borehole sampling was performed during 1992 at one location within IHSS 168 and two locations downgradient of the IHSS. The total data set of OU 11 subsurface geologic materials includes results for 11 locations within IHSS 168 and 4 locations outside of IHSS 168 (Table 4.1-2). Samples collected are all of Rocky Flats Alluvium. Analytical results for samples collected within and downgradient of IHSS 168 were compared to results for analyses of samples collected from background locations to identify PCOCs for use in the risk assessment.

Ground-water samples were collected from wells screened in the UHSU and LHSU. Because these units represent separate flow systems, the data were divided by hydrostratigraphic unit. As presented in Section 3.6, within OU 11, the UHSU comprises Rocky Flats Alluvium and weathered bedrock. The LHSU is composed of unweathered bedrock. Wells that screen the UHSU have been further subdivided into three areas: upgradient wells (4 wells), wells within IHSS 168 (14 wells), and downgradient wells (10 wells) (Table 4.1-3). Ground-water samples collected from these areas are comparable but constitute three distinct populations.

Identification of PCOCs was made by comparing UHSU data from wells within IHSS 168 and downgradient of IHSS 168 to sitewide background data. An additional comparison of the UHSU wells upgradient of IHSS 168 to the UHSU wells downgradient of the IHSS was performed to identify impacts to ground-water quality that originate within IHSS 168.

Only one LHSU well is present within IHSS 168, and no LHSU wells are present upgradient or downgradient of the IHSS (Table 4.1-3). Ground-water quality in the

LHSU was evaluated by comparing data from the LHSU well within IHSS 168 to sitewide background data.

4.1.2 Statistical Analysis Procedures

The flow chart presented in Figure 4.1-1 illustrates the process for background comparisons, geochemical analyses and professional judgment, and identification of PCOCs. The statistical methodology for site-to-background comparisons for inorganic analytes and radionuclides followed the procedures outlined in Statistical Comparisons of Site-to-Background Data in Support of RFI/RI Investigations (EG&G, 1994e). The PCOC identification process consisted of the following steps: (1) the hot-measurement test, (2) the Gehan test, (3) the Slippage test, (4) the Quantile test, (5) the t-test, and (6) professional judgment/geochemical analysis. Analytes having elevated concentrations relative to background concentrations, as indicated by the hot-measurement test or any one of the inferential statistical tests (Gehan, Slippage, Quantile, and t-test), are considered candidates for PCOC designation. The actual PCOC list reflects the results of geochemical analyses and professional judgment supplementing the statistical tests. The five comparison tests are described below.

Chemical data from OU 11 were evaluated using the hot-measurement test, which compares each measurement with an upper tolerance limit (UTL) value for the corresponding analyte in the background data. The hot-measurement test is not considered a formal statistical test because false positive and power requirements cannot be specified. However, the hot-measurement test is useful as a screening tool to ensure that unusually large measurements are adequately evaluated regardless of the output of the more formal inferential statistical tests. The UTL concentration used during comparison of site to background data was the $UTL_{99/99}$ value in accordance with Rocky Flats guidance on statistical comparisons (EG&G, 1994e). This UTL represents a value for which there is a 99-percent confidence that the UTL is equal to or greater than the true 99th percentile of the background population. UTL values for background data were calculated from the background data received from RFEDS. Analytes with individual measurements exceeding the $UTL_{99/99}$ value were considered candidates for PCOC identification. Summary statistics for background data, including $UTL_{99/99}$ values, are included in the CDPHE Conservative Screen Final Letter Report (Appendix D).

Inferential statistical tests (Gehan, Slippage, Quantile, and t-test) were used to compare the means and medians of the OU 11 and background populations. The null (H_0) and alternative (H_a) hypotheses used during the statistical analyses are as follows (Gilbert, 1993):

H_0: Chemical concentrations within OU 11 are not significantly greater than those in the background area.

H_a: Chemical concentrations within OU 11 are significantly greater than those in the background area.

The nonparametric Gehan test (Palachek *et al.* 1993; Gehan, 1965) can be used to evaluate data sets with multiple detection limits and nondetections and can be used regardless of the distribution of the data. The Gehan test is a generalization of the more common nonparametric analysis of variance (ANOVA), the Wilcoxon Rank-Sum test. The Gehan test was performed for all analytes. The parametric ANOVA t-test was used only when background and site data contained less than 20 percent nondetections and normality assumptions based on the Shapiro-Wilk test were satisfied.

Other nonparametric tests used to compare background and site data included the Slippage and Quantile tests. The Slippage test consisted of counting the number of OU 11 measurements that exceeded the maximum background measurement. If the number of measurements exceeding the maximum background measurement was greater than a critical value obtained from tables in Rosenbaum (1954), then the analyte was identified as a candidate for the PCOC list.

The Quantile test is similar to the Slippage test and was performed by listing the combined background and OU 11 measurements from smallest to largest. The Quantile test counted the number of measurements from OU 11 that were among the largest measurements of the combined data sets. If the number of measurements was greater than a critical value, the analyte was considered a PCOC candidate. The largest measurement and critical values were determined from tables in Gilbert and Simpson (1992).

The final identification of PCOCs was subject to professional review of the test results, geochemical analyses, and graphic presentations of the data. The PCOC list for OU 11 is presented in Table 4.1-4.

4.2 Summary of PCOCs

Results of the statistical comparisons of OU 11 data to background data are presented in Appendix D (CDPHE Conservative Screen Final Letter Report). Few of the chemicals that failed the statistical tests are associated with wastes disposed by spray application at the WSF (IHSS 168) or exhibited contaminant-like traits when subjected to geochemical analyses.

In surficial soils, three analytes were identified as PCOCs: americium-241, plutonium-239,240, and nitrate/nitrite. However, analytical results for five metals, five

radionuclides, and nitrate/nitrite were initially identified as statistically different in surficial soils from OU 11 when compared to background soils. Several analytes were included as statistically different only because their concentrations exceeded the background UTL value at one location.

In the subsurface geologic materials from IHSS 168 and downgradient, two analytes were identified as PCOCs: tritium and nitrate/nitrite. However, results for 4 metals, 6 radionuclides, and 10 organic compounds were initially identified as statistically significant. The statistical differences were often attributable to common laboratory contamination and, in the case of one organic compound, an investigation-introduced occurrence.

In ground water, no analytes were identified as PCOCs. However, results for 19 metals, 3 radionuclides, 10 organic compounds, and nitrate/nitrite were initially identified as statistically significant in ground water from the UHSU within and downgradient of IHSS 168. Many of the metals and radionuclides identified as significant were associated with a single, questionable sampling event, and many of the organic compounds were identified as laboratory contaminants.

All analytes identified by the inferential statistical tests and background-comparison methods were considered in the following discussion of the source characteristics and the nature and extent of contamination regardless of their designation as a PCOC. Descriptions of the spatial and temporal distributions of chemicals at OU 11 support the following two tasks: (1) characterization of the nature and extent of contamination and (2) compilation of the list of analytes considered PCOCs in the conservative screen and risk evaluation.

The final step in identification of PCOCs for use in the risk assessment is geochemical analysis and professional review. The professional judgment of the reviewer is required to consider critical factors such as the spatial and temporal distribution of analytes; historic information regarding past operations at the site; inter-element correlations; mass-balance calculations; and knowledge of the hydrology, geochemistry, and geology of the site. The list of PCOCs for the site incorporates results of inferential statistical tests, hot-measurement screen, geochemical analysis, and professional judgment.

4.3 Source Characterization

Spray application of excess liquids from SEPs 207-B North and 207-B Center is the only known source of potential contamination at the WSF (OU 11). Areas of past spray application were identified using aerial photographs (DOE, 1992a) and records of waste disposal (DOE, 1992b). These areas are included within IHSS 168. Historic records are the primary source of information available to characterize the potential

source of contamination. The following paragraphs provide a summary of available source-characterization information and identify chemical and physical characteristics of the source at IHSS 168.

The history of the WSF land application activities is presented in Section 1.2. Excess liquids from the SEPs were applied to the WSF from April 1982 to October 1985 (DOE, 1992a). The SEPs originally contained process wastewater; however, all process wastes were removed from Ponds 207-B North, Center, and South in the late 1970s (Rockwell International, 1988b), prior to the initiation of spray activities at the WSF. Contaminants could have migrated into the shallow ground water near the SEPs through leakage from the ponds during the storage of process wastewater. Recovered ground water collected in the ITS downgradient of the SEPs could therefore contain contaminants that may have migrated from any of the ponds (DOE, 1992a). These potential contaminants may have been applied to the WSF via Pond 207-B North (used as a repository for shallow ground water collected in the ITS) if they were captured by the ITS during the period of spray application. Contaminants potentially present in captured ground water downgradient of the SEPs include beryllium, cadmium, chromium, copper, cyanide, nickel, americium, plutonium, uranium, tritium, and fluoranthene (DOE, 1992a).

Chemical characterization of ITS water within Pond 207-B North in 1984 and 1985 indicated that concentrations of nitrate, chloride, sulfate, sodium, potassium, calcium, and magnesium were generally higher than in background ground water. Evaporation from the pond led to enrichment of major-ion (chloride, sulfate, sodium, potassium, calcium, and magnesium) concentrations during storage within the pond. Low-level concentrations of uranium-234 and uranium-238 were also detected. The only organic compound detected in water from Pond 207-B North was methylene chloride, although this compound was also detected in blanks (DOE, 1991b). At the same time, sanitary effluent within Pond 207-B Center was characterized by elevated concentrations of nitrate, gross alpha, and gross beta (DOE, 1992a).

4.3.1 Additional Source Characterization

The source of potential contamination within OU 11 is well described by historical records. Aerial photographs verify the location of spray equipment and the extent of spray application. An HPGe total gamma exposure survey was conducted as part of the combined phases RFI/RI to confirm the results of a previous sitewide gamma survey (EG&G, 1994a). Results of the HPGe survey conducted in 1994 are consistent with the previous survey results in the vicinity of the WSF. Areas of elevated gamma radiation, as measured by the HPGe survey, did not coincide with the three documented spray application areas within IHSS 168, and gamma-radiation measurements did not delineate the spray-application areas. These results suggest that the spray-application

areas have no gamma "signature" and that the results of the gamma survey are of limited use in defining local source areas within IHSS 168. No other sources of gamma radiation were identified in the immediate vicinity of IHSS 168.

Analytical data collected during the RFI/RI indicate that nitrate/nitrite concentrations in soil correlate with the locations of the spray areas. Nitrate/nitrite concentrations in soil may be the best chemical indicator of source areas in OU 11. The background UTL value for nitrate/nitrite is exceeded in soils from the spray-application areas and from locations at pipeline junctures (see Figure 4.4-1). Soil nitrate/nitrite concentrations are discussed in greater detail in the following section.

4.4 Surficial Soils

This section identifies PCOCs in surficial soils from the 0- to 2-inch depth interval and describes the nature and extent of contamination within OU 11 soils. Analytical results for the 53 surficial soil samples collected during the combined phases RFI/RI were used in this analysis. Soil samples were analyzed for metals, radionuclides, and nitrate/nitrite as per the FSP TM (EG&G, 1994a). The inferential statistical tests described in Section 4.1.2 were used to determine which analytes in OU 11 surficial soils were statistically different from the background data set. Spatial trends in concentrations of analytes and locations where analyte concentrations exceed the background UTL value are described below.

4.4.1 Nitrate/Nitrite

Nitrate/nitrite is a contaminant associated with liquids stored in the SEPs and was identified as a PCOC in surficial soils at OU 11 (see Table 4.1-4). Results from the inferential statistical tests indicate that nitrate/nitrite concentrations in surficial soils at OU 11 are higher than in background soils. Twenty-two surficial soil samples from OU 11 contain nitrate/nitrite at concentrations exceeding the background UTL value (9.6 mg/kg). Sampling locations within the spray application areas and at pipeline junctures typically show the highest nitrate/nitrite concentrations (Figure 4.4-1). Within the spray application areas, samples from channel and non-channel locations have similar nitrate/nitrite concentrations. Two samples collected at a pipeline juncture approximately 600 feet east of the IHSS 168 boundary also show nitrate/nitrite concentrations exceeding the background UTL, but these concentrations are lower than nitrate/nitrite concentrations in soils collected from spray area 1. Nitrate/nitrite at these two locations may have originated from leakage at the pipeline juncture (see Figure 4.4-1). The extent of nitrate/nitrite in surficial soils coincides generally with areas of spray application.

4.4.2 Metals

Results from the inferential statistical tests indicate that arsenic and lead concentrations are statistically higher in surficial soils at OU 11 than in background soils. The UTL value was exceeded at one location for arsenic (UTL is 13 mg/kg) and at four locations for lead (UTL is 62 mg/kg) (see Figures 4.4-2 and 4.4-3). Copper concentrations in surficial soils at OU 11 were not significantly higher than background concentrations based on the results of the inferential statistical tests; however, one sample exceeded the background UTL value of 30 mg/kg (see Figure 4.4-4).

Arsenic, lead, and copper have similar spatial distributions in soil at OU 11 (Figures 4.4-2, 4.4-3, and 4.4-4 respectively). Surficial soils within spray area 1 have lower concentrations of these metals than soils east of the spray areas. The concentrations of these metals that occur in surficial soils within and east of spray areas 2 and 3 are similar to concentrations that are present in surficial soils from outside IHSS 168. Therefore, the distribution of these metals in soils does not appear to be controlled by potential sources of contamination (spray areas or pipeline junctures).

Arsenic and lead were each detected in all soil samples at OU 11 and in the background data set. They are naturally occurring metals. The pattern of arsenic and lead distribution is consistent with a natural source for these metals as opposed to a contaminant source related to spray application of wastes. Locations where UTL exceedances of arsenic and lead were detected are not coincident with areas of spray application. Additionally, concentrations of arsenic and lead that exceed background UTLs are within the range of regional background concentrations (Severson and Tourtelot, 1994; Shacklette and Boerngen, 1984).

Antimony and silver were evaluated because these analytes were detected in OU 11 soils. Antimony was detected at concentrations of 3.0 to 3.5 mg/kg in three surficial soil samples collected at OU 11, and silver was detected at 0.60 mg/kg in one sample. No antimony or silver was detected in the background soil samples, but the detection limits reported for these samples ranged from 12 to 50 mg/kg for antimony and from 2 to 10 mg/kg for silver. Therefore, antimony and silver were detected in OU 11 soils at concentrations lower than the reported detection limits for the background samples. The single copper concentration that exceeded the background UTL value (88.1 mg/kg) occurred in a sample that also had detectable concentrations of antimony and silver, reinforcing the association with naturally occurring chalcophile elements. This sample was collected from a location outside of IHSS 168. The metals present in surficial soils all appear at concentrations reflective of naturally occurring metal content of soils. Spray activities have not resulted in residual metals in surficial soils.

4.4.3 Radionuclides

Radionuclides identified as PCOCs in surficial soils at OU 11 include americium-241 and plutonium-239,240 (see Table 4.1-4). Results of inferential statistical tests indicate that the activities of these radionuclides were significantly greater in OU 11 soils than in background soils. The uranium isotope activities present at OU 11 were also identified as statistically different from the background data set.

Plutonium-239,240 and americium-241 activities in surficial soils at OU 11 show similar distribution patterns (Figures 4.4-5 and 4.4-6). Nineteen surficial soil samples collected at OU 11 had plutonium-239,240 activities that exceeded the background UTL value. Five surficial soil samples collected at OU 11 had americium-241 activities that exceeded the background UTL value. The maximum activity for both plutonium-239,240 and americium-241 occurred in a sample collected from a drainage channel located east and immediately downgradient of spray area 1. One sample from a pipeline juncture located east of the IHSS 168 boundary had plutonium-239,240 and americium-241 activities greater than background UTL values. The same sample had an elevated nitrate/nitrite concentration indicating a possible association with the pipeline juncture. However, the evidence is not conclusive because there were other non-channel surficial soil samples located outside the spray application areas that also indicated UTL exceedances for both of these radionuclides.

Surficial soil concentrations of uranium were identified as statistically different from background data, with statistical results varying by isotope. The concentrations of uranium isotopes in surficial soils are generally in the upper range of background concentrations. Additionally, Appendix D of this report presents a summary of isotopic abundances in naturally occurring and industrial uranium. The analysis of isotopic abundances indicates that uranium occurring in surficial soils at OU 11 is in the isotopic proportions expected of natural uranium.

Recent background data from the Background Soils Characterization Project (DOE, 1995) were compared to the OU 11 data for the uranium isotopes in Table 4.4-1. Most of the OU 11 sample results are within the range of the background results.

Maximum uranium-233,234 and uranium-238 activities in OU 11 surficial soils are from a sample collected south of the spray application areas. Locations where uranium activities exceeded the background UTL values are not coincident with locations where activities of americium-241, plutonium-239,240, and nitrate/nitrite (the surficial soil PCOCs) exceeded their UTL values and thus do not appear to coincide with spray activities. In summary, the nature and extent of plutonium and americium activities appear to coincide with OU 11 history, while the evidence associating uranium activities to spraying is much less conclusive.

4.5 Subsurface Geologic Materials

This section presents the PCOCs identified by comparisons of site and background data and geochemical analyses and describes the nature and extent of contamination in subsurface geologic materials at OU 11. Data from samples of subsurface geologic materials were aggregated by location and geologic unit as described in Section 4.1.1 to make comparisons with background data. Comparison methods described in Section 4.1.2 were used to determine which analytes were detected at concentrations higher than background concentrations. Spatial and temporal patterns of occurrences were reviewed to identify actual contamination.

Chemical data from subsurface geologic materials collected during the combined phases RFI/RI and previous investigations were used to assess the nature and extent of contamination in subsurface geologic materials at OU 11. Samples of subsurface geologic materials that were collected prior to the combined phases RFI/RI are from boreholes 46192, 46292, 46392, and 46492 (see Figure 2.2-3). Chemical data from these samples were included in the OU 11 database. With the focus of the combined phases RFI/RI on ground water within the alluvial deposits, no additional bedrock wells were drilled. Thus, the existing data set of bedrock geologic materials is too limited to support background comparisons. Comparisons of OU 11 Rocky Flats Alluvium samples to background samples of Rocky Flats Alluvium are presented.

Analytes identified as significant in the statistical comparisons or exceeding the background UTL were further evaluated by examining their spatial distribution in the subsurface. Some exceedances of the UTL are expected in a data set of this size (more than 100 samples) because the UTL value includes only the 99th percentile of the background data. Spatial occurrence of individual analytes was assessed by comparing the analyte concentration to the depth of each sample for each analyte and noting trends in concentration with depth at each borehole. The presence and spatial distribution of all organic compounds (SVOCs and VOCs) detected were also evaluated.

4.5.1 Metals

Within IHSS 168, three metals—barium, cobalt, and mercury—were present in subsurface geologic material samples at concentrations exceeding the background UTL value. These metals were identified as significant because their concentrations each exceeded the background UTL values in one out of 132 samples. Barium, cobalt, and mercury concentrations in IHSS 168 are not statistically different than their respective concentrations in the background data set. The individual occurrences do not reflect site contamination.

Data from subsurface geologic materials downgradient of IHSS 168 were also compared to the background data set for Rocky Flats Alluvium. Three additional

metals—chromium, molybdenum, and sodium—were also each detected once at concentrations above the background UTL in samples from the downgradient boreholes. However, the concentrations of these metals are not statistically different from concentrations in borehole samples from background data, and their distributions are not spatially correlated with source areas or with each other.

One additional metal, cesium, was detected in samples from OU 11 but was not detected in background samples. The detection limit reported with the background results varied between 200 and 484 mg/kg. In the samples from OU 11, the concentrations detected ranged from 0.77 to 6.6 mg/kg. Cesium results show no spatial distribution pattern with depth and no other pattern associated with the probable source areas, and OU 11 concentrations are of very low levels.

There are no trends in the concentrations of these metals with depth, nor are there patterns within the areal distribution of values exceeding the background UTL value. Thus, metals do not appear to be related to waste disposal activities at IHSS 168.

4.5.2 Radionuclides

Comparisons of analytical results for subsurface geologic materials from IHSS 168 and downgradient to results for background samples indicate that americium-241, plutonium-239,240, tritium, uranium-233,234, uranium-235, and uranium-238 activities are statistically different from their respective background activities. Radionuclides were detected in every subsurface geologic material sample in both the OU 11 and background data sets.

Americium and plutonium activities occasionally exceeded the background UTL value. Activity versus depth plots indicate that distributions of americium and plutonium in the subsurface do not appear related to a source at the ground surface. For example, americium-241 and plutonium-239,240 activities in samples from all boreholes in IHSS 168 are generally constant with depth (Figures 4.5-1 and 4.5-2). At one location, borehole 46292, plutonium-239,240 activities exceeded the background UTL value (0.02 pCi/L) in 8 of 19 samples collected. However, there is no trend in plutonium activity with depth, and samples from nearby boreholes do not exhibit similar plutonium activities.

Given the chemical properties of americium and plutonium (immobile as dissolved constituents of ground water or surface water), maximum activities were expected to occur at shallow depths near the contaminant source, in this case the spray application areas. At OU 11, the maximum activities of the two radionuclides were not collocated, as expected if they originated from the same source material.

Uranium-235 activities were also variable with depth but showed no consistent trend. Figure 4.5-3 shows the variation of activities with depth for uranium-235 in boreholes 50194 and 50394. Activities of uranium-233,234 and uranium-238 in IHSS 168 generally increased with depth (Figures 4.5-4 and 4.5-5). However, the maximum activities were from different depths in each of the boreholes, and boreholes showing increases in uranium activities with depth are not necessarily located within the spray application areas. Appendix D (CDPHE Conservative Screen Final Letter Report) presents an evaluation of isotopic ratios of the uranium occurrences at OU 11. This evaluation concludes that the relative activities of the uranium isotopes reflect naturally occurring uranium.

Figure 4.5-6 shows that the tritium activities in subsurface geologic materials decreased with depth; the highest activities occurred in samples collected within 10 feet of the ground surface. Eight of the 124 tritium measurements (6 percent) exceeded the background UTL value. The apparent correlation of tritium with depth corresponds with the depositional history of surficial spraying, and the tritium occurrences in the subsurface geologic materials are considered potentially source-related. Tritium is included as a PCOC.

4.5.3 Semivolatile Organic Compounds

Within IHSS 168, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, diethyl phthalate, and dimethyl phthalate were detected. Bis(2-ethylhexyl)phthalate and di-n-butyl-phthalate were also detected in downgradient boreholes. Upgradient of IHSS 168 in borehole 50294, bis(2-ethylhexyl)phthalate and 10 other SVOCs (anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, phenanthrene, and pyrene) were detected.

Bis(2-ethylhexyl)phthalate and di-n-butyl-phthalate were detected in many boreholes in OU 11. The spatial occurrence of these compounds is irregular within IHSS 168. Concentrations of bis(2-ethylhexyl)phthalate and di-n-butyl-phthalate at individual boreholes in IHSS 168 varied randomly. Dimethyl phthalate was detected in only 1 of 138 samples (sample collected from borehole 50894 at 18 feet below ground surface). Dimethyl phthalate was not detected in other samples from the same borehole. Diethyl phthalate was detected in only 5 of 138 samples in IHSS 168 (boreholes 50394, 50894, and 50994). Three of the detections occurred in borehole 50394 with concentrations decreasing with depth at this location.

In summary, phthalate compounds exhibited no regular distribution patterns in boreholes at OU 11 although they occurred frequently. However, the random occurrences and inconsistent concentrations are not characteristic of pervasive contamination. In fact, phthalates are common environmental contaminants that may

be introduced during sampling. Bis(2-ethylhexyl)phthalate and diethyl phthalate were detected in more than 10 percent of the equipment rinsates collected during subsurface geologic material sampling at OU 11. Thus, the presence of phthalate compounds in subsurface geologic material samples collected at OU 11 is not likely to be indicative of contamination; their origin may be associated with the investigatory work.

4.5.4 Volatile Organic Compounds

Within IHSS 168, 2-butanone, chloroform, acetone, methylene chloride, toluene, and trichloroethene (TCE) were detected. In samples collected from boreholes downgradient of the IHSS, acetone, chloroform, methylene chloride, and toluene were detected.

VOCs were detected at least once in most of the boreholes in the OU 11 area. However, most of the VOCs detected in subsurface geologic materials (all but six of the detectable concentrations) were acetone, methylene chloride, and toluene. The EPA describes these compounds as common laboratory contaminants (EPA, 1988b). For acetone and toluene, all but one of the detectable results were reported as estimated concentrations below the detection limit (J-qualified results, less than 10 µg/kg). Methylene chloride was present at concentrations above the detection limit at depths from 15 to 70 feet below the ground surface. Concentrations of acetone, methylene chloride, and toluene vary randomly with depth at individual boreholes. The lack of a consistent pattern of concentration with depth suggests that the occurrences of acetone, methylene chloride, and toluene are not related to the spray application of liquid wastes at IHSS 168.

The only other occurrences of VOCs in OU 11 subsurface geologic material samples were chloroform (in 3 of 3 samples in borehole 46392), TCE (in 1 of 15 samples in borehole 50394), and 2-butanone (in 2 of 14 samples in borehole 51494). The isolated occurrences of TCE and 2-butanone do not appear indicative of VOC contamination at OU 11. Chloroform detections in borehole 46392, east of IHSS 168, are associated with drill cuttings and drilling mud introduced in the hole during drilling. The chloroform in the drilling mud is coincident with chloroform detections in the ground water. Chloroform detected in ground water has diminished in concentration each quarter since well development, reinforcing the association between chloroform and drilling mud and well installation. (If residual chloroform in drill materials was spreading contamination, the associated ground-water concentrations would not be diminishing.)

In summary, VOCs were detected infrequently and appear to have random distribution at very low concentrations (usually below reported detection limits) in subsurface geologic materials from across OU 11. Most of the occurrences of VOCs are

associated with analytes identified as common laboratory contaminants (acetone, methylene chloride, and toluene). Therefore, the subsurface geologic materials do not appear to be contaminated by VOCs originating from waste disposal at OU 11.

4.5.5 Other Analytes

In addition to the standard suite of analytes for subsurface geologic materials, analyses for nitrate/nitrite were performed because of its association with liquids historically sprayed at IHSS 168. No analyses of nitrate/nitrite were performed for background subsurface geologic materials, and thus background comparisons could not be completed. The background UTL for nitrate/nitrite in surficial soils is 9.6 mg/kg. The maximum concentration detected in subsurface geologic materials from OU 11 was 2.0 mg/kg, and nitrate/nitrate concentrations show no spatial distribution pattern in the subsurface. Thus, despite the association between elevated nitrate/nitrite concentrations in surficial soils and source areas within IHSS 168, nitrate/nitrite does not appear to be a contaminant to subsurface geologic materials at OU 11. It has been conservatively included in the list of PCOCs because there were no background values for comparison and it is associated with the site history (see Table 4.1-4).

4.6 Ground Water

This section identifies PCOCs in ground water based on comparisons of site and background ground-water data and discusses the nature and extent of ground-water contamination at OU 11. Data from 32 wells screened in the UHSU and 1 well screened in the LHSU were used to describe the nature and extent of contamination in OU 11 ground water. Chemical data were collected from the first quarter of 1990 through the third quarter of 1994 and include data from samples collected during ongoing quarterly ground-water monitoring and during the combined phases RFI/RI (August and September 1994).

Statistical comparisons (described in Section 4.1.2) were performed to determine which analytes are present in OU 11 ground water at significantly higher concentrations than in background ground water. Comparisons of site-to-background data were made based on the data aggregations shown in Table 4.1-1. Ground-water data from the UHSU and LHSU were compared to background data to evaluate the identification of PCOCs. Statistical comparisons were performed separately for UHSU and LHSU ground water. Concentrations of analytes in ground water from OU 11 were also compared to background UTL values, and spatial and temporal trends in analyte concentrations were examined to determine if the occurrence of certain analytes is related to a source of contamination. It is important to note that, with large data sets such as this (100 or more samples), occasional UTL exceedances are expected because the UTL value includes only the 99th percentile of the background data.

For the LHSU, statistical analyses were performed, but the results of these analyses were of limited value because the OU 11 LHSU data set consists only of samples from one well.

Ground-water-quality data from all sub-units of the UHSU were used to delineate the nature and extent of ground-water contamination in the UHSU. Water-quality data from the variably saturated zone are few due to low production volumes associated with these wells and the limited number of samples collected from this zone to date. Statistical comparisons between water quality of the variably saturated zone and other UHSU sub-units is inappropriate with the limited data set. However, review of chemical data indicates that there is no distinction between water from wells screened in the variably saturated zone and water from wells screened below the water table. Furthermore, ground water in the variably saturated zone is hydraulically connected to water in saturated portions of the UHSU (see Section 3.6). Therefore, there is no reason to consider ground-water-quality data from the variably saturated zone separately.

To identify PCOCs in UHSU ground water, several different sets of OU 11 data were compared to background data (Table 4.1-1). Both total and dissolved concentrations were used in all comparisons. Comparisons to background were made using data from IHSS 168 wells and wells downgradient of IHSS 168 as well as data only from IHSS 168 wells. The nature and extent of ground-water contamination is discussed in terms of all analytes identified as statistically significant using all comparisons.

4.6.1 Nature and Extent of UHSU Ground-Water Contamination

In UHSU ground water, results for 19 metals, 4 radionuclides, cyanide, and nitrate/nitrite either were identified by the inferential statistical tests as statistically different or had reported detections exceeding the background UTL. Either the identification as "statistically different" or an exceedance of the UTL resulted in geochemical evaluation of the analyte as a potential contaminant. Additionally, all VOCs and SVOCs detected in ground water were reviewed as possible contaminants.

The nature and extent of ground-water contamination at OU 11 were delineated by examining spatial and temporal variations in ground-water chemistry. Spatial variations were evaluated by generating maps of $UTL_{99/99}$ exceedances for metals and radionuclides and maps showing the frequency of detections at each well for VOCs and SVOCs. Temporal variations in ground-water quality were assessed by reviewing time-series plots showing analyte concentrations versus time at individual monitoring wells.

4.6.1.1 Metals

Results for 19 total metals were identified as statistically different from background data based on the inferential statistical tests or an exceedance of the background UTL value.

Results for 14 of these metals had exceedances of the UTL in one sample collected from well 5086. This sample had an extremely high total suspended solids (TSS) content (1,900 mg/L), high activities of plutonium and americium, and much higher metals concentrations than other samples collected previously and subsequently from the same well (Figure 4.6-1 and Table 4.6-1). The TSS content of this sample is more than two orders of magnitude higher than typical TSS contents in well 5086, and it is not representative of ground water from the UHSU. The likely explanations for the elevated metals values in the one sample event are poor well purging and/or disruption of bottom sediments during sampling.

In contrast, results for 11 total metals exceeded the background UTL at well 5286, and results for 9 of these metals exceeded the UTL in more than one sample. Total metal concentrations exceeded their UTL values more consistently at this location, upgradient of IHSS 168, than at wells within IHSS 168. Given the upgradient location of well 5286, the high total metal concentrations do not appear related to contamination within IHSS 168.

Background UTLs for total mercury, cesium, and tin were also exceeded at other locations. Concentrations of these metals are not consistently elevated with respect to background at any location. UTL exceedances of total mercury, cesium, and tin occur in various parts of OU 11; however, there is no consistent spatial or temporal pattern to their occurrence.

In summary, metals are rarely present in ground water at concentrations exceeding background UTLs, and UTL exceedances are not often repeated in successive ground-water samples from the same well. This is particularly notable because data from 19 sampling events were evaluated for some wells. There is no consistent spatial or temporal distribution of metals in UHSU ground water at OU 11, and therefore, there is no evidence that spray activity resulted in elevated metals concentrations in UHSU ground water.

4.6.1.2 Radionuclides

Activities of total americium-241, plutonium-239,240, tritium, and gross beta exceeded the background UTLs in ground water from OU 11 (Figure 4.6-2). Low frequencies of exceedances for the radionuclides—4 of 185 samples for americium-241, 1 of 187 samples for plutonium-239,240, and 3 of 193 samples for tritium—strongly

demonstrate that radionuclides do not consistently show elevated activities in ground water from OU 11. In fact, one of the americium detections and the single plutonium detection are associated with the questionable sample from well 5086 (see Section 4.6.1.1). Plutonium-239,240 and americium-241 activities upgradient of IHSS 168 exceeded the background UTL in 1 of 15 samples collected from well 5186. These upgradient activities are clearly not associated with spraying at OU 11.

4.6.1.3 Semivolatile Organic Compounds

To assess the occurrence of SVOCs, maps displaying detection frequencies were constructed. Figure 4.6-3 shows the frequency of SVOC detections in ground water from OU 11. Bis(2-ethylhexyl)phthalate was detected once in three different wells (two in IHSS 168 and one downgradient), and diethyl phthalate was detected once within IHSS 168. Both of these phthalate compounds are considered common laboratory contaminants by EPA, and both have been detected in sitewide ground-water monitoring programs at frequencies and concentrations greater than the OU 11 frequencies and concentrations.

4.6.1.4 Volatile Organic Compounds

To assess the occurrence of VOCs in OU 11 ground water, their detection frequencies at individual wells were reviewed. Acetone, methylene chloride, and toluene were detected with limited frequency (41 of 442 samples or 9 percent) in ground-water samples from within and downgradient of IHSS 168. The low frequency at which these analytes were detected suggests that VOCs associated with past waste-disposal operations at OU 11 have not contaminated ground water. Acetone, methylene chloride, and toluene are common laboratory contaminants, and laboratory contamination would result in sporadic detections similar to the frequencies observed in the analytical results for OU 11 ground-water samples. At OU 11, the most recurrent VOC detected through time is methylene chloride. Methylene chloride has been detected in 26 of 203 samples (12.8 percent) collected within and downgradient of IHSS 168. In unimpacted wells immediately upgradient of OU 11, it has been detected in 8 of 35 samples (22.8 percent).

Other VOCs were detected in ground water from IHSS 168 as well as from upgradient and downgradient of IHSS 168, including PCE, benzene, and chloroform. PCE has been detected in ground water from five wells located in, upgradient of, and downgradient of IHSS 168 at a frequency of 7 in 240 samples. Benzene has been detected in ground water from four wells in and downgradient of IHSS 168 at a frequency of 4 in 204 samples. Chloroform was detected in 1 of 9 samples from well 5286, located upgradient of IHSS 168, and in 10 of 10 samples from well 46392, located downgradient of the IHSS. The chloroform detections in well 46392,

downgradient of OU 11, have been related to the introduction of drilling mud at the well, not spray activities at OU 11. The chloroform concentrations have decreased consistently since well installation, indicating dissipation, and now are at levels an order of magnitude below the UTL value.

The temporal distribution of the VOCs is characterized by isolated, individual detections that are not reproducible from one quarter to the next. The majority of VOC detections are not reproducible from quarter to quarter or from year to year, and the VOCs are generally detected only once per well (see Figures D-95, D-98, and D-110 in Appendix D, CDPHE Conservative Screen Final Letter Report).

In summary, the inconsistency in areal distributions of VOCs and the lack of recurrent detections within wells leads to the conclusion that VOCs are not contaminants of UHSU ground water at OU 11.

4.6.1.5 Other Analytes

Nitrate/nitrite concentrations in ground water are of particular interest because of historic waste disposal practices at OU 11. Results for nitrate/nitrite in UHSU ground water at OU 11 failed none of the statistical tests; therefore, nitrate/nitrite concentrations in OU 11 ground water are not statistically different from nitrate/nitrite concentrations in background ground water. However, nitrate/nitrite concentrations do exceed the background UTL value (6,373 µg/L) in 5 of 209 samples (Figure 4.6-4). The highest concentration of nitrate/nitrite in ground water from OU 11 (13,000 µg/L) was measured in well 46192 which is located upgradient of IHSS 168. Four of the five nitrate/nitrite detections observed within OU 11 occurred in one well. The detections were erratic, as illustrated in the time series plot, included in the CDPHE Conservative Screen Final Letter Report (Figure D-125, Appendix D). Additionally, the erratic detections all fall below the maximum values detected in the background data set.

4.6.2 Comparison of Upgradient and Downgradient UHSU Ground Water

Statistical comparisons of ground-water quality upgradient and downgradient of IHSS 168 were performed to assess the impact of past spraying activities at IHSS 168. Comparisons of total analytes indicate that total uranium-233,234 and uranium-238 had higher activities in ground water from the downgradient wells than from the upgradient wells. Similarly, comparisons for the dissolved analytes indicate that six metals (aluminum, calcium, magnesium, manganese, sodium, and strontium) and three radionuclides (gross alpha, uranium-233,234, and uranium-238) were present at higher concentrations in ground water downgradient of IHSS 168. The increases in the concentrations of dissolved metals (including uranium) may be due to chemical evolution of ground water as it flows through geologic media, as suggested by the results of the Groundwater Geochemistry Report (EG&G, 1995a).

In the vicinity of OU 11, UHSU ground water is undersaturated with respect to several carbonates, manganese oxyhydroxides, sulfates, and aluminosilicates. Dissolution of these phases in ground water is expected, leading to increases in the concentrations of major ions (i.e., calcium, magnesium, and sodium) and some metals as ground water flows through the UHSU. Increases in downgradient concentrations of the dissolved metals relative to their upgradient concentrations are predicted by thermodynamic modeling of ground-water/mineral interactions (EG&G, 1995a).

4.6.3 LHSU Ground-Water Contamination

LHSU ground-water quality at OU 11 has been monitored by one LHSU well (well 4886) within IHSS 168. Ground-water-quality data from this well have been reviewed in previous reports (EG&G, 1994d and 1993b). These reports concluded that the LHSU has not been affected by the spray application of wastes at OU 11. Additional ground-water samples collected from well 4886 are consistent with and verify the conclusions of these reports.

Results for six total metals were identified as statistically different on the basis of the inferential statistical tests (barium, magnesium, manganese, calcium, chromium, and nickel). Only one analyte, total tritium, occurred at activities exceeding the background UTL.

Methylene chloride, toluene, and TCE also were detected in ground water from the LHSU well. Methylene chloride was detected in 3 of 18 samples; toluene and TCE were detected in 1 of 18 samples.

4.7 Summary: Contaminant Distribution

A comprehensive list of PCOCs for all media is presented in Table 4.1-4.

Three analytes were identified as PCOCs in surficial soils at OU 11. They are nitrate/nitrite, americium-241, and plutonium-239,240. The inferential statistical tests and background comparisons identified results for five metals, five radionuclides, and nitrate/nitrite as statistically different from the background data set. However, the majority of the analytes were identified because they had concentrations exceeding the background UTL value at one or more locations. None of the metals are considered contaminants associated with past spray activities within IHSS 168. The uranium isotopes and the metals detected have been associated with naturally occurring uranium and metals in the Front Range.

In the subsurface geologic materials from IHSS 168, nitrate/nitrite and tritium were identified as PCOCs. The background comparisons and inferential statistical tests identified results for four metals, six radionuclides, and nitrate/nitrite as statistically

different from the background data set. Very few of the analytes identified in subsurface geologic materials have distribution patterns consistent with their origination from a source at OU 11. For example, most of the metals and radionuclides show no trends in concentration with depth. Tritium is the exception to this, with concentrations decreasing with sample depth. SVOCs are frequently present in subsurface geologic material samples, but they have also been detected, at similar frequencies, in equipment rinses. VOCs are detected infrequently and do not show spatial distribution patterns consistent with a source at or near the ground surface. Chloroform was detected in drilling mud used at a well downgradient of the IHSS and is thought to be associated with the drilling methodology.

No PCOCs were identified in ground water at OU 11. Results for 19 metals, 4 radionuclides, cyanide, and nitrate/nitrite were identified in the statistical tests and background comparisons as different from background. Twelve of these analytes were single exceedances of the background UTL. Thirteen metal exceedances and one radionuclide exceedance are associated with an anomalous sampling event in 1992 in one well with an abnormally high TSS content. Seven metal exceedances were detected in one downgradient well that was apparently poorly developed. In the initial sampling round of well 46292 in 1992, elevated metal values were detected. Elevated values have not been repeated in subsequent sampling events.

Chloroform has been detected in well 46392 downgradient of OU 11. The concentrations detected have been consistently decreasing since well installation in 1992 and are thought to be associated with well installation methodology. Chloroform has not been detected in ground water within OU 11 and is not associated with any OU 11 sources including liquids previously sprayed at the site.

The ground-water data are slightly different than the data used for the other media because chemical data are available from locations that have been sampled repeatedly through time. The record of temporal variation in chemical concentrations directs the interpretation of the statistical results and UTL exceedances. Metals, radionuclides, SVOCs, and VOCs do not have consistently high concentrations at individual well locations through time. Appendix D (CDPHE Conservative Screen Final Letter Report) includes time series plots for the analytes. These time series plots are critical in evaluating the recurrence or consistency of an analyte in a well through time.

Table 4.1-1
Data Aggregation for Background Comparisons to Support Site Characterization and Risk Assessment Objectives

Media	OU 11 Data Set	Background Data Set	Objective of Comparison
Surficial Soils	All samples collected within and east of IHSS 168 (0–2 inches)	OU 1 and OU 2 background soils	PCOC selection for use in risk assessment, site characterization, nature and extent description
Subsurface Geologic Materials	Borehole samples from IHSS 168 (Qrf)	Sitewide background data for (Qrf)	Site characterization
	Borehole samples from within and downgradient of IHSS 168 (Qrf)	Sitewide background data for (Qrf)	PCOC selection, site characterization, nature and extent description
Ground Water	UHSU samples from wells in IHSS 168	Sitewide background data for UHSU ground water	Site characterization
	LHSU samples from wells in IHSS 168	Sitewide background data for LHSU ground water	PCOC selection, nature and extent description
	UHSU samples from wells within and downgradient of IHSS 168	Sitewide background data for UHSU ground water	PCOC selection, site characterization, nature and extent description
	UHSU samples from wells upgradient of IHSS 168	UHSU samples from downgradient of IHSS 168	Nature and extent description

Definitions:

IHSS individual hazardous substance site

LHSU lower hydrostratigraphic unit

OU operable unit

PCOC potential contaminant of concern

Qrf Rocky Flats Alluvium

UHSU upper hydrostratigraphic unit

Table 4.1-2
Boreholes Included in Background Comparisons

Boreholes in IHSS 168	Boreholes Downgradient of IHSS 168
46292	46392
50194	46492
50394	51194
50494	51294
50694	
50794	
50894	
50994	
51094	
51494	
51694	

Definition:

IHSS individual hazardous substance site

Table 4.1-3
Monitoring Wells Included in Background Comparisons

UHSU Wells Upgradient of IHSS 168	UHSU Wells Within IHSS 168	UHSU Wells Downgradient of IHSS 168	LHSU Wells Within IHSS 168
5186	4986	46392	4886
5286	5086	46492	
46192	B411289	B110889	
50294	B411389	B110989	
	46292	B111189	
	50194	B410589	
	50394	B410689	
	50694	B410789	
	50794	51194	
	50894	51294	
	50994		
	51094		
	51494		
	51594		

Definitions:

IHSS individual hazardous substance site

LHSU lower hydrostratigraphic unit

UHSU upper hydrostratigraphic unit

Table 4.1-4
PCOCs at OU 11

PCOCs by Media	Maximum Concentration or Activity	Units	Location of Maximum Concentration or Activity
Surficial Soils (0 to 2 inches)			
Americium-241	0.43	pCi/g	SS102094
Plutonium-239,240	2.2	pCi/g	SS102094
Nitrate/Nitrite	37	mg/kg	SS100894
Subsurface Geologic Materials (0 to 12 feet)			
Tritium	3.4	pCi/g	51294
Nitrate/Nitrite	2.0[1]	mg/kg	50694/51694/50894

[1] Although nitrate/nitrite does not appear to be a contaminant to subsurface geologic materials at OU 11, it has been conservatively included in the PCOC list because there were no background values for comparison and it is associated with the site history (see Section 4.5.5).

Definitions:

mg/kg milligrams per kilogram

OU operable unit

pCi/g picocuries per gram

PCOCs potential contaminants of concern

Table 4.4-1
Comparison of OU 11 Uranium Isotope Data to Background Data

Uranium Isotope	OU 11 Sample Range (pCi/g)	BSCP Background Range (pCi/g)
U-233, 234	1.3–4.3	0.6–3.1
U-235	0.013–0.3	0.11–0.34
U-238	1.4–4.5	0.74–2.6

Definitions:

BSCP Background Soils Characterization Project (DOE, 1995)

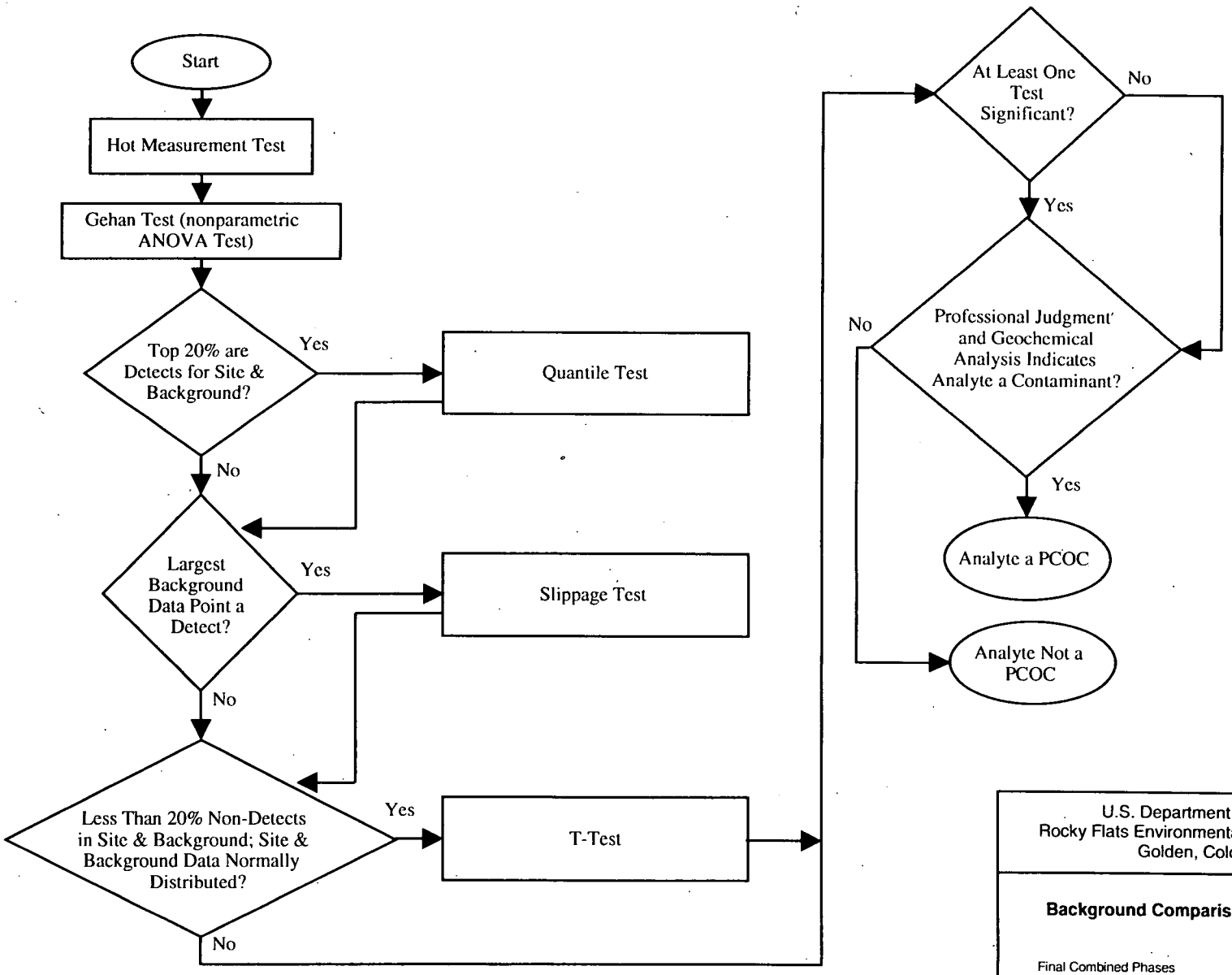
OU operable unit

pCi/g picocuries per gram

Table 4.6-1
Metals and Radionuclides Detected in Well 5086[1] in February 1992

Metals	Radionuclides
Aluminum	Americium
Barium	Plutonium
Beryllium	
Chromium	
Cobalt	
Copper	
Iron	
Lead	
Magnesium	
Manganese	
Nickel	
Potassium	
Vanadium	
Zinc	

[1] Data from well 5086 as sampled during February 1992. Samples from this well contained 1,900 micrograms per liter of total suspended solids.



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Background Comparison Methodology

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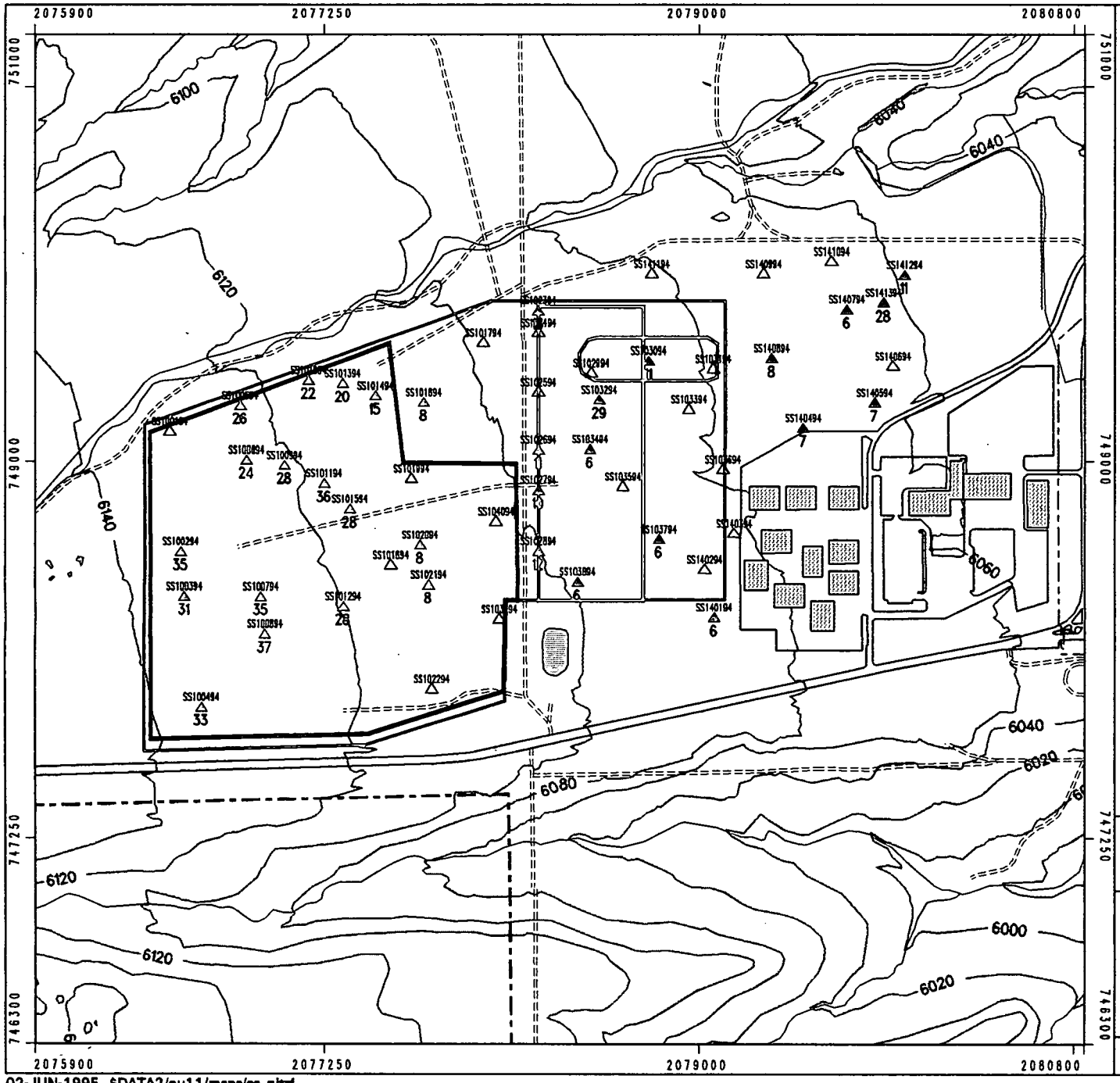
Figure 4.1-1

G95\ES\Background Comp.2-2509.Imp



EXPLANATION

- △ Sample Location
- ▲ Values above the background mean +2 standard deviations (BM+2SD)
- Spray Area 1
- Spray Area 2
- Spray Area 3
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

*Concentrations are in mg/kg
BM+2SD = 5

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
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Surficial Soil (0 to 2 Inches) Nitrate/Nitrite Concentrations*

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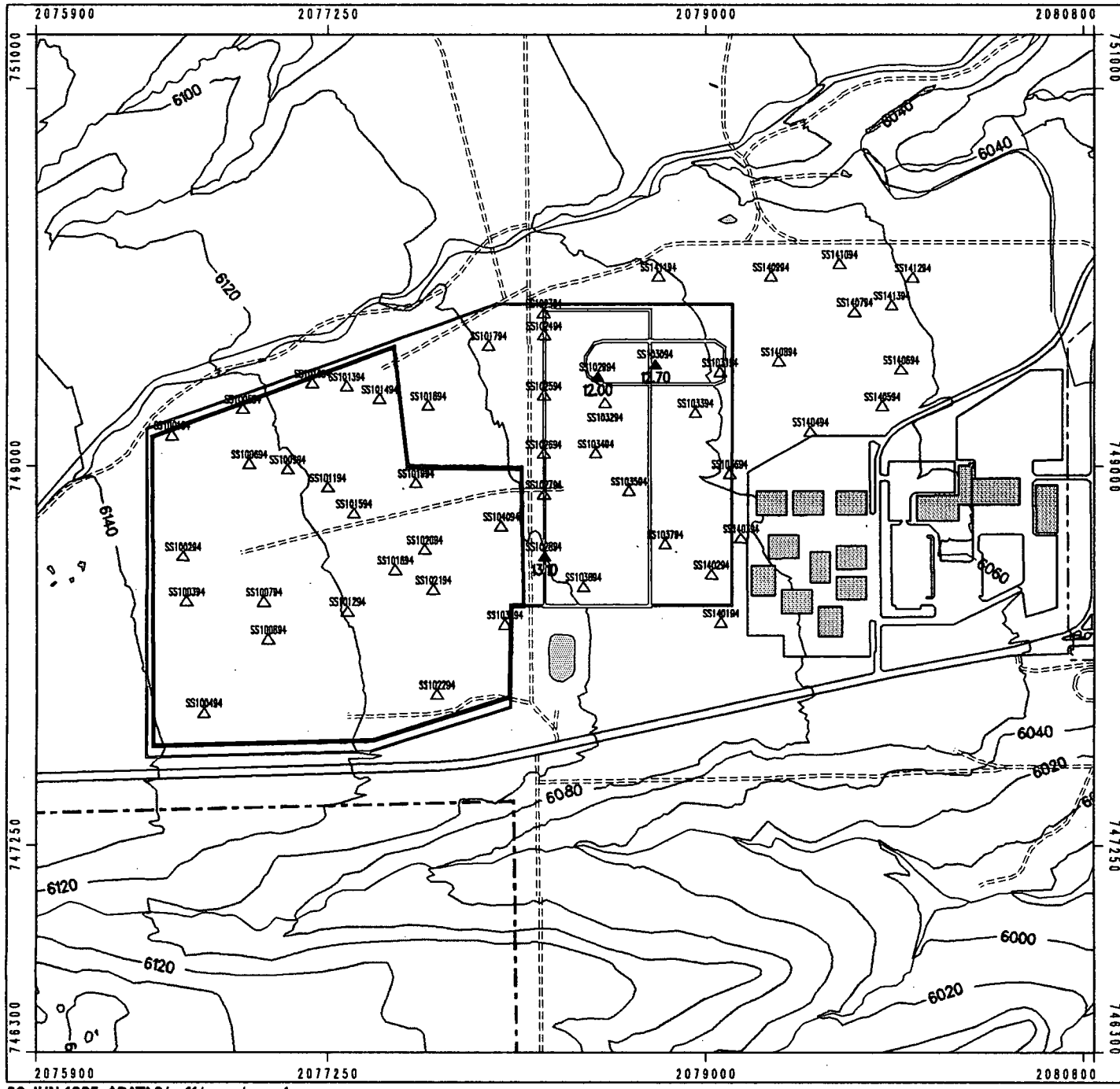
Figure 4.4-1

02-JUN-1995 $DATA2/ou11/maps/ss_nitrf



EXPLANATION

- △ Sample Location
- ▲ Values above the background mean +2 standard deviations (BM+2SD)
- Spray Area 1
- Spray Area 2
- Spray Area 3
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

*Concentrations are in mg/kg
BM+2SD = 10.000

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Surficial Soil (0 to 2 Inches) Arsenic Concentrations*

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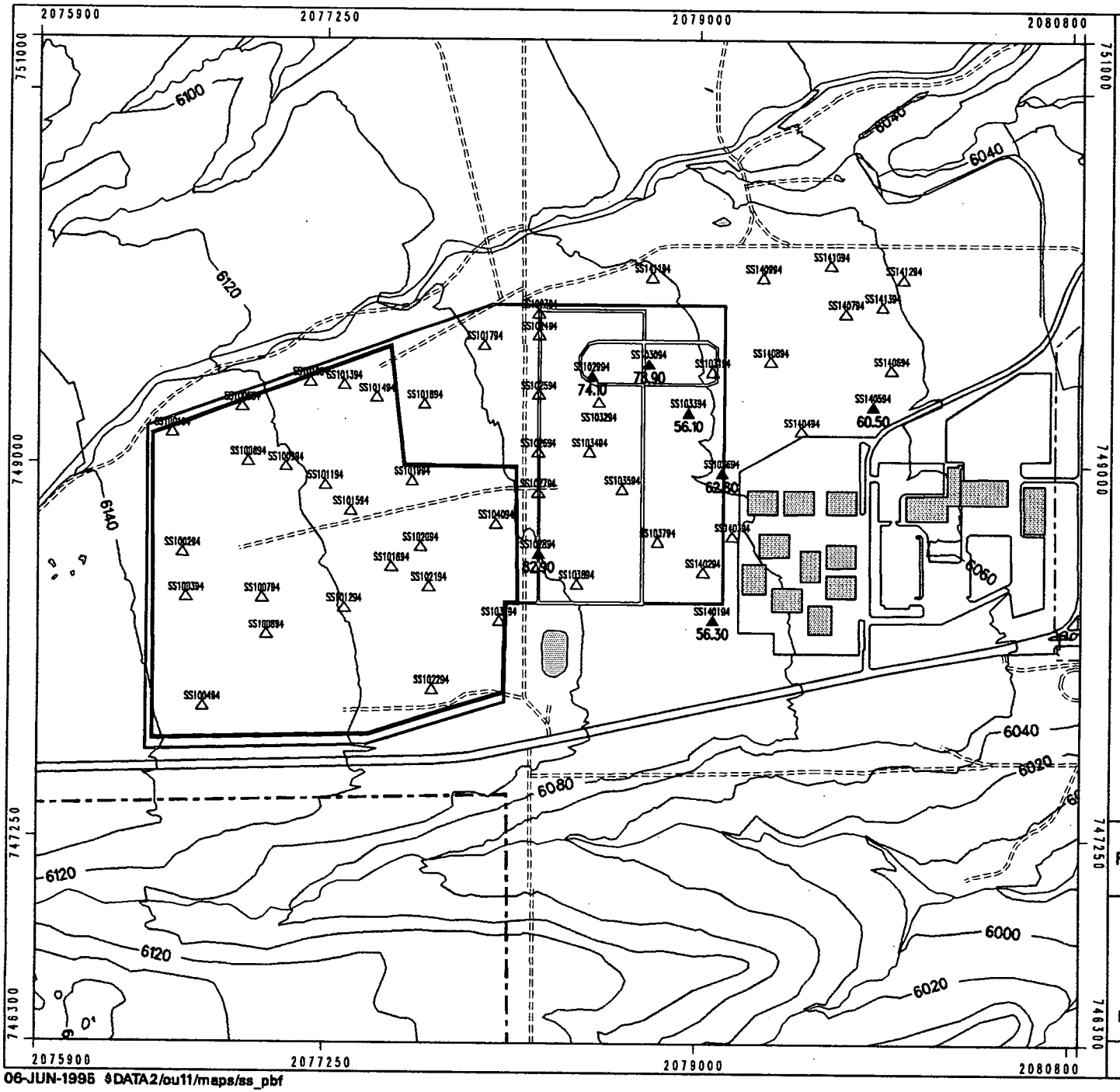
Figure 4.4-2

06-JUN-1995 $DATA2/ou11/maps/ss_asf



EXPLANATION

- △ Sample Location
- ▲ Values above the background mean +2 standard deviations (BM+2SD)
- Spray Area 1
- Spray Area 2
- Spray Area 3
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

*Concentrations are in mg/kg
BM+2SD = 50.000

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Surficial Soil (0 to 2 Inches) Lead Concentrations*

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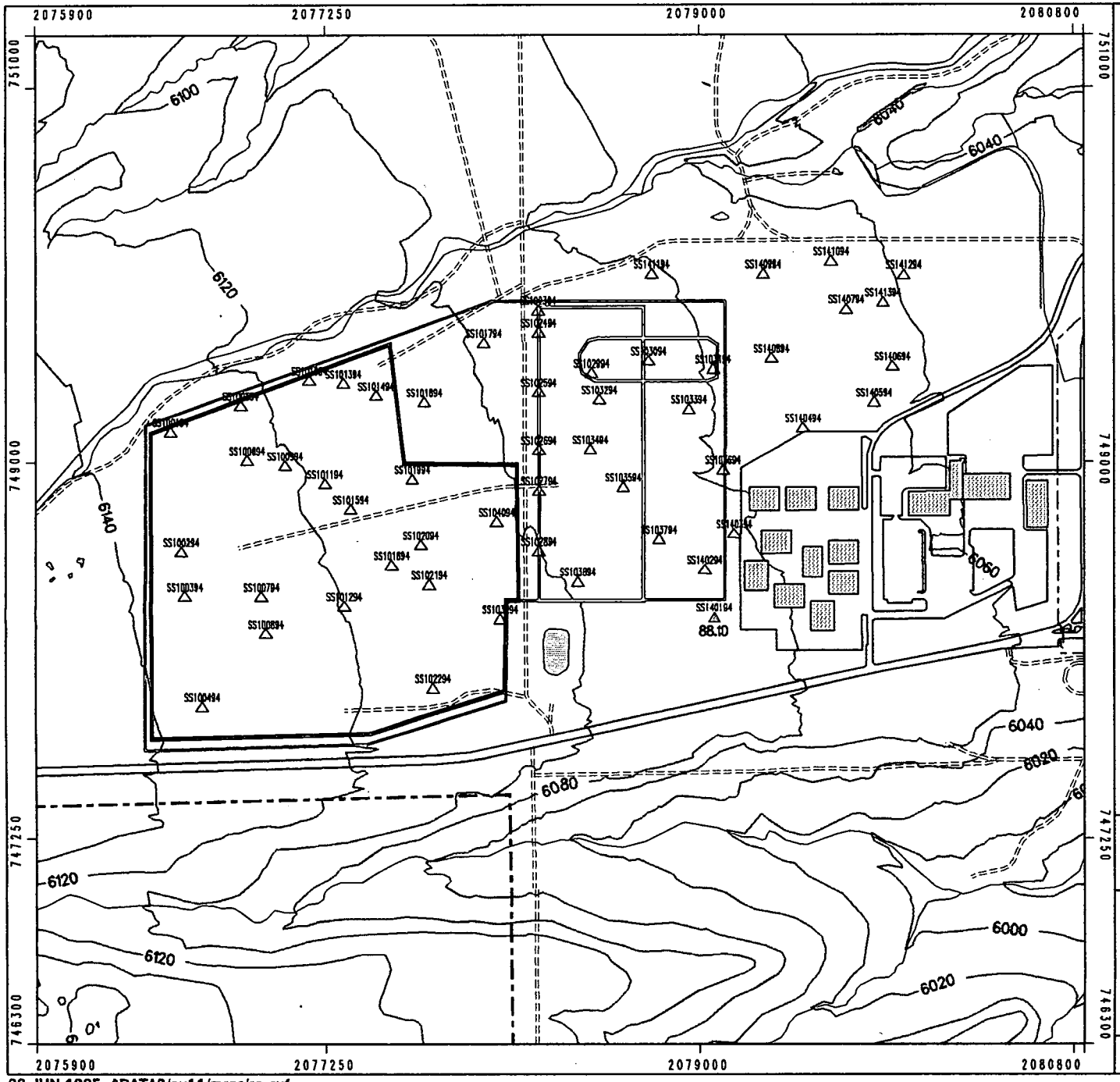
Figure 4.4-3

06-JUN-1995 $DATA2/ou11/maps/ss_pbf



EXPLANATION

- Sample Location
- Values above the background mean +2 standard deviations (BM+2SD)
- Spray Area 1
- Spray Area 2
- Spray Area 3
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

*Concentrations are in mg/kg
BM+2SD = 22

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Surficial Soil (0 to 2 Inches) Copper Concentrations*

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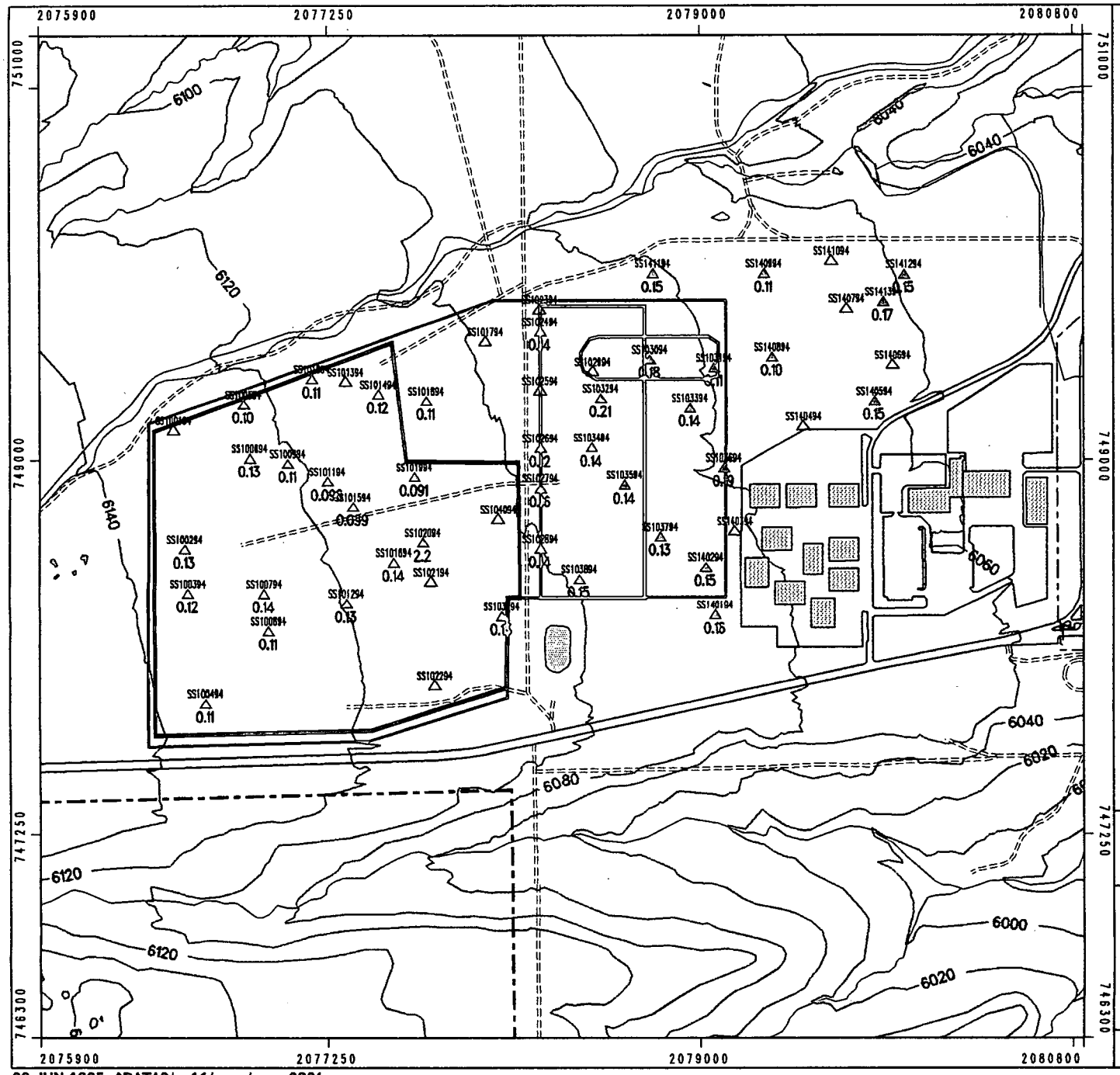
Figure 4.4-4

02-JUN-1995 $DATA2/ou11/maps/ss_cuf



EXPLANATION

- Sample Location
- Values above the background mean +2 standard deviations (BM+2SD)
- Spray Area 1
- Spray Area 2
- Spray Area 3
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

*Activities are in pCi/g
BM+2SD = 0.090

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Surficial Soil (0 to 2 Inches) Plutonium-239,240 Activities*

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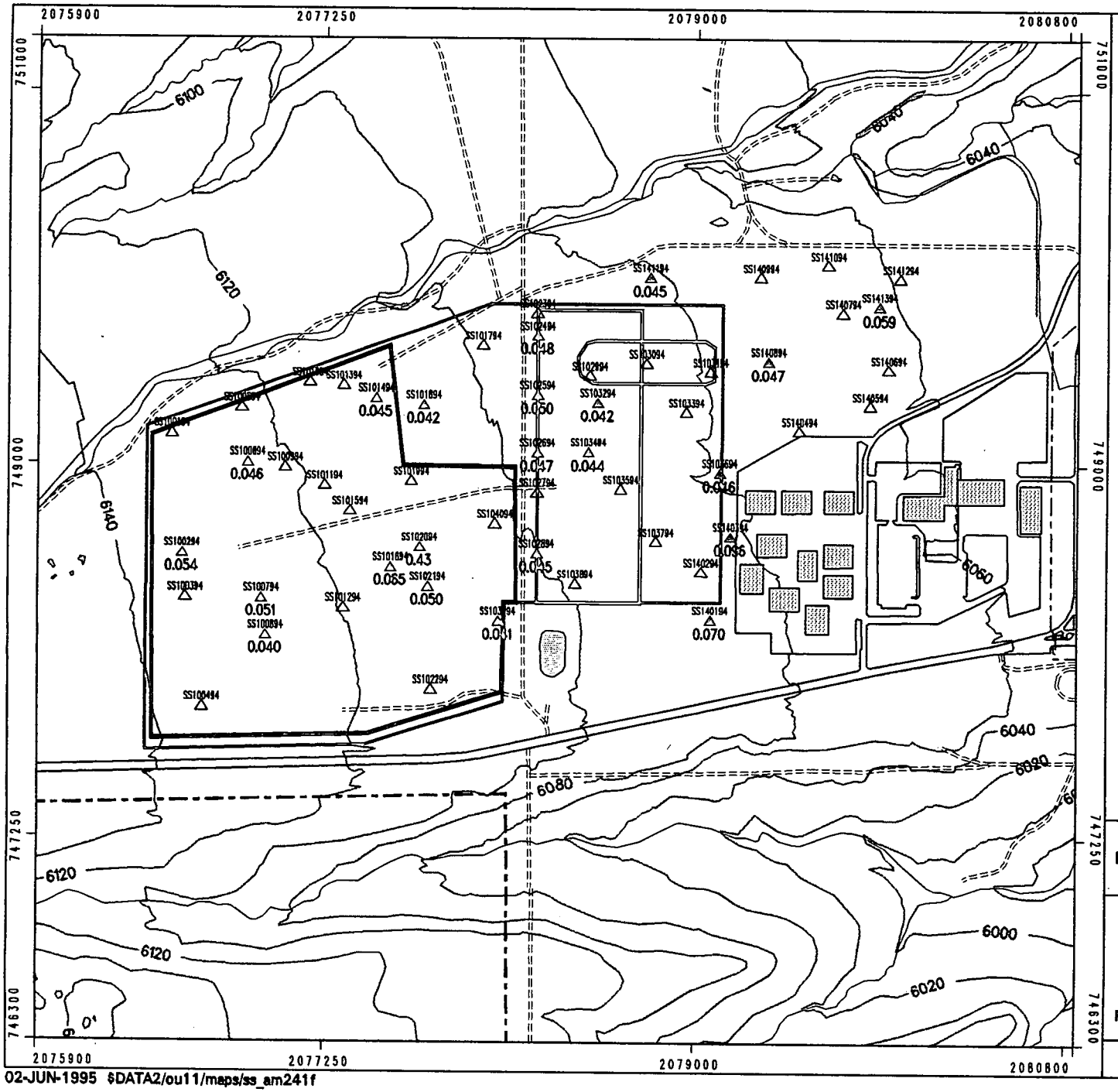
Figure 4.4-5

02-JUN-1995 $DATA2/ou11/maps/ss_pu239f



EXPLANATION

- Sample Location
- Values above the background mean +2 standard deviations (BM+2SD)
- Spray Area 1
- Spray Area 2
- Spray Area 3
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

*Activities are in pCi/g
BM+2SD = 0.039

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Surficial Soil (0 to 2 Inches) Americium-241 Activities*

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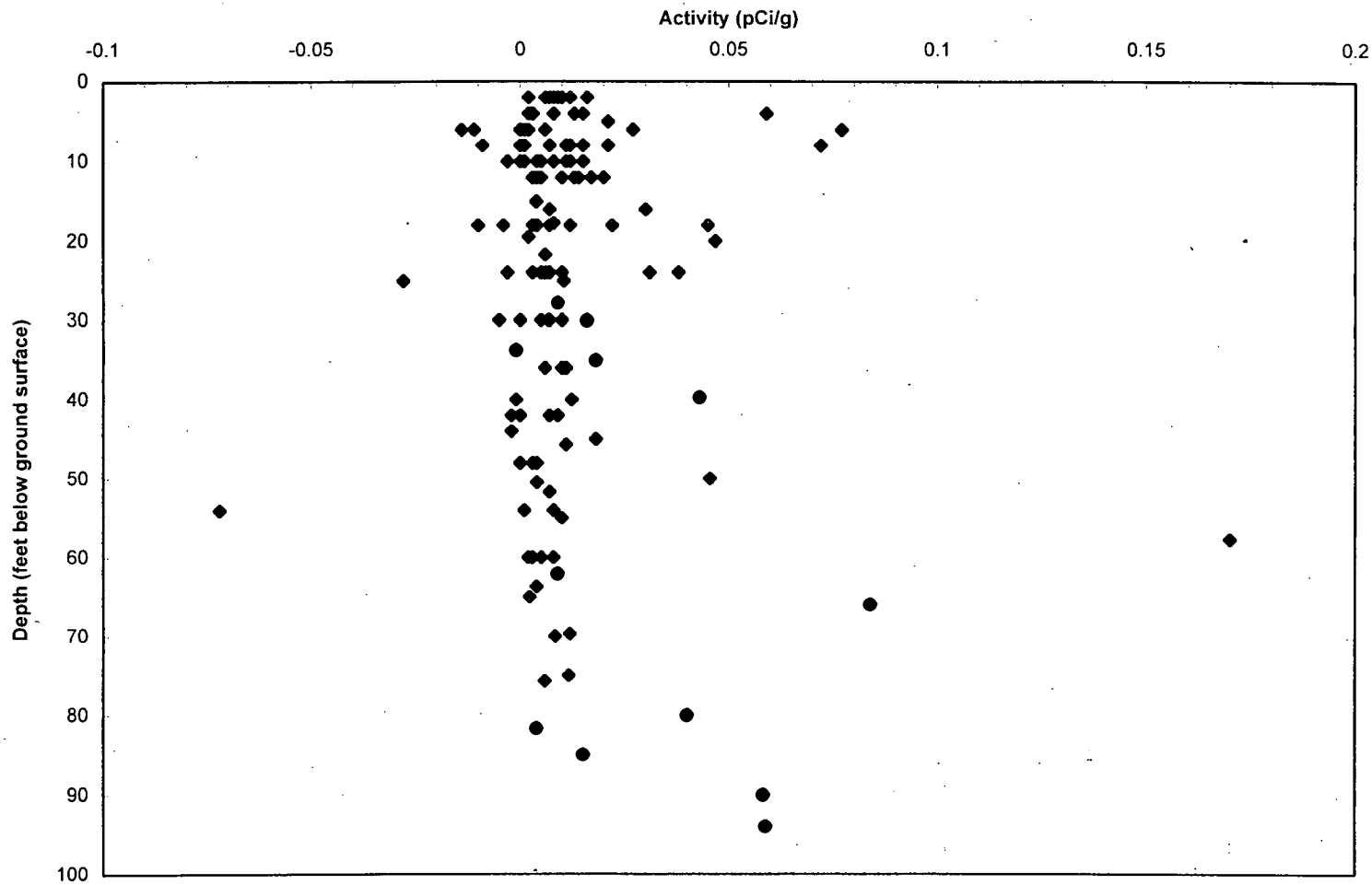
Figure 4.4-6

02-JUN-1995 $DATA2/ou11/maps/ss_am241f



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Variation of Activity with Depth for Americium-241 in IHSS 168 Subsurface Geologic Materials

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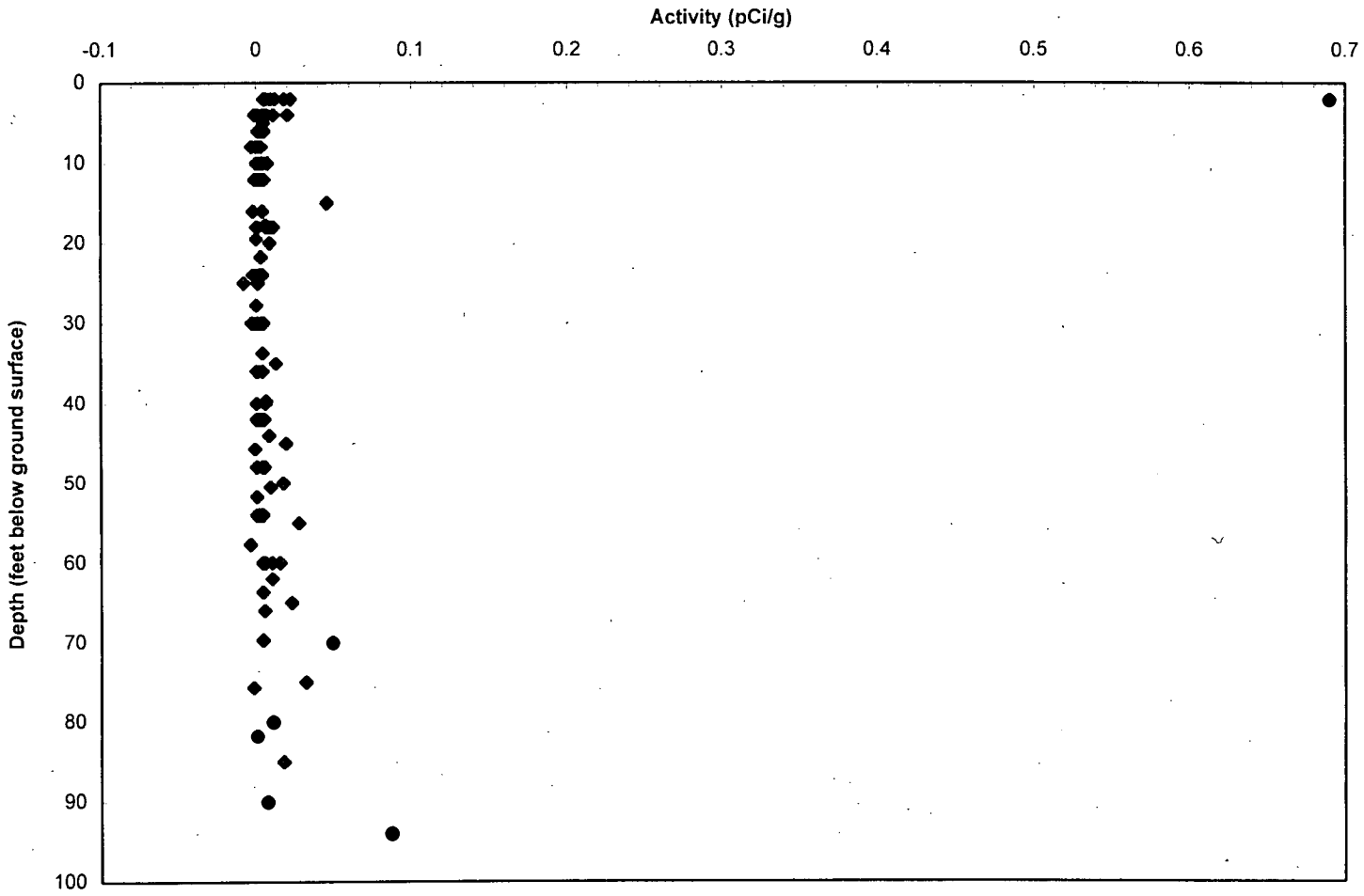
Figure 4.5-1

MEP C:\DOCS\OU11\PLOTS\BH_RADS.XLS Fig 4.5-1 6/5/95



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Variation of Activity with Depth for Plutonium-239,240 in IHSS 168 Subsurface Geologic Materials

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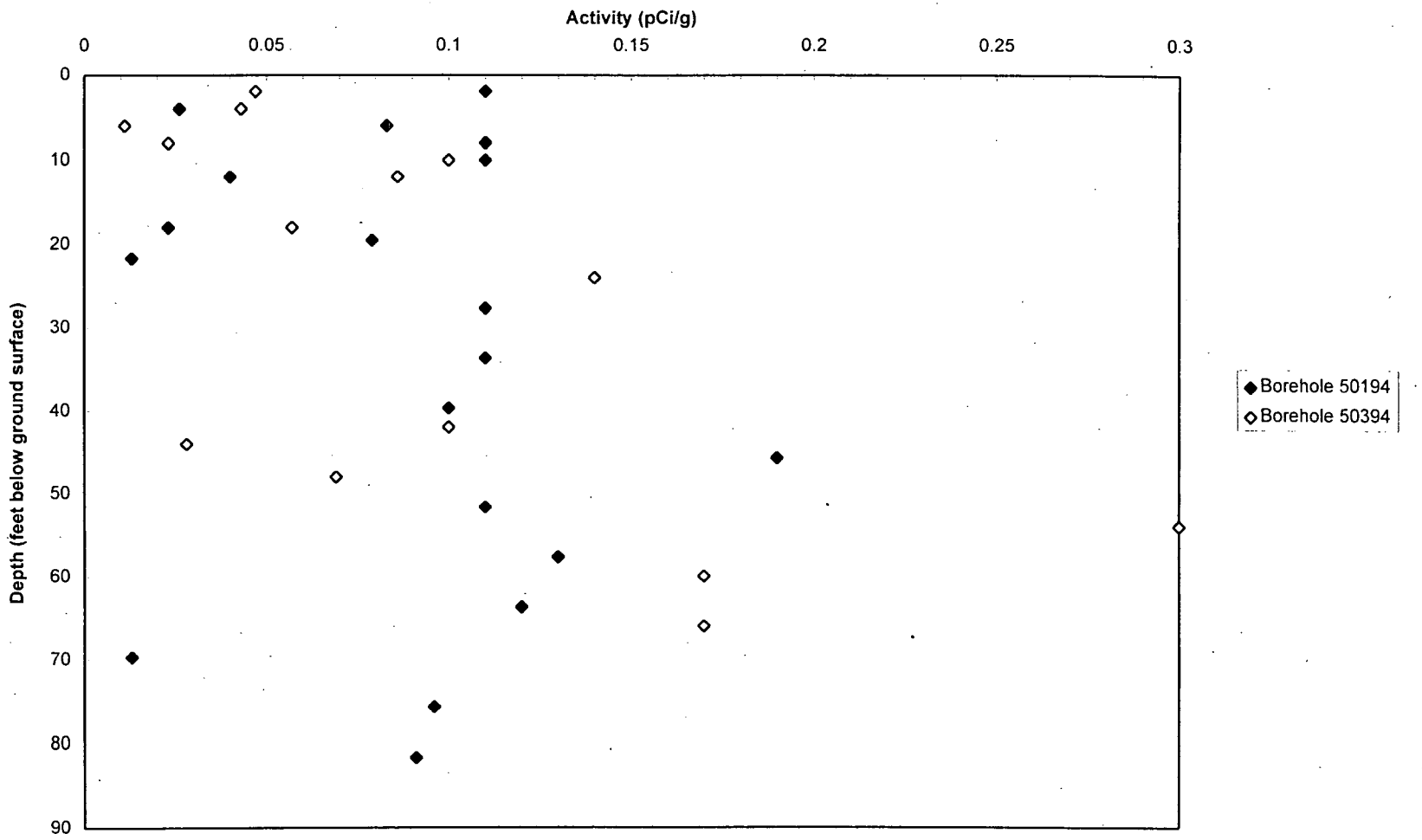
Operable Unit 11

June 1995

Figure 4.5-2

MEP C:\DOCS\OU11\PLOTS\BH_RADS.XLS Fig 4.5-2 6/5/95



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Variation of Activity with Depth for Uranium-235 in Boreholes 50194 and 50394

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Operable Unit 11

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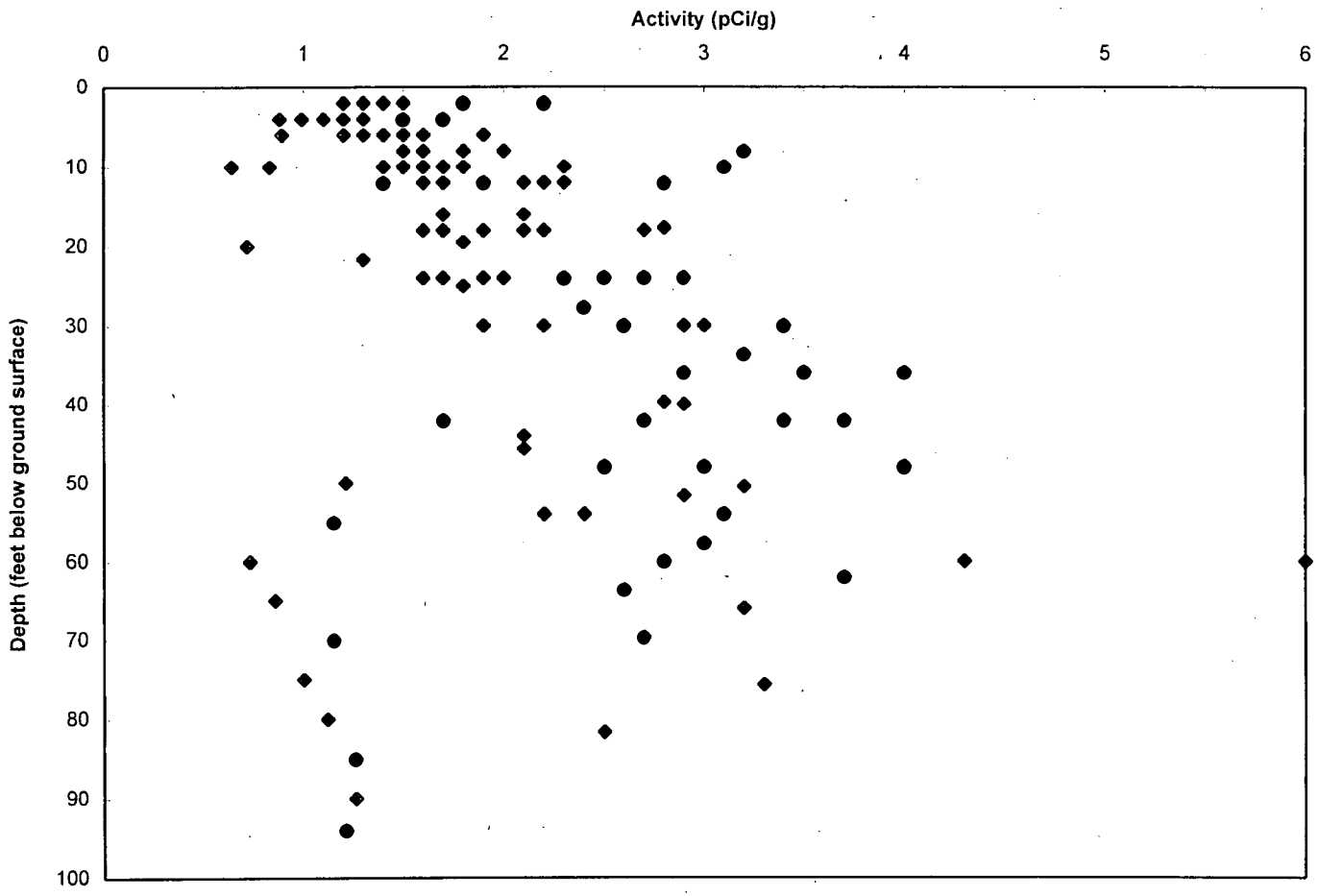
Figure 4.5-3

MEP C:\DOCS\OU11\PLOTS\BH_RADS XLS Fig 4.5-3 6/5/95



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Variation of Activity with Depth for Uranium-233,234 in IHSS 168 Subsurface Geologic Materials

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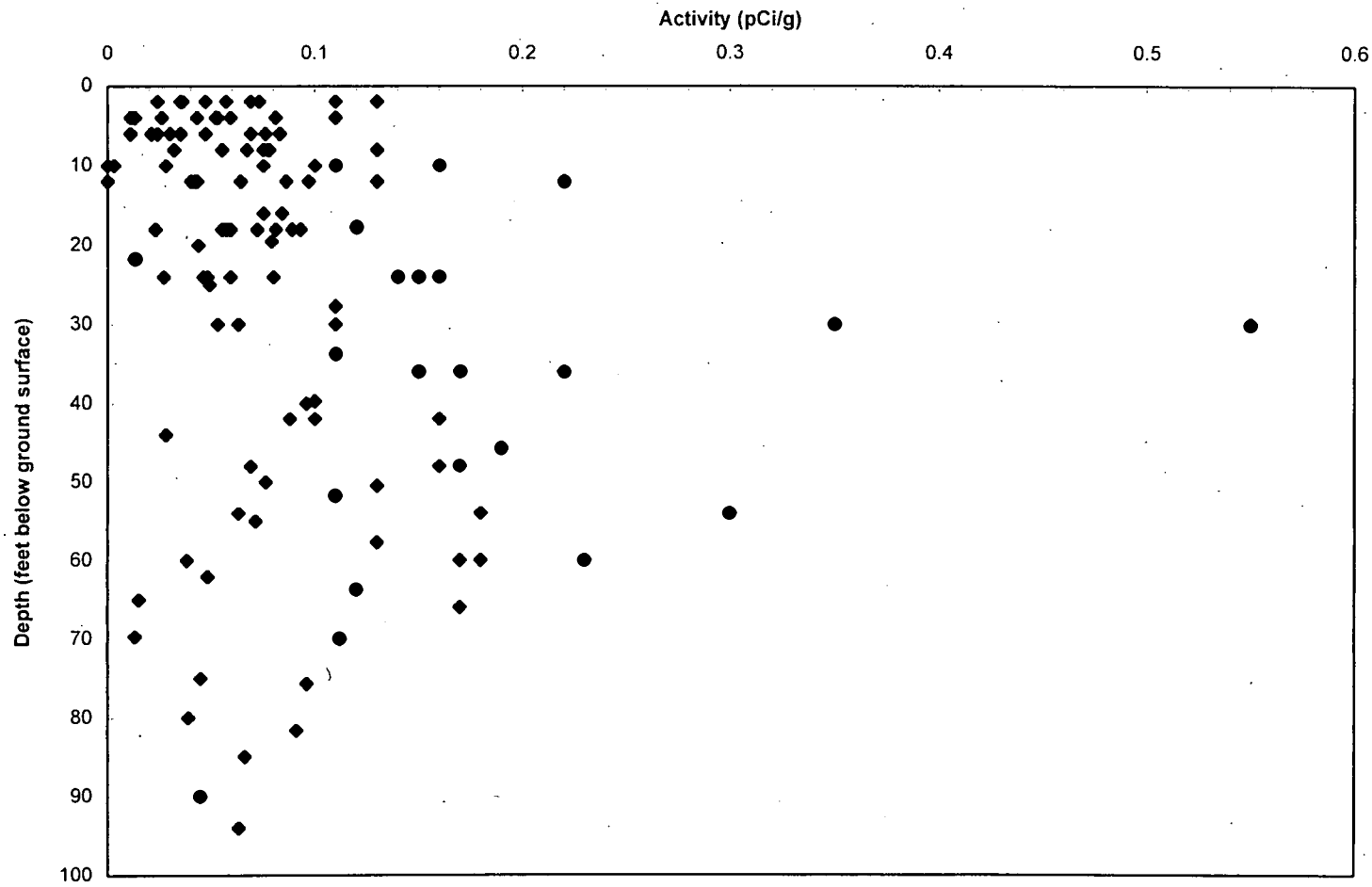
June 1995

Figure 4.5-4

MEP C:\DOCS\OU11\PLOTS\BH_RADS.XLS Fig 4.5-4 6/5/95



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Variation of Activity with Depth for Uranium-238 in IHSS 168 Subsurface Geologic Materials

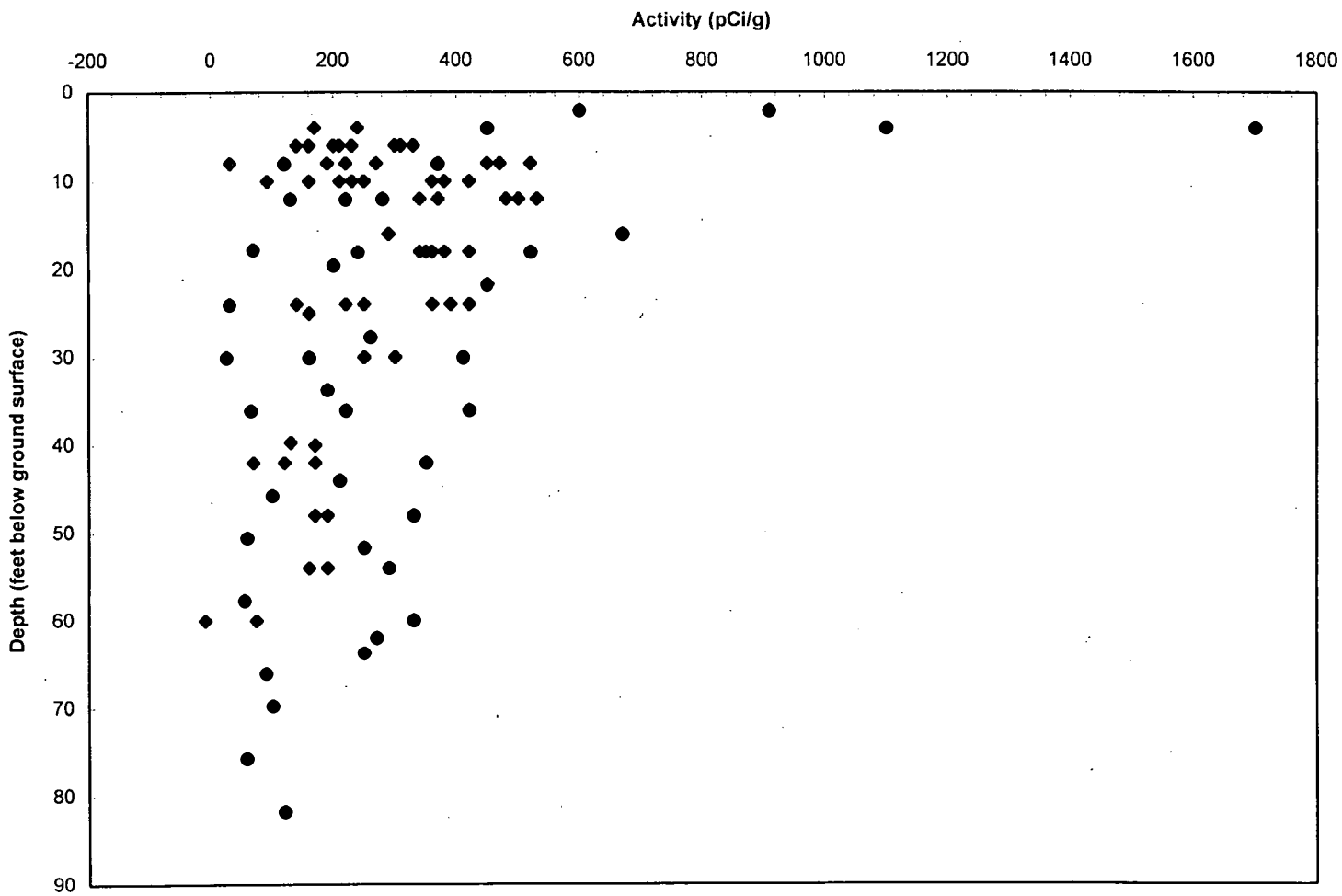
Final Combined Phases RFI/RI Report

Operable Unit 11

June 1995

Figure 4.5-5

MEP C:\DOCS\OU11\PLOTS\BH_RADS XLS Fig 4.5-5 6/5/95



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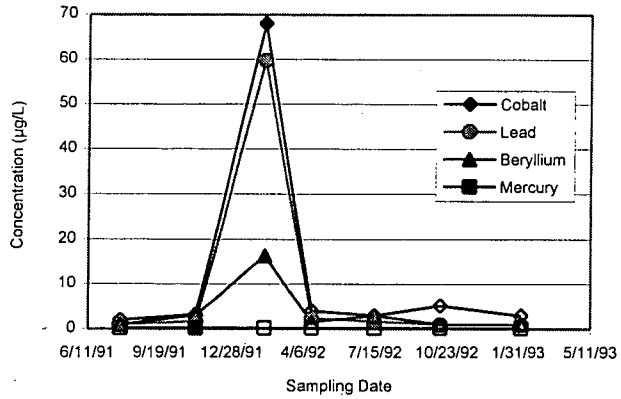
Rocky Flats Environmental Technology Site
Golden, Colorado

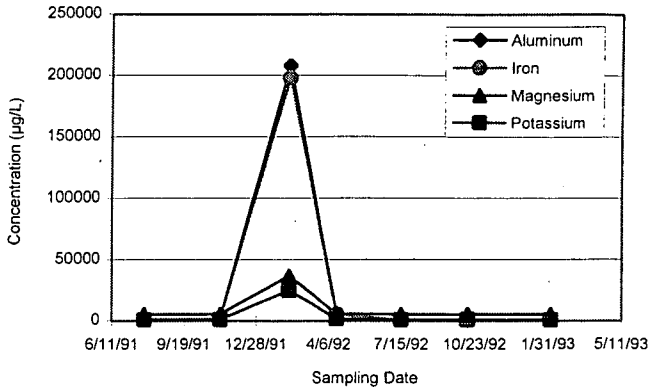
Variation of Activity with Depth for Tritium in IHSS 168 Subsurface Geologic Materials

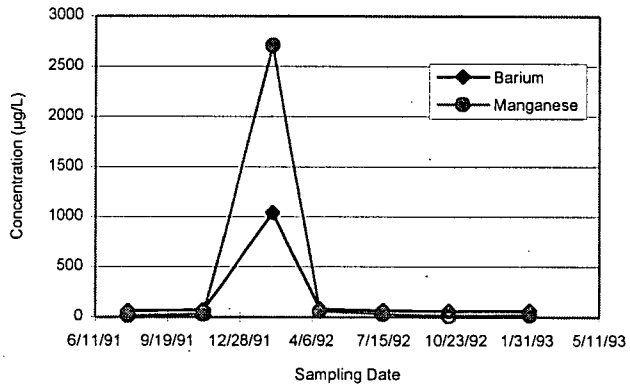
Final Combined Phases RFI/RI Report — Operable Unit 11

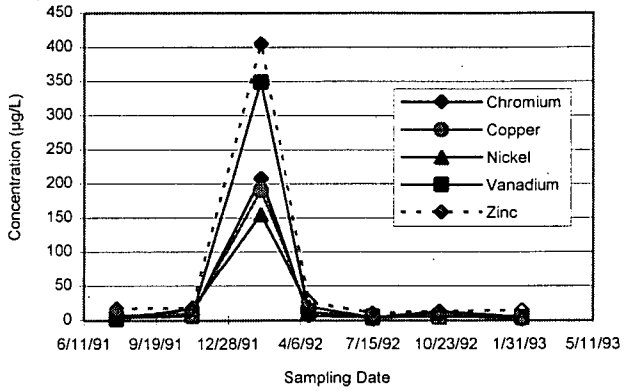
June 1995 — Figure 4.5-6

MEP C:\DOCS\OU11\PLOTS\BH_RADS.XLS Fig 4.5-6 6/5/95









Solid Symbol = Hit - Y
Hollow Symbol = Hit - N

U.S. Department of Energy
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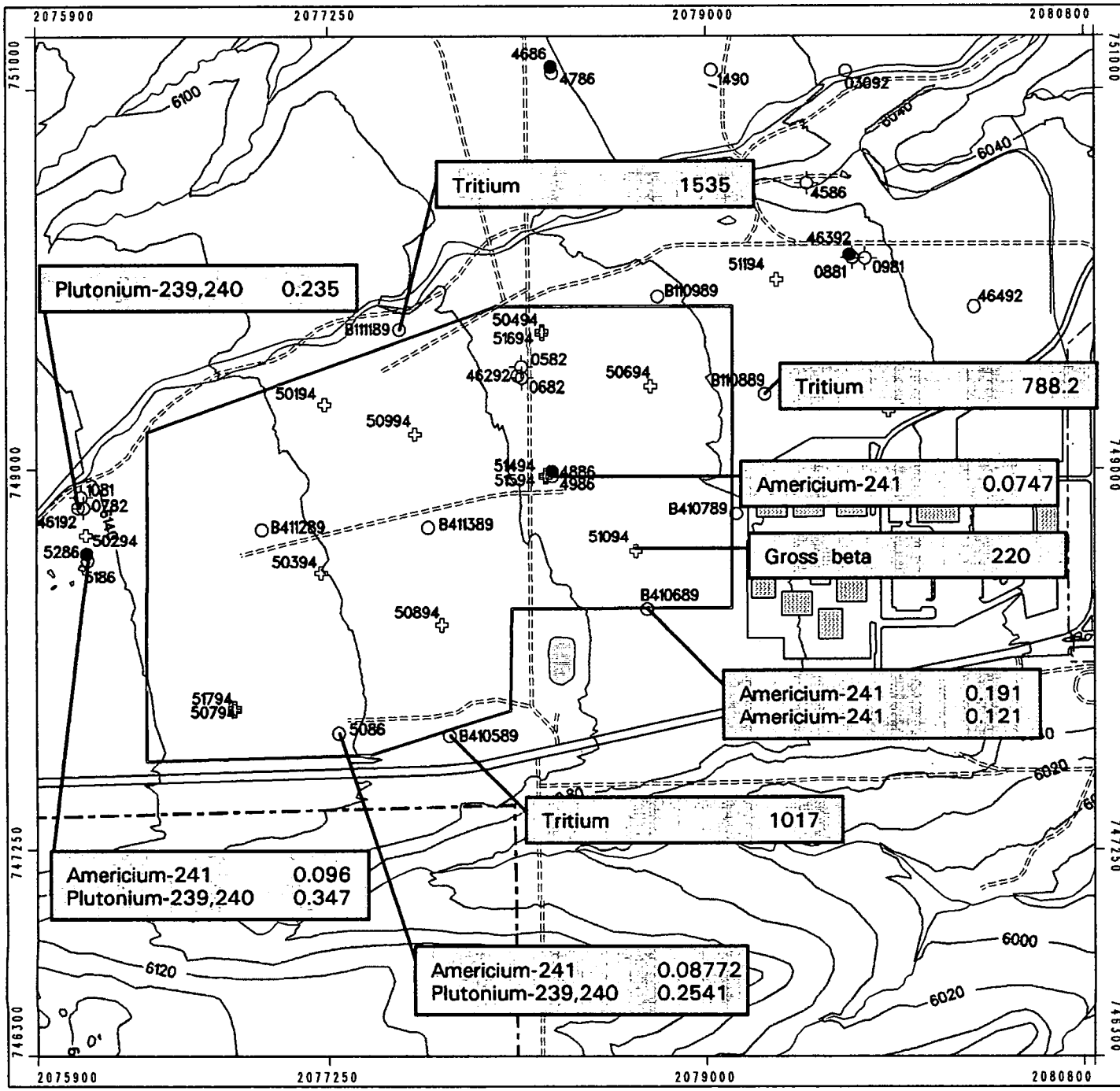
Golden, Colorado

Variation of Concentration with Time for Total Metals in Well 5086

Final Combined Phases
RFI/RI Report — Operable Unit 11

June 1995 — Figure 4.6-1



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

NOTE: *All exceedances from 1st Quarter 1990 through 3rd Quarter 1994 are shown.
Background $UTL_{99/99}$ (pCi/L) for:
Americium-241 = 0.04
Gross beta = 199
Plutonium-239,240 = 0.058
Tritium = 600

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

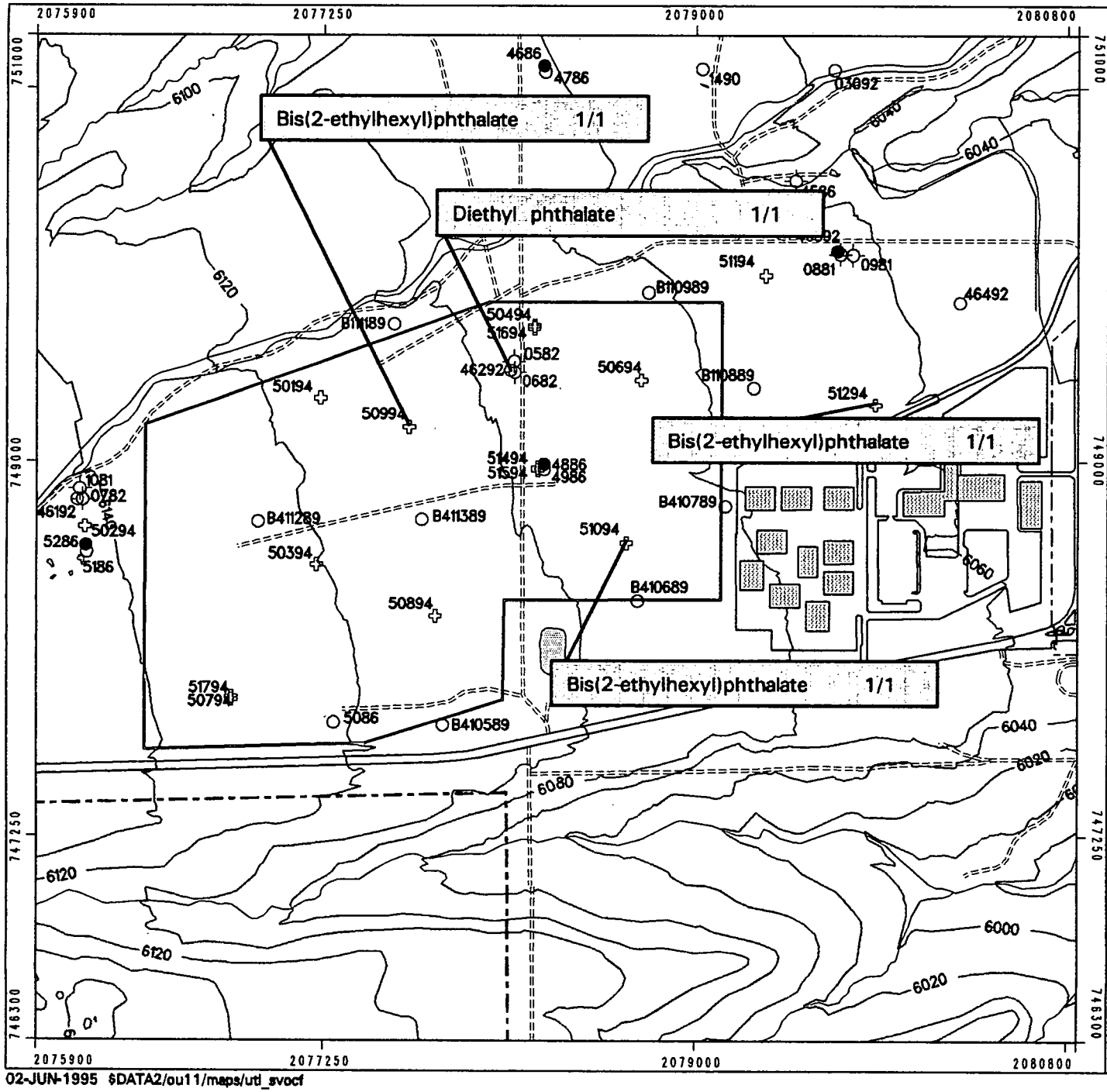
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Total Radionuclide $UTL_{99/99}$ Exceedances* in UHSU Ground Water

Final Combined Phases RFI/RI Report — Operable Unit 11

June 1995 — Figure 4.6-2

02-JUN-1995 $DATA2/ou11/maps/utl_tradf



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20 ft. Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

NOTE: *All occurrences from 1st Quarter 1990 through 3rd Quarter 1994 are shown.

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Semivolatile Organic Compound Frequency of Occurrence* in UHSU Ground Water

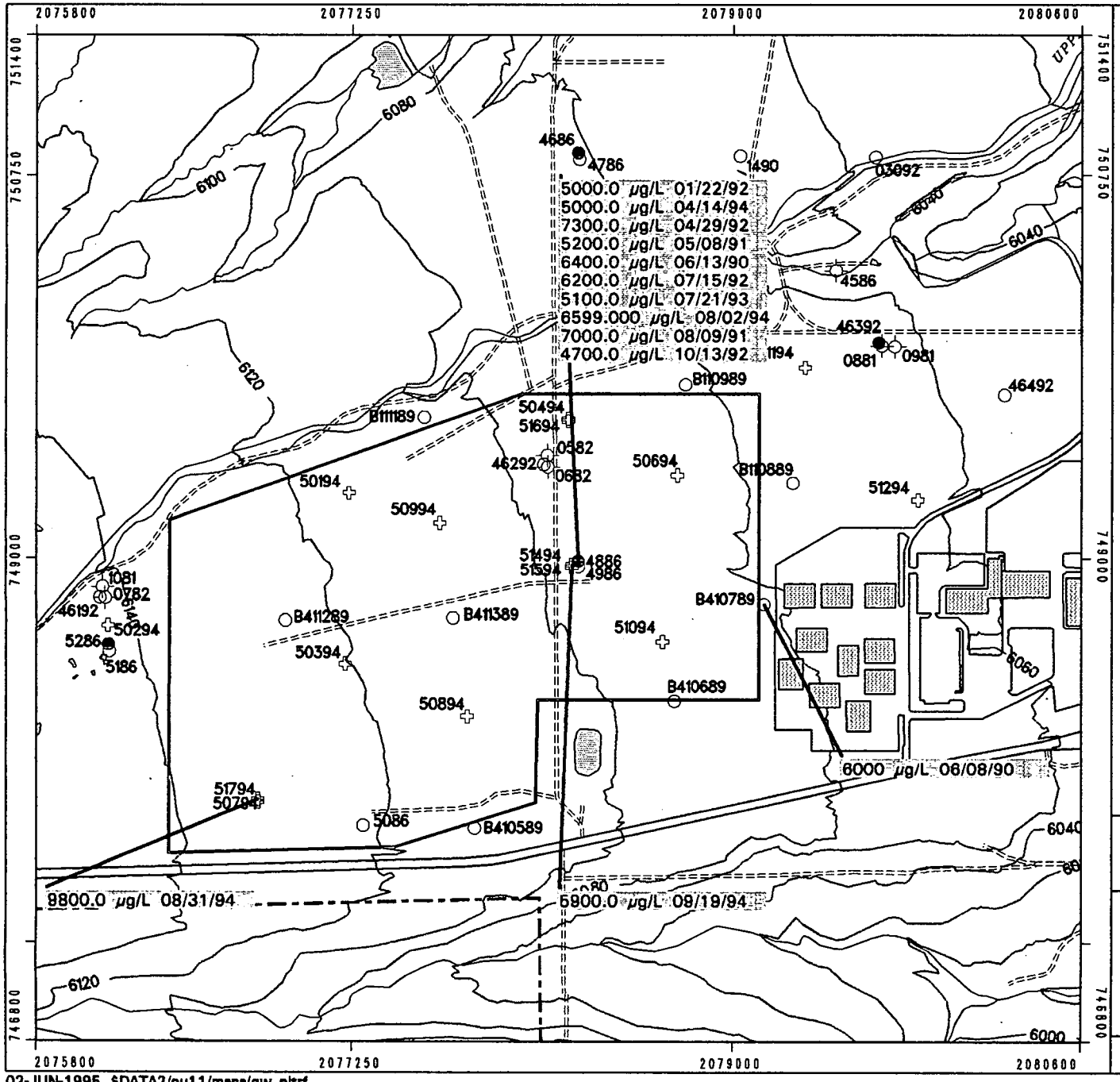
Final Combined Phases
RFI/RI Report

Operable Unit 11

June 1995

Figure 4.6-3

02-JUN-1995 $DATA2/ou11/maps/utl_svocf



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
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- Security Fences
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- OU 11 (IHSS 168)
- Lakes and Ponds
- Buildings and Trailers (130 Complex)

*Includes values above the background mean +2 standard deviations (BM+2SD)

Concentrations are in µg/L
BM+2SD = 4551

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Nitrate/Nitrite Concentrations* (and Sample Dates) in UHSU Ground Water

Final Combined Phases
RFI/RI Report

Operable Unit 11

June 1995

Figure 4.6-4

02-JUN-1995 $DATA2/ou11/maps/gw_nitrf

5. OU 11 Contaminant Fate and Transport

An understanding of the fate and transport of PCOCs is important in finalizing decisions regarding the future of the site. The OU 11 PCOCs were discussed in Section 4, Nature and Extent of Contamination, and in the CDPHE Conservative Screen Final Letter Report (Appendix D). The OU 11 PCOCs identified through the field investigations and statistical comparisons include americium-241 and plutonium-239,240 in surficial soils, nitrate/nitrite in surficial soils and subsurface geologic materials, and tritium in subsurface geologic materials. This section evaluates the mobility and persistence of these PCOCs in the OU 11 media.

The mobility and persistence of the PCOCs are affected by the physical and chemical properties of the PCOC and the media. Rates of migration, type and rate of PCOC degradation, retardation or transformation during transport, and the potential pathways for migration are considered in evaluating the potential for migration of each PCOC. By integrating pertinent aspects of the site conceptual model with data for the spatial distribution of PCOCs (see Section 4), along with an understanding of the geochemical behavior of each PCOC, the potential for contaminant migration can be assessed.

5.1 Potential Migration Pathways and Transport Processes

Surficial soils and subsurface geologic materials are the media hosting PCOCs and represent the principal pathways for contaminant migration at OU 11. PCOCs present in surficial soils may potentially migrate into subsurface geologic materials and eventually to the water table. En route, the PCOCs may be subject to a variety of potential physiochemical processes, such as adsorption/desorption and oxidation/reduction. Chemical properties of individual analytes control the rate at which potential migration of PCOCs occurs. PCOCs with high solubilities and geochemically conservative (i.e., nonreactive) behaviors will be more mobile, whereas PCOCs with low solubilities or an affinity for adsorptive solid phases will be less mobile. The thick vadose zone in OU 11 provides a large area and long flow path along which PCOCs may be adsorbed onto geologic materials. Thus, in some instances the vadose zone may act as a natural barrier to the downward migration of PCOCs to the water table. However, preferential flow paths in the OU 11 vadose zone may enhance the rate of downward movement of PCOCs (DOE, 1994). No PCOCs were identified in OU 11 ground water, indicating that the total mass of PCOCs leached from surficial soils and subsurface geologic materials is insignificant.

5.2 PCOC Behavior and Mobility

The chemical characteristics of the PCOCs, in addition to the physical and chemical characteristics of the OU 11 soils and the vadose zone, control PCOC mobility. This section discusses the environmental characteristics that influence mobility, the characteristics of the PCOCs identified at OU 11, and the expected interactions of media and PCOCs based on these characteristics.

5.2.1 Environmental Characteristics

5.2.1.1 Geologic

Geologic characteristics in OU 11 were determined during the RFI/RI field investigation activities. Activities providing geologic information included borehole drilling, core logging and subsurface geologic material sampling. The surficial materials at OU 11 are exclusively Rocky Flats Alluvium. The Rocky Flats Alluvium consists of poorly sorted, unconsolidated clay, silt, sand, and gravel deposits. These deposits are mildly calcareous and weakly cemented in places. The clay that exists in the Rocky Flats Alluvium decreases soil porosity and permeability, thus reducing the hydraulic conductivity of the subsurface geologic materials and, hence, the associated rate of PCOC transport.

5.2.1.2 Hydraulic

Alluvial deposits at RFETS generally have low saturated permeabilities, ranging between 10^{-5} and 10^{-6} cm/sec, because of their poor sorting and clay content. Areas disturbed by excavation or construction may have higher permeabilities due to differing compaction or composition, but OU 11 soils are relatively undisturbed. Primary infiltration at OU 11 is through macropores, which have the effect of channeling water vertically and laterally through preferred pathways in the soil. These preferred pathways may result in localized areas of increased PCOC mobility or infiltration and adjacent soils that are essentially unaffected by infiltrating water or PCOC migration. Clays present in the soils may limit PCOC mobility by adsorption processes.

5.2.1.3 Chemical

Geochemical characteristics of the Rocky Flats Alluvium as presented in a site report (DOE, 1994) indicate that these clayey soils have a high cation exchange capacity (30 milliequivalents of sodium per 100 grams [meq Na/100 g]), an average electrical conductivity typical of moderately saline soils, and sparse total organic carbon (TOC) (0.01 percent to 1.40 percent). The pH in pore waters has been reported as ranging from 7 to 8.5. The implications of these soil chemical characteristics have been evaluated for each PCOC and are presented in the following subsection.

5.2.2 PCOC Characteristics

Due to the complex interaction among the factors influencing chemical mobility, it is often difficult to predict the precise environmental fate of an individual compound. However, compounds of similar chemical nature have overriding characteristics that can be used to predict the overall fate of the group. Table 5.2-1 lists the PCOCs and their relevant physical and chemical properties that influence mobility.

5.2.2.1 Nitrate/Nitrite

Although nitrate/nitrite is a naturally occurring anion in soil organic matter and soil moisture, elevated nitrate concentrations are almost always due to anthropogenic activities, most commonly crop fertilization. At OU 11, the liquids from the SEPs sprayed across the site contained high concentrations of nitrate, derived from nitric acid used in plutonium processing. The spray application resulted in elevated levels of nitrate/nitrite in surficial soils and a slight increase in concentration of nitrate/nitrite in subsurface geologic materials.

The chemical characteristics of nitrate/nitrite support a two-fold fate for the compound. Most nitrate and ammonium salts are highly soluble in water, and dissolved nitrogen is very mobile, especially under relatively oxidizing conditions. This characteristic would support a model of relatively fast migration of the nitrates through the ground-water system. The second fate for consideration involves the presence of nitrogen-fixing plants in the OU 11 spray areas. The plant surveys conducted as part of the OU 11 RFI/RI field investigation (see Section 3.7.1) identified higher plant biomass and lower plant basal coverage in spray areas when compared to non-spray areas. Both of these vegetative differences identified in the spray areas are attributable to supplemental nitrogen.

Distribution of nitrate/nitrite in surficial soils coincides with spray areas and areas downgradient of spray activities. Residual concentrations of nitrate/nitrite, as measured in soil samples collected in 1994, are low. The distribution of nitrate/nitrite in subsurface geologic materials is also within the spray areas, although the concentrations are erratically distributed and are present at levels barely above detection limits. Nitrate/nitrite was not identified as a PCOC in OU 11 ground water, and the detections of nitrate/nitrite in ground water are all within the range of detections in background wells. In summary, the sampling conducted in 1994 provides evidence indicating that the additional nitrate/nitrite supplied by spray irrigation of SEP waters was primarily bound up in the surficial soils and associated vegetation and is not detectable at elevated levels in ground waters at the site. Thus, physical evidence indicates much of the nitrogen was taken up by plants before deep infiltration or downward migration of nitrate could occur.

5.2.2.2 *Plutonium-239,240 and Americium-241*

Plutonium and americium mobility in a soil-water system are influenced by several factors, including the physical and chemical factors of the soils and pore waters and the characteristics of the radionuclides themselves. Plutonium and americium exhibit a strong affinity for the solid phase. Distribution coefficient (K_d) values for americium and plutonium are included in Table 5.2-2. The K_d values calculated from the retardation factors used in a study by Staley, *et al.* are also presented in this table (Staley, *et al.*, 1979). Both sets of values indicate that the potential for adsorption of plutonium and americium is several orders of magnitude greater than for VOCs or nitrate. The geochemical behavior of these two radionuclides is dominated by their propensity to bind to soils under the geochemical conditions found at RFETS.

Plutonium and its decay product, americium, have been identified as PCOCs in surficial soils at OU 11. Their distribution, localized in the surficial soils rather than dispersed into the underlying subsurface geologic materials and ground water, supports the geochemical behavior described above. Thus, the important transport processes to consider would be surficial activities such as wind erosion or overland sediment transport. Ground water transport of americium and plutonium at OU 11 would be limited due to the strong adsorption of these species onto the soil matrix. Americium and plutonium may adhere to colloidal particles in ground-water systems, and this may increase their effective solubility and mobility (DOE, 1994). Although colloidal transport enhances the mobility of plutonium and americium in vadose zone waters, these radionuclides were only minimally detected in UHSU ground water at OU 11. Thus, colloidal transport of americium and plutonium does not appear to have carried these radionuclides downward to the water table.

The observed vertical distribution of plutonium and americium at OU 11 in surficial soils, subsurface geologic materials, and ground water shows that activity levels decrease rapidly with increasing depth. In subsurface geologic materials, there are only erratic detections of either radionuclide, and in ground water, there are only a few detections. This observed distribution pattern is consistent with the extremely low solubility and strong adsorption potential for these PCOCs.

5.2.2.3 *Tritium*

Tritium is a radioactive isotope of hydrogen whose behavior differs from that of the metal radionuclides. Except for slight differences in vapor pressure, tritiated water behaves like ordinary water (Jacobs, 1974). A small fraction may associate with hydrogen-containing soil organic compounds or as part of structural hydroxyl groups (Jacobs, 1974). However, field studies have confirmed that tritium travels at about the same velocity as soil pore water and ground water (Brown, 1967). Therefore, tritium

may be transported rapidly through the vadose zone in preferential flow paths or may remain in the vadose pore water. Tritium, if transported in ground water, could have moved approximately 290 feet in the ten years since spraying ended (Table 3.6-3). However, there is no spatial correlation between tritium in ground water and tritium in subsurface geologic materials and no evidence of tritium in downgradient ground waters.

5.3 Summary of PCOC Fate and Transport

The mobility and ultimate fate of the PCOCs at OU 11 is driven by a combination of factors related to the physical and chemical properties of the soil matrix and the geochemical behavior of each PCOC. The important soil characteristics that control PCOC fate at OU 11 are the high clay content and the resultant high anion exchange capacity, low TOC content, slightly alkaline pH, and the heterogeneous nature of the soils. Except for the low TOC content, all of these characteristics generally impede migration.

The radionuclides americium and plutonium generally adsorb readily to soil particles and exhibit little mobility in the alkaline, oxidizing environment found throughout RFETS. In contrast, tritium readily combines with oxygen to form tritiated water, which exhibits behavior and mobility of regular water. The remaining PCOC, nitrate/nitrite, tends to move rapidly through the soil in areas that are consistently infiltrated with water. However, nitrogen is an essential nutrient for plant growth. The uptake of nitrate/nitrite nitrogen by indigenous plants, which has been documented as a higher amount of plant biomass than is normally seen at RFETS, has reduced the amount of nitrate/nitrite available for transport to the ground water. The nitrate/nitrite available for transport would probably exhibit fairly conservative behavior and could have moved rapidly through the soil/ground-water systems at OU 11.

In summary, americium and plutonium, identified as PCOCs in surficial soils at the OU 11 site, have exhibited little migration since spray activities ceased in 1985.. Most of the nitrate/nitrite appears to have been taken up as "fertilizer" by indigenous plants. Tritium, as tritiated water, would have behaved similarly to regular water but has not been detected at levels above background for OU 11 ground water. Analysis of the fate and transport characteristics of the PCOCs does not indicate a potential for any changes to the current conditions. The potential for offsite migration of PCOCs appears to be extremely limited.

Table 5.2-1
Physical and Chemical Properties of OU 11 PCOCs

PCOC	Solubility[1] (mg/L)	Molecular Weight (g/mol)	Specific Gravity	Soil Half Life (days)
Nitrate/Nitrite	9.21E+05	62/46	2.26	NA
Americium-241	ND	241	ND	1.58E+05
Plutonium-239	ND	239	ND	8.8.1E+06
Plutonium-240	ND	240	ND	2.4E+06
Tritium	ND	3	0.07	4.56E+03

Sources: Superfund Public Health Evaluation Manual, EPA 540/1-86/060; Merck Index, Eleventh Edition

[1] Solubility measured at 25° Celsius.

Definitions:

g/mol grams per mole

mg/L milligrams per liter

NA not applicable

ND not determined

PCOC potential contaminant of concern

OU operable unit

Table 5.2-2
Soil/Water Distribution Coefficients for Plutonium and Americium

	K_d[1] (cm^3/g)						Assumed Retardation Factor (Dames and Moore[2])			
	Sand		Loam		Clay		Sand		Clay	
Analyte	Mean	Range	Mean	Range	Mean	Range	R	K_d[3]	R	K_d[3]
Plutonium	550	27-36,000	1,200	100-5,933	5,100	316-190,000	840	(45.6)	7,200	(391)
Americium	1,900	8.2-300,000	9,600	400-48,309	8,400	25-400,000	300	(16.3)	2,500	(136)

[1] K_d values correspond to all isotopes of each element.

[2] Dames and Moore data are from Staley, G.B., G.P. Turi, and D.L. Schreiber, U.S. Nuclear Regulatory Commission, "Radionuclide Migration from Low-Level Waste: A General Overview," Management of Low-Level Radioactive Waste, Volume 2, Pergamon Press, New York, 1979.

[3] K_d is calculated by Eq. (5.2.1) with $\rho = 1.84$ g/cm^3 and ϕ_e - 0.10

Definitions:

cm^3/g cubic centimeters per gram

K_d distribution coefficient

R retardation factor

6. Risk Assessment for Human Health and Environment

A CDPHE risk-based conservative screen was performed for OU 11 in lieu of a baseline risk assessment (BRA) and is attached as Appendix D. A BRA will not be performed for OU 11 based on results of the OU 11 CDPHE risk-based conservative screen in accordance with the CDPHE/EPA/DOE Risk Assessment Agreement (CDPHE/EPA/DOE, 1994). This section includes a summary of the OU 11 CDPHE screen and an evaluation of ecological risk at OU 11.

6.1 Summary of OU 11 CDPHE Risk-Based Conservative Screen

A CDPHE risk-based conservative screen was performed using OU 11 data from the surface to a depth of 12 feet and unfiltered UHSU ground-water data. The PCOCs identified in soil (0 to 12 feet) were americium-241, plutonium-239,240, tritium, and nitrate/nitrite. No PCOCs were identified in UHSU ground water. One source area was identified for OU 11 based on the distribution of the PCOCs. For this source area, the maximum detected concentration or activity of each PCOC was compared to a risk-based concentration (RBC). Chemical-specific RBCs, referred to as programmatic risk-based preliminary remediation goals (PPRGs), were used to calculate an RBC ratio for each PCOC based on residential exposure. PCOC-specific ratios were then summed to yield carcinogenic and noncarcinogenic total ratio sums. A summary of the total ratio sums for OU 11 is shown in Table 6.1-1.

Using the total ratio sums, CDPHE conservative screen decision criteria were applied to classify the OU 11 source area. The total ratio sums for the OU 11 source area are less than 1 and, consistent with the CDPHE conservative screen decision criteria, indicate a low-hazard source area and a recommendation for no action. An evaluation of dermal contact for PCOCs in surficial soil at the OU 11 source area confirms that OU 11 is a candidate for no action in accordance with the CDPHE/EPA/DOE Risk Assessment Agreement (CDPHE/EPA/DOE, 1994). Figure 6.1-1 schematically presents the risk assessment agreement. Because results of the comparison of OU 11 total ratio sums to CDPHE conservative screen decision criteria and the dermal evaluation indicate no action at OU 11, no areas of concern are identified at OU 11 and a BRA is not warranted.

6.2 Screening-Level Ecological Risk Assessment

The ecological risk assessment (ERA) portion of the BRA evaluates the potential for PCOCs associated with OU 11 to result in adverse effects to the environment in the absence of remedial action. Protection of environmental (ecological) receptors is mandated in sections 104 and 105 of CERCLA, which require assessment of risks and

impacts in accordance with the National Oil and Hazardous Substances Contingency Plan (NCP) (40 CFR Part 300.430 [e][2][i][G]). Protection of ecological receptors is also stipulated in the IAG between DOE, EPA, and CDPHE, which states that one objective of the RFI/RI is to provide data to establish the BRA for human health and the environment.

As a result of recent agreements among DOE, EPA, and CDPHE, ecological risk at RFETS is assessed on the watershed scale rather than performing ERAs for each OU. This strategy ensures that ecological risks are being evaluated on an ecologically relevant scale. The major components of this process have been verbally approved by EPA and CDPHE and written approval is pending. Under this scheme, ecological risks from OU 11 sources will be considered for their contribution to the ERAs in the Woman Creek and Walnut Creek watersheds. However, to facilitate early closure of OU 11, a screening-level risk assessment is documented here in advance of the watershed ERAs.

A sitewide ecological risk assessment methodology (ERAM) has been developed to support risk management decisions at RFETS. The ERAM is documented in a series of technical memoranda, which are subject to the review and approval of EPA and CDPHE. The methodology focuses primarily on evaluating the effects of PCOCs identified in each of the 16 OUs at RFETS.

The initial phases of the ERAM correspond to elements of EPA's eight-step (draft) guidance on conducting ERAs at Superfund sites (EPA, 1994). The first two steps of EPA's process, Step 1 - Preliminary Problem Formulation and Ecological Effects Characterization and Step 2 - Preliminary Exposure Estimate and Risk Calculation, are intended to allow risk assessors and managers to rapidly determine whether a site poses ecological risk. The purpose of a screening-level risk assessment is to determine whether or not a significant ecological risk exists at the site. A risk does not exist unless (1) the stressor has the ability to cause one or more adverse effects and (2) it co-occurs with or contacts an ecological component long enough and at sufficient intensity to elicit the identified adverse effect (EPA, 1994). In Step 2, "Risks are estimated by comparing maximum likely exposure levels with the screening-level ecotoxicity benchmarks. This step evaluates the decision that either: (1) the site preliminary screening is adequate to determine that there is little or no ecological threat; or (2) the ecological risk assessment should continue" (EPA, 1994).

The screening-level ERA performed for the OU 11 RFI/RI was conducted in accordance with steps 1 and 2 of the EPA methodology described in ERAM documents. The first step identifies site characteristics, PCOCs, exposure routes, and key receptors. Step 2 is a preliminary exposure estimate and conservative risk calculation using ecotoxicological benchmarks and maximum PCOC concentrations in

environmental media. The PCOCs are taken from Tier 1 of the ecological contaminant of concern (ECOC) screening methodology and are derived from the "Gilbert" approach as employed for the human health risk assessment (Gilbert and Simpson, 1992).

Subsequent steps of the EPA methodology are more detailed and are aimed at refining risk estimates and determining site-specific cleanup goals. These steps are performed only if the screening-level risk assessment indicates significant risk. If none of the PCOCs is present at ecotoxic concentration, the site is considered to present *de minimis* risk and a more detailed evaluation of the toxicity and exposure or a quantitative risk assessment is not warranted (EPA, 1994).

6.2.1 Step 1 - Preliminary Problem Formulation and Ecological Effects Characterization

The preliminary problem formulation focuses on defining the following elements:

- environmental setting
- nature and extent of contamination
- potential receptors and exposure pathways

6.2.1.1 Environmental Setting

The environmental setting for OU 11 is described in Section 1.2 and in the ERAM Technical Memorandum No. 2 - Sitewide Conceptual Model (EG&G, 1995d). OU 11 (IHSS 168) covers approximately 105 acres west of the main industrial area of RFETS (Figure 1.2-1). As described in Section 1.2, water from SEPs 207B North and 207B Center was sprayed on sections of OU 11 to reduce volume through evaporation. Water was sprayed primarily on three areas totaling approximately 14 acres. Water from the SEPs contained organic compounds, metals, and radionuclides that may have been deposited in spray areas of OU 11.

The biota in OU 11 exhibited no sign of stress associated with the spray areas or areas where sprayed water had pooled. As presented in Appendix E, which summarizes results of the OU 11 ecological data collection and analysis, no vegetative stress was evident from casual observation or from vegetation community data collected in 1993. Thus, the motivation for the OU 11 ERA was "source-driven" with a possible contaminant source (the spray areas) but no obvious ecological effects upon which to focus the investigation.

The entire site is occupied by xeric and mesic mixed grassland typical of Rocky Flats (EG&G, 1995d). There are no persistent water bodies, wetlands, or riparian areas within IHSS 168. A narrow riparian zone exists along the North Walnut Creek drainage just north of the IHSS (EG&G, 1995d). Flows in the creek bed of this section

are intermittent and dry most of the year. A more well-developed riparian area exists along Woman Creek approximately one-quarter mile to the south of IHSS 168. Flows in this section of Woman Creek are more persistent but vary widely through the year (EG&G, 1995d).

Field surveys in 1992 through 1994 have not revealed the presence of any federal- or state-protected species in OU 11. Riparian areas along North Walnut Creek and Woman Creek have been identified as potential habitat for Preble's meadow jumping mouse (*Zapus hudsonius preblei*), a federal category 2 species that is a candidate for listing as threatened under the Endangered Species Act. This species has been identified from the Woman Creek riparian area but not from the North Walnut Creek area adjacent to OU 11. OU 11 also does not contain habitat suitable for the federally endangered Diluvium ladies' tresses (*Spiranthes diluvialis*) (EG&G, 1995e). Other protected wildlife species may occasionally use OU 11, but habitats critical to their survival are not present.

General wildlife use of OU 11 may include browse and resting areas for mule deer and hunting of small mammals and birds by mammalian and avian predators such as coyote, red fox, red-tailed hawks, and American kestrels. The site lacks trees and shrubs for tree-nesting birds but may be used by ground-nesting birds.

6.2.1.2 *Nature and Extent of Contamination and Exposure Pathways*

Phase I RFI/RI activities conducted at OU 11 are described in Section 2.2. Analytical data from site sampling were used to identify the PCOCs listed in Table 4.1-4 (see Section 4.1). PCOCs were identified only for soils (0 to 12 feet deep) and include the radionuclides americium-241, plutonium-239,240, and tritium, and nitrate/nitrite.

Based on the PCOCs, the following potential exposure pathways were identified:

- soil→plants→herbivorous mammals, granivorous birds
- soil→invertebrates→small mammals, insectivorous birds
- soil→small mammals (incidental ingestion)→mammalian and avian predators
- soil→mammalian and avian receptors (incidental ingestion)

Based on the potential receptors, exposure, pathways, and PCOCs, small mammals were identified as the bounding exposure scenario because of their small home ranges and intimate association with surficial soil. RFETS site-specific radionuclide toxicity benchmarks were developed by Los Alamos National Laboratory (LANL) based on this assumption (Higley and Kuperman, 1995).

6.2.2 Step 2 - Preliminary Exposure Estimate and Risk Calculation

6.2.2.1 Methods

The objective of the screening-level estimation of risk is to determine, with a high degree of confidence, whether contaminants are present at concentrations that may be toxic to ecological receptors (EPA, 1994). The hazard quotient (HQ) approach is used to estimate risk by comparing site-specific estimates of exposure to ecotoxicological benchmarks:

$$HQ = \frac{exposure\ estimate}{benchmark}$$

Benchmarks were derived to approximate no-observed-adverse-effects-levels (NOAELs), which represent the greatest exposures at which no adverse effects are observed. Benchmarks are usually selected so that significant ecological effects are not expected when exposures are lower than the benchmarks (HQ < 1). Concentrations or exposures exceeding benchmarks (HQ > 1) do not necessarily indicate significant risk but do indicate that the contaminant should be further evaluated in the ERA.

Conservative assumptions associated with estimating exposure and benchmarks are used to minimize the chance of underestimating risk of exposures at OU 11. Specifically, receptors were assumed to spend all of their time in areas of maximum PCOC concentrations. In addition, the PCOC content of all food consumed by the receptors was assumed to be equal to the maximum concentrations in soils. These assumptions are consistent with Step 2 of the EPA guidance (EPA, 1994) and the Tier 2 screen of the RFETS ERAM (EG&G, 1995e).

Radionuclide benchmarks were developed for site-specific conditions (Higley and Kuperman, 1995). The benchmarks are expressed as the minimum radionuclide activities in soils that would result in an exposure equal to the NOAEL. In the case of radionuclides, the NOAEL is a radiological dose rate of 0.1 rad/day (IAEA, 1992). Based on this dose rate, the soil concentration that would result in the NOAEL was calculated based on site-specific data on transfer of radionuclides to plant tissue, the main food of deer mice and meadow voles. Because dose rates vary among radionuclides, separate benchmarks were calculated for each and are shown in Table 6.2-1.

The benchmark for nitrate/nitrite was based on data presented in the Oak Ridge National Laboratory toxicity benchmarks for wildlife (Opresko *et al.*, 1994). The benchmark is based on a study in which guinea pigs were fed nitrates at various doses to determine effects on reproduction (Sleight and Atallah, 1968). The NOAEL for this study was 507 mg/kg/day, which translates to a concentration of about 8,600 mg nitrate

per kg of food. Thus, the HQ for exposure of deer mice to nitrates in soil was calculated by comparing this concentration to the maximum nitrate/nitrite concentration in soils at OU 11.

6.2.2.2 *Results*

Conservative estimates of site exposures did not exceed benchmark values for any of the PCOCs (i.e., all HQs < 1) (Table 6.2-1). In addition, in no case was the HQ greater than 0.1 indicating the exposures were at least ten times lower than NOAELs. The sum of the HQs, called the hazard index (HI), is often used as a rough indicator of the cumulative risk of the site. The HI for OU 11 is 0.006, well below 1.0 indicating that total risk from the site is negligible. Results of the Step 2 screen indicate that none of the PCOCs at OU 11 is present at potentially ecotoxic concentrations or should be identified as ECOCs and subjected to further analysis.

6.2.2.3 *Risk Characterization and Preliminary Ecological Effects Evaluation*

As noted in Section 6.2.1, the risk assessment for OU 11 is not driven by readily observable ecological effects. The spray areas of IHSS 168 represent potential contaminant source areas and exposure points for biota. However, the conservative screen of PCOC concentrations revealed that none of the chemical contaminants was present at concentrations toxic to small mammals using the site. Small mammals were used because they have the greatest potential exposure to contaminants in soils and, therefore, represent the bounding scenario for exposure to site contaminants.

It is possible that contaminants at OU 11 could affect ecological endpoints that are not readily observable and are not amenable to the toxicological screening approach used. Data on vegetation community structure, vegetative litter, biomass, and nutrient content of soils were collected at OU 11 as part of the ERA and the RFETS sitewide EcMP. The existing ecological data relevant to OU 11 are presented in Appendix E to support results of the ECOC screen. Appendix E also includes descriptions of OU 11 sampling efforts and digital files of ecological data. The 1995 EcMP annual report (due in mid-1995) will comprehensively describe the sampling and analysis conducted for OU 11.

To date no significant ecological effects have been noted. Data were collected from spray areas and non-spray areas to determine potential effects of activities at OU 11. Results of the investigation indicated no adverse effects in spray areas. Trends in the data are consistent with effects of supplemental watering and fertilizing in a semiarid grassland. While this may cause effects to vegetation such as increased biomass and litter, the effects are not detrimental to the grassland ecosystem.

Table 6.1-1
Summary of Total Ratio Sums for OU 11

Source Area	Medium	Carcinogenic Ratio Sum	Noncarcinogenic Ratio Sum
OU 11	Soil (0 to 12 feet)	0.82	0.000084
Total Ratio Sum[1]		0.82	0.000084

[1] Assuming long-term residential exposure to maximum detected concentrations/activities

Table 6.2-1
Hazard Quotients for Exposure of Small Mammals to Radionuclides and Nitrate/Nitrite at OU 11

PCOC	Maximum Concentrations in OU 11 soils	Ecotoxicological Benchmark Concentration	Units	Hazard Quotient
Americium-241	0.43	1900	pCi/g	2.26E-04
Plutonium-239,240	2.2	3800	pCi/g	5.79E-04
Tritium	3.4	3500	pCi/g	9.71E-04
Nitrate/Nitrite	37	8639	mg/kg	4.3E-3
			Hazard Index =	0.00606

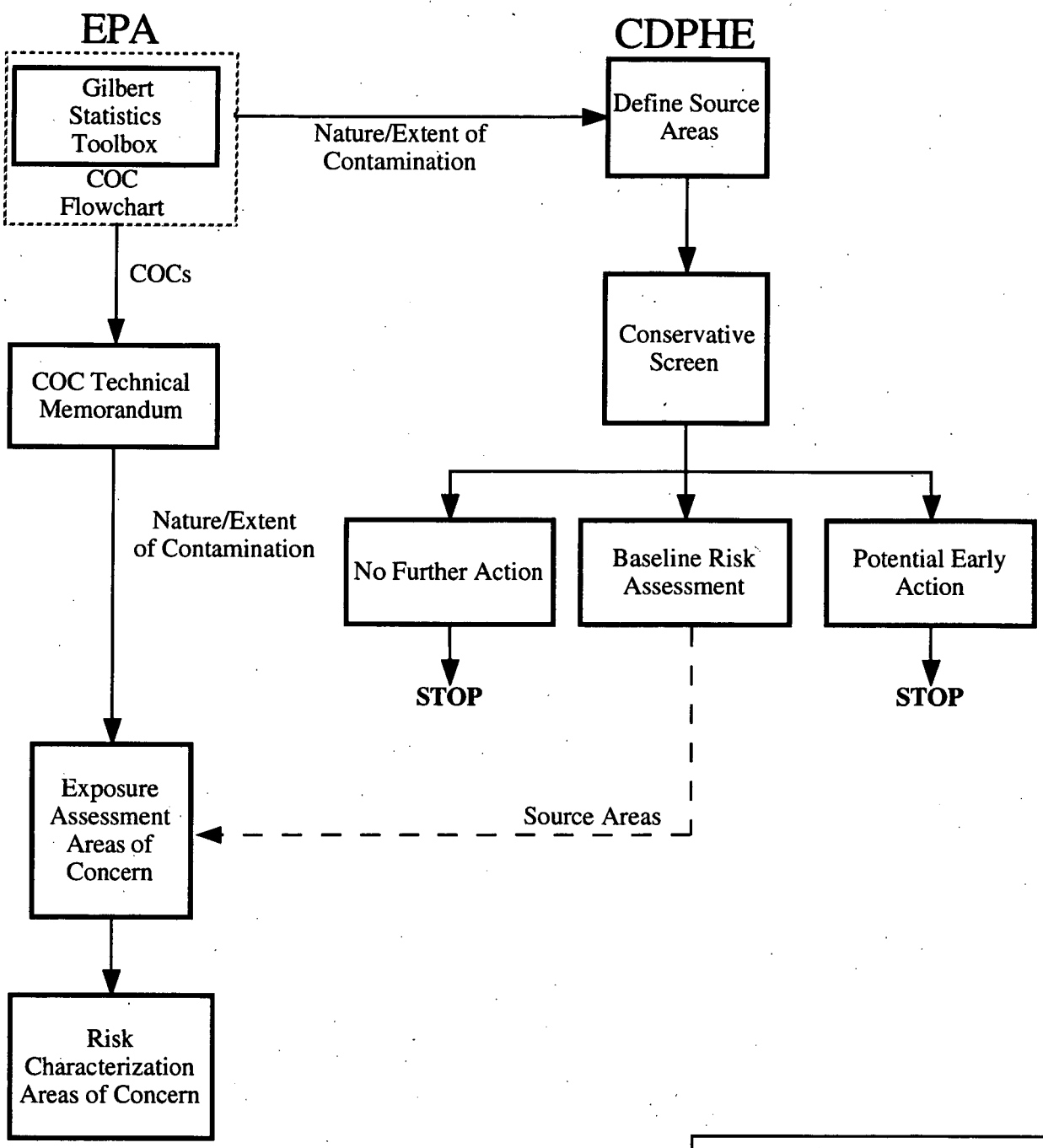
Definitions:

mg/kg milligrams per kilogram

OU operable unit

pCi/g picocuries per gram

PCOC potential contaminant of concern



U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

CDPHE/EPA/DOE
Risk Assessment Agreement

Final Combined Phases
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Operable Unit 11

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Figure 6.1-1

G95\ES\CDPHE flow simple-2509.imp

7. Summary, Conclusions, and Recommendations

The combined phases RFI/RI for OU 11 has been conducted under a hybrid RCRA/CERCLA regulatory program, as agreed to in the IAG. In addition, specific objectives and procedures for the OU 11 combined phases RFI/RI were identified in the OU 11 FSP TM (EG&G, 1994a). All of the requirements specified in the IAG and in the FSP TM have been met and are described in this Final Combined Phases RFI/RI Report. The investigations conducted for this combined phases program focused on acquiring the necessary data to support a determination for OU 11 as to whether:

1. Spray activities at the site had resulted in residual contamination in the site media (soils, ground water),

2. Perched ground-water conditions are present at the site, and

3. OU 11 poses risk to human health and/or the environment.

In the regulatory framework, the above determinations direct decisions concerning OU 11's ability to meet RCRA clean closure performance standards and CERCLA's no-further-action criteria.

The approach to determining the above issues was specified in the OU 11 FSP TM and included:

1. An HPGe survey,
2. A surficial soils sampling program at OU 11 and downgradient,
3. A borehole drilling and sampling program at OU 11 and downgradient, and
4. A monitoring well installation and sampling program at OU 11 and downgradient.

7.1 Conclusions

Based on the results of the combined phases RFI/RI activities, the following conclusions have been drawn:

1. **The requirements of the IAG and the OU 11 FSP TM have been met and are documented in the Final Combined Phases RFI/RI Report.**

   Sections 1 and 2 present a detailed evaluation of the requirements of the IAG and the FSP TM. Table 2.1-1 lists the specific requirements and references the section(s) in this Final Combined Phases RFI/RI Report that addresses the requirement.

2. **The DQOs specified in the FSP TM have been met.**

   Section 2.3 presents the DQOs for the combined phases investigation and evaluates the results of the investigation against the specific OU 11 DQO and PARCC criteria.

3. **Perched ground water is present at OU 11, on a very localized scale.**

   The results of the combined phases investigation presented in Section 3 show that a zone of variable saturation exists in the alluvium above the regional ground-water table at OU 11. The variable saturation can be equated to a very localized "perching" of ground water. There is no evidence from this investigation supporting elevated contamination in the perched system.

4. **The following PCOCs have been identified at OU 11:**

Media	Analyte
surficial soils	nitrate/nitrite americium-241 plutonium-239,240
subsurface geologic materials	tritium nitrate/nitrite
ground water	none

Section 4, the Nature and Extent of Contamination, presents the methodology for background comparisons and PCOC identification. Section 6 and Appendix D of this report summarize the results of the statistical tests, geochemical analyses, and professional judgement process undertaken to identify PCOCs at the site. This process was implemented at OU 11 utilizing methodology agreed to by DOE, CDPHE, and EPA. Section 6 and Appendix D also present the results of the CDPHE risk-based conservative screen.

5. **There is no evidence to indicate the existence of an imminent threat of a release of hazardous or radioactive constituents from OU 11 to the environment.**

Sampling results presented in Section 4, reviewed relative to the site hydrogeologic conceptual model in Section 3 and the fate and transport mechanisms presented in Section 5, show that current conditions at OU 11 are highly unlikely to result in releases to the environment.

6. **There is no current or imminent threat at OU 11 under present or projected land uses.**

Based on the CDPHE Conservative Screen process presented in Appendix D and the evaluation of the concentrations and distributions of PCOCs presented in Section 4, OU 11 poses minimal health risks, assuming long-term residential exposure. The carcinogenic and non-carcinogenic ratio sums are less than 1. By CDPHE criteria, this warrants a no-further-action consideration, pending evaluation of potential risk from dermal exposure. The risk at OU 11 from dermal exposure is also minimal, as documented in Appendix D. The investigations at the OU 11 site identified no remediation requirements or imminent health threats.

7.2 Recommendations

The combined phases RFI/RI investigation identified no residual risks at OU 11. Spray disposal activities of the early 1980s have left no chemicals at concentrations that pose a threat to human health. In fact, the residual effect still evident at the site is in the density of vegetation. The enhanced vegetation densities parallel the effect of fertilization from the supplemental nitrogen and water of the spray liquids. The results of this RFI/RI investigation support no remediation at the site. A program of continued monitoring of the existing RCRA wells could be conservatively maintained if necessary.

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Section 4
Figures

Appendix A
Borehole Logs

Appendix B
Well Construction Diagrams

Appendix C
OU 11 Data Quality

Major Divisions			Letter	Symbol	Description
Coarse Grained Soils	Gravel and Gravelly Soils	Clean Gravels (<5% fines)	GW		Well graded gravels or gravel-sand mixtures, little or no fines. Uc >4 (lab only)
			GP		Poorly graded gravels or gravel sand mixtures, little or no fines.
	More than 50% of coarse fraction retained on no. 4 sieve	Gravel with Fines (>12% fines)	GM		Silty gravels, gravel-sand-silt mixtures.
			GC		Clayey gravels, gravel-sand-clay mixtures.
More than 50% of material is larger than no. 200 sieve size	Sand and Sandy Soils	Clean Sand (<5% fines)	SW		Well graded sands or gravelly sands, little or no fines. Uc >6 (lab only)
			SP		Poorly-graded sands or gravelly sands, little or no fines.
	More than 50% of coarse fraction passed no. 4 sieve	Sands with Fines (>12% fines)	SM		Silty sands, sand-silt mixtures.
			SC		Clayey sands, sand-clay mixtures.
Fine Grained Soils	Silts and Clays	Low Plasticity	ML		Inorganic silts, and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL		Organic silts and organic silty clays of low plasticity.
More than 50% of material is smaller than no. 200 sieve size		High Plasticity	MH		Inorganic silts, micaceous or diatomaceous fine sand or silty soils.
			CH		Inorganic clays of high plasticity, fat clays.
			OH		Organic clays of medium to high plasticity, organic silts.
Highly Organic Soils			PT		Peat, humus, swamp soils with high organic contents.

Note: After Unified Soil Classification System

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Key to Soil Types

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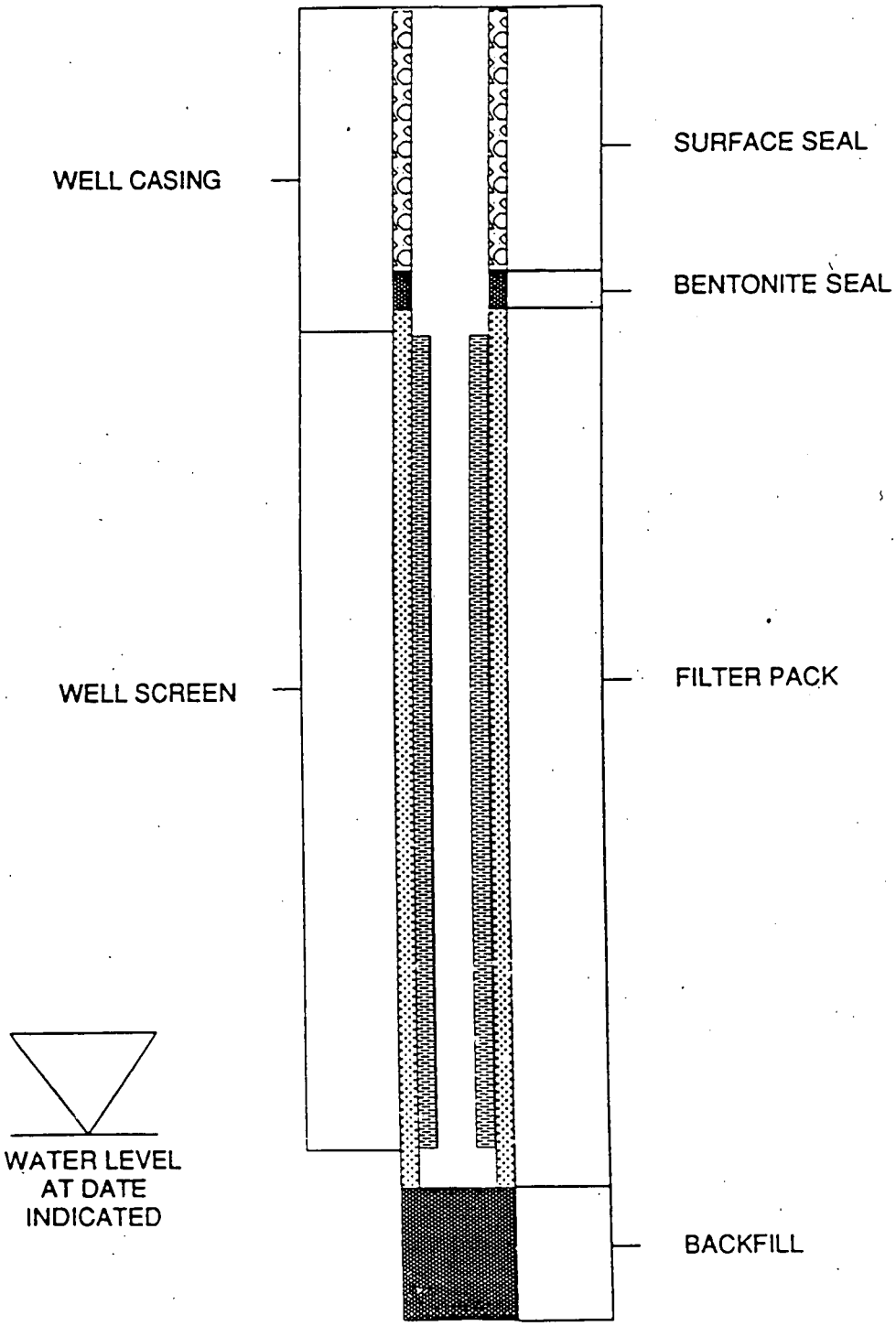
Figure A-1

G95\ES\TITLEBLOCKS\Soil Types-2509.lmp



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Schematic Diagram of Well/Piezometer Construction

Final Combined Phases
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Figure A-2

G95\ES\TITLEBLOCKS\Soil Types-2509.lmp

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT):	6114.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749310	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50194
EAST:	2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/07/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH / SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
BH00115ST			1.50 /2.00	6114	0			GW:	Sandy gravel with trace silt. Dark brown (7.5 YR 3/3). Gravel clasts up to 3"; sand fine to coarse. Well graded. Gravel mainly subrounded; sand subrounded to angular where broken. Gravel mainly quartzite; sand quartz. Organic material. Dry. 80% gravel, 18% sand, and 2% silt.
				6113	1			NO RECOVERY:	No recovery (1.50-2.00').
BH00116ST			6.00 /1.50	6112	2			SW:	Gravelly sand with some silt and trace clay. Brownish yellow (10 YR 6/6) to reddish yellow (7.5 YR 6/8). Gravel up to 2"; sand fine to very coarse (mean=medium to coarse). Well graded. Gravel mainly subangular; sand subangular to angular. Gravel mainly quartzite with some feldspar; sand quartz. Trace carbonaceous material. Abundant rock flour from 7.0-9.0'. Rotted diorite from 9.0-9.75'. Dry. 60% sand, 32% gravel, 6% silt, and 2% clay. No recovery (3.75-4.00'), (5.75-6.00'), and (7.75-8.00').
			1.00 /0.50	6111	3				
BH00121ST			8.00 /2.00	6110	4				
				6109	5				
BH00122ST			1.40 /1.00	6108	6				
			4.00 /1.00	6107	7				
BH00123ST			0.80 /0.50	6106	8				
			4.00 /1.50	6105	9			NO RECOVERY:	No recovery (9.75-10.00').
					10				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT):	6114.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749310	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50194
EAST:	2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/07/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGGS.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		CL SIL SAN GRA	100% CL 100%	1.00 /1.00	6113	10			SW:	Gravelly sand with some silt and trace clay. Same as above - see description 2.0-10.0'.
	CH0124ST			1.00 /0.30	6113	11			SC:	Clayey sand with some gravel and trace silt. Reddish yellow to strong brown (7.5 YR 6/8, 5/8). Gravel fine; sand coarse to fine (mean=fine). Well graded. Gravel mainly quartzite with some granite; sand quartz plus rock fragments. Slightly moist. 76% sand, 15% clay, 6% gravel, and 3% silt.
				2.50 /0.70	6112	12			SW:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/6). Gravel medium to fine; sand very coarse to fine (mean=medium to coarse). Well graded. Gravel quartzite; sand quartz. Rock flour abundant from 11.3-11.75', including broken boulder >=4". Sands finer from 17.5-17.75'. Slightly moist. 49% sand, 41% gravel, 8% clay, and 2% silt. No recovery (11.75-12.00') and (17.75-18.00').
				1.50 /2.00	6111	13				
					6110	14				
	CH0125ST CH0125ST (DUP)			2.10 /1.50	6109	15				
				1.50 /1.50	6108	16				
				3.00 /1.00	6107	17				
					6106	18				
	CH0127ST				6105	19				
				4.50 /3.50		20			CL:	Clay with some sand and silt. See description 20.0-21.5'.

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT):	6114.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 749310	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50194
EAST: 2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/07/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH00128ST				6091	20			CL:	Clay with some sand and silt. Light yellowish brown (10 YR 6/4) to light brownish gray (2.5 YR 6/2). Fine sand. Poorly graded. Sand subrounded. Low to medium plasticity. Sand quartz. Trace carbonaceous material. Slightly moist. 83% clay, 9% silt, and 8% sand.
					6093	21				
				5.00 /2.50	6092	22			GC:	Gravelly clay with abundant sand and trace silt. Light yellowish brown (2.5 Y 6/3). Gravel coarse to fine; sand coarse to fine (mainly medium to fine). Well graded. Gravel subrounded to subangular; sand subangular. Low plasticity. Gravel quartzite; sand quartz. Trace carbonaceous material. Dry to slightly moist. 38% clay, 31% gravel, 27% sand, and 4% silt.
					6091	23				
	GH00129ST			3.00 /2.00	6090	24			GC:	Gravelly sand with some clay and silt. Yellowish red (5 YR 5/8) to yellowish brown (10 YR 5/6). Gravel coarse to fine (clasts up to 3"); sand very coarse to fine. Well graded. Gravel subrounded to subangular; sand subangular. Gravel quartzite; sand quartz and rock fragments. Rotted diorite from 30.9-31.2'. Slightly moist. Wet 1-inch interval at 28.0'. 40% gravel, 25% sand, 23% clay, and 12% silt. No recovery (27.45-27.70').
					6089	25				
				2.50 /1.70	6088	26				
					6087	27				
				2.00 /1.30	6086	28				
					6085	29				
						30				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT):	6114.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749310	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50194
EAST:	2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/07/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (CL, SIL, SAN, GRA)	PERCENT RECOVERY (0%–100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	BH0013051			3.80 /3.00	6081	30			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. Moist to very moist.
				3.00 /1.70	6082	31				
					6083	32				
				5.00 /1.80	6080	33			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0' - with less gravel and more sand. No large clasts. No recovery (33.50-33.75').
					6081	34				
	BH0013351			2.80 /3.00	6079	35			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. Yellowish red (5 YR 5/8). Higher sand content.
					6078	36				
					6077	37				
					6076	38				
				4.00 /1.20	6075	39			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. Clay-rich interval. Large broken boulders.
									NO RECOVERY:	No recovery (39.50-39.70')
						40			GC:	Gravelly sand with some clay and silt. See description 40.0-52.6'.

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT):	6114.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749310	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50194
EAST:	2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/07/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		0% 50% 100%	0% 100%			40			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. From 40.6-42.1' broken cobble fragments (clasts >=4"). Sand includes mica; some rotted schist. Dry. No recovery (45.45-45.70').
					6074	41				
				4.20 /3.80	6073	42				
	BH00134ST				6072	43				
					6071	44				
				3.50 /2.20	6070	45				
					6069	46				
				5.00 /2.80	6068	47				
					6067	48				
	BH00135ST				6066	49				
					6065	50				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT):	6114.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749010	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50194
EAST:	2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/07/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				4.00 /3.20	6064	50			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. No recovery (51.45-51.70').
					6063	51				
					6062	52				
					6061	53			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. Transition to higher percentage clay. Fe-oxide, trace carbonaceous material.
				5.00 /4.30	6060	54			GC:	Gravelly clay with some sand and trace silt. Strong brown (7.5 YR 5/6) to pale yellow (5 Y 7/3). Gravel coarse to fine (clasts up to 2"). Sand very coarse to fine. Well graded. Gravel subrounded; sand subangular. Gravel mainly quartzite; sand quartz, feldspar, and rock fragments. Trace carbonaceous material and Fe-oxide. Dry to slightly moist. 40% clay, 35% gravel, 24% sand, and 1% silt.
CH001065T					6059	55				
					6058	56	07/15/94		GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0' - with pockets of clay. No recovery (57.45-57.70').
				4.40 /1.70	6057	57				
					6056	58			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. Dry.
					6055	59				
				4.20 /4.30		60				

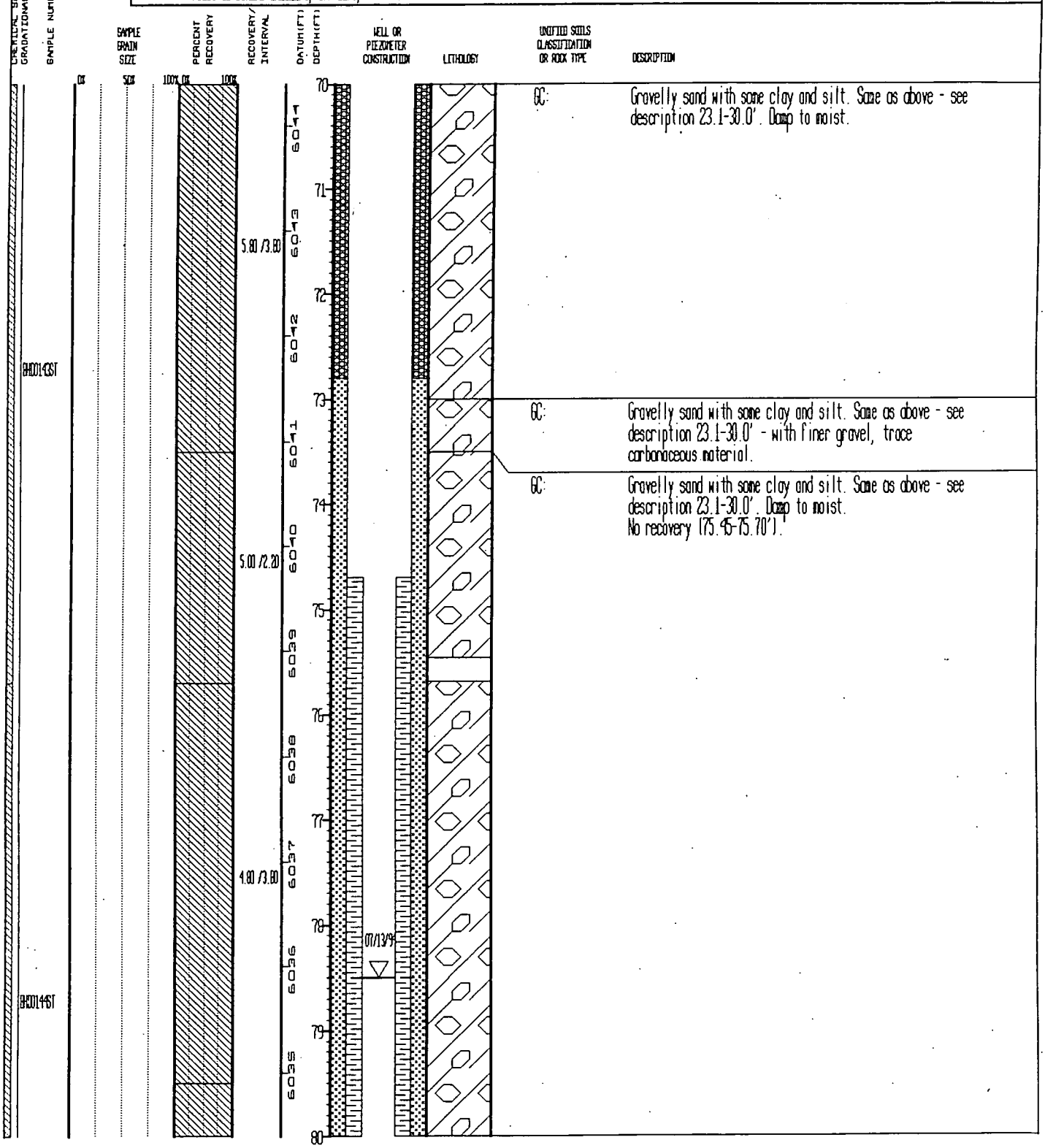
STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT): 6114.40	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749310	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	50194
EAST:	2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/07/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH001395T			4.00 /1.70	6054 6053 6052 6051	60 61 62 63			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'.
				3.00 /1.30	6050	64				
				1.30 /1.00	6049	65				
	GH001405T			2.40 /2.00	6048 6047	66 67			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. Slightly moist.
				4.00 /1.70	6046 6045	68 69			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. Moist to wet. No recovery (69.45-69.70').
						70			GC:	Gravelly sand with some clay and silt. See description 70.0-73.0'.

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT): 6114.40	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749310	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	50194
EAST:	2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/07/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGOR.



STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT):	6114.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749010	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50194
EAST:	2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/07/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				3.90 /2.20	6034	80			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. Damp to moist. No recovery (81.45-81.70').
					6033	81				
					6032	82				
				5.00 /2.80	6031	83			CL:	Sandy clay with some gravel and silt. Strong brown (7.5 YR 5/6) to pale yellow (5 Y 7/3). Gravel fine; sand coarse to fine. Well graded. Gravel subrounded; sand angular to subangular. Gravel mainly quartzite; sand quartz. Moist to dry. 42% clay, 38% sand, 10% gravel, and 10% silt.
					6030	84				
				5.00 /1.50	6029	85			SC:	Gravelly sand with some clay and silt. Clasts up to 4". Pale yellow clay present in lower 0.5'. Dry.
					6028	86			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0' - including olive color (5 Y 5/4). Clasts up to 3"; mean 1/2 to 1". Gravel subrounded. Dry.
				4.50 /2.30	6027	87				
					6026	88				
				4.50 /3.00	6025	89			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0' - with less gravel. Gravel fine. Trace carbonaceous material. Dry to moist.
						90				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT): 6114.40	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749310	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	50194
EAST:	2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/07/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM(FT)	DEPTH(FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		GR SAND	100% GR 100%	4.50 /3.00	6021 6023 6022 6021 6020 6019 6018 6017 6016 6015	90 91 92 93 94 95 96 97 98 99 100			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0' - with less gravel. Gravel fine. Trace carbonaceous material. Dry to moist.
				4.00 /3.00					GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. Gravel clasts up to 4" (mainly medium). Gravel quartzite, granite. Rotted diorite.
				4.00 /4.00					GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0' - with sandy lenses. Saturated to wet.

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 105.50	GROUND ELEVATION (FT):	6114.40	PROJECT NUMBER:	OU11-RFI/RI
NORTH: 749010	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS
EAST: 2077234	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/07/94

LOG OF BORING NUMBER: 50194

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SCREEN; 80' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D. L. RIGOR.

CRUMBLING SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
			100%	5.00 /4.00	6014	100			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0' - with sandy lenses. Saturated to wet.
					6013	101				
					6012	102				
					6011	103			GC:	Gravelly sand with some clay and silt. Same as above - see description 23.1-30.0'. Moist to dry.
				5.00 /3.00	6010	104				
					6009	105				
					6008	106				Total Depth Drilled: 105.50 Total Depth Casing: 97.00 Bottom of Filter Pack: 97.40
					6007	107				
					6006	108				
					6005	109				
						110				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 18.20	GROUND ELEVATION (FT):	6142.00	PROJECT NUMBER:	OU11-RFI/RI
NORTH: 748704	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS
EAST: 2076128	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/08/94

LOG OF BORING NUMBER: **50294**

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 10.0' SCREEN; 10.0' RISER. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

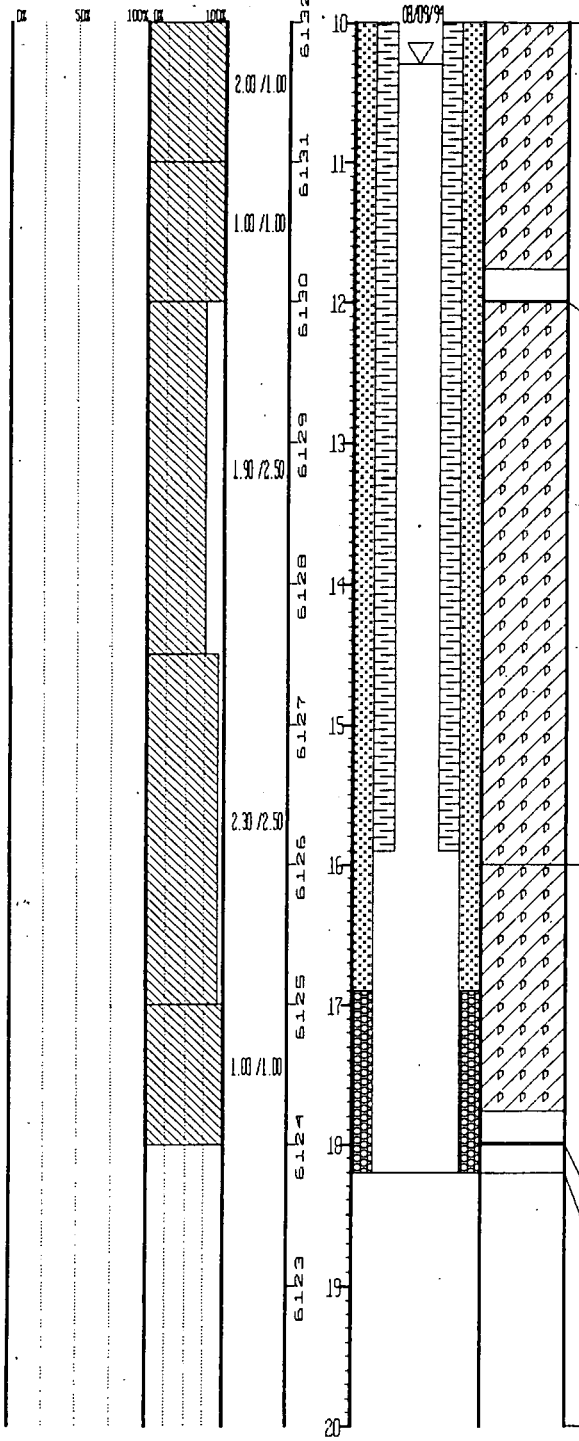
Sample Number	Recovery/Interval	Datum (ft)	Depth (ft)	Unified Soils Classification or Rock Type	Description
GH0229ST	4.00 /2.00	6141	0–2	GC:	Sandy gravel grading to gravelly sand with some clay and trace silt. Dark brown to brown (7.5 YR 3/3 to 7.5 YR 4/3). Gravel coarse to fine (prominently fine with clasts to 2.5"). Sand coarse to fine (prominently fine). Well graded. Gravels subangular to rounded. Sands dominantly subangular. Medium plasticity. Gravels made up of quartzite, biotite, and schist; sand made up of quartz, feldspar, and biotite. Organics present. Dry. 43% gravel, 37% sand, 15% clay, and 5% silt. No recovery (1.75-2.00').
GH0240ST	1.00 /1.00	6139	3–4	SC:	Sandy gravel grading to gravelly sand with some clay and trace silt. Same as above - see description 0.0-3.0' - with different gravel, sand, clay, and silt content percentages 58% sand, 24% gravel, 16% clay, and 2% silt. No recovery (3.75-4.00').
GH0241ST	4.00 /1.00	6137	5–6	SC/SW:	Gravelly sand with some clay and trace silt. Brown (7.5 YR 4/3) to strong brown (7.5 YR 5/6). Gravel coarse to fine (primarily fine with clasts to 3"); sand coarse to fine (prominently medium). Gravel subangular to subrounded; sand angular to subrounded. Medium to high plasticity. Gravel made up mainly of quartzite, sand is mainly quartz. Saturated to wet. 48% sand, 41% gravel, 9% clay, and 2% silt. No recovery (5.00-6.00').
GH0242ST	1.50 /1.00	6135	7–8	SC:	Gravelly sand with some clay and trace silt. Same as above - see description 4.0-5.0' - with different gravel, sand, clay, and silt content percentages. Moist. 54% sand, 29% gravel, 16% clay, and 1% silt. No recovery (7.75-8.00') and (9.75-10.00').
GH0243ST	1.50 /1.00	6133	9–10		

Sample grain size: GR, SAN. Percent recovery: 100%, 100%. Well or piezometer construction: 08/09/94.

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 18.20	GROUND ELEVATION (FT): 6142.00	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 748704	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	50294
EAST: 2076128	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 08/08/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 10.0' SCREEN; 10.0' RISER. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER O.L. RIGOR.

CHEMICAL SAMPLE DEPTH | GRADATIONAL SAMPLE DEPTH | SAMPLE NUMBER | SAMPLE GRAIN SIZE | PERCENT RECOVERY | RECOVERY/INTERVAL | DATUM (FT) | DEPTH (FT) | WELL OR PIEZOMETER CONSTRUCTION 08/09/94 | LITHOLOGY | UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION



SC: Clayey sand with some silt and trace gravel. Strong brown (7.5 YR 5/8) to yellowish brown (10 YR 5/8). Gravel medium to fine; sand coarse to fine (prominently medium and fine). Poorly graded. Gravel subrounded, sand subangular to rounded. Low plasticity. Gravel is made up of quartzite. Sand is mainly quartz with feldspar and plagioclase. Carbonaceous material. Moist. 68% sand, 16% clay, 11% silt, and 5% gravel.
No recovery (11.75-12.00').

SC/SW: Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/6). Gravel coarse to fine (prominently fine with clasts to 4.5"). Sand coarse, medium, and fine (mainly medium). Well graded. Gravel subangular to rounded. Sand subangular to subrounded. Low to medium plasticity. Gravel is mainly quartzite, sand is quartz, feldspar, biotite, and plagioclase. Trace carbonaceous material. Very moist to moist. 62% sand, 29% gravel, 8% clay, and 1% silt.

SC/SW: Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/6). Gravel and sand coarse, medium, and fine (primarily medium to fine). Well graded. Gravel and sand angular to subrounded. Highly plastic. Gravel and sand primarily quartz with feldspars, plagioclase, and hornblende. Pockets of clay-rich layers. Becomes lighter in color with depth and has higher clay content (less gravel at 16.5'). Moist. 48% sand, 45% gravel, 6% clay, and 1% silt grading to 48% sand, 38% gravel, 13% clay, and 1% silt.
No recovery (17.75-18.00').

NO RECOVERY: No recovery (18.00-18.20').

Total Depth Drilled: 18.20 Total Depth Casing: 18.20
Bottom of Filter Pack: 16.90

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 66.80	GROUND ELEVATION (FT):	6120.30	PROJECT NUMBER:	OU11-RFI/RI
NORTH:	749529	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS
EAST:	2077216	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/19/94

LOG OF BORING NUMBER: 50394

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 15' SCREEN; 50' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% – 50% – 100%)	PERCENT RECOVERY (0% – 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
					6120	0			NO RECOVERY:	No recovery (0.00-0.75').
	GH001675T			1.50 /2.00	6119	1			GW/gm:	Sandy gravel with some silt and trace clay. Dark grayish brown (10 YR 4/2). Gravel medium to fine (clasts up to 2"); sand coarse to fine (even distribution). Well graded. Gravel subangular to subrounded; sand subangular to angular. Gravel quartzite and schist; sand quartz and rock fragments. Organic material. Dry. 57% gravel, 35% sand, 7% silt, and 1% clay. No recovery (1.75-2.00').
				1.00 /1.00	6118	2				
	GH001685T			1.00 /1.00	6117	3			GW/gm:	Sandy gravel with some silt and trace clay. Same as above - see description 0.75-2.0' - with higher clay content.
									GW/gm:	Sandy gravel with some silt and trace clay. Same as above - see description 0.75-2.0'. No recovery (3.75-4.00').
				1.00 /1.00	6116	4				
	GH001695T			1.50 /1.00	6115	5			SM/sc:	Gravelly sand with some silt and clay. Yellowish red (5 YR 5/8) to strong brown (7.5 YR 5/6). Gravel coarse to fine (clasts up to 3"); sand coarse to fine (mainly medium to fine). Well graded. Gravel subrounded; sand subangular. Gravel quartzite; sand quartz plus rock fragments. Trace carbonaceous material and rotted granite. Slightly moist to moist. 49% sand, 33% gravel, 10% silt, and 8% clay. No recovery (5.75-6.00'), (7.75-8.00'), and (9.75-10.00').
				1.50 /1.00	6114	6				
	GH001705T			1.50 /1.00	6113	7				
				1.25 /1.00	6112	8				
	GH001715T			1.00 /1.00	6111	9				
						10				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 66.80	GROUND ELEVATION (FT):	6120.30	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	748529	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50394
EAST:	2077216	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 15' SCREEN; 50' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				1.00 /1.00	6110	10			SM/sc:	Gravelly sand with some silt and clay. Same as above - see description 9.0-10.0'. No recovery (11.75-12.00').
	BH0172ST			1.25 /1.00	6109	11				
				1.00 /1.00	6108	12				
				1.00 /1.00	6107	13			SM:	Silty sand with some gravel and clay. Strong brown (7.5 YR 5/8). Gravel coarse to fine (up to 1"); sand coarse to fine (mainly medium to fine). Well graded. Gravel subrounded to subangular; sand subrounded to subangular. Gravel quartzite; sand quartz plus rock fragments. Slightly moist. 55% sand, 21% silt, 17% gravel, and 7% clay. No recovery (17.75-18.00').
					6106	14				
	BH0173ST			2.80 /3.00	6105	15				
					6104	16				
				0.80 /1.00	6103	17				
					6102	18			SC:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/8-4/6). Well graded. Gravel subangular to subrounded, fine to coarse (clasts up to 3"), mainly medium. Sand angular to subrounded, fine to coarse. Gravel quartzite and plagioclase; sand quartz. Slightly moist. 60% sand, 24% gravel, 11% clay, and 5% silt.
				2.00 /1.50	6101	19				
						20				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 66.80	GROUND ELEVATION (FT):	6120.30	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	748529	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50394
EAST:	2077216	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 15' SCREEN; 50' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

CRITICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH001765T			2.00 /1.50	6100	20			SM/sc:	Silty clayey gravelly sand. Strong brown (7.5 YR 5/6), pale red (2.5 YR 7/3), very pale brown (10 YR 8/2.1), and yellow (10 YR 8/6). Gravel coarse to fine (prominently fine with clasts to 3"); sand coarse to fine. Well graded. Gravel angular to subangular; sand angular to subangular. Gravel quartzite and quartz; sand quartz and plagioclase. Slightly moist to moist. 53% sand, 16% gravel, 16% silt, and 15% clay.
					6099	21				
				2.70 /2.00	6098	22				
						23			SM:	Silty sand with some clay and gravel. Strong brown (7.5 YR 5/8) to yellow (2.5 Y 7/8). Gravel coarse to fine (mainly fine with clasts up to 1"); sand coarse to fine (mainly fine). Well graded. Gravel subangular to subrounded; sand angular to subrounded. Gravel quartzite and schist; sand mainly quartz and plagioclase. Slightly moist to dry. 51% sand, 20% silt, 16% gravel, and 13% clay. No recovery (23.75-24.00').
				1.00 /1.00	6097					
					6096	24				
				1.50 /2.00	6095	25				
					6094	26			SM:	Gravelly sand with some silt and clay. Strong brown (7.5 YR 5/8). Gravel coarse to fine; sand coarse to fine. Well graded. Gravel angular to subrounded; sand angular to subrounded. Gravel quartzite; sand quartz, plagioclase, and feldspar. Slightly moist to dry. 58% sand, 23% gravel, 11% silt, and 8% clay. No recovery (29.75-30.00').
	GH001885T			1.50 /2.00	6093	27				
					6092	28				
				1.50 /2.00	6091	29				
						30				

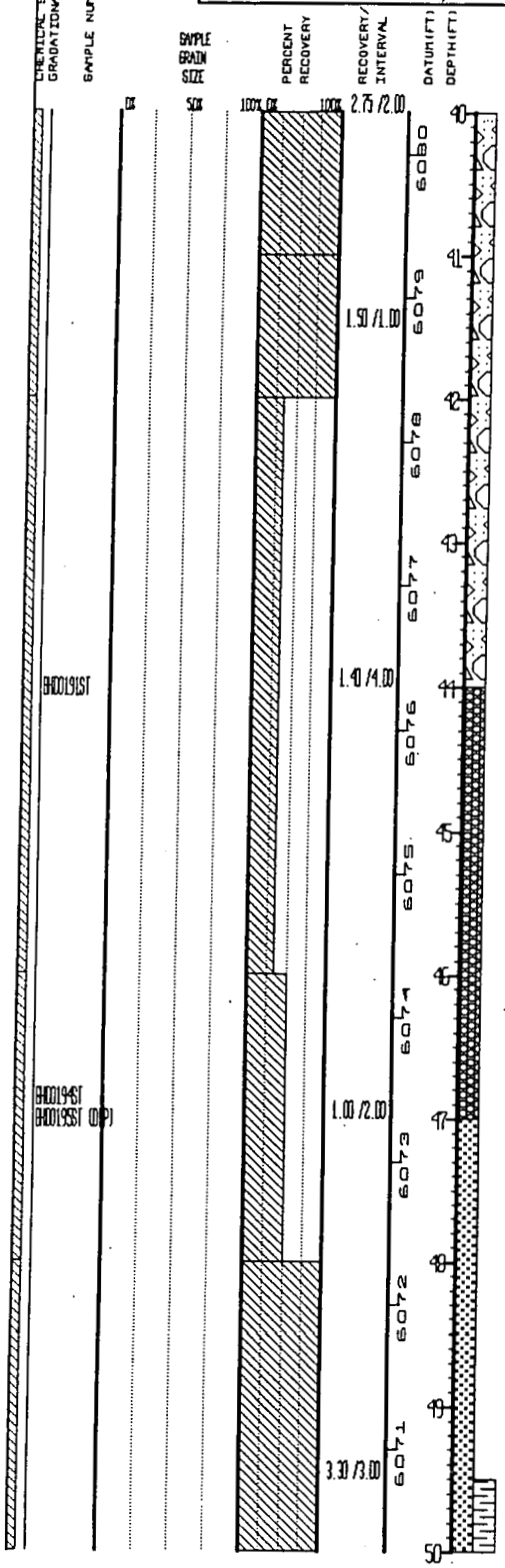
STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 66.80	GROUND ELEVATION (FT): 6120.30	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 749529	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	50394
EAST: 2077216	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 15' SCREEN; 50' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. FIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				2.00 /2.00	6090	30			SM:	Gravelly sand with some silt and clay. Same as above - see description 26.0-30.0'.
					6089	31				
					6088	32			SM:	Gravelly sand with some silt and clay. Same as above - see description 26.0-30.0' - with increasing gravel.
	GH001895T			2.70 /2.00	6087	33				
					6086	34				
				1.40 /1.00	6085	35			SM:	Gravelly sand with some silt and clay. Same as above - see description 26.0-30.0' - with higher percentage gravel and lower percentage sand. 40% sand, 35% gravel, 18% silt, and 7% clay. No recovery (35.75-36.00').
				1.40 /1.00	6084	36				
					6083	37				
				2.50 /3.00	6082	38				
	GH001905T				6081	39				
				2.75 /2.00		40				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 66.80	GROUND ELEVATION (FT):	6120.30	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	748529	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50394
EAST:	2077216	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/19/94	

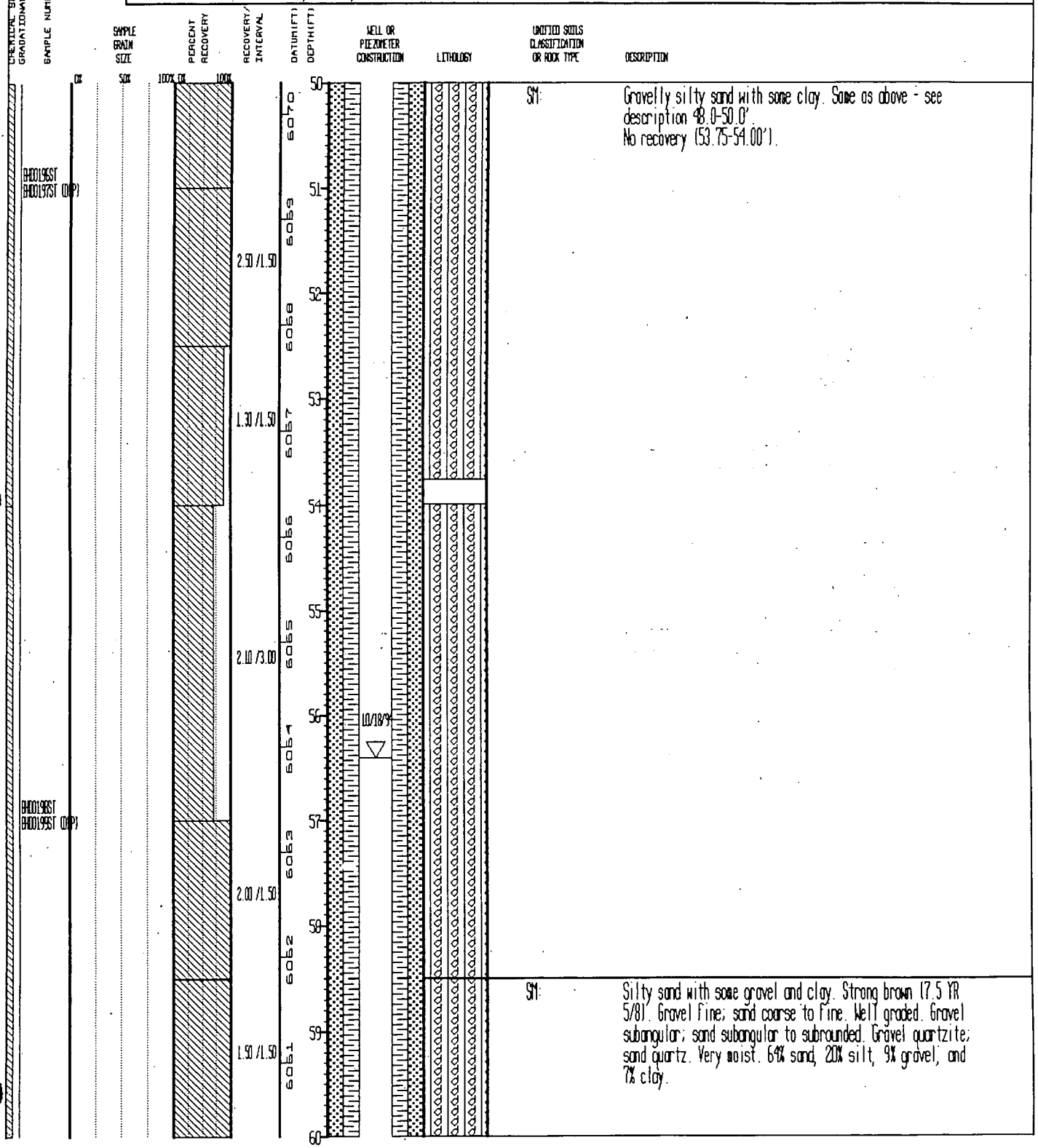
REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 15' SCREEN; 50' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. HIGOR.



SM:	Gravelly sand with some silt and clay. Same as above - see description 26.0-30.0'. Rock flour from 42.0-46.0'. No recovery (41.75-42.00').
SC:	Clayey sand with some silt and gravel. Brown (7.5 YR 5/4). Gravel fine; sand coarse to fine. Well graded. Gravel subangular; sand subrounded to subangular. Gravel quartzite; sand quartz and mica. Moist. 60% sand, 22% clay, 10% silt, and 8% gravel. No recovery (47.75-48.00').
SM:	Gravelly silty sand with some clay. Strong brown (7.5 YR 5/8). Gravel medium to fine; sand coarse to fine. Well graded. Gravel subrounded to subangular; sand subrounded to subangular. Gravel quartzite; sand quartz, mica, and rock fragments. Trace carbonaceous material at 57.0'. Moist. 53% sand, 20% gravel, 20% silt, and 7% clay.

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 66.80	GROUND ELEVATION (FT): 6120.30	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749529	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	50394
EAST:	2077216	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 15' SCREEN; 50' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.



STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 66.80	GROUND ELEVATION (FT):	6120.30	PROJECT NUMBER:	OU11-RFI/RI
NORTH: 748529	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS
EAST: 2077216	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/19/94

LOG OF BORING NUMBER: 50394

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 15' SCREEN; 50' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		CL 50%	100% CL 100%	3.00/3.00	6060, 6059, 6058	60, 61, 62			SM:	Gravelly silty sand with some clay. Same as above - see description 48.0-50.0'.
	BH0020ST BH0020ST (DUP)			2.50/3.00	6057, 6056	63, 64			SC:	Clayey sand with some gravel and silt. Strong brown (7.5 YR 4/6). Gravel fine; sand coarse to fine. Gravel subrounded; sand subangular to subrounded. Gravel quartzite; sand quartz. Moist to slightly moist. 53% sand, 23% clay, 18% gravel, and 6% silt.
					6055	65			SM:	Gravelly silty sand with some clay. Same as above - see description 48.0-50.0'. No recovery (65.75-66.00').
				0.00/1.00	6054	66	08/01/94		NO RECOVERY:	No recovery (66.00-66.80').
					6053, 6052, 6051	67, 68, 69, 70				Total Depth Drilled: 66.80 Total Depth Casing: 66.80 Bottom of Filter Pack: 65.80

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 21.00	GROUND ELEVATION (FT): 6092.30	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:	
NORTH: 749648	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	50494	
EAST: 2078240	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/18/94		

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 10' SCREEN; 20' BLANK CASING. ALL MATERIALS INSTALLED ACCORDING TO SOPS. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH / SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
			0.00 /0.75	6092	0			NO RECOVERY:	No recovery (0.00-0.75').
GH00147ST			1.00 /1.25	6091	1			GW:	Sandy gravel with trace silt. Dark brown (7.5 YR 3/2). Gravel coarse to fine; sand coarse to fine. Well graded. Gravel rounded to subangular; sand subrounded to subangular. Gravel quartzite and schist; sand quartz and mica. Dry. 69% gravel, 26% sand, and 5% silt.
			1.50 /1.50	6090	2				
GH00148ST			0.50 /0.50	6089	3				
			1.00 /1.00	6088	4			SM:	Gravelly sand with some silt and trace clay. Brownish yellow (10 YR 6/8) to strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts up to 4"); sand coarse to fine (mean=medium) Well graded. Gravel subrounded to subangular; sand mainly subrounded. Gravel quartzite; sand quartz and mica. Trace carbonaceous material. Rotted schist and granite. Abundant rock flour from 12.0-13.0'. Dry to slightly moist. 54% sand, 30% gravel, 11% silt, and 5% clay.
GH00149ST			1.00 /1.00	6087	5				
			1.00 /1.00	6086	6				
GH00150ST			1.00 /1.00	6085	7				
			0.50 /1.00	6084	8				
GH00151ST			0.00 /1.00	6083	9			NO RECOVERY:	No recovery (9.00-10.00').
					10				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 21.00	GROUND ELEVATION (FT):	6092.30	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH: 749648	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50494
EAST: 2078240	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/18/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP, 2.0' SUMP; 10' SCREEN; 20' BLANK CASING. ALL MATERIALS INSTALLED ACCORDING TO SOPS. CORE LOGGER O.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	OVA	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
			SOIL	100% OK	100%	6092	10			SM	Gravelly sand with some silt and trace clay. Same as above - see description 3.5-9.0'. No recovery (11.75-12.00').
	BH01SS5T				1.70 /1.75	6091	11				
					0.25 /0.25	6090	12				
					1.50 /1.50	6089	13				
						6088	14			SC/sm	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/8). Gravel coarse to fine (mainly medium to fine, some clasts up to 2"); sand coarse to fine. Well graded Gravel subangular to subrounded; sand subangular. Gravel quartzite; sand quartz and mica. Slightly moist to moist Clay lenses more moist. 53% sand, 34% gravel, 8% clay, and 5% silt. No recovery (17.75-18.00').
	BH01SS5T				2.00 /2.00	6087	15				
					3.00 /2.50	6086	16				
						6085	17				
						6084	18				
					2.00 /2.50	6083	19				
							20				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 24.00	GROUND ELEVATION (FT): 6092.30	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:	
NORTH: 749648	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	50494	
EAST: 2078240	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/18/94		

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 10' SCREEN; 20' BLANK CASING. ALL MATERIALS INSTALLED ACCORDING TO SOPS. CORE LOGGER D.L. RIGOR.

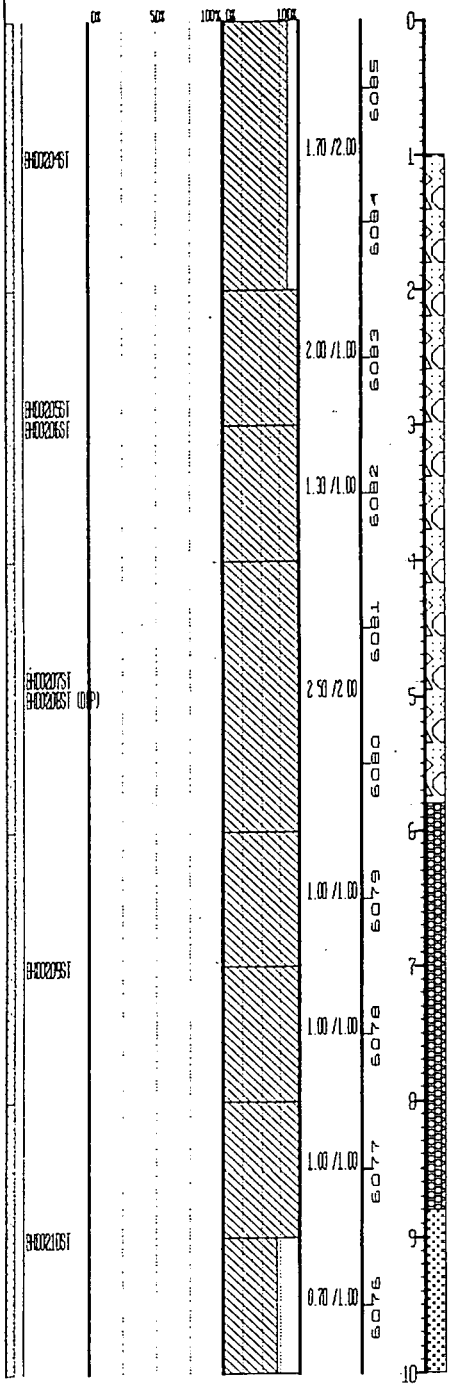
CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH001S6ST		100%	3.25 /3.50	6072	20			SC/sm:	Gravelly sand with some clay and trace silt. Same as above - see description 14.2-20.0' No recovery (23.75-24.00').
					6071	21				
					6070	22				
					6069	23	07/27/94			
					6068	24				Total Depth Drilled: 24.00 Total Depth Casing: 24.00 Bottom of Filter Pack: 23.00
					6067	25				
					6066	26				
					6065	27				
					6064	28				
					6063	29				
						30				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 30.00	GROUND ELEVATION (FT):	6085.50	PROJECT NUMBER:	OU11-RFI/RI
NORTH: 749392	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS
EAST: 2078742	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/28/94

LOG OF BORING NUMBER: **50694**

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 15' SCREEN; 15' BLANK RISER. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR

CHEMICAL SAMPLE DEPTH | GRADATIONAL SAMPLE DEPTH | SAMPLE NUMBER | SAMPLE GRAIN SIZE (0% – 50% – 100%) | PERCENT RECOVERY (0% – 100%) | RECOVERY/INTERVAL | DATUM (FT) | DEPTH (FT) | WELL OR PIEZOMETER CONSTRUCTION | LITHOLOGY | UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION



UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
GP	Sandy gravel with trace clay and silt. Strong brown (7.5 YR 4/6) to dark brown (7.5 YR 3/4). Gravel coarse to fine; sand coarse to fine. Poorly graded. Gravel subrounded; sand subangular to angular. Gravel mainly quartzite and metamorphic rock fragments; sand mainly quartz with hornblende, mica, and rock fragments. Organics present, grass and roots. Loose gravels in dusty matrix. Dry. 81% gravel, 13% sand, 5% clay, and 1% silt. No recovery (1.75-2.00').
GC:	Sandy gravel with some clay and trace silt. Strong brown (7.5 YR 5/6) to yellowish red (5 YR 5/6). Gravel medium to fine with clasts to 1"; sand coarse to fine (mainly medium). Moderately to well graded. Gravel subangular to subrounded; sand angular to subrounded. Gravel made up of quartzite; sand is quartz with abundant feldspar and rock fragments, and mica. Dry. 52% gravel, 34% sand, 12% clay, and 2% silt.
GP	Sandy gravel with trace clay and silt. Same as above - see description @ 0-2.0'.
SC:	Gravelly sand with some clay and trace silt. Yellowish red (5 YR 5/8 to 5 YR 4/6). Gravel coarse to fine (mainly medium with cobbles up to 5"); sand coarse to fine. Gravel subangular; sand subangular to rounded. Gravel made up of quartzite and metamorphic rock fragments. Sand is mainly quartz with feldspar, hornblende, mica, and rock fragments (loose material. Dry to slightly moist. 44% sand, 28% gravel, 22% clay, and 6% silt. No recovery (5.75-6.00') and (7.75-8.00').
GC:	Clayey gravel and sand with some silt. Yellowish brown (10 YR 5/6). Gravel coarse to fine (mainly fine with clasts to 3"); sand coarse, medium, and fine (mainly fine). Very well graded. Gravel subrounded to subangular; sand subangular to rounded. Gravel mainly quartzite with metamorphic rock fragments and weathered granite; sand is prominently quartz and rock fragments. Loose material. Dry to damp. 34% gravel, 34% sand, 23% clay, and 9% silt. No recovery (9.75-10.00').

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 30.00	GROUND ELEVATION (FT): 6085.50	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 749392	AREA: OU11, W SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	50694
EAST: 2078742	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/28/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 15' SCREEN; 15' BLANK RISER. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		0% 50% 100%	0% 100%			10			GC:	Clayey gravel and sand with some silt. Same as above - see description 9.0-10.0'.
	EH0021ST			1.20 /1.00	6075					
				0.70 /1.00	6074	11				
						12			SC:	Gravelly sand with some clay and trace silt. Yellowish red (5 YR 5/8 to 5 YR 4/6). Gravel coarse to fine (mainly medium with clasts to 5"); sand coarse to fine (mainly fine). Well graded. Gravel subangular; sand subangular to rounded. Gravel made up of quartzite and metamorphic rock fragments. Sand is mainly quartz with feldspar, hornblende, mica, and rock fragments. Loose to consolidated. Slightly moist to wet. 44% sand, 28% gravel, 22% clay, and 6% silt. No recovery (11.75-12.00') and (17.75-18.00').
				2.00 /2.00	6073					
	EH0022ST EH0023ST (DUP)				6072	13				
					6071	14				
				2.30 /2.00	6070	15				
						16				
				1.00 /1.00	6069					
	EH0026ST					17				
				1.20 /1.00	6068					
						18				
					6067					
				2.20 /2.00		19				
					6066	20				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 30.00	GROUND ELEVATION (FT):	6085.50	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH:	749092	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50694
EAST:	2078742	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/28/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 15' SCREEN; 15' BLANK RISER. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D L. HIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				0.80 /1.00	6065	20			SC:	Gravelly sand with some clay and trace silt. Same as above - see description 11.75-20.0'. Very moist to wet.
	BH02175T BH02185T (DUP)					21				
				3.00 /2.00	6064	22			SC:	Clayey gravelly sand and some silt. Reddish yellow (7.5 YR 6/8), brown (7.5 YR 5/4) to strong brown (7.5 YR 5/8). Gravel medium to fine (mainly fine); sand coarse to fine (mainly medium). Very well graded. Gravel subangular, sand subrounded to rounded. Gravel made up of quartzite and metamorphic rock fragments, weathered granite. Sand made up of mainly quartz and rock fragments. Very slightly moist to wet. 60% sand, 15% clay, 15% gravel, and 10% silt.
					6063	23	08/05/94			
				1.00 /1.00	6062					
				1.00 /1.00	6061	24			SC:	Gravelly sand with some clay and silt. Yellowish brown (10 YR 5/6) to light yellowish brown (10 YR 6/4). Gravel coarse to fine (mainly fine with cobbles to 5"); sand coarse, medium, and fine. Well graded. Gravel and sand subangular to rounded. Gravel made up of quartzite, weathered schist, and metamorphic rock fragments. Sand made up of quartz, rose quartz, hornblende, mica, and rock fragments. Large cobbles concentrated from 25.0-25.5', occur with distinct color change. Slightly moist. 55% sand, 19% clay, 18% gravel, and 8% silt. No recovery (23.75-24.00').
				2.50 /1.00	6060	25				
					6059	26			SC:	Gravelly sand with some clay and trace silt. Reddish brown (5 YR 5/4) to reddish yellow (7.5 YR 6/8). Gravel coarse, medium, and fine (mainly fine with clasts to 3"); sand coarse, medium, and fine (mainly medium). Well graded. Gravel subangular to subrounded; sand subangular to rounded. Gravel mainly made up of quartzite and other rock fragments; sand is mainly feldspar with rose quartz, and other rock fragments. Increasing coarse fraction with increasing depth. Material is consolidated. Very slightly moist. 59% sand, 26% gravel, 10% clay, and 5% silt
	BH02165T					27				
				2.80 /3.00	6058	28				
					6057	29				
				1.20 /1.00	6056	30				

Total Depth Drilled: 30.00 Total Depth Casing: 29.10
Bottom of Filter Pack: 28.00

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 25.00	GROUND ELEVATION (FT): 6132.80	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	747899	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: S. M. LYNN	50794
EAST:	2076816	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/21/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 10' SCREEN; 15' RISER. ALL SOPS FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	BH00184ST	CL SAND GRAVEL 100% 100%		1.25 /2.00	6132	0			GW/gp:	Sandy gravel with some silt and trace clay. Light brown (7.5 YR 6/4). Gravel mainly medium to fine with clasts to 3" max. diameter (mean=0.5"), angular to subangular, made up of quartzite and plagioclase. Sand coarse to fine (mean=medium), subangular to subrounded, made up of quartz, plagioclase, dominantly feldspar. Moderately graded. Abundance of fine fraction increases with depth. Dry. 48% gravel, 43% sand, 7% silt, and 2% clay.
				1.00 /1.00	6131	1				
	BH00185ST			1.00 /1.00	6130	2				
				1.00 /1.00	6129	3			SM:	Gravelly sand with some silt and clay. Strong brown (7.5 YR 5/8), pale olive (5 Y 6/3). (Pale olive only present in 4.0-5.0'). Gravel coarse to fine (clasts up to 3"); sand coarse to fine (mainly medium). Well graded. Gravel subangular to subrounded; sand subangular. Gravel mainly quartzite; sand mainly quartz, some mica. Trace carbonaceous material. Clay pockets (olive green clay from 4.0-5.0'). Some rock flour from 4.0-5.5'. Dry. 52% sand, 30% gravel, 11% silt, and 7% clay. No recovery (3.75-4.00') and (7.75-8.00').
	BH00186ST			1.00 /1.00	6128	4				
				2.00 /2.00	6127	5				
	BH00187ST			1.00 /1.00	6126	6				
				1.10 /1.00	6125	7				
	BH00188ST			1.00 /1.00	6124	8			SM:	Gravelly sand with some silt and clay. Same as above - see description 3.5-9.0' - with fine gravel only. No recovery (9.75-10.00').
					6123	9				
						10				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 25.00	GROUND ELEVATION (FT): 6132.80	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 747899	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: S. M. LYNN	50794
EAST: 2376816	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/21/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 10' SCREEN; 15' RISER. ALL SOPS FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER O.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
			100%	1.00/1.00	6122	10–11			SM	Gravelly sand with some silt and clay. Same as above - see description 3.5-9.0'
	B4001825T			0.90/1.00	6121	11–12			SM	Gravelly sand with some silt and clay. Same as above - see description 9.0-10.0'. No recovery (11.75-12.00').
				2.00/2.00	6120	12–13			SM	Gravelly sand with some silt and clay. Same as above - see description 3.5-9.0' - including several lenses of fine-grained sand. Moist to slightly moist.
					6119	13–14				
					6118	14–15				
	B4001825T			2.00/2.00	6117	15–16			GC	Clayey gravel with some sand and trace silt. Strong brown (7.5 YR 5/8) to pale yellow (5 Y 7/4). Gravel coarse to fine (mainly clasts 1"-2"), sand coarse to fine (mean=medium). Moderately graded. Gravel subrounded to subangular; sand subangular. Gravel quartzite; sand mainly quartz. Moist to slightly moist. 45% gravel, 28% clay, 22% sand, and 5% silt. No recovery (17.75-18.00').
				1.20/1.00	6116	16–17	07/22/94			
				1.00/1.00	6115	17–18				
				0.50/1.00	6114	18–19			GC	Sandy gravel with some clay and trace silt. Strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts up to 4"); sand coarse to fine (mean=medium). Well graded. Gravel subrounded to subangular; sand subangular to angular. Gravel granite and quartzite; sand mainly quartz. Rotted diorite. Some rock flour from 22.0-23.0'. Clay pockets. Wet from 18.0-19.0', slightly moist to moist other intervals. 47% gravel, 26% sand, 22% clay, and 5% silt.
	B4001855T			1.20/1.00	6113	19–20				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 25.00	GROUND ELEVATION (FT):	6132.80	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	747899	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	S. M. LYNN	50794
EAST:	2076816	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/21/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 10' SCREEN; 15' RISER. ALL SOPS FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% – 50% – 100%)	PERCENT RECOVERY (0% – 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				2.00/2.00	6112	20–21			GC:	Sandy gravel with some clay and trace silt. Same as above - see description 18.0-20.0'.
				0.50/1.00	6111	22				
	GH00187ST				6110	23				
				1.30/2.00	6109	24	07/22/94		GC:	Sandy gravel with some clay and trace silt. Same as above - see description 18.0-20.0'. Minimum amount of coarse gravel Interfingered clay. Moist to wet. No recovery (24.75-25.00').
					6108	25				Total Depth Drilled: 25.00 Total Depth Casing: 25.00 Bottom of Filter Pack: 24.50
					6107	26				
					6106	27				
					6105	28				
					6104	29				
					6103	30				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 30.00	GROUND ELEVATION (FT)	6111.10	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH: 748289	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50894
EAST: 2077776	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/29/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 15.0' SCREEN; 15' RISER. ALL SOPS FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER O.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH0219ST			2.00 /2.00	6110	1			GW/gm:	Sandy gravel with some silt and trace clay. Strong brown (7.5 YR 4/6). Gravel fine to coarse (clasts up to 4"). Sand very coarse to very fine (approx. equal amounts). Well graded. Gravel subangular to angular; sand mainly angular. Gravels mainly quartzite, some granite; sand quartz plus rock fragments. Some rock flour. Trace organic material. Dry. 76% gravel, 15% sand, 7% silt, and 2% clay. No recovery (1.75-2.00').
				1.20 /1.00	6109	2				
	GH0221ST			0.00 /1.00	6108	3			NO RECOVERY:	No recovery (3.00-4.00').
				1.20 /1.00	6107	4			GW/gc:	Sandy gravel with some clay and trace silt. Light brown (7.5 YR 6/4) to strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts up to 2.5"); sand very coarse to fine (mean=medium). Well graded. Gravel subangular; sand subangular to angular. Gravel quartzite; sand quartz plus rock fragments. Trace calcareous material at 4.0-4.5'. Dry. 51% gravel, 39% sand, 7% clay, and 3% silt. No recovery (5.75-6.00').
	GH0221ST			1.00 /1.00	6106	5				
				0.50 /1.00	6105	6				
	GH0222ST			1.30 /1.00	6104	7			SC:	Gravelly sand with some clay and silt. Strong brown (7.5 YR 5/8). Well graded. Gravel subrounded to subangular (clasts up to 4"); sand subangular. Gravel quartzite; sand quartz (coarse, includes rock fragments). Slightly moist 7.0-8.0'; moist to 10.0'. Moist to very moist 10.0-12.0'. 46% sand, 29% gravel, 17% clay, and 8% silt. No recovery (7.75-8.00') and (9.75-10.00')
				1.00 /1.00	6103	8				
	GH0223ST			1.10 /1.00	6102	9				
						10				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 30.00	GROUND ELEVATION (FT): 6111.40	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 748289	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	50894
EAST: 2077776	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/29/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 15.0' SCREEN; 15' RISER. ALL SOPS FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY / INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH00225T			1.00 /1.00	6101	10			SC:	Gravelly sand with some clay and silt. Same as above - see description 7.0-10.0'. No recovery (11.75-12.00').
				0.80 /1.00	6100	11				
				2.00 /2.00	6099	12			SC:	Gravelly sand with some clay and silt. Same as above - see description 7.0-10.0' - with lenses of very fine sand. Slightly moist.
	GH00226T			3.00 /2.00	6098	13			SC:	Gravelly sand with some clay and silt. Same as above - see description 7.0-10.0'. Rock flour.
					6097	14				
					6096	15	08/01/94			
	GH00229T			0.90 /1.50	6095	16			SM:	Gravelly sand with some clay and silt. Same as above - see description 7.0-10.0' - with higher percentage of silt than clay. Wet to saturated. 40% sand, 34% gravel, 16% silt, and 10% clay.
				0.30 /0.50	6094	17			SC:	Gravelly sand with some clay and silt. Same as above - see description 7.0-10.0'. Strong brown (7.5 YR 5/8). Beginning at 18.0', red (2.5 YR 5/8) to yellowish red (5 YR 5/8). Weathered granite. Slightly moist. No recovery (17.75-18.00').
				2.00 /2.00	6093	18				
					6092	19				
						20				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 30.00	GROUND ELEVATION (FT):	6111.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH:	748289	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	50894
EAST:	2077776	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/29/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 15.0' SCREEN; 15' RISER. ALL SOPS FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		CL SGR	100% CR 100%	1.50/1.00	6091	20			SC	Gravelly sand with some clay and silt. Same as above - see description 7.0-10.0'. No recovery (23.75-24.00').
	GH0230ST GH0231ST (DUP)			3.00/2.00	6090	21				
				1.00/1.00	6089	22				
					6088	23				
				3.00/2.50	6087	24			SC	Gravelly sand with some clay and silt. Same as above - see description 7.0-10.0' - with clay lenses.
					6086	25				
					6085	26	08/03/94			
	GH0232ST GH0233ST (DUP)			2.00/2.50	6084	27			SC	Gravelly sand with some clay and silt. Same as above - see description 7.0-10.0' - with sand lenses. No recovery (29.75-30.00').
					6083	28				
				1.50/1.00	6082	29				
						30				Total Depth Drilled: 30.00 Total Depth Casing: 27.30 Bottom of Filter Pack: 26.00

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 21.00	GROUND ELEVATION (FT): 6107.60	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749172	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: D. L. RIGGR	50994
EAST:	2077650	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' PUSH CAP; 1.0' SUMP; 10' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		CL SIX 100% CL 100%		0.00/0.75	6107	0			NO RECOVERY:	No recovery (0.00-0.75').
	GH001575T			1.50/1.25	6106	1			GW:	Gravel with some sand and trace silt and clay. Dark brown (7.5 YR 3/3). Gravel coarse to fine (clasts up to 2"); sand coarse to fine (even distribution). Well graded. Gravel subrounded; angular where broken. Sand angular to subangular. Gravel quartzite and granite; sand quartz and rock fragments. Dry. 83% gravel, 13% sand, 3% silt, and 1% clay.
				1.50/1.50	6105	2			GC:	Sandy gravel with some clay and silt. Reddish yellow (7.5 YR 6/8) to strong brown (7.5 YR 5/8). Gravel coarse to fine (up to 1" clasts), sand coarse to fine (mainly medium to fine). Well graded. Gravel subrounded; sand subangular. Gravel mainly quartzite; sand quartz. Organic material. Dry. 46% gravel, 33% sand, 13% clay, and 8% silt. No recovery (3.75-4.00').
	GH001585T			1.00/0.50	6104	3				
				1.50/1.50	6103	4			GC:	Sandy gravel with some clay and silt. Same as above - see description 2.0-4.0'. Slightly calcareous. No organic material. Slightly moist.
	GH001595T			0.90/0.90	6102	5			GC:	Sandy gravel with some clay and silt. Same as above - see description 2.0-4.0'. No calcareous material. Trace carbonaceous material. Some clasts up to 3". No recovery (5.75-6.00').
				0.60/0.60	6101	6				
	GH001605T			0.50/1.00	6100	7			NO RECOVERY:	Poor recovery. Broken boulder. No recovery (6.40-7.75').
						8			NO RECOVERY:	No recovery (7.75-8.00')
	GH001615T			1.50/1.50	6099	9			GC:	Sandy gravel with some clay and silt. Same as above - see description 2.0-4.0'. No recovery (9.75-10.00').
				0.50/0.50	6098	10				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 24.00	GROUND ELEVATION (FT):	6107.60	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749172	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	D. L. RIGGR	50994
EAST:	2077650	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' PUSH CAP; 1.0' SUMP; 10' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH / SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
BH001623T			1.50/1.50	6097	10			GC:	Sandy gravel with some clay and silt. Same as above - see description 2.0-4.0'. Becoming moist.
			0.50/0.50	6096	11			GC:	Sandy gravel with some clay and silt. Same as above - see description 2.0-4.0' - with more gravel and broken boulder. No recovery (11.75-12.00').
			3.50/3.50	6095	12			SC:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/8). Gravel coarse to fine; sand coarse to fine (mean=medium). Well graded. Gravel subrounded; sand subrounded to subangular. Gravel quartzite; sand quartz plus rock fragments. Moist. 54% sand, 22% gravel, 21% clay, and 3% silt
BH001633T				6094	13			SC:	Gravelly sand with some clay and trace silt. Same as above - see description 12.0-14.0' - with pockets of silt.
			2.00/2.00	6093	14	08/03/94		SM:	Silty sand with some gravel and clay. Strong brown (7.5 YR 5/6). Gravel medium to fine; sand coarse to fine (mean=fine). Well graded. Gravel subrounded to subangular; sand subangular. Gravel quartzite; sand quartz. Moist to very moist. 53% sand, 21% silt, 19% gravel, and 7% clay. No recovery (17.75-18.00').
			0.50/0.50	6092	15			SM:	Silty sand with some gravel and clay. Same as above - see description 15.5-18.0' - with higher percentage silt. Wet. 38% sand, 30% silt, 26% gravel, and 6% clay.
				6091	16			NO RECOVERY:	Poor recovery. Broken boulders with abundant rock flour just above no recovery interval. No recovery (19.20-20.00').
				6090	17				
				6089	18				
				6088	19				
					20				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 24.00	GROUND ELEVATION (FT):	6107.60	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749172	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	D. L. RIGGR	50994
EAST:	2077650	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' PUSH CAP; 1.0' SUMP; 10' SCREEN; ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH001665T	0% 50% 100%	0% 100%	5.00 /5.00	6087	20			NO RECOVERY:	Poor recovery. Broken boulders with abundant rock flour. No recovery (20.00-21.40').
					6086	21			SC:	Clayey sand with some gravel and silt. Strong brown (7.5 YR 5/6) to yellowish red (5 YR 5/8). Gravel medium to fine; sand coarse to fine (60% fine). Gravel subangular; sand subangular to angular. Gravel quartzite; sand quartz. Moist. 52% sand, 25% clay, 16% gravel, and 7% silt. No recovery (23.75-24.00')
					6085	22	07/20/94			
				1.50 /1.00	6084	23				
					6083	24				Total Depth Drilled: 24.00 Total Depth Casing: 24.00 Bottom of Filter Pack: 24.00
					6082	25				
					6081	26				
					6080	27				
					6079	28				
					6078	29				
						30				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 60.00	GROUND ELEVATION (FT):	6091.20	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH:	749630	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN)	2.00	GEOLOGIST:	J. A. HIGGINS	51094
EAST:	2078674	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/01/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 20' SCREEN, 40' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. HIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% – 50% – 100%)	PERCENT RECOVERY (0% – 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH0009SS1			1.30 /2.00	6091 6090	0 1			GM:	Sandy gravel with some silt and trace clay. Very dark grayish brown (10 YR 3/2). Coarse to fine gravel; clasts >= 2" with broken boulder in top 1'; sands very coarse to fine. Well graded. Gravel subangular to subrounded; sands mainly subangular. Gravels mainly quartzite; sands quartz plus rock fragments. Dry. 55% gravel, 37% sand, 6% silt, and 2% clay. No recovery (1.75-2.00') and (3.75-4.00').
	GH0009SS1			2.70 /2.00	6089 6088	2 3				
	GH0010SS1			3.00 /2.00	6087 6086	4 5			SC/SW:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/6) to yellowish brown (10 YR 5/6). Coarse gravel, clasts up to 2", fine to very coarse sand. Well graded. Gravels subrounded to subangular; sands mainly subrounded. Gravels composed of quartzite and schist; sand mainly composed of quartz. Some carbonaceous material present. Slightly moist. 48% sand, 40% gravel, 8% clay, and 4% silt. No recovery (5.75-6.00') and (7.75-8.00').
	GH0010SS1			2.40 /2.00	6085 6084	6 7				
				1.80 /1.00	6083	8			SC/SW:	Gravelly sand with some clay and trace silt. Same as above - see description 5.0-8.0' - with slightly more sand.
	GH0012SS1			2.00 /1.00	6082	9 10			SC/SW:	Gravelly sand with some clay and trace silt. Same as above - see description 5.0-8.0'. No recovery (9.75-10.00').

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 60.00	GROUND ELEVATION (FT):	6091.20	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	748630	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51094
EAST:	2078674	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/01/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 20' SCREEN, 40' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				1.50 /0.50	6089	10			SC/SW:	Gravelly sand with some clay and trace silt. Same as above - see description 5.0-8.0'. Abundant rock flour 10.0-10.5'. Large broken rock fragments >=3" 11.0-11.75' and 16.0-16.5'. No recovery (11.75-12.00').
				0.30 /0.50	6088	11				
	GH001031			3.00 /1.00	6087	12				
				1.70 /2.00	6086	13				
				0.50 /0.50	6085	14				
	GH001041			5.50 /1.50	6084	15				
				2.50 /2.00	6083	16				
				1.50 /1.50	6082	17			SC:	Clayey sand with some gravel and trace silt. Brown (7.5 YR 5/4). Medium gravel; coarse to very fine sand. Well graded. Gravel mainly subangular; sands subrounded to subangular. Gravels quartzite; sands quartz and mica. Comp. 66% sand, 20% clay, 9% gravel, and 5% silt.
					6081	18			SC/SW:	Gravelly sand with some clay and trace silt. See description 20.0-22.4'.
					6080	19				
					6079	20				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 60.00	GROUND ELEVATION (FT): 6091.20	PROJECT NUMBER: 0011-RFI/RI	LOG OF BORING NUMBER:
NORTH 748630	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51094
EAST: 2078674	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/01/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 20' SCREEN, 40' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH01075T			5.00/2.50	6071	20			SC/SW	Gravelly sand with some clay and trace silt. Yellowish red (5 YR 5/8). Medium to fine gravel; coarse to very fine sand (mean=medium). Well graded. Gravel mainly subangular; sands subangular. Gravels quartzite; sands quartz and mica. Slightly moist. 66% sand, 25% gravel, 7% clay, and 2% silt
					6070	21				
					6069	22				
				3.00/1.60	6068	23			SC	Gravelly sand with some clay and trace silt. Same as above - see description 20.0-22.4' - with twice the percentage of clay. Moist. Sand (mean=fine). 58% sand, 27% gravel, 14% clay, and 1% silt
					6067	24			NO RECOVERY	No recovery (23.75-24.00').
									SC/SW	Gravelly sand with some clay and trace silt. Same as above - see description 20.0-22.4'. Coarse to fine gravel (clasts up to 4"). Rock flour from 29.2-29.5'. Moist. Trace carbonaceous material.
				2.00/2.50	6066	25				
					6065	26				
	GH01085T			2.50/1.00	6064	27				
					6063	28				
				3.00/2.50	6062	29				
						30				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 60.00	GROUND ELEVATION (FT): 6091.20	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 748630	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51094
EAST: 2078674	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/01/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 20' SCREEN, 40' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT) / DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		CL SIL SAN 100% CL 100%		3.00 /2.50	6061 6060	30 31		SC/SW:	Gravelly sand with some clay and trace silt. Same as above - see description 20.0-22.4' Rock flour from 31.5-33.0'. No recovery (35.75-36.00').
	B4001095T			3.00 /2.50	6059 6058	32 33			
				4.00 /1.00	6057 6056	34 35			
				2.00 /3.00	6055 6054	36 37	07/07/94		
	B4001105T			1.00 /1.00	6053 6052	38 39			
						40			

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 60.00	GROUND ELEVATION (FT):	6091.20	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH:	748630	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51094
EAST:	2078674	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	07/01/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 20' SCREEN, 40' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY / INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		CL SOIL	100% CL 100%	2.50 /1.00	6051	40			CL	Sandy clay with trace gravel and silt. Pale yellow (5 Y 8/2) to brownish yellow (Fe-oxide staining) (10 YR 6/8). Gravel fine; sand dominantly fine grained. Well graded. Gravel subrounded; sand mainly subrounded. Low to medium plasticity. Gravel quartzite; sand quartz. Moist. Some carbonaceous material present; mainly in top 2'. 50% clay, 46% sand, 3% gravel, and 1% silt. No recovery (41.75-42.00').
				2.00 /1.00	6050	41				
	EH01L15T				6049	42	07/11/94			
					6048	43				
				5.00 /4.00	6047	44				
					6046	45			SC/SW	Gravelly sand with some clay and trace silt. Same as above - see description 20.0-22.4'
					6045	46			SC	Clayey sand with some clay and trace gravel and silt. Strong brown (7.5 YR 5/6). Gravel fine; sand coarse to fine (mainly medium to fine). Well graded. Gravel subangular; sand subrounded to subangular. Gravel quartzite; sand quartz. Moist. 82% sand, 10% clay, 4% gravel, and 4% silt.
					6044	47				
	EH01L25T			4.00 /3.00	6043	48			SC	Clayey sand with trace silt. Light yellowish brown (10 YR 6/4) to brownish yellow (10 YR 6/6). Fine sand. Well graded. Sand subrounded to subangular. Sand quartz and mica. Moist 67% sand, 30% clay, and 3% silt
					6042	49			SC	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/8). Gravel up to 2"; coarse to fine. Sand very coarse to fine. Well graded. Gravel subrounded; sand subangular. Gravel quartzite; sand quartz. Wet. 48% sand, 38% gravel, 11% clay, and 3% silt.
				3.00 /1.50		50				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 60.00	GROUND ELEVATION (FT): 6091.20	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 748630	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51094
EAST: 2078674	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 07/01/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELL CONSTRUCTED WITH 0.3' END CAP; 2' SUMP; 20' SCREEN, 40' BLANK CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH / SAMPLE NUMBER	SAMPLE GRAIN SIZE (CL SCL)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				6041	50			SC:	Gravelly sand with some clay and trace silt. Same as above - see description 48.0-50.0'. Saturated at 50.5'. No recovery (50.25-50.50').
				6040	51				
			3.50/3.00	6039	52			SC/SW:	Gravelly sand with some clay and trace silt. Light gray (5 Y 7/2). Gravel coarse to fine (clasts up to 3"). Sand coarse to fine (mainly medium to coarse). Well graded. Gravel subrounded to angular where broken during drilling. Sand mainly subangular. Gravel quartzite and weathered granite; sand quartz. Damp to wet. 47% sand, 43% gravel, 9% clay, and 1% silt.
				6038	53				
				6037	54			SC/SW:	Gravelly sand with some clay and trace silt. Same as above - see description 52.0-54.0' - mixed with reworked bedrock (claystone).
			3.50/3.00	6036	55				
				6035	56			SC/SW:	Gravelly sand with some clay and trace silt. Same as above - see description 52.0-54.0' - including trace carbonaceous material and Fe-oxide staining.
				6034	57				
			4.00/3.50	6033	58			SILTY CLAYSTONE:	Top of bedrock. Silty Claystone. Light gray (2.5 Y 7/2) to brownish yellow (10 YR 6/8) with trace carbonaceous material and Fe-oxide stains (making core appear mottled). Slightly friable. 5% porosity. Moist. 80% clay and 20% silt.
				6032	59				
					60				Total Depth Drilled: 60.00 Total Depth Casing: 60.00 Bottom of Filter Pack: 60.00

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 52.30	GROUND ELEVATION (FT): 6071.40	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER
NORTH: 749883	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: S. M. LYNN	51194
EAST: 2079328	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 08/10/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2' SEDIMENT SUMP; 15' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		0% 50% 100%	0% 100%			0			GW/gc:	Sandy gravel with trace silt and clay. Dark brown (7.5 YR 3/3). Gravel coarse to fine (clasts to 2"); sand coarse to fine. Well graded. Gravel subrounded to subangular; sand subangular. Gravel mainly quartzite; sand mainly quartz, some feldspar with some organic material. Dry. 59% gravel, 35% sand, 4% clay, and 2% silt.
	1S1024S1			1.00 /2.00	6071	1				
				1.00 /1.00	6070	2			SC:	Clayey sand with some gravel and silt. Yellowish red (5 YR 5/8) to strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts up to 3"); sand coarse to fine (mainly medium to fine). Gravel subrounded to subangular; sand subangular. Gravel quartzite; sand quartz. Some organic material. Dry. 60% sand, 17% clay, 15% gravel, and 8% silt.
	1S1024S1			0.50 /1.00	6069	3				
				2.00 /1.00	6068	4			SM:	Gravelly sand with some silt and clay. Strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts up to 2", large clasts >4" at 9.0'). Sand coarse to fine. Gravel subrounded to subangular; sand subangular. Gravel quartzite; sand quartz, mica, plus rock fragments. Dry. 57% sand, 29% gravel, 8% silt, and 6% clay. No recovery (3.75-4.00'), (5.75-6.00'), and (7.75-8.00').
	1S1025S1			1.00 /1.00	6067	5				
				0.90 /1.00	6066	6				
	1S1025S1			1.00 /1.00	6065	7				
				1.00 /1.00	6064	8				
	1S1025S1			1.00 /1.00	6063	9			NO RECOVERY:	No recovery (9.75-10.00').
					6062	10				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 52.30	GROUND ELEVATION (FT):	6071.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749883	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	S. M. LYNN	51194
EAST:	2079328	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/10/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2' SEDIMENT SUMP; 15' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% – 50% – 100%)	PERCENT RECOVERY (0% – 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				1.20 /1.00	6061	10			SM:	Gravelly sand with some silt and clay. Same as above - see description 3.0-10.0' - with abundant rock flour 12.0-12.5'. Slightly moist. No recovery (11.75-12.00') and (17.75-18.00').
	BH0253ST			1.60 /1.00	6060	11				
				3.00 /1.00	6059	12				
					6058	13				
				2.50 /2.50	6057	14				
	BH0254ST				6056	15				
				0.50 /1.50	6055	16				
				1.00 /1.00	6054	17				
					6053	18			SM:	Gravelly sand with some silt and trace clay. Strong brown (7.5 YR 5/6-5/8). Gravel medium to fine; sand coarse to fine (mainly coarse to medium). Well graded. Gravel subrounded to subangular; sand subrounded. Gravel quartzite; sand quartz. Wet to saturated. 45% sand, 40% gravel, 12% silt, and 3% clay.
				4.00 /3.00	6052	19			SC:	Gravelly sand with some clay and trace silt. Brown (7.5 YR 5/4). Gravel medium to fine; sand coarse to fine. Gravel subangular; sand subangular to angular. Gravel quartzite; sand quartz. Moist to wet. 42% sand, 38% gravel, 16% clay, and 4% silt.
						20				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 52.30	GROUND ELEVATION (FT):	6071.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749883	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	S. M. LYNN	51194
EAST:	2079328	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/10/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2' SEDIMENT SUMP; 15' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	BH025751			0.30 /1.00	6051	20			SC:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts up to 3"); sand coarse to fine (mean=fine). Moderately well graded. Gravel subangular; sand subangular. Gravel quartzite; sand quartz. Trace carbonaceous material. Wet to dry. 40% sand, 34% gravel, 23% clay, and 3% silt
				1.00 /1.00	6050	21				
				1.20 /1.00	6049	22				
				3.00 /3.00	6048	23			SM:	Gravelly sand with some silt and clay. Same as above - see description 3.0-10.0'. Slightly moist. No recovery (23.75-24.00').
				2.10 /2.00	6047	24				
	BH025851 BH025851 (DUP)			1.00 /1.00	6046	25			SC:	Gravelly sand with some clay and trace silt. Brown (7.5 YR 5/4). Gravel coarse to fine (clasts to 2"); sand coarse to fine (mainly fine). Well graded. Gravel subrounded to subangular; sand angular to subrounded. Gravel mainly quartzite; sand mainly quartz plus rock fragments. Moist to very moist. 62% sand, 23% gravel, 10% clay, and 5% silt
					6045	26				
					6044	27			SC:	Clayey sand with some gravel and trace silt. Yellowish red (5 YR 5/8) to strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts to 2"); sand coarse to fine (mainly medium to fine). Well graded. Gravel subangular; sand subrounded to subangular. Gravel granite and quartzite; sand quartz. Dry. 54% sand, 20% clay, 22% gravel, and 4% silt.
					6043	28				
					6042	29			SC:	Gravelly sand with some clay and silt. Yellowish red (5 YR 5/6) to strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts to 2"); sand coarse to fine (mean=medium). Well graded. Gravel subrounded to subangular; sand subangular. Gravel quartzite; sand quartz plus rock fragments. Trace manganese staining. Moist to dry. 48% sand, 28% gravel, 15% clay, and 9% silt
						30				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 52.30	GROUND ELEVATION (FT):	6071.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749883	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	S. M. LYNN	51194
EAST:	2079328	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/10/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2' SEDIMENT SUMP; 15' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

UNIFORM SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				2.80 /3.00	6041	30			SC:	Gravelly sand with some clay and silt. Same as above - see description 29.0-30.0'.
					6040	31				
					6039	32				
	GH0027SS1				6038	33			SC:	Clayey sand with some gravel and trace silt. Reddish yellow (7.5 YR 6/8) to strong brown (7.5 YR 5/8). Gravel medium to fine; sand coarse to fine (mainly medium). Moderately graded. Gravel subangular; sand subangular to rounded. Gravel quartzite; sand mainly quartz plus rock fragments. Dry. 52% sand, 24% clay, 20% gravel, and 4% silt.
				2.50 /2.00	6037	34				
				1.00 /1.00	6036	35			SC	Gravelly sand with some clay and trace silt. Reddish yellow (7.5 YR 6/8) to strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts to 4"); sand coarse to fine (prominently medium). Well graded. Gravel subangular; sand subangular to rounded. Gravel feldspar and quartzite; sand quartz, feldspar, mica, and hornblende. Dry to slightly moist. 50% sand, 28% gravel, 18% clay, and 4% silt.
					6035	36				
					6034	37			SC:	Clayey sand with some gravel and trace silt. Same as above - see description 27.5-29.0'. Increase in sand and gravel content with depth. No recovery (35.75-36.00').
				4.20 /4.00	6033	38				
	GH0027SS1				6032	39				
						40				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 52.30	GROUND ELEVATION (FT):	6071.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749883	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	S. M. LYNN	51194
EAST:	2079328	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/10/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2' SEDIMENT SUMP; 15' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				1.00 /1.00	6031	40			SC:	Clayey sand with some gravel and trace silt. Same as above - see description 35.0-40.0'
				1.20 /1.00	6030	41			CH:	Sandy clay with some silt and trace gravel. Reworked bedrock. Reddish yellow (7.5 YR 6/8) to light olive gray mottling (light olive gray only 42.0-42.7'). Gravel coarse to fine (coarse and increase 42.0-42.7'); sand coarse to fine (mainly fine). Gravel subrounded; sand subrounded. Very plastic. Gravel quartzite; sand mainly quartz. Trace carbonaceous material. 60% clay, 28% sand, 11% silt, and 1% gravel. No recovery (41.75-42.00').
	BH02775I			1.10 /1.00	6029	42				
					6028	43			SC	Gravelly sand with some clay and trace silt. Reddish yellow (5 YR 6/8) to strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts to 2"); sand coarse to fine (mainly medium) Moderately graded. Gravel subangular; sand subangular. Gravel quartzite and granite; sand quartz plus rock fragments. Very moist to slightly moist (more moist in clay-rich layers). 55% sand, 25% gravel, 17% clay, and 3% silt.
					6027	44				
				4.00 /4.00		45				
	BH02805I BH02815I (DUP)				6026					
					6025	46			SM:	Gravelly sand with some silt and clay. Strong brown (7.5 YR 5/8) Gravel coarse to fine; sand coarse to fine (mainly medium). Well graded Gravel subrounded to subangular; sand subangular to angular. Gravel quartzite and granite; sand quartz plus rock fragments. Weathered granite. Slightly moist. 48% sand, 37% gravel, 9% silt, and 6% clay.
				1.00 /1.00	6024	47			SC/SW:	Gravelly sand with some clay and trace silt Strong brown (7.5 YR 5/8) to reddish yellow (7.5 YR 6/8). Gravel medium to fine; sand coarse to fine (mainly medium) Moderately graded. Gravel quartzite; sand quartz plus rock fragments Gravel subangular to subrounded; sand subangular Moist to very moist 73% sand, 17% gravel, 7% clay, and 3% silt. No recovery (47.75-49.00')
					6023	48				
				3.50 /3.00	6022	49			SC:	Clayey sand with some silt and gravel. Strong brown (7.5 YR 5/8) to reddish yellow (7.5 YR 6/6). Gravel coarse to fine (mainly fine); sand coarse to fine (mainly medium to coarse). Moderately graded. Gravel subangular; sand subangular to subrounded. Gravel quartzite; sand quartz and mica. Moist. 53% sand, 25% clay, 16% silt, and 6% gravel
						50				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 52.30	GROUND ELEVATION (FT):	6071.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749883	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	S. M. LYNN	51194
EAST:	2079328	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/10/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2' SEDIMENT SUMP; 15' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	9H0028ZST	GR SOIL	100% GR 100%	1.00 /1.00	6021 6020 6019 6018 6017 6016 6015 6014 6013 6012	50 51 52 53 54 55 56 57 58 59 60	08/26/94 08/17/94		SC:	Gravelly sand with some clay and trace silt (49.0-52.0'). Strong brown (7.5 YR 5/8). Gravel coarse to fine (mainly medium to fine); sand coarse to fine (mainly medium). Moderately graded. Gravel subangular; sand subangular to subrounded. Gravel quartzite; sand quartz, mica, feldspar, and hornblende. Moist to wet. 52% sand, 32% gravel, 13% clay, and 3% silt. No recovery (51.75-52.00').

Total Depth Drilled: 52.30 Total Depth Casing: 52.00
Bottom of Filter Pack: 51.00

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 37.70	GROUND ELEVATION (FT):	6062.80	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 749278	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51294
EAST: 2079847	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/11/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2' SEDIMENT SUMP; 15' SCREEN; 25' RISER. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. HIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				1.50 /2.00	6062	0			SC	Gravelly sand with some clay and silt. Brown (7.5 YR 4/4) Gravel coarse, medium, and fine (prominently medium with cobbles up to 3"). Sand coarse, medium, and fine. Very well graded. Gravel angular to subrounded; sand angular to subangular. Gravel mainly quartzite with weathered schist, gneiss, and granite rock fragments. Loose, dusty material. Organics in top 2'. Dry. 38% sand, 34% gravel, 14% silt, and 14% clay. No recovery (1.75-2.00').
	3H0261ST			1.40 /1.00	6061	1				
				0.00 /1.00	6060	2			NO RECOVERY	No recovery (3.00-4.00')
	3H0261ST			2.00 /1.00	6059	3			SC	Gravelly sand with some clay and silt. Brownish yellow (10 YR 6/6). Gravel coarse, medium, and fine (prominently fine with cobbles up to 4.5"). Sand coarse, medium, and fine (mostly medium). Gravel subangular to subrounded; sand subangular to subrounded. Gravel made up of mainly quartzite and metamorphic rock fragments. Sand made up of quartz, feldspar, and some hornblende and mica. Below 10' lots of rock flour present due to large cobble concentration and rotary drilling. Slightly moist from 4-8' and 10-11'; moist from 8-10'. 54% sand, 32% gravel, 8% clay, and 6% silt. No recovery (5.75-6.00'), (7.75-8.00'), and (9.75-10.00')
	3H0262ST			1.00 /1.00	6058	4				
				1.00 /1.00	6057	5				
	3H0263ST			1.00 /1.00	6056	6				
				1.30 /1.00	6055	7				
	3H0264ST			0.70 /1.00	6054	8				
					6053	9				
						10				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 37.70	GROUND ELEVATION (FT): 6052.80	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 749278	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51294
EAST: 2079847	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 08/11/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2' SEDIMENT SUMP; 15' SCREEN; 25' RISER. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (CL SILT SAND GRAVEL)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH0026751			4.00 /1.00	6052	10			SC:	Gravelly sand with some clay and silt. Same as above - see description 4.0-10.0'.
	GH0026851			1.30 /1.00	6051	11			SC:	Clayey sand with some gravel and trace silt. Reddish yellow (7.5 YR 6/6) with light olive gray (5 Y 6/2) mottling. Gravel subrounded to rounded; sand angular to subrounded. Gravel coarse, medium, and fine (prominently fine with clasts up to 2"). Sand coarse, medium, and fine (mainly fine). Gravel is quartzite and other metamorphic rock fragments. Sand made up mainly of quartz and feldspar with rock fragments present. Darker color due to iron staining. This is reworked bedrock. Moist. 64% sand, 19% clay, 15% gravel, and 2% silt. No recovery (11.75-12.00').
					6050	12				
						13				
				5.00 /5.00	6049	14			SC:	Gravelly clayey sand with some silt. Strong brown (7.5 YR 5/8) mottled with light olive gray (5 Y 6/2) and red (10 R 5/8). Gravel coarse, medium, and fine (mainly fine with clasts up to 2"). Sand coarse, medium, and fine (prominently medium to fine). Gravel subrounded to rounded; sand angular to subangular. Gravel is quartzite and metamorphic rock fragments. Sand is mainly quartz with rose quartz, feldspar, and rock fragments. Lots of weathered granite present, this is still reworked bedrock. Moist. 70% sand, 12% gravel, 12% clay, and 6% silt.
	GH0027151				6048	15				
					6047	16				
				1.00 /1.00	6046	17			SC:	Clayey sand with some gravel and trace silt. Strong brown (7.5 YR 5/6) mottled with weak red (10 R 4/3), pale red (2.5 YR 7/3) and brownish yellow (10 YR 6/8). Gravel coarse, medium, and fine (mainly fine with clasts to 3"). Sand coarse, medium, and fine (mainly medium). Gravel and sand subangular to subrounded. Gravel made up of quartzite and rock fragments. Sand is quartz, feldspar, and some mica and rock fragments. Much weathered granite, schist, and gneiss. Slightly moist. 62% sand, 19% clay, 14% gravel, and 5% silt. No recovery (17.75-18.00').
				2.20 /2.00	6045	18				
					6044	19				
					6043	20				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 31.70	GROUND ELEVATION (FT)	6062.80	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH: 749278	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51294
EAST: 2079847	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/11/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2' SEDIMENT SUMP; 15' SCREEN; 25' RISER. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. HIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
						20			SC	Clayey sand with some gravel and trace silt. Same as above - see description 17.0-20.0'.
	BH0272SI			2.00 /2.00	6042	21			SC	Gravelly sand with some clay and silt. Strong brown (7.5 YR 5/6) to brown (7.5 YR 5/4) with mottling of reddish yellow (5 YR 6/6) and pale olive (5 Y 6/3). Gravel coarse, medium, and fine (predominately fine with cobbles up to 3.5"). Sand coarse, medium, and fine (predominately fine). Gravel subangular to subrounded; sand subrounded. Gravel made up of quartzite and metamorphic rock fragments. Sand made up of quartz, feldspar, hornblende, and rock fragments. Pockets of clean fine sand from 25-27', lens of pale olive silty sand with black manganese staining from 22.8-23.0'. Slightly moist to moist, dry to very slightly moist from 24-27'. Rotary core from 22-23'; very hot core from 24-27'. 51% sand, 24% gravel, 16% clay, and 9% silt. No recovery (23.75-24.00')
					6041	22				
				1.00 /1.00	6040	23				
				1.00 /1.00	6039	24	08/17/94			
					6038	25				
				2.00 /3.00	6037	26				
	BH0273SI				6036	27			GC	Sandy gravel with some clay and silt. Strong brown (7.5 YR 5/8). Gravel coarse, medium, and fine (mainly medium with cobbles to 5.5"). Sand coarse, medium, and fine (mainly medium). Gravel and sand subangular to subrounded. Gravel made up of mainly quartzite with other metamorphic rock fragments. Sand mainly quartz with some feldspar and trace hornblende and rock fragments. Core is loose and broken. Dry to slightly moist. 45% gravel, 30% sand, 15% clay, and 10% silt
				2.00 /2.00	6035	28				
					6034	29				
				1.00 /1.00	6033	30			SC/SW	Gravelly sand with some clay and trace silt. See description 30.0-31.5'. No recovery (29.75-30.00').

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 37.70	GROUND ELEVATION (FT): 6052.80	PROJECT NUMBER: 0011-RFI/RI	LOG OF BORING NUMBER:
NORTH: 749278	AREA: 0011, W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51294
EAST: 2079847	LOCATOR NUMBER: L-7	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 08/11/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2' SEDIMENT SUMP; 15' SCREEN; 25' RISER. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% – 50% – 100%)	PERCENT RECOVERY (0% – 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				3.40/3.00	6032	30			SC/SW:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 4/6). Gravel medium to fine. Sand coarse, medium, and fine (mainly medium). Gravel subangular to subrounded; sand subangular to subrounded. Gravel is quartzite and other metamorphic rock fragments. Sand is quartz, feldspar, hornblende and other rock fragments. Moist to wet. 54% sand, 36% gravel, 8% clay, and 2% silt.
					6031	31				
					6030	32			SC:	Gravelly sand with some clay and trace silt. Same as above - see description 30.0-31.5' - with slightly different gravel, sand, silt, and clay content percentages. Color change to dark yellowish brown (10 YR 3/4). Moist to wet. 51% sand, 35% gravel, 11% clay, and 3% silt.
					6029	33			SM:	Gravelly sand with some silt and trace clay. Strong brown (7.5 YR 5/6). Gravel coarse, medium, and fine (prominently medium to fine with clasts up to 3"). Sand coarse, medium, and fine (mainly medium to fine). Gravel and sand subangular to subrounded. Gravel is quartzite and rock fragments. Sand is quartz and rock fragments. Core is well consolidated. Wet to moist. 49% sand, 38% gravel, 9% silt, and 4% clay
	GH0021-6T				6028	34				
				4.00/4.00	6027	35				
					6026	36				
					6025	37			NO RECOVERY:	No recovery (37.00-37.70').
					6024	38				Total Depth Drilled: 37.70 Total Depth Casing: 37.30 Bottom of Filter Pack: 36.00
					6023	39				
						40				

STATE PLANE COORDINATE		TOTAL DEPTH (FT): 72.00	GROUND ELEVATION (FT): 6097.40	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER
NORTH:	748982	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51494
EAST:	2078256	LOCATOR NUMBER: 0	BORE-HOLE DIAMETER (IN): 7.00	DATE DRILLED: 06/22/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3" END CAP; 2.0' SUMP; 20' SLOTTED SCREEN. ALL SOPS FOLLOWED IN INSTALLATION PROCEDURES. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (CK 50% 100% CK 100%)	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
					6097	0			GM:	Sndy grvl w/some slt & tr cly. Dk gry brn (10YR4/2) to brn (10YR4/3). Clasts to >4" (grvls & cbbls); snds f-crs (avg med-crs). W. graded. Grvls subrnd-rnd (anglr where broken during drilling); snds dom subanglr. Low plast. Grvls mstly schist, gneiss, qtzt; sands mstly qtz + rk frags. Dry. 51% grvl, 34% sand, 12% slt, & 3% cly.
	EH0007451			2.50 /2.00	6096	1			CL:	Sndy cly w/some slt & tr grvl. Yllw rd (5YR5/6) to dk rd (2.5YR4/6). Tr grvl; abund f snd. Mod grad. Subanglr. Qtz. Fe-oxds. Scatt cly pckts. Dry to sl moist. 55% cly, 35% snd, 10% slt, & <1% grvl. No recovery (1.75-2.00').
	EH0007551			2.40 /2.00	6095	2			GM:	Sndy grvl w/some cly & tr slt. V dk gry brn (10YR3/2). Grvls to 2"; snds f-crs (dom med-crs). W graded. Grvls subrnd (anglr where broken during drilling); snds dom subanglr. Low plast. Grvls dom schist, gneiss, & qtzt; snds mostly qtz. Dry to v slightly moist. 59% grvl, 30% sand, 8% cly, & 3% slt.
	EH0007651			2.80 /2.00	6094	3			GC/gw:	Sndy grvl w/some slt & tr cly. Str brn (7.5YR5/8) to yllw rd (5YR5/8). Med-crs grvl (to 1") V f-v crs snd. Tr carb matl. W graded. Grvls subanglr-subrnd; snds subanglr. Grvls qtzt, gneiss, schist, & granite; snd mostly qtzt & rk frags. Dry to v slightly moist. 68% grvl, 21% snd, 7% slt, & 4% cly. No recovery (3.75-4.00').
	EH0007751			1.40 /2.00	6093	4			SM:	Grvlly snd w/some slt & tr cly. Dk yllw brn (10YR4/6). Grvls f-crs (to 1"). Sand v f-crs. Rotted schist. W graded. Grvl subrnd; snd subanglr-anglr. Low plast. Cobbls schist, qtzt, snds mostly qtzt w/broken rk frags. Dry. 44% snd, 42% grvl, 11% slt & 3% cly.
	EH0007851			1.90 /2.00	6092	5			GM:	Sndy grvl w/some cly & tr slt. Brn yllw to rd yllw. Grvls & cbbls to 4"; snds f-crs, dom med-crs. W graded. Grvls subanglr (cbbls rnd); snds mainly subanglr. Low plast. Grvls qtzt, schist; sands dom qtzt. Rk flour at top 1", tr carb matl. Fe-oxds. Dry. 46% grvl, 44% snd, 6% cly, & 4% slt. No recovery (5.75-6.00').
					6091	6			SM:	Grvlly snd w/some cly & tr slt. Pale olv (5Y6/8) to yllw brn (10YR5/8). Crs grvl w/clasts to 4"; snd v f-v crs. W graded. Grvls mainly subanglr; sands anglr-subanglr. Grvls mostly qtzt; snds qtz. Dry. 52% snd, 40% grvl, 6% cly, & 2% slt. No recovery (7.40-7.75') and (7.75-8.00').
					6090	7			SM:	Grvlly snd w/some slt & tr cly. See description 10.0-17.2'
					6089	8				
					6088	9				
						10				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 72.00	GROUND ELEVATION (FT):	6097.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	748982	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51494
EAST:	2078256	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	06/22/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SLOTTED SCREEN. ALL SOPS FOLLOWED IN INSTALLATION PROCEDURES. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	BH0008-5T			3.65 /2.00	6087	10			SM:	Gravelly sand with some silt and trace clay. Strong brown (7.5 YR 5/6) to yellowish brown (10 YR 5/6). Cobbles up to 3", coarse gravels; sands fine to very coarse (mainly fine). Well graded. Gravel subrounded to subangular; sand subrounded to angular. Gravel mainly quartzite; sands quartz with trace of carbonaceous material at 9.6'. Abundant rock flour present in 11-12' and 13-14' intervals. No bedding. Slightly moist. 60% sand, 32% gravel, 6% silt, and 2% clay. No recovery (9.75-10.00') and (11.75-12.00').
					6086	11				
				1.30 /1.00	6085	12				
				1.00 /1.00	6084	13				
				0.50 /0.50	6083	14				
	BH0008GST BH0008IST (DUP)			3.00 /1.50	6082	15				
				1.30 /1.00	6081	16				
				1.50 /1.00	6080	17			SC:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/6) to dark red (2.5 YR 4/6) with pale olive (5 Y 6/3) present in 17.2-20' interval. Gravels up to 2"; sands fine to coarse. Well graded. Gravels subrounded to subangular; angular where broken during drilling. Sands dominantly subangular. Gravels dominantly quartzite; sands dominantly quartz. Moist. 51% sand, 28% gravel, 19% clay, and 2% silt. No recovery (17.75-18.00').
					6079	18				
				2.30 /2.00	6078	19				
						20				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 72.00	GROUND ELEVATION (FT):	6097.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH:	749982	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51494
EAST:	2078256	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	06/22/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SLOTTED SCREEN. ALL SOPS FOLLOWED IN INSTALLATION PROCEDURES. CORE LOGGER D.L. RIGGR

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
			100%	21.00-/1.50	6077	20			SC	Gravelly sand with some clay and trace silt. Same as above - see description 17.2-20.0'. No recovery (23.75-24.00') and (29.75-30.00')
	GH0082ST			2.50 /1.50	6076	21				
				1.00 /1.00	6075	22				
				2.50 /2.00	6074	23				
				2.20 /2.00	6073	24				
	GH0087ST			2.30 /2.00	6072	25				
					6071	26				
					6070	27				
					6069	28				
					6068	29				
						30				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 72.00	GROUND ELEVATION (FT):	6097.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	748982	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51494
EAST:	2078256	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	06/22/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SLOTTED SCREEN. ALL SOPS FOLLOWED IN INSTALLATION PROCEDURES. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (CS / SDX)	PERCENT RECOVERY (100% OS / 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				3.00 /1.00	6067	30			SC:	Gravelly sand with some clay and trace silt. Same as above - see description 17.2-20.0'. Dry.
					6066	31				
				2.00 /3.00	6065	32				
	GH0009GST				6064	33				
				3.70 /2.00	6063	34			SC:	Gravelly sand with some clay and trace silt. Same as above - see description 17.2-20.0'. Moist to dry. Very large broken boulder (>4") at 35.6-36.8'. No recovery (35.75-36.00').
					6062	35				
					6061	36				
				5.00 /3.00	6060	37				
					6059	38				
	GH0009ISST			5.00 /2.00	6058	39			SM/SW:	Gravelly sand with some silt and trace clay. Yellowish brown (10 YR) to yellowish red (5 YR 5/8). Gravel up to 2"; average 1/2". Sands very fine to very coarse (dominantly fine). Well graded. Subrounded to subangular gravel; sand subangular. Gravel dominantly quartzite, sands dominantly quartz. Dry to very slightly moist. 69% sand, 20% gravel, 7% silt, and 4% clay.
						40				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 72.00	GROUND ELEVATION (FT): 6097.40	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 748982	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51494
EAST: 2078256	LOCATION NUMBER: 0	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 06/22/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SLOTTED SCREEN. ALL SOPS FOLLOWED IN INSTALLATION PROCEDURES. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		CS SD	100% CR 100%	5.00 /2.00	6057	40			SM:	Gravelly sand with some silt and trace clay. Same as above - see description 39.0-40.0'.
				2.30 /1.00	6056	41			SC:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/6) to dark red (2.5 YR 4/6). Gravels up to 2" present in top 1' of interval; sands fine to coarse. Well graded. Gravels subrounded to subangular; sands dominantly subangular. Gravels dominantly quartzite; sands dominantly quartz. Very dry to slightly moist. 50% sand, 28% gravel, 19% clay, and 3% silt. No recovery (41.75-42.00') and (47.75-48.00').
					6055	42				
				3.00 /2.00	6054	43				
					6053	44				
	EH0009251				6052	45				
				5.00 /4.00	6051	46				
					6050	47				
					6049	48			SC	Gravelly sand with some clay and trace silt. Same as above - see description 41.0-48.0'. Moist.
					6048	49				
						50				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 72.00	GROUND ELEVATION (FT): 6097.40	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER
NORTH:	748982	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51494
EAST:	2072256	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 06/22/94	

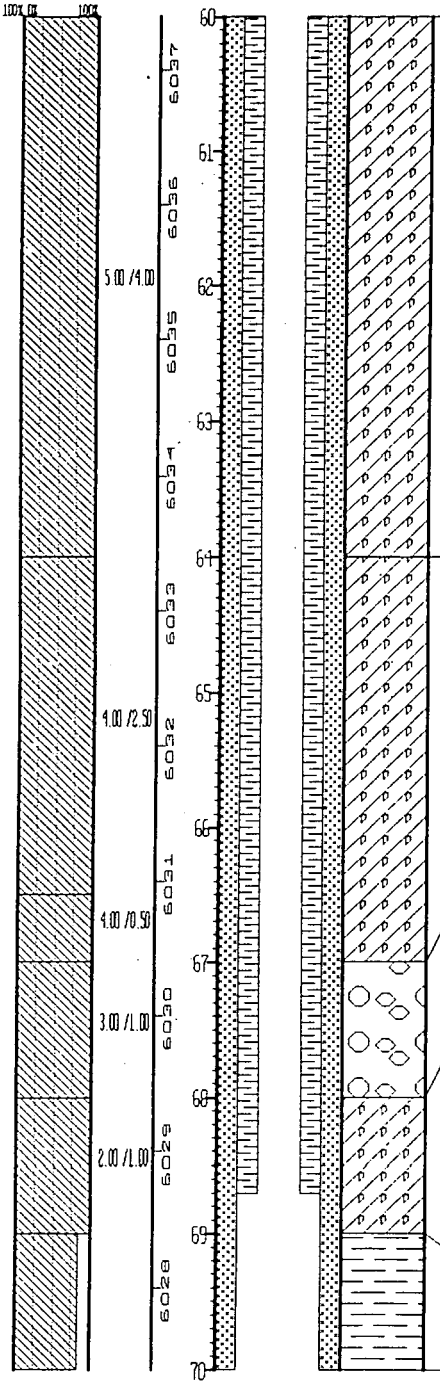
REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SLOTTED SCREEN. ALL SOPS FOLLOWED IN INSTALLATION PROCEDURES. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	BH0009SST			5.00 /6.00	6047	50			SC:	Gravelly sand with some clay and trace silt. Same as above - see description 41.0-48.0'. No recovery (53.75-54.00').
					6046	51				
					6045	52	06/00/94			
					6044	53				
					6043	54				
					6042	55			SC:	Clayey sand with some silt. Strong brown (7.5 YR 5/6). Fine to coarse sands, mainly fine. Well graded. Subangular. Quartz. No bedding. Moist. 75% sand, 18% clay, and 7% silt.
					6041	56				
	BH0009-4ST			5.75 /6.00	6040	57				
					6039	58	06/28/94		SC:	Gravelly sand with some clay and trace silt. Same as above - see description 41.0-48.0' No recovery (59.75-60.00')
					6038	59				
						60				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 72.00	GROUND ELEVATION (FT):	6097.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	748982	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51494
EAST:	2078256	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	06/22/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SLOTTED SCREEN. ALL SOPS FOLLOWED IN INSTALLATION PROCEDURES. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH | GRADATIONAL SAMPLE DEPTH | SAMPLE NUMBER | SAMPLE GRAIN SIZE (CL 50% 100%) | PERCENT RECOVERY (0% 100%) | RECOVERY/INTERVAL | DATUM (FT) | DEPTH (FT) | WELL OR PIEZOMETER CONSTRUCTION | LITHOLOGY | UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION



UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
SC:	Gravelly sand with some clay and trace silt. Same as above - see description for 41.0-48.0'. Gravel up to 4".
SC:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/6) to dark red (2.5 YR 4/6); interval includes pale olive clay (5 Y 6/3). Gravels up to 2", sands fine to coarse. Well graded. Gravels subrounded to subangular; sands dominantly subangular. Gravels dominantly quartzite; sands dominantly quartz. Wet to saturated. 50% sand, 28% gravel, 19% clay, and 3% silt.
GW	Sandy gravel with trace silt. Reddish yellow (7.5 YR 6/6). Gravels approximately 4"; sands subangular to subrounded. Mainly quartzite gravels, quartz sands. Dry. 70% gravel, 27% sand, and 3% silt.
SC:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/6) to dark red (2.5 YR 4/6). Gravels up to 2"; sands fine to coarse. Well graded. Gravels subangular to subrounded; sands dominantly subangular. Gravels dominantly quartzite, sands dominantly quartz. Moist to dry. 50% sand, 28% gravel, 19% clay, and 3% silt.
CLAYSTONE	Top of Bedrock. Claystone. Pale olive (5 Y 6/3). Fe-oxide staining. Porosity approx. 10% No cement. Friable. Moist. >90% clay.

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 72.00	GROUND ELEVATION (FT)	6097.40	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH:	749982	AREA: OU 11 W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51494
EAST:	2078256	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	06/22/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SUMP; 20' SLOTTED SCREEN. ALL SOPS FOLLOWED IN INSTALLATION PROCEDURES. CORE LOGGER D.L. RIGGR.

CHEMICAL SAMPLE DEPTH	GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/ INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
			0% 50%	100% 0% 100%	2.50 /3.00	6027 6026 6025 6024 6023 6022 6021 6020 6019 6018	70 71 72 73 74 75 76 77 78 79 80			CLAYSTONE:	Claystone. Same as above - see description 69.0-70.0'.

Total Depth Drilled: 72.00 Total Depth Casing: 70.70
Bottom of Filter Pack: 71.00

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 22.00	GROUND ELEVATION (FT)	6097.50	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH:	749972	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	D. L. RIGGS	51594
EAST:	2078255	LOCATION NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/18/94	

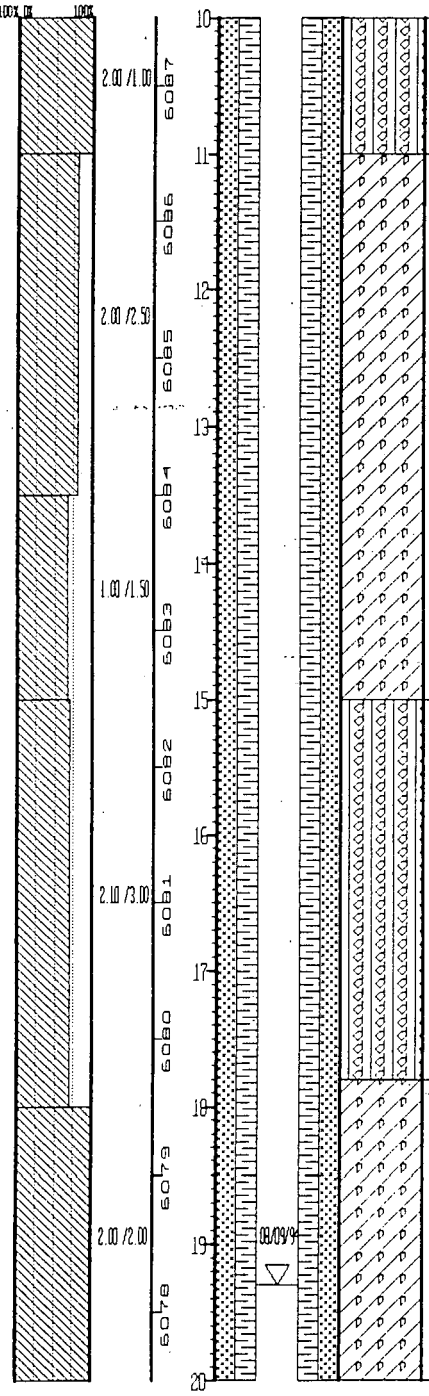
REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 10.0' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		CL SCR	100% CR 100%	2.00/2.00	6097	0			GW	Gravel with some sand and trace silt and clay. Dark brown (7.5 YR 3/3). Gravel coarse to fine (clasts to 3"); sand coarse to fine. Well graded. Gravel subrounded to angular (where broken), sand subrounded to subangular. Gravel mainly quartzite and granite; sand mainly quartz. Trace organics. Dry. 80% gravel, 16% sand, 3% silt, and 1% clay.
				2.00/2.00	6096	1			SM	Sandy gravel with some silt and trace clay. Yellowish red (5 YR 5/8) to strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts to 3"); sand coarse to fine (mainly medium). Well graded. Gravel subrounded to subangular; sand subrounded to subangular (mainly subrounded). Gravel quartzite; sand quartz plus rock fragments. Trace staining in lower 1'. Abundant rock flour from 4.0-4.5'. Dry to very slightly moist. 56% sand, 31% gravel, 9% silt, and 4% clay.
				2.00/2.00	6095	2				
				2.00/1.00	6094	3				
				3.20/3.00	6093	4				
				2.00/2.00	6092	5			SM	Silty sand with some clay and gravel. Strong brown (7.5 YR 5/8) to reddish yellow (7.5 YR 6/8). Gravel medium to fine, sand coarse to fine (mainly medium to fine). Moderately graded. Gravel subrounded to subangular; sand angular to subangular. Gravel quartzite; sand quartz, hornblende, and rock fragments. Very slightly moist. 55% sand, 30% silt, 8% clay, and 7% gravel.
					6091	6				
					6090	7			SM/SC	Gravelly sand with some silt and clay. Strong brown (7.5 YR 5/6). Gravel coarse to fine (clasts to 4", mainly medium to fine); sand coarse to fine. Well graded. Gravel subrounded to subangular; sand subangular. Gravel quartzite; sand quartz, mica, and rock fragments. Very moist to moist. 55% sand, 30% gravel, 8% silt, and 7% clay.
					6089	8				
					6088	9				
						10				

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 22.00	GROUND ELEVATION (FT): 6097.50	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 748972	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: D. L. RIGOR	51594
EAST: 2078255	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 08/18/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 10.0' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION.

CHEMICAL SAMPLE DEPTH | GRADATIONAL SAMPLE DEPTH | SAMPLE NUMBER | SAMPLE GRAIN SIZE (CL SIL SAN GR) | PERCENT RECOVERY (50% 100% CL 100%) | RECOVERY/INTERVAL | DATUM (FT) | DEPTH (FT) | WELL OR PIEZOMETER CONSTRUCTION | LITHOLOGY | UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION



SM/SC:	Gravelly sand with some silt and clay. Same as above - see description 6.0-10.0'.
SC:	Gravelly sand with some clay and silt. Reddish brown (5 YR 5/4) to strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts >4"); sand coarse to fine (mainly medium). Well graded. Gravel subrounded to subangular; sand subrounded to subangular. Gravel quartzite; sand quartz plus rock fragments. Trace staining. Rotted diorite. Moist to slightly moist. 49% sand, 32% gravel, 11% clay, and 8% silt.
SM:	Gravelly sand with some silt and trace clay. Strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts to 2", mainly medium to fine); sand coarse to fine (mainly medium to fine). Moderately graded. Gravel subrounded to subangular; sand subrounded to subangular. Gravel mainly quartzite; sand mainly quartz plus rock fragments. Very moist. 62% sand, 25% gravel, 9% silt, and 4% clay.
SC:	Gravelly sand with some clay and trace silt. Yellowish red (5 YR 5/8) to strong brown (7.5 YR 5/8). Gravel coarse to fine (clasts to 4", mainly medium to fine); sand coarse to fine. Well graded. Gravel angular to subangular; sand subangular. Gravel quartzite; sand quartz plus rock fragments. Very moist to moist. 65% sand, 21% gravel, 11% clay, and 3% silt.

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 22.00	GROUND ELEVATION (FT):	6097.50	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	748972	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	D. L. RIGGS	51594
EAST:	2078255	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/18/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 10.0' SCREEN. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION.

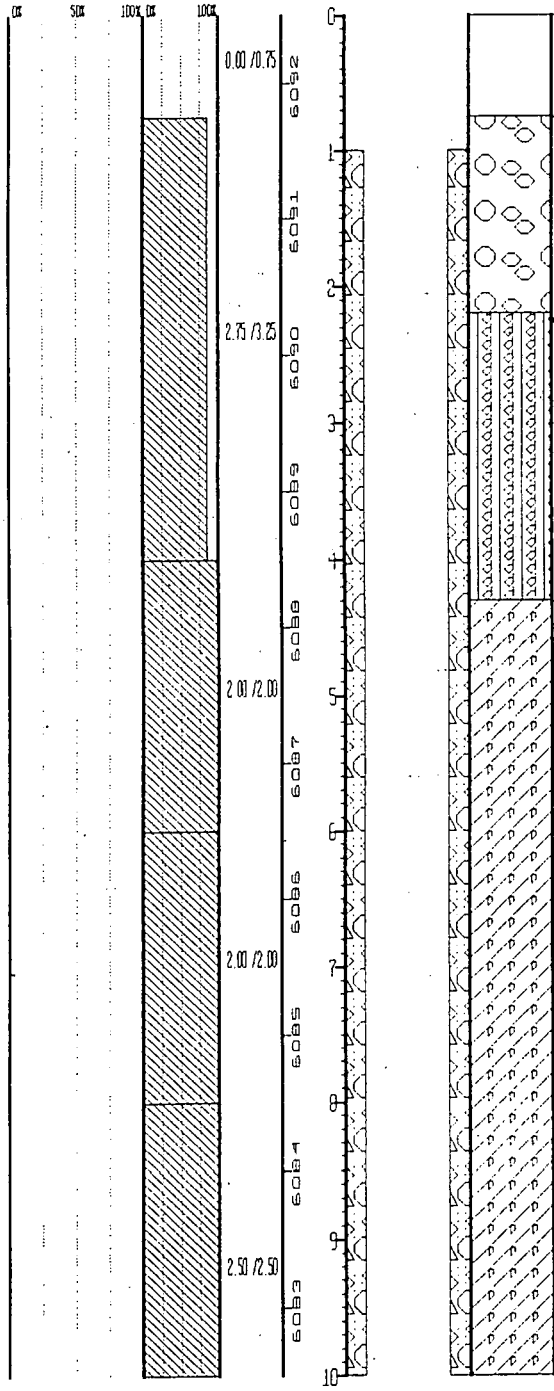
CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (CL SILT SAND)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				2.00/2.00	6077 6076 6075 6074 6073 6072 6071 6070 6069 6068	20 21 22 23 24 25 26 27 28 29 30	08/27/94		SM	Silty sand with some gravel and trace clay. Strong brown (7.5 YR 5/8). Gravel medium to fine; sand coarse to fine. Moderately graded. Gravel subrounded to subangular; sand subangular. Gravel quartzite; sand quartz, hornblende, and rock fragments. Wet to moist. 72% sand, 15% silt, 9% gravel, and 4% clay.

Total Depth Drilled: 22.00 Total Depth Casing: 22.00
Bottom of Filter Pack: 21.00

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 62.30	GROUND ELEVATION (FT):	6092.50	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER
NORTH:	749638	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51694
EAST:	2078239	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 15' SCREEN; 50' CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.

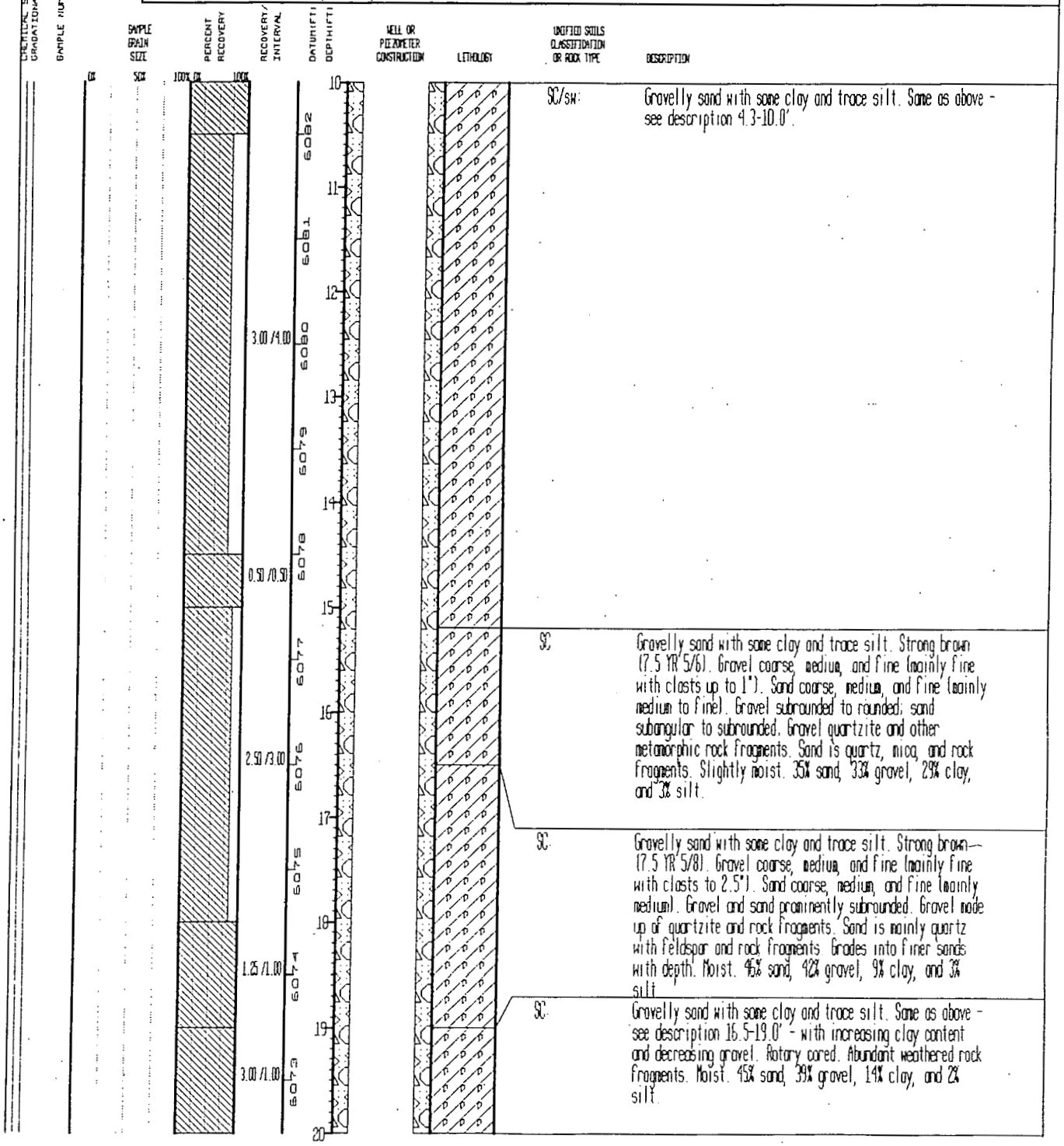
CHEMICAL SAMPLE DEPTH
GRADATIONAL SAMPLE DEPTH
SAMPLE NUMBER
SAMPLE GRAIN SIZE
PERCENT RECOVERY
RECOVERY/INTERVAL
DATUM (FT)
DEPTH (FT)
WELL OR PIEZOMETER CONSTRUCTION
LITHOLOGY
UNIFIED SOILS CLASSIFICATION OR ROCK TYPE
DESCRIPTION



NO RECOVERY:	0.0-0.75' removed using a shovel prior to drilling. No recovery (0.00-0.75').
GW:	Gravelly sand with trace silt and clay. Dark brown (7.5 YR 3/2). Well graded. Gravel subangular to subrounded; sand angular to subrounded. Gravel coarse, medium, and fine (mainly medium with clasts up to 1.5"). Sand coarse, medium, and fine (mainly coarse). Gravel is quartzite and other metamorphic rock fragments. Sand is mainly quartz with feldspar. Loose and dusty. Organics. Dry. 61% gravel, 33% sand, 4% silt, and 2% clay
SM:	Silty sand with some gravel and trace clay. Strong brown (7.5 YR 5/8 to 7.5 YR 4/6). Gravel coarse, medium, and fine (mainly medium with clasts to 3.5"). Sand coarse, medium, and fine (mainly medium). Gravel subrounded; sand subrounded to subangular. Gravel made up of quartzite, sand mainly quartz with abundant feldspar and mica. Dry. 49% sand, 28% silt, 20% gravel, and 3% clay.
SC/SW:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/6). Gravel coarse, medium, and fine (prominently fine with clasts up to 4"). Sand coarse, medium, and fine (mainly medium). Gravel subangular to subrounded; sand subangular to rounded. Gravel mainly quartzite rock fragments. Sand mainly quartz with mica, feldspar, hornblende, and metamorphic rock fragments. Lots of weathered granite blocks and weathered gneiss and schist abundant throughout section. Slightly moist. 59% sand, 30% gravel, 6% clay, and 5% silt.

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 62.30	GROUND ELEVATION (FT)	6092.50	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 749638	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51694
EAST: 2078239	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 15' SCREEN; 50' CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGGR.



STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 62.30	GROUND ELEVATION (FT): 6092.50	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH: 749638	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51694
EAST: 2078239	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 08/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 15' SCREEN; 50' CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM(FT)	DEPTH(FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
		CL SC	100% CL 100%	1.50/3.00	6072 6071	20 21 22			GC:	Sandy gravel with some clay and trace silt. Brown (7.5 YR 4/4). Gravel coarse, medium, and fine (mainly medium to fine with cobbles up to 4"). Sand coarse, medium, and fine (mainly coarse). Gravel subangular to subrounded; sand angular to subrounded. Gravel is quartzite and other metamorphic rock fragments. Sand is quartz, feldspar, and rock fragments. Very well consolidated. Moist. 46% gravel, 42% sand, 10% clay, and 2% silt.
					6070	23			SC:	Gravelly sand with some clay and trace silt. Same as above - see description 19.0-20.0'. Moist to wet.
				2.00/3.00	6069 6068 6067	24 25			SC:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/6). Gravel coarse, medium, and fine (mainly medium with cobbles up to 4"). Sand coarse, medium, and fine (mainly medium). Gravel and sand subangular to subrounded. Gravel is quartzite and metamorphic rock fragments. Sand is quartz, hornblende, and rock fragments. Abundant weathered gneiss, granite, and schist. Wet. 68% sand, 17% gravel, 14% clay, and 1% silt.
				1.00/1.00	6066	26			NO RECOVERY:	Rotary coring conducted throughout interval (usually indicative of large cobbles). No recovery (26.00-28.00').
	GH0223ST			0.00/1.00	6065	27				
				2.50/2.00	6064	28			SC:	Gravelly sand with some clay and trace silt. Reddish brown (5 YR 5/4) to yellowish red (5 YR 5/8). Gravel medium to fine (clasts up to 1"). Sand coarse, medium, and fine (mainly medium). Gravel subrounded; sand subangular. Well consolidated. Moist. 51% sand, 27% gravel, 18% clay, and 4% silt.
					6063	29 30			SC:	Gravelly sand with some clay and trace silt. See description 30.0-35.4'. No recovery (29.75-30.00')

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 62.30	GROUND ELEVATION (FT): 6092.50	PROJECT NUMBER: OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749638	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51694
EAST:	2078239	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 08/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 15' SCREEN; 50' CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY / INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	GH0028951 GH0028951 (DUP)	CL SC	100% CL 100%	3.75 /3.50 2.00 /1.50 1.20 /1.00	6062 6061 6060 6059 6058 6057	30 31 32 33 34 35			SC:	Gravelly sand with some clay and trace silt. Strong brown (7.5 YR 5/8) to brown (7.5 YR 4/4) to yellowish red (5 YR 5/8). Gravel coarse, medium, and fine (prominently fine with cobbles up to 3.5"). Sand coarse, medium, and fine (mainly medium). Gravel subrounded; sand subangular to rounded. Gravel made up of quartzite and rock fragments. Sand is quartz and rock fragments. Loose core with abundant weathered gneiss, schist, and granite. Slightly moist to very moist. 43% sand, 42% gravel, 12% clay, and 3% silt.
					6056 6055	36 37			SC	Clayey sand with trace gravel and silt. Strong brown (7.5 YR 5/8). Gravel coarse, medium, and fine (mainly fine with cobbles up to 4"). Sand coarse, medium, and fine (prominently medium). Gravel subangular; sand subrounded. Gravel mainly quartzite; sand mainly quartz. Abundant weathered feldspar, schist, and gneiss fragments present. Main component is in sand. Lenses of more clay-rich pockets from 35.9-36.2', 38.5-39.0', and 40.0-40.5'. Moist to very moist. 78% sand, 13% clay, 6% gravel, and 3% silt. No recovery (35.75-36.00').
	GH0029051			5.00 /5.00	6054 6053	38 39 40				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 62.30	GROUND ELEVATION (FT): 6092.50	PROJECT NUMBER: 0011-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749638	AREA: 0011, W. SPRAY FIELD	CASING DIAMETER (IN): 2.00	GEOLOGIST: J. A. HIGGINS	51694
EAST:	2078239	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN): 7.00	DATE DRILLED: 08/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 15' SCREEN; 50' CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. HIGGR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
						40			SC	Clayey sand with trace gravel and silt. Same as above - see description 35.4-40.0'.
				1.00/1.00	6052, 6051	41, 42			SC	Gravelly sand with some clay and silt. Reddish brown (5 YR 5/4). Gravel medium to fine (mainly fine). Sand coarse, medium, and fine (mainly medium). Gravel subangular to subrounded; sand subangular to subrounded. Gravel mainly quartzite and metamorphic rock fragments. Sand mainly quartz with feldspar, hornblende, and rock fragments. Abundant granite, schist, and gneiss (weathered) throughout section. Clean fine sand pockets throughout section. Moist to wet. 41% sand, 40% gravel, 11% clay, and 8% silt. No recovery (41.75-42.00') and (47.75-48.00').
				5.00/5.00	6050, 6049, 6048	43, 44				
	BH0291ST BH0292ST (DUP)				6047	45				
				1.00/1.00	6046, 6045	46, 47				
					6044	48				
					6043	49, 50				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 62.30	GROUND ELEVATION (FT):	6092.50	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749638	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51694
EAST:	2078239	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 15' SCREEN; 50' CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY / INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				4.50 /5.00	6042	50			SC:	Gravelly sand with some clay and silt. Same as above - see description 41.0-50.0'.
	9H0293SI				6041	51			SC	Clayey sand with some gravel and silt. Strong brown (7.5 YR 5/8) with pale olive (5 Y 6/3) mottling. Gravel fine (clasts to 2"). Sand coarse, medium, and fine (mainly fine). Gravel and sand subrounded to subangular. Gravel quartzite, sand quartz, rose quartz, feldspar, and rock fragments. Core well consolidated with weathered granite chunks. Black staining in spots and chunks of reworked bedrock. Moist. 48% sand, 25% clay, 16% gravel, and 11% silt.
					6040	52				
				1.00 /1.00	6039	53			SC:	Clayey sand with trace gravel and silt. Strong brown (7.5 YR 5/8) to yellowish brown (10 YR 5/8). Gravel coarse, medium, and fine (mainly medium with clasts to 2"). Sand coarse, medium, and fine (prominently medium). Gravel subangular to subrounded; sand subrounded. Gravel made up of quartzite; sand is mainly quartz. Abundant weathered granite. Core is chunky and brittle. Moist. 78% sand, 13% clay, 6% gravel and 3% silt. No recovery (53.75-54.00')
					6038	54				
					6037	55			SC:	Clayey sand with some gravel and trace silt. Strong brown (7.5 YR 5/8) to yellow (10 YR 7/8) to olive yellow (2.5 Y 6/8). Gravel coarse, medium, and fine with clasts to 2.5" (mainly fine). Sand coarse, medium, and fine (mainly medium). Gravel and sand subangular to subrounded. Gravel quartzite; sand mainly quartz with feldspar and rock fragments. Section is interlayered with sections of reworked bedrock with higher clay content and other sections of higher gravel content with large cobble concentrations. Moist to wet. 74% sand, 14% clay, 8% gravel, and 4% silt. 54.5-55.5' and 56.0-57.0' - reworked bedrock with black staining and pale olive (5 Y 6/3) mottling (percentages similar to 50.5-52.0'). 57.8-59.0' and 59.4-60.2' - coarser fraction core chunked up with large cobbles up to 3". No recovery (59.75-60.00').
				5.00 /5.00	6036	56				
	9H0294SI 9H0295SI (DUP)				6035	57				
					6034	58				
						59				
				2.00 /1.00	6033	60				

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 62.30	GROUND ELEVATION (FT):	6092.50	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	749638	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51694
EAST:	2078239	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/19/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 15' SCREEN; 50' CASING. ALL SOPS WERE FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
	BH0029SST			2.50/2.30	6032, 6031, 6030, 6029, 6028, 6027, 6026, 6025, 6024, 6023	60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70			SC	Clayey sand with some gravel and trace silt. Same as above - see description 54.5-60.0'. 60.2-62.0' - coarser section with large cobbles and abundant weathered granite, schist, and gneiss (coarse fraction percentages up to 47% gravel, 37% sand, 11% clay, and 5% silt). No recovery (61.75-62.00').

Total Depth Drilled: 62.30 Total Depth Casing: 62.30
Bottom of Filter Pack: 61.00

STATE PLANE COORDINATE:		TOTAL DEPTH (FT): 10.30	GROUND ELEVATION (FT)	6132.80	PROJECT NUMBER:	OU11-RFI/RI	LOG OF BORING NUMBER:
NORTH:	747910	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS	51794
EAST:	2076815	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/18/94	

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 5' SCREEN; 5' RISER. ALL SOPS FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER O.L. HIGGIN.

CHEMICAL SAMPLE DEPTH / GRADATIONAL SAMPLE DEPTH / SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
			0.00 /0.75	6132	0			NO RECOVERY	Core from 0.0-0.75' removed prior to drilling. No recovery (0.00-0.75').
			2.75 /2.25	6131	1, 2			SM/SW	Gravelly sand with some silt and trace clay. Dark brown (7.5 YR 3/3). Gravel coarse to fine (clasts to 3"); sand coarse to fine. Well graded. Gravel subangular; sand subangular. Gravel quartzite; sand quartz plus rock fragments. Organic material. Dry. 53% sand, 40% gravel, 6% silt, and 1% clay.
			1.00 /1.00	6130	3			SM/SW	Gravelly sand with some silt and trace clay. Dark red (2.5 YR 4/8) to dark brown (7.5 YR 3/3). Gravel coarse to fine (clasts to 2"); sand coarse to fine. Well graded. Gravel subrounded to subangular; sand subangular. Gravel quartzite, sand quartz plus rock fragments. Dry. 76% sand, 13% gravel, 7% silt, and 4% clay.
			2.00 /2.00	6129	4, 5			SM	Gravelly sand with some silt and trace clay. Strong brown (7.5 YR 5/8). Gravel medium to fine; sand coarse to fine. Moderately graded. Gravel subrounded; sand subangular to angular. Gravel quartzite; sand quartz plus rock fragments. Dry. 61% sand, 27% gravel, 8% silt, and 4% clay.
			1.00 /1.00	6128	6				
			1.50 /1.50	6127	7			SM	Gravelly sand with some silt and trace clay. Strong brown (7.5 YR 5/8). Gravel coarse to fine; sand coarse to fine (mainly medium to fine). Well graded. Gravel subangular, sand subangular. Gravel quartzite; sand quartz plus rock fragments. Dry. 68% sand, 19% gravel, 10% silt, and 3% clay.
			1.50 /1.50	6126	8				
				6125	9	08/23/94			
				6124	10				
				6123					

STATE PLANE COORDINATE:	TOTAL DEPTH (FT): 10.30	GROUND ELEVATION (FT):	6132.80	PROJECT NUMBER:	OU11-RFI/RI
NORTH: 747910	AREA: OU11, W. SPRAY FIELD	CASING DIAMETER (IN):	2.00	GEOLOGIST:	J. A. HIGGINS
EAST: 2076815	LOCATOR NUMBER: 0	BOREHOLE DIAMETER (IN):	7.00	DATE DRILLED:	08/18/94

LOG OF BORING NUMBER: 51794

REMARKS: DRILLED USING RESONANT SONIC DRILL RIG. WELLS CONSTRUCTED WITH 0.3' END CAP; 2.0' SEDIMENT SUMP; 5' SCREEN; 5' RISER. ALL SOPS FOLLOWED DURING DRILLING, SAMPLING, AND INSTALLATION. CORE LOGGER D.L. RIGOR.

CHEMICAL SAMPLE DEPTH	GRADATIONAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
						6122	10				Total Depth Drilled: 10.30 Total Depth Casing: 10.30 Bottom of Filter Pack: 9.00
						6121	11				
						6120	12				
						6119	13				
						6118	14				
						6117	15				
						6116	16				
						6115	17				
						6114	18				
						6113	19				
							20				

U.S. Department of Energy Rocky Flats Plant

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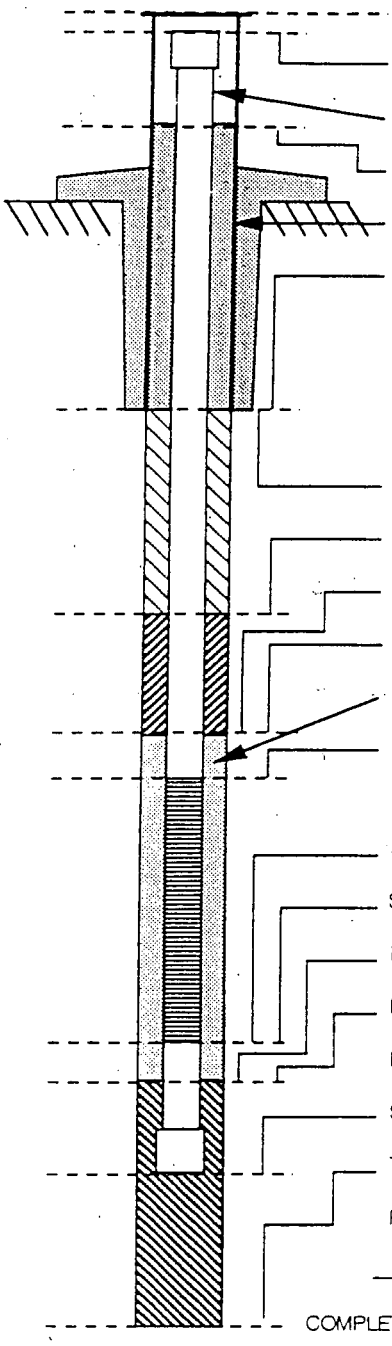
Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 50194 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 070794 DATE COMPLETED: 071494
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 105.5 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0

INITIAL WATER LEVEL (FT): 78.5 DATE MEASURED: 071394
COMPLETED WATER LEVEL (FT): 56.65 DATE MEASURED: 071594



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5

IF APPLICABLE
SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA

CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 0.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 68.1 TYPE: Volclay PureGold Pellets
BENTONITE SEAL, BOTTOM (FT): 72.8
FILTER PACK, TOP (FT): 72.8
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 74.7 SCREEN, TOP (FT): 74.7
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 94.7 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 94.7 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 97.4
BACKFILL, TOP (FT): 97.4 TYPE: Cave-in 103-103.5'; Bentonite 97.4-103'
BACKFILL, BOTTOM (FT): 105.5
SUMP, BOTTOM (FT): 97.0
TOTAL DEPTH (FT): 105.5

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2' sump; 20' screen, 80' blank.
All SOPs followed during drilling, sampling and installation.

COMPLETED BY: J. Higgins DATE: 071494
CHECKED BY: S. Lynn DATE: 071494

U.S. Department of Energy Rocky Flats Plant

Form GT.6B
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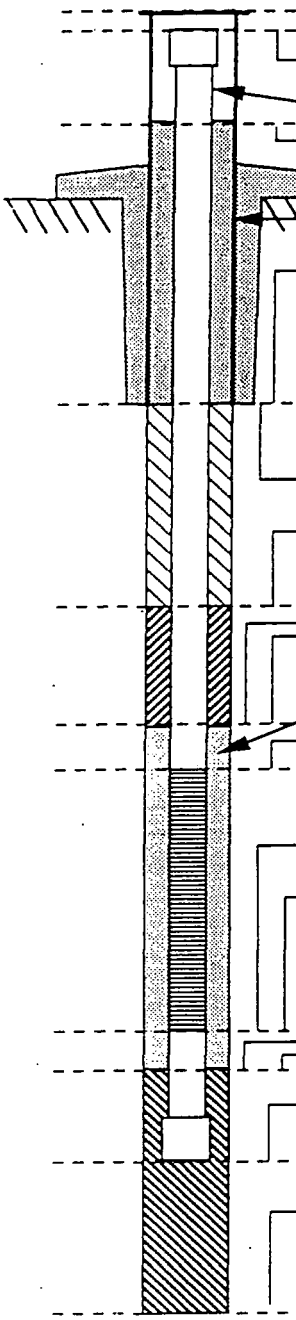
Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 50294 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 080894 DATE COMPLETED: 081094
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 18.0 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0

INITIAL WATER LEVEL (FT): 10.3 DATE MEASURED: 080994
COMPLETED WATER LEVEL (FT): NA DATE MEASURED: NA



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5

IF APPLICABLE
SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA

CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 0.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 1.0 TYPE: Volclay PureGold 1/4" Pellets
BENTONITE SEAL, BOTTOM (FT): 4.0
FILTER PACK, TOP (FT): 4.0
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 5.9 SCREEN, TOP (FT): 5.9
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 15.9 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 15.9 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 16.9
BACKFILL, TOP (FT): 16.9 TYPE: 1/4" Bentonite Pellets
BACKFILL, BOTTOM (FT): 18.2
SUMP, BOTTOM (FT): 18.2
TOTAL DEPTH (FT): 18.2

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2' sediment sump; 10' screen; 10' riser.
All SOPs followed during sampling, drilling, and installation.

COMPLETED BY: J. Higgins DATE: 081094
CHECKED BY: S. Lynn DATE: 082994

U.S. Department of Energy Rocky Flats Plant

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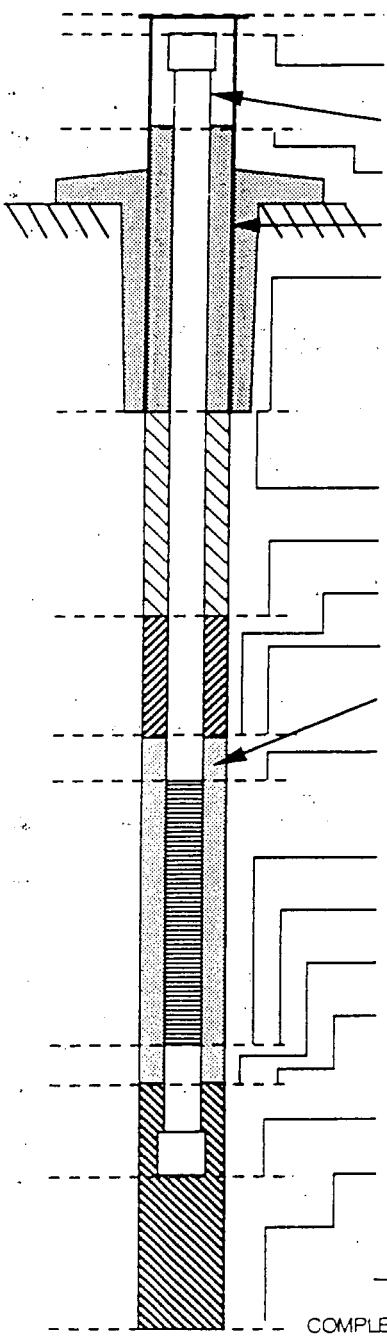
Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 50394 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 071994 DATE COMPLETED: 072794
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 66.8 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0
INITIAL WATER LEVEL (FT): Dry DATE MEASURED: 072794
COMPLETED WATER LEVEL (FT): 66.30 DATE MEASURED: 080194



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6 5/8 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5
IF APPLICABLE: SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA
CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 0.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 44.0 TYPE: Volclay PureGold Pellets
BENTONITE SEAL, BOTTOM (FT): 47.0
FILTER PACK, TOP (FT): 47.0
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 49.5 SCREEN, TOP (FT): 49.5
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 64.5 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 64.5 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 65.8
BACKFILL, TOP (FT): 65.8 TYPE: 1/4" Bentonite Pellets
BACKFILL, BOTTOM (FT): 66.8
SUMP, BOTTOM (FT): 66.8
TOTAL DEPTH (FT): 66.8

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap' 2' sump; 15' screen; 55' blank.
All materials installed in accordance with SOPs.

COMPLETED BY: J. Higgins DATE: 072794
CHECKED BY: S. Lynn DATE: 072794

U.S. Department of Energy Rocky Flats Plant

Form GT.6B
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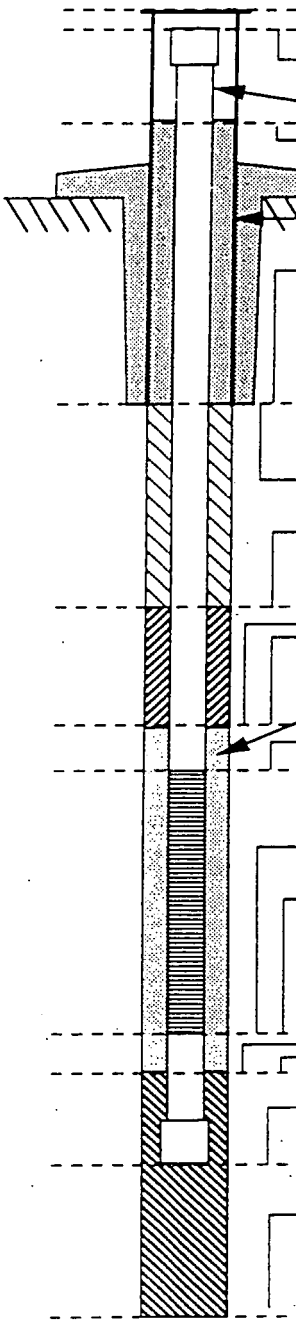
Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 50494 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 071894 DATE COMPLETED: 072794
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 24.0 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): _____

INITIAL WATER LEVEL (FT): 23.0 DATE MEASURED: 072794
COMPLETED WATER LEVEL (FT): Dry DATE MEASURED: 080394



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6 5/8" TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5

IF APPLICABLE
SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA

CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 0.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 6.6 TYPE: Volclay PureGold Pellets
BENTONITE SEAL, BOTTOM (FT): 9.7
FILTER PACK, TOP (FT): 9.7
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 11.7 SCREEN, TOP (FT): 11.7
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 21.7 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 21.7 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 23.0
BACKFILL, TOP (FT): 23.0 TYPE: 1/4" Bentonite Pellets
BACKFILL, BOTTOM (FT): 24.0
SUMP, BOTTOM (FT): 24.0
TOTAL DEPTH (FT): 24.0

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2' sediment sump; 10' screen; 20' blank.
All SOPs followed during drilling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 072794
CHECKED BY: S. Lynn DATE: 072794

U.S. Department of Energy Rocky Flats Plant

Form GT.6B (Rev.3) ORR 3/31/94

Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 50694 PROJECT NAME: OU 11 WSF PROGRAM: RCRA

SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.

DRILLING METHOD: Resonant Sonic DATE DRILLED: 072894 DATE COMPLETED: 080594

RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor

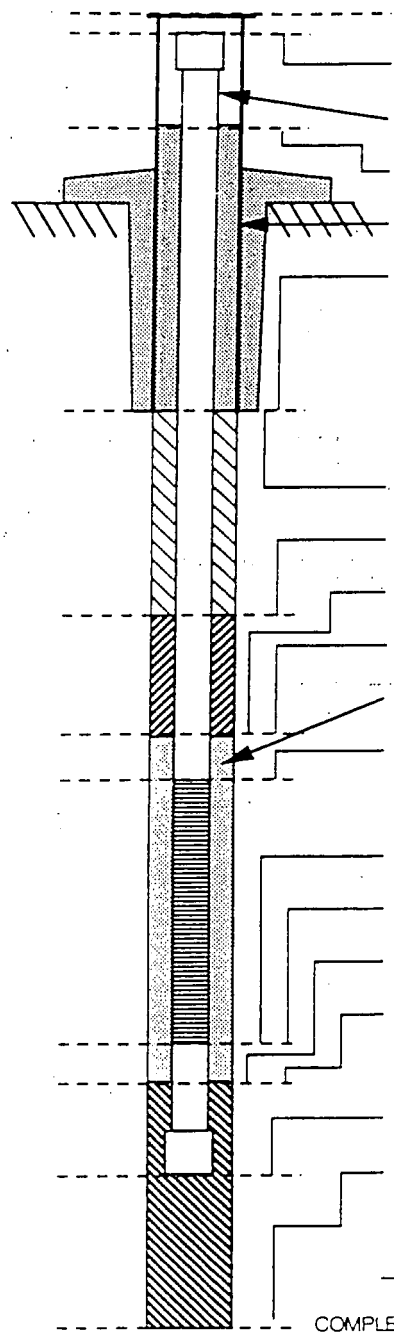
COMPLETED DEPTH (FT): 30.0 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered

BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0

INITIAL WATER LEVEL (FT): 22.7 DATE MEASURED: 080594

COMPLETED WATER LEVEL (FT): NA DATE MEASURED: NA



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)

SURFACE CASING (STICKUP), TOP (FT): 2.0

SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC

SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement

PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel

PROTECTIVE CASING, BOTTOM (FT): 2.5

IF APPLICABLE SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA

SECONDARY CASING, I.D. (IN): NA TYPE: NA

CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA

GROUT SEAL, TOP (FT): 0.0 TYPE: PureGold Bentonite-Cement

BENTONITE SEAL, TOP (FT): 5.8 TYPE: Volclay PureGold Pellets

BENTONITE SEAL, BOTTOM (FT): 8.8

FILTER PACK, TOP (FT): 8.8

FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media

SURFACE CASING, BOTTOM (FT): 11.8 SCREEN, TOP (FT): 11.8

SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0

SCREEN, BOTTOM (FT): 26.8 TYPE: Sch 40 PVC BRAND: Titan

SUMP, TOP (FT): 26.8 TYPE: Sch 40 PVC

FILTER PACK, BOTTOM (FT): 28.0

BACKFILL, TOP (FT): 28.0 TYPE: Cave-in 29.1-30'; Bentonite Pellets 28-29.1'

BACKFILL, BOTTOM (FT): 30.0

SUMP, BOTTOM (FT): 29.1

TOTAL DEPTH (FT): 30.0

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2' sediment sump; 15' screen' 15' riser.

All SOPs followed during drilling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 080594

CHECKED BY: S. Lynn DATE: 082994

U.S. Department of Energy Rocky Flats Plant

Form GT.6B
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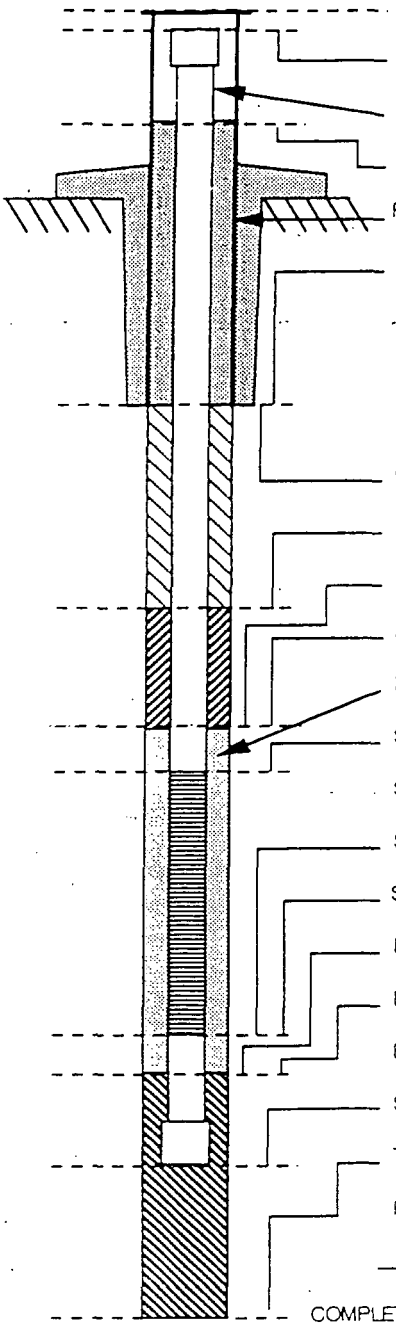
Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 50794 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 072194 DATE COMPLETED: 072294
RIG GEOLOGIST: S. Lynn LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 25.0 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0

INITIAL WATER LEVEL (FT): 16.8 DATE MEASURED: 072294
COMPLETED WATER LEVEL (FT): 23.8 DATE MEASURED: 072294



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5

IF APPLICABLE
SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA

CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 1.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 8.0 TYPE: Volclay PureGold Pellets
BENTONITE SEAL, BOTTOM (FT): 11.0
FILTER PACK, TOP (FT): 11.0
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 13.0 SCREEN, TOP (FT): 13.0
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 23.0 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 23.0 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 24.5
BACKFILL, TOP (FT): 24.5 TYPE: 1/4" Bentonite Pellets
BACKFILL, BOTTOM (FT): 25.0
SUMP, BOTTOM (FT): 25.0
TOTAL DEPTH (FT): 25.0

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap. 2' sediment sump. 10' screen, 15' riser.
All SOPs followed during drilling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 072294
CHECKED BY: S. Lynn DATE: 082994

U.S. Department of Energy Rocky Flats Plant

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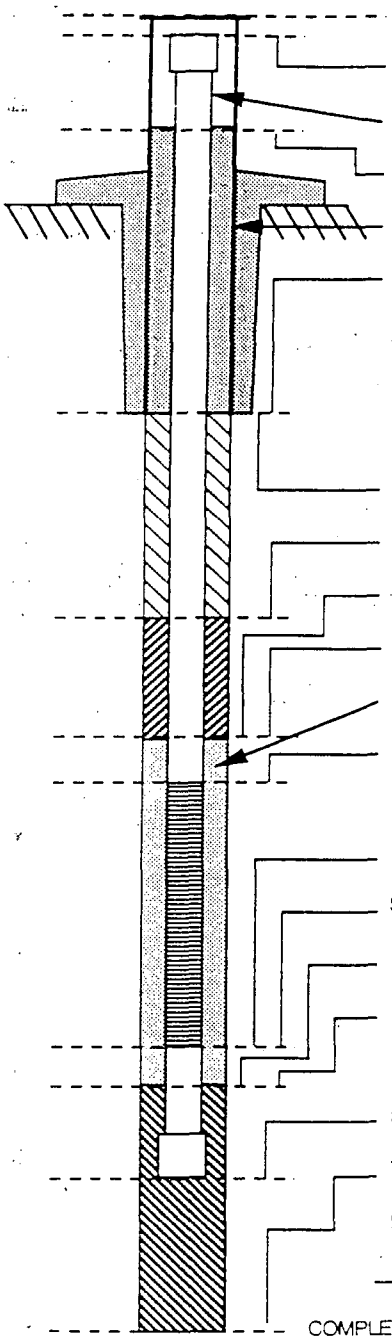
Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 50894 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 072994 DATE COMPLETED: 080194
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 30.0 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0

INITIAL WATER LEVEL (FT): 15.45 DATE MEASURED: 080194
COMPLETED WATER LEVEL (FT): 26.70 DATE MEASURED: 080394



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5
IF APPLICABLE SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA
CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 0.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 4.2 TYPE: Volclay PureGold 1/4" Pellets
BENTONITE SEAL, BOTTOM (FT): 7.2
FILTER PACK, TOP (FT): 7.2
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 10.0 SCREEN, TOP (FT): 10.0
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 25.0 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 25.0 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 26.0
BACKFILL, TOP (FT): 26.0 TYPE: Cave-in and 1/4" Bentonite Pellets
BACKFILL, BOTTOM (FT): 30.0
SUMP, BOTTOM (FT): 27.3
TOTAL DEPTH (FT): 30.0

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2.0' sediment sump; 15' screen; 15' riser.
All SOPs followed during driling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 080194
CHECKED BY: S. Lynn DATE: 080194

U.S. Department of Energy Rocky Flats Plant

Form GT.6B
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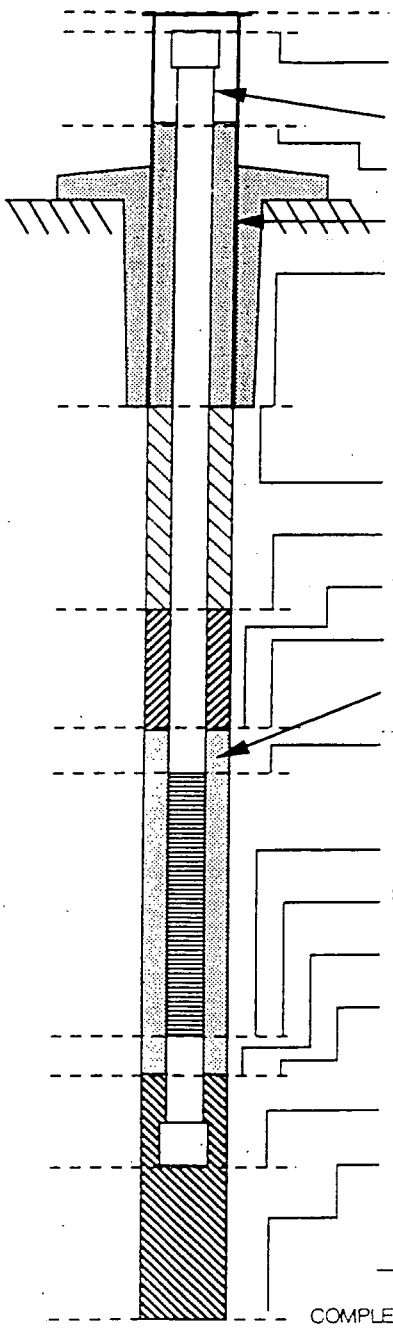
Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 50994 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 071994 DATE COMPLETED: 072094
RIG GEOLOGIST: D. Rigor, S. Lynn LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 24.0 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0
INITIAL WATER LEVEL (FT): 22.8 DATE MEASURED: 072094
COMPLETED WATER LEVEL (FT): 14.87 DATE MEASURED: 080394



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5
IF APPLICABLE SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA
CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 1.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 7.0 TYPE: Volclay PureGold Pellets
BENTONITE SEAL, BOTTOM (FT): 10.0
FILTER PACK, TOP (FT): 10.0
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 13.0 SCREEN, TOP (FT): 13.0
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 23.0 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 23.0 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 24.0
BACKFILL, TOP (FT): None TYPE: None
BACKFILL, BOTTOM (FT): None
SUMP, BOTTOM (FT): 24.0
TOTAL DEPTH (FT): 24.0

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' push cap; 1' sump; 10' screen. All SOPs followed during drilling, sampling, and installation.

COMPLETED BY: D. Rigor DATE: 072094
CHECKED BY: S. Lynn DATE: 082994

U.S. Department of Energy Rocky Flats Plant

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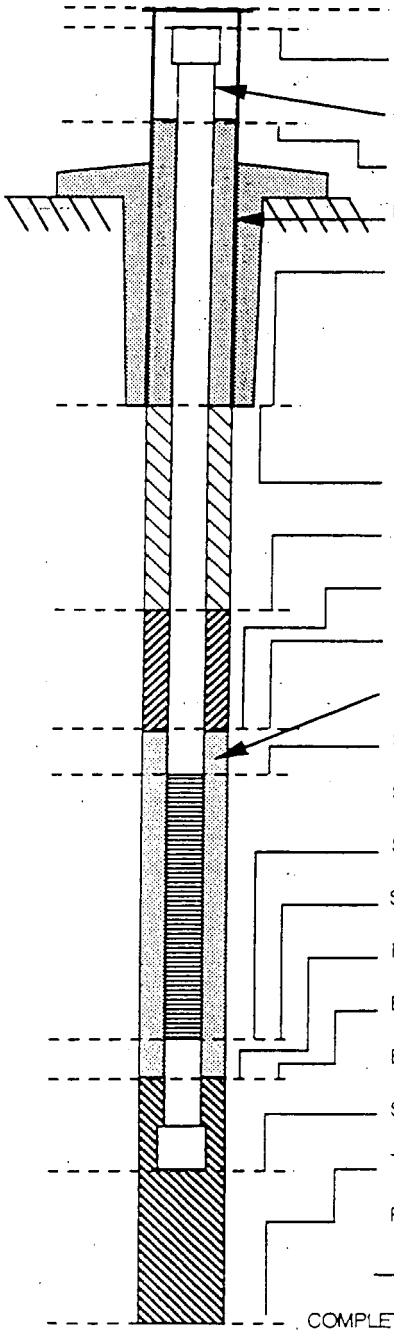
Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 51094 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 070194 DATE COMPLETED: 070794
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 60.0 ESTIMATED DEPTH TO BEDROCK (FT): 58.0
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0

INITIAL WATER LEVEL (FT): 37.5 DATE MEASURED: 070794
COMPLETED WATER LEVEL (FT): 42.36 DATE MEASURED: 071194



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5

IF APPLICABLE
SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA

CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 1.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 32.0 TYPE: Volclay PureGold Pellets
BENTONITE SEAL, BOTTOM (FT): 35.5
FILTER PACK, TOP (FT): 35.5
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 37.7 SCREEN, TOP (FT): 37.7
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 57.7 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 57.7 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 60.0
BACKFILL, TOP (FT): None TYPE: None
BACKFILL, BOTTOM (FT): None
SUMP, BOTTOM (FT): 60.0
TOTAL DEPTH (FT): 60.0

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2' sediment sump; 20' screen; 40' blank.
All SOPs followed during drilling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 070794
CHECKED BY: S. Lynn DATE: 082994

U.S. Department of Energy Rocky Flats Plant

Form GT.6B (Rev.3) ORR 3/31/94

Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 51194 PROJECT NAME: OU 11 WSF PROGRAM: RCRA

SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.

DRILLING METHOD: Resonant Sonic DATE DRILLED: 081094 DATE COMPLETED: 081794

RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor

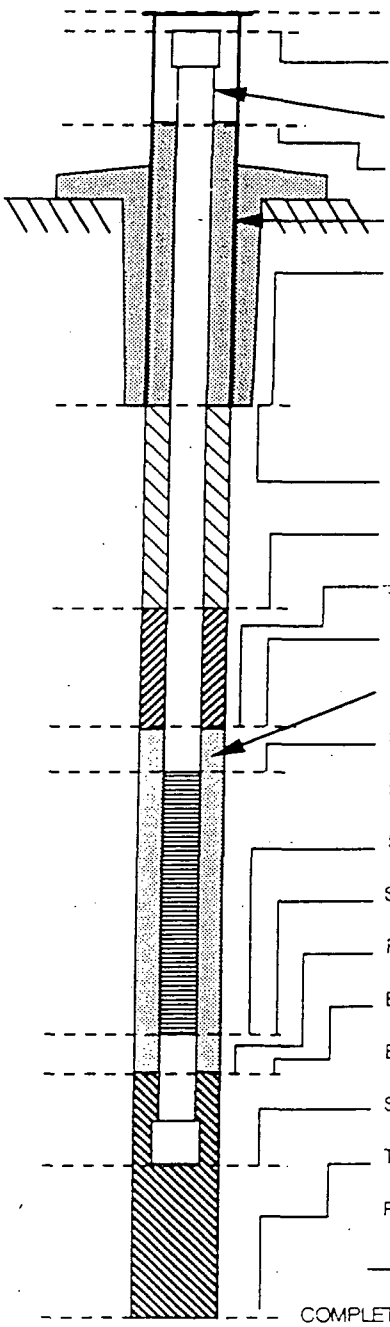
COMPLETED DEPTH (FT): 52.3 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered

BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0

INITIAL WATER LEVEL (FT): 51.0 DATE MEASURED: 081794

COMPLETED WATER LEVEL (FT): 53.05 DATE MEASURED: 083194



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)

SURFACE CASING (STICKUP), TOP (FT): 2.0

SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC

SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement

PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel

PROTECTIVE CASING, BOTTOM (FT): 2.5

IF APPLICABLE

SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA

SECONDARY CASING, I.D. (IN): NA TYPE: NA

CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA

GROUT SEAL, TOP (FT): 0.0 TYPE: PureGold Bentonite-Cement

BENTONITE SEAL, TOP (FT): 30.0 TYPE: Volclay PureGold 1/4" Pellets

BENTONITE SEAL, BOTTOM (FT): 32.85

FILTER PACK, TOP (FT): 32.85

FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media

SURFACE CASING, BOTTOM (FT): 35.0 SCREEN, TOP (FT): 35.0

SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0

SCREEN, BOTTOM (FT): 50.0 TYPE: Sch 40 PVC BRAND: Titan

SUMP, TOP (FT): 50.0 TYPE: Sch 40 PVC

FILTER PACK, BOTTOM (FT): 51.0

BACKFILL, TOP (FT): 51.0 TYPE: 1/4" Bentonite Pelelts

BACKFILL, BOTTOM (FT): 52.3

SUMP, BOTTOM (FT): 52.3

TOTAL DEPTH (FT): 52.3

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2' sediment sump; 15' screen, 40' blank. All SOPs followed during drilling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 081794

CHECKED BY: S. Lynn DATE: 082994

U.S. Department of Energy Rocky Flats Plant

Form GT.6B
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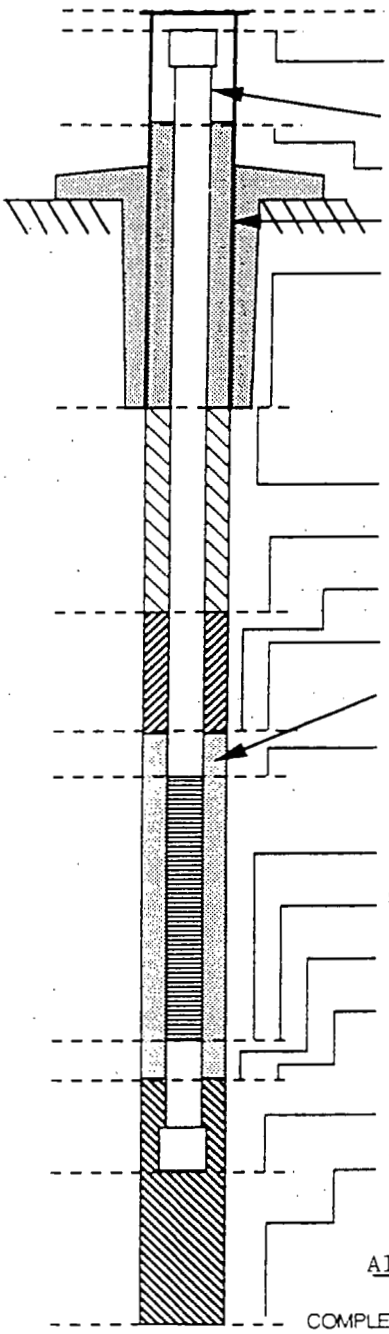
Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 51294 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 081194 DATE COMPLETED: 081794
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 37.7 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0

INITIAL WATER LEVEL (FT): 24.0 DATE MEASURED: 081794
COMPLETED WATER LEVEL (FT): 23.31 DATE MEASURED: 081894



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5

IF APPLICABLE
SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA

CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 0.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 13.7 TYPE: Volclay PureGold 1/4" Pellets
BENTONITE SEAL, BOTTOM (FT): 17.0
FILTER PACK, TOP (FT): 17.0
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 20.0 SCREEN, TOP (FT): 20.0
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 35.0 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 35.0 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 36.0
BACKFILL, TOP (FT): 36.0 TYPE: 1/4" Bentonite Pellets
BACKFILL, BOTTOM (FT): 37.7
SUMP, BOTTOM (FT): 37.3
TOTAL DEPTH (FT): 37.7

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2' sediment sump; 15' screen; 25' riser.
All SOPs followed during drilling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 081794
CHECKED BY: S. Lynn DATE: 082994

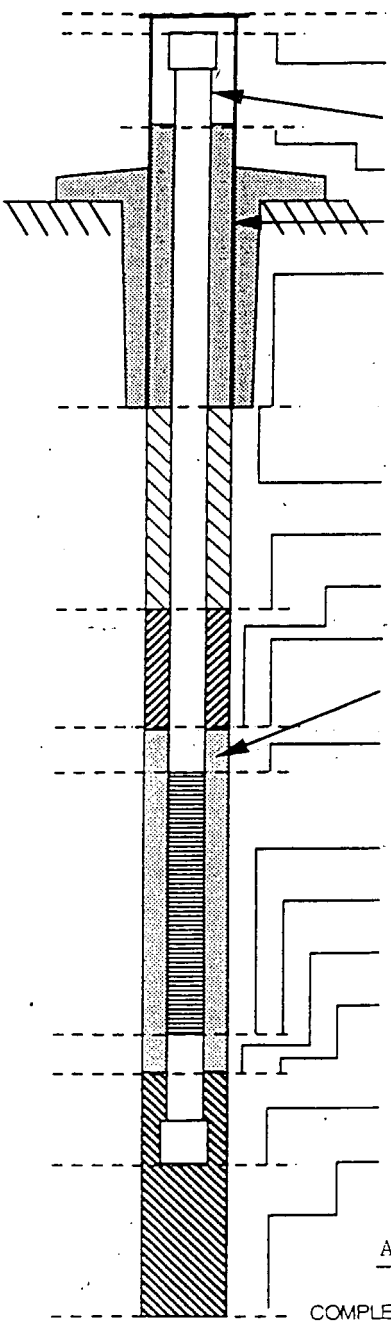
U.S. Department of Energy Rocky Flats Plant

Form GT.6B
(Rev. 3) ORR 3/31/94

Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 51494 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 062294 DATE COMPLETED: 063094
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 72.0 ESTIMATED DEPTH TO BEDROCK (FT): 69.0
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): _____
INITIAL WATER LEVEL (FT): 58.8 DATE MEASURED: 062894
COMPLETED WATER LEVEL (FT): 52.65 DATE MEASURED: 063094



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5
IF APPLICABLE SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA
CENTRALIZER, O.D. (IN): 7.0 TOP (FT): 43.2 BOTTOM (FT): 43.7
GROUT SEAL, TOP (FT): 1.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 42.9 TYPE: Volclay PureGold Pellets
BENTONITE SEAL, BOTTOM (FT): 46.5
FILTER PACK, TOP (FT): 46.5
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 48.7 SCREEN, TOP (FT): 48.7
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 68.7 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 68.7 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 71.0
BACKFILL, TOP (FT): 71.0 TYPE: Bentonite Pellets
BACKFILL, BOTTOM (FT): 72.0
SUMP, BOTTOM (FT): 70.7
TOTAL DEPTH (FT): 72.0

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2' sediment sump' 20' screen; 50' blank casing
All SOPs followed during drilling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 062294
CHECKED BY: S. Lynn DATE: 062494

U.S. Department of Energy Rocky Flats Plant

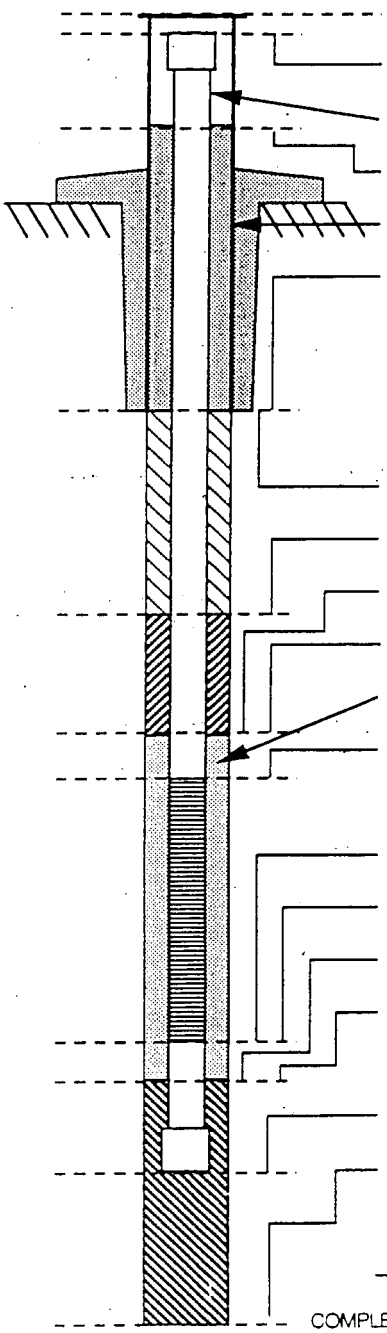
Form GT.6B
(Rev.3) ORR 3/31/94

Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 51594 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 081894 DATE COMPLETED: 081994
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 22.0 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0

INITIAL WATER LEVEL (FT): 23.13 DATE MEASURED: 082394
COMPLETED WATER LEVEL (FT): 22.05 DATE MEASURED: 082494



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5

IF APPLICABLE
SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA

CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 5.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 5.0 TYPE: Volclay PureGold 1/4" Pellets
BENTONITE SEAL, BOTTOM (FT): 8.1
FILTER PACK, TOP (FT): 8.1
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 10.0 SCREEN, TOP (FT): 10.0
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 20.0 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 20.0 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 21.0
BACKFILL, TOP (FT): 21.0 TYPE: 1/4" Bentonite Pellets
BACKFILL, BOTTOM (FT): 22.0
SUMP, BOTTOM (FT): 22.0
TOTAL DEPTH (FT): 22.0

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2.0' sediment sump; 10' screen; 10' riser.
All SOPs followed during drilling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 082394
CHECKED BY: S. Lynn DATE: 082994

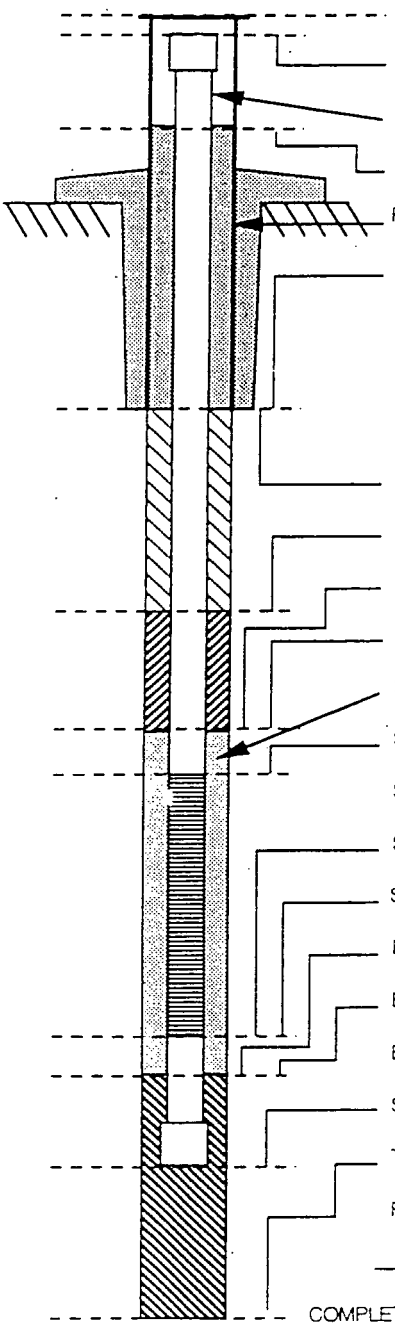
U.S. Department of Energy Rocky Flats Plant

Form GT.6B
(Rev. 3) ORR 3/31/94

Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 51694 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 081994 DATE COMPLETED: 082394
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 62.3 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0
INITIAL WATER LEVEL (FT): Dry DATE MEASURED: 082394
COMPLETED WATER LEVEL (FT): Dry DATE MEASURED: 082494



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 40 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 2.5
IF APPLICABLE SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA
CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): 0.0 TYPE: PureGold Bentonite-Cement
BENTONITE SEAL, TOP (FT): 39.2 TYPE: Volclay PureGold 1/4" Pellets
BENTONITE SEAL, BOTTOM (FT): 42.5
FILTER PACK, TOP (FT): 42.5
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 45.0 SCREEN, TOP (FT): 45.0
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 60.0 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 60.0 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 61.0
BACKFILL, TOP (FT): 61.0 TYPE: 1/4" Bentonite Pellets
BACKFILL, BOTTOM (FT): 62.3
SUMP, BOTTOM (FT): 62.3
TOTAL DEPTH (FT): 62.3

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2.0'sediment sump; 15' screen; 50' casing.
All SOPs were followed during drilling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 082394
CHECKED BY: S. Lynn DATE: 092994

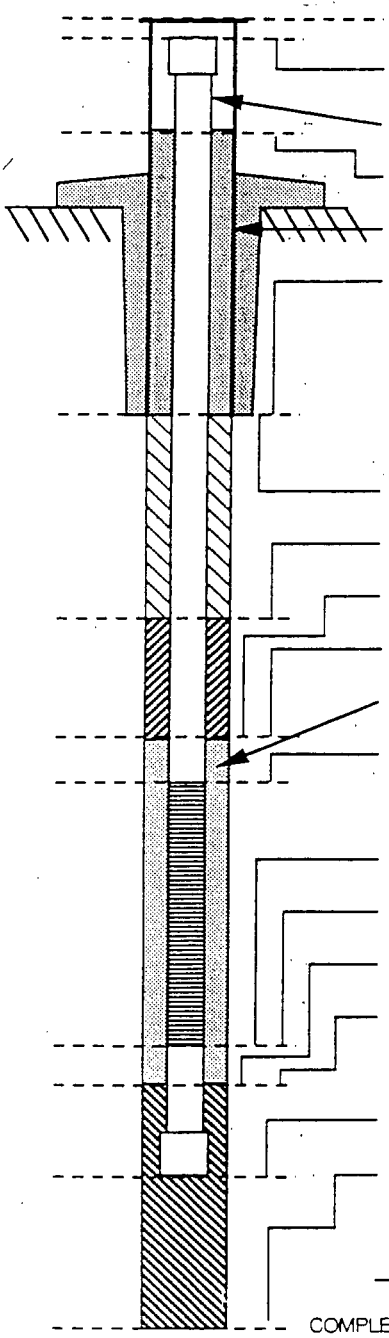
U.S. Department of Energy Rocky Flats Plant

Form GT.6B
(Rev.3) ORR 3/31/94

Groundwater Monitoring Well and Piezometer Report

LOCATION CODE: 51794 PROJECT NAME: OU 11 WSF PROGRAM: RCRA
SCREENED FORMATION: Alluvium DRILLING CONTRACTOR: Water Development Corp.
DRILLING METHOD: Resonant Sonic DATE DRILLED: 081894 DATE COMPLETED: 082394
RIG GEOLOGIST: J. Higgins LOGGING GEOLOGIST: D. Rigor
COMPLETED DEPTH (FT): 10.3 ESTIMATED DEPTH TO BEDROCK (FT): Not Encountered
BOREHOLE DIAMETER IN SCREENED INTERVAL (IN): 7.0

QUANTITY OF FLUIDS LOST DURING DRILLING (GAL): 0
INITIAL WATER LEVEL (FT): 9.9 DATE MEASURED: 082394
COMPLETED WATER LEVEL (FT): Dry DATE MEASURED: 082694



PROTECTIVE CASING, TOP (FT): 2.5 (FROM GROUND SURFACE)
SURFACE CASING (STICKUP), TOP (FT): 2.0
SURFACE CASING, I.D. (IN): 2.0 TYPE: Sch 20 PVC
SURFACE SEAL, TOP (FT): 1.0 TYPE: non-shrink cement
PROTECTIVE CASING, I.D. (IN): 6.0 TYPE: Mild Steel
PROTECTIVE CASING, BOTTOM (FT): 1.5
IF APPLICABLE SECONDARY CASING, TOP (FT): NA BOTTOM (FT): NA
SECONDARY CASING, I.D. (IN): NA TYPE: NA
CENTRALIZER, O.D. (IN): NA TOP (FT): NA BOTTOM (FT): NA
GROUT SEAL, TOP (FT): NA TYPE: NA
BENTONITE SEAL, TOP (FT): 0.0 TYPE: Volclay PureGold 1/4" Pellets
BENTONITE SEAL, BOTTOM (FT): 2.5
FILTER PACK, TOP (FT): 2.5
FILTER PACK TYPE: 16-40 Silica Sand BRAND: Colorado Environmental Media
SURFACE CASING, BOTTOM (FT): 3.0 SCREEN, TOP (FT): 3.0
SCREEN SLOT SIZE (.000 IN): 0.010 SCREEN, I.D. (IN): 2.0
SCREEN, BOTTOM (FT): 8.0 TYPE: Sch 40 PVC BRAND: Titan
SUMP, TOP (FT): 8.0 TYPE: Sch 40 PVC
FILTER PACK, BOTTOM (FT): 9.0
BACKFILL, TOP (FT): 9.0 TYPE: 1/4" Bentonite Pellets
BACKFILL, BOTTOM (FT): 10.3
SUMP, BOTTOM (FT): 10.3
TOTAL DEPTH (FT): 10.3

ALL MEASUREMENTS WILL BE MADE FROM GROUND SURFACE.

REMARKS: 0.3' end cap; 2.0' sediment sump; 5' screen; 5' riser.
All SOPs followed during drilling, sampling, and installation.

COMPLETED BY: J. Higgins DATE: 082394
CHECKED BY: S. Lynn DATE: 093094

Acronyms and Abbreviations

CLP	Contract Laboratory Program
CRDL	contract-required detection limit
EPA	U.S. Environmental Protection Agency
FSP TM	Technical Memorandum—Revised Field Sampling Plan and Data Quality Objectives
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
IDL	instrument detection limit
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
OU	operable unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCE	tetrachloroethene
pCi/g	picocuries per gram
pCi/L	picocuries per liter
%R	percent recovery
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFEDS	Rocky Flats Environmental Database System
RFI/RI	RCRA Facility Investigation/Remedial Investigation

RPD	relative percent difference
SOP	standard operating procedure
SVOC	semivolatile organic compound
TCL	target compound list
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
VOA	volatile organic analysis
VOC	volatile organic compound

OU 11 Data Quality

Quality of the Operable Unit (OU) 11 data was assessed in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. This appendix describes each PARCC parameter, summarizes the quality control (QC) data available to assess the parameter, presents the results of the data-quality evaluation for each analyte group for each media sampled, and evaluates the overall quality of the environmental data over the sampling period.

Precision

Precision is a quantitative measure of variability that is evaluated by comparing analytical results for real samples to analytical results for corresponding duplicate samples. Evaluating precision among duplicate samples provides information not only on reproducibility of sampling methods but also on reproducibility of analytical methods.

Quantitative estimates of precision are made by calculating the relative percent difference (RPD) as defined by the following equation:

$$RPD = (R - D) / ([R + D]/2) \times 100$$

where:

R = concentration of analyte in real sample
D = concentration of analyte in duplicate sample

Data that were rejected during data validation were eliminated from the data set prior to any data-quality assessment calculations. Data that were qualified as usable (V, A, or J) or that did not have a data validation code were used in the precision calculations. Data that were qualified with a U, indicating nondetections, were also used in the precision calculations. When both real and duplicate results for a sample pair were nondetections, the RPD was calculated to be zero percent. Although poor reproducibility is inherent in results at levels near the detection limits, a nondetection in both the real and duplicate sample is considered an identical result. All radionuclide results are considered detections, and thus, even though the result may be qualified with a U, RPDs were calculated using the result. For those sample pairs where a detectable result is reported for one sample and a nondetection (U qualifier) is reported for the other sample, RPDs were calculated by substituting the detection limits for the nondetection. In these cases, the true precision of the analysis cannot be calculated because the value reported for a nondetection is inherently imprecise. Therefore, the

RPD values calculated for these sample pairs are only relative estimates of the precision.

QC criteria for RPDs are specified in the Quality Assurance Project Plan (QAPjP) (EG&G, 1990), the General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G, 1991a), and the OU 11 Technical Memorandum—Revised Field Sampling Plan and Data Quality Objectives (FSP TM) (EG&G, 1994). Acceptable RPDs are less than 20 percent for analytes in water (ground water) and less than 35 percent for analytes in soil (surficial soils and subsurface geologic materials).

Where data are sufficient, summary statistics for RPDs were calculated by analyte group for each media sampled. The statistics include the number of duplicates for which the RPD could be calculated, the number of duplicates for which RPDs exceed the QC criterion (that is, 20 or 35 percent), the arithmetic average, the standard deviation, and the coefficient of variation. These summaries are presented in Tables C-1, C-2, C-3, and C-4. In addition, overall precision compliance is calculated per analyte using the number of RPDs below 35 percent. In accordance with the OU 11 FSP TM and Administrative Procedure ADM-08.02, Evaluation of ERM Data for Usability in Final Reports (EG&G, 1991b), at least 85 percent of all QC samples are required to comply with established precision goals. In most cases, the number of duplicates exceeding the QC criterion, the average RPD calculated, and the overall precision compliance is indicative of the overall precision of the data. However, when the number of samples is small or when the coefficient of variation exceeds 100 percent of the average, the average may not be a good measure of the central tendency of the data, and it is important to examine the other parameters as well.

For some analytes (i.e., radionuclides), RPD values calculated for individual sample pairs commonly exceed the acceptable limits for precision. For analytes that do not meet precision goals in more than 50 percent of the sample pairs, or where the average RPD exceeds the acceptable RPD value, all of the results reported for that analyte are qualified as estimated results. Similarly, if analytes do not meet the overall precision compliance goal of 85 percent, all results reported for that analyte are qualified as estimated results. The assessment of precision by analyte group for the media sampled are discussed below. The RPD values and final qualifications of results are tabulated in Tables C-1 and C-2.

Surficial-Soils Assessment

Five duplicate surficial-soil samples were collected during the OU 11 Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI). Precision of surficial-soil sample analytical results for metals, radionuclides,

cyanide, and major ions was assessed. Table C-1 presents the RPDs for all real and duplicate sample pairs.

Metals

Approximately 24 percent of the metal results from surficial-soil duplicate sample pairs were reported as U-qualified by the laboratory. Approximately 31 percent of the results were reported by the laboratory with a B, E, or N qualifier, indicating estimated results. All results for cesium, mercury, and silver were reported as nondetections (RPD is zero percent). Metals for which the majority of the results were reported as nondetections include antimony, molybdenum, selenium, thallium, and tin. Of these, approximately 36 percent have a result for one sample of the pair and a nondetection for the other sample. The remaining metals, including aluminum, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, nickel, potassium, sodium, strontium, vanadium, and zinc, have fewer than one-half of the results reported as nondetections.

RPDs calculated for metals in surficial soils are presented in Table C-1. Based on the number of sample pairs exceeding the QC criterion for precision and the average RPD, overall precision for metals is very good. Approximately 91 percent of RPDs calculated for metals met the QC criterion of 35 percent. Metal results generally meet the overall compliance goal of 85 percent with the exception of antimony, copper, molybdenum, nickel, selenium, thallium, and tin. The majority of RPDs exceeding 35 percent for these metals were calculated using a detection and a nondetection. As stated previously, true precision cannot be calculated in this case because the value reported for a nondetection is inherently imprecise.

For those metals with fewer than one-half of the results reported as nondetections (aluminum, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, iron, lead, lithium, magnesium, manganese, potassium, sodium, strontium, vanadium, and zinc), all RPDs calculated are less than 35 percent. Based on the precision analysis, results for all metals, with the exception of antimony, copper, molybdenum, nickel, selenium, thallium, and tin, met the QC requirement for precision (see Table C-1). Because the average RPDs for these metals exceeded 35 percent or the overall precision compliance is less than 85 percent, results have been qualified as estimated results. It should be noted that it is difficult to reproduce metal concentrations between duplicate soil samples because of the heterogeneous nature of the matrix. Resultant RPDs may reflect poor sampling precision due to the soil matrix, rather than poor laboratory precision.

Radionuclides

All reported results for radionuclides are considered detectable even though 20 percent of the radionuclide results for surficial-soil duplicate sample pairs were reported by the laboratory as nondetections. Approximately 26 percent of the radionuclide results were reported by the laboratory with a B, J, or an X qualifier, indicating estimated or calculated concentrations. RPDs calculated for radionuclides in surficial soils are presented in Table C-1. RPDs were calculated for every pair of duplicate results even though many were reported as not detectable (U qualifier). Overall precision is poor for the majority of radionuclides. Approximately 8 percent of RPDs calculated for radionuclides met the QC criterion of 35 percent. None of the radionuclides meet the overall precision compliance goal of 85 percent. All RPDs calculated for plutonium-239,240, uranium-233,234, and uranium-238 exceeded 35 percent. The majority of RPDs for individual surficial-soil sample pairs exceeded 35 percent for americium-241 and uranium-235. Reproducibility of radionuclide concentrations among field duplicates can be difficult to achieve due to analytical limitations. Many of the concentrations detected in surficial soils were at levels near the minimum detectable activity.

Results for radionuclides (americium-241, plutonium-239,240, uranium-233,234, uranium-235, and uranium-238) have been qualified as estimated values based on the results of the precision analysis (see Table C-1).

Cyanide and Nitrate/Nitrite

Duplicate sample pairs of surficial soils were analyzed for cyanide and nitrate/nitrite. All cyanide results were reported with a U qualifier indicating estimated results (RPD is zero percent). Table C-1 presents RPDs calculated for cyanide and nitrate/nitrite. Approximately 80 percent of RPDs were below the QC criterion of 35 percent, including all of the cyanide results. Based on the results of the precision analysis, results for cyanide met the QC requirement for precision. Nitrate/nitrite RPDs did not meet the overall precision compliance goal of 85 percent. The results for nitrate/nitrite are considered estimated results.

Subsurface Geologic Materials Assessment

Nineteen duplicate samples of subsurface geologic materials were collected during the OU 11 RFI/RI. Precision of analytical results for metals, radionuclides, semivolatile organic compounds (SVOCs), and cyanide, major ions, and inorganic parameters was assessed. Duplicate samples of subsurface geologic materials were not collected for volatile organic compound (VOC) analysis because of the *in situ* nature of sampling for VOCs (two samples cannot be collected from the same depth interval). Table C-2 presents the RPDs for all real and duplicate sample pairs.

Metals

Approximately 30 percent of all metal results for duplicate pairs were reported with a U qualifier by the laboratory. Approximately 35 percent of the results were reported by the laboratory with a B, N, or S qualifier indicating estimated or calculated results. All results for antimony and mercury were reported as nondetections (RPD is zero percent). Metals for which most of the results were reported as nondetections include cadmium, cesium, selenium, silver, thallium, and tin. Of these, approximately 7 percent have a result for one sample of the pair and a nondetection for the other sample. The remaining metals, including aluminum, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, sodium, strontium, vanadium, and zinc, have results reported for the majority of duplicate sample pairs.

RPDs calculated for metals in subsurface geologic materials are presented in Table C-2. Approximately 88 percent of RPDs calculated for metals met the QC criterion of 35 percent. For those metals with fewer than one-half of the results reported as nondetections, RPDs for individual soil samples exceeded 35 percent except for barium, beryllium, and vanadium; however, average RPDs exceeded the QC criterion only for chromium and molybdenum. Metals generally met the overall precision compliance goal of 85 percent, with the exception of aluminum, arsenic, chromium, cobalt, lead, lithium, manganese, molybdenum, and nickel.

Based on the average RPD and precision compliance, overall precision for metal analyses is good. Values for the following metals have been qualified as estimated based on these results: aluminum, arsenic, chromium, cobalt, copper, lead, lithium, manganese, molybdenum, and nickel (see Table C-2). It is difficult to reproduce metal concentrations between duplicate soil samples because of the heterogeneous nature of the matrix. The RPDs calculated may reflect poor sampling precision due to the soil matrix rather than poor laboratory precision.

Radionuclides

All reported results for radionuclides are considered detectable even though approximately 48 percent of all radionuclide results for duplicate pairs were reported by the laboratory as nondetections. Approximately 35 percent of the radionuclide results were reported by the laboratory with a B or J qualifier to indicate estimated values. RPDs calculated for radionuclides in subsurface geologic materials are presented in Table C-2. RPDs were calculated for every pair of duplicate results even though many were reported as not detectable (U qualifier). Approximately 17 percent of RPDs calculated for radionuclides met the QC criterion of 35 percent. None of the radionuclides met the overall precision compliance goal of 85 percent.

Based on the number of sample pair RPDs exceeding 35 percent, the average RPDs, and overall precision compliance, precision is poor for the majority of radionuclides. A majority of RPDs exceeded 35 percent for each of the radionuclides analyzed.

Values for the following radionuclides have been qualified as estimated based on the precision analysis: americium-241, plutonium-239,240, tritium, uranium-233,234, uranium-235, and uranium-238 (see Table C-2).

SVOCs

Over 98 percent of the SVOC results for duplicate samples were reported with a U qualifier by the laboratory. Some results for 1,4-dichlorobenzene, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and diethyl phthalate were reported with a B or J qualifier, indicating estimated results. The RPDs calculated for these analytes ranged from a low of 6 percent (di-n-butyl phthalate) to a high of 177 percent (1,4,dichlorobenzene). Approximately 98 percent of RPDs met the QC criterion of 35 percent. All SVOCs, with the exception of di-n-butyl phthalate, met the overall precision compliance goal of 85 percent.

Based on the number of sample pair RPDs exceeding 35 percent, the average RPDs, and overall precision compliance, precision is excellent for SVOCs. The only SVOC that did not meet the QC requirement for precision is di-n-butyl phthalate; results for this analyte have been qualified as estimated (see Table C-2).

Cyanide, Major Ions, and Inorganic Parameters

Approximately 34 percent of the cyanide, major-ion, and inorganic parameter results for duplicate sample pairs were reported by the laboratory with a U qualifier (RPD is zero percent), including all cyanide data. RPDs were calculated for nitrate/nitrite and percent solids. Based on the results of the precision analysis, precision is excellent for percent solids. Approximately 81 percent of RPDs were below 35 percent. Only nitrate/nitrite did not meet the overall precision compliance goal of 85 percent. Results for nitrate/nitrite have been qualified as estimated results based on the number of sample pairs exceeding the QC criterion of 35 percent, the average RPD, and overall precision compliance (see Table C-2).

Ground-Water Assessment

The quality of ground-water analyses was determined and described in the Groundwater Geochemistry Report (EG&G, 1995). The following description of data quality for ground-water samples is from that report and refers to all ground-water samples collected between the first quarter of 1990 through the first quarter 1994. This time period overlaps with the time period from which the samples used in the OU 11

RFI/RI were collected. Detailed summary tables of RPD values and trip blank, field blank and equipment rinse analyses are included with the Groundwater Geochemistry Report.

The primary irregularity identified during the assessment of metals data is that results reported at concentrations greater than the instrument detection limit (IDL), but less than the contract-required detection limit (CRDL), were not consistently assigned a "B" result qualifier. In accordance with procedures established by U.S. Environmental Protection Agency (EPA's) Contract Laboratory Program (CLP), the B result qualifier should be assigned (by the laboratory) where a target analyte is detected at a concentration greater than the IDL but less than the CRDL.

Metals

For dissolved metals, the RPDs were greater than 20 percent for just over half of the analytes (15 of 29 total). The poor precision for these analytes is a result of the low concentrations (concentrations near the IDL) of many of the metals. For major metals (calcium, sodium, etc.) that have concentrations well above the detection limit, the precision is much better; RPDs were as low as 2 percent for such metals. RPDs for dissolved metals ranged from a low of 2 percent for strontium to a high of 57 percent for iron.

For total metals, the RPDs were greater than 20 percent for just over one-third of the analytes (20 of 29 total). The poor precision for these analytes is a result of the low concentrations (concentrations near the instrumental detection limit) of many of the metals. RPDs for total metals ranged from a low of 3.2 percent for thallium to a high of 52 percent for cadmium.

Radionuclides

For this review, all radionuclides were considered detected unless explicitly rejected in accordance with the laboratory qualifiers and validation codes. Overall, the RPDs calculated for duplicate radionuclide analyses indicate poor reproducibility of results. Using all results for dissolved radionuclides, the average RPDs ranged from a low of 12.4 percent for uranium-233,234 to a high of 197.3 percent for americium-241. Duplicates were available for most analytes and for most years between 1990 and 1994.

Using all results for total radionuclides, the average RPDs ranged from a low of 14 percent for uranium-233,234 to a high of 67 percent for gross beta. Duplicates were available for most analytes and for most years between 1990 and 1994.

SVOCs

The RPDs for all duplicate sample results and precision could not be adequately assessed because of the limited data set for detected analytes.

VOCs

The RPDs for all duplicate sample results and precision could not be adequately assessed because of the limited data set for detected analytes. In addition, there are no specific criteria established by EPA for determining acceptable RPDs for VOCs in field duplicates.

Water-Quality Parameters

There are no clearly established acceptance criteria for the precision of water-quality parameters. RPDs for cyanide and nitrate/nitrite were therefore considered acceptable using a general criterion of 20 percent.

For water-quality parameters used in the OU 11 RFI/RI (cyanide and nitrate/nitrite), the overall average RPD for cyanide was 30 percent, which exceeded the QC criterion. Average RPDs for cyanide ranged from a low of 17 percent to a high of 48 percent. The overall average RPD for nitrate/nitrite was 11 percent. Average RPDs ranged from a low of 4 percent to a high of 17 percent.

Accuracy

Accuracy is a measure of the closeness of a reported concentration to the true value. Analytical accuracy is determined by laboratory analyses of materials with known analyte concentrations such as laboratory standards, laboratory control samples, and matrix spike samples. This measure is expressed as bias and is determined by calculating percent recovery from spiked samples. Percent recovery (%R) is defined as:

$$\%R = (SSR - SR) / SA \times 100$$

where:

SSR = spiked sample result
SR = sample result
SA = spike added

The QC criterion for percent recovery, specified in the OU 11 FSP TM (EG&G, 1994) and the GRRASP (EG&G, 1991a), is 80 percent to 120 percent for all analytes in all media.

Spike data consists of matrix spike (MS) and matrix spike duplicate (MSD) data for ground water. No information on spike concentrations is available for the sitewide ground-water monitoring program from 1990 to 1994; thus accuracy cannot be evaluated.

For all other media sampled (surficial soils and subsurface geologic materials), accuracy is evaluated by the data validation subcontractor based on QC information supplied by the analytical laboratory. Analytical accuracy is reported by the laboratory and is based on analysis of internal standards or laboratory spikes. The laboratory qualifiers and validation codes associated with each result are used to classify the usability of results, and these qualifiers are based in part on the reported accuracy of analyses. Therefore, the accuracy of laboratory analyses of media other than water has not been described quantitatively for the OU 11 data set.

In accordance with Administrative Procedure ADM-08.02 (EG&G, 1991b), the accuracy of field measurements indicates how accurate the resultant data are. Ground-water-level measurements were collected during the third and fourth quarters of 1994. In accordance with Groundwater Standard Operating Procedure (SOP) GW.01, Water Level Measurements in Wells and Piezometers (EG&G, 1992), water-level measurements were measured to the nearest 0.01 foot.

Field-measurement data collected for ground water sampled from 1990 to 1994 as part of the sitewide ground-water monitoring program could not be quantitatively assessed; both numeric and non-numeric values were present for most variables (pH, dissolved oxygen, specific conductance, temperature, total alkalinity, and depth to water table). The following table summarizes salient points for the entire data file of field measurements from 1990 to 1994:

Variable	Total Records	Numeric	Non-numeric	Missing
pH	7,424	5,208	63	2,153
DO	7,424	3,211	832	3,381
TEMP	7,424	5,210	63	2,151
SCOND	7,424	4,590	85	2,749
TOT_ALK	7,424	3,863	155	3,406
WAT_DEP	7,424	4,489	165	2,770

Where:

DO = dissolved oxygen
TEMP = temperature
SCOND = specific conductance
TOT_ALK = total alkalinity
WAT_DEP = depth to water table from top of casing

Accuracy is also a quantitative measure of data quality that refers to the degree of difference between measured or calculated values and the true value. The closer to the true value, the more accurate the measurement. The accuracy of some field measurement data can also be qualitatively described by comparing field measurement results to laboratory measurements of soil moisture. Soil moisture was measured in the field on samples composited from 2-foot intervals. In general, field results for soil moisture measurements are greater than the laboratory results. It is likely that the compositing of the subsurface geologic material samples for laboratory analysis resulted in their drying out relative to the samples analyzed in the field. Although the field measurements were used as a screening tool to evaluate soil moistures encountered during drilling, the laboratory measurements were ultimately used to evaluate the existence of possible perched zones.

Accuracy of the data is also evaluated by reviewing the accuracy of the analytical instruments used by the laboratory. The detection limits reported for the OU 11 data were compared to the CRDLs in the GRRASP. The OU 11 detection limits reported by the laboratories generally consisted of a range. The majority of CRDLs were within the range of OU 11 detection limits. However, the detection limit ranges for some analytes, including all VOCs analyzed for in ground water using EPA Method 524.2, were well below the CRDLs. This indicates that the analytical method or the actual instrument used by the laboratory was very sensitive and able to detect much smaller concentrations of analytes than required by the GRRASP. The detection limit ranges for cyanide and nitrate/nitrite in ground water were above the CRDLs for these analyte, indicating that the level of accuracy required by the GRRASP was not met for cyanide and nitrate/nitrite. Similarly, the CRDLs for some VOCs in ground water analyzed using the volatile organic analysis (VOA) CLP method constituted the lower member of the detection limit range (i.e., the ranges reported by the laboratory included the CRDLs as well as detection limits in excess of the CRDLs).

Representativeness

Representativeness is a qualitative parameter that expresses the degree to which sample data accurately and precisely represent the characteristics of a particular site or condition. The representativeness of OU 11 samples is determined by evaluating

whether or not the samples collected are truly representative of the concentrations in the field or if they have been affected by the introduction of contamination during collection and handling. Adherence to the field sampling plan for OU 11 ensured that samples collected from environmental media are representative of site conditions. Possible contamination in the laboratory is addressed by laboratory quality assurance (QA) procedures and during data validation.

Possible contamination of the OU 11 environmental samples during sample collection and transport was evaluated by examining analytical results for field blanks, trip blanks, and equipment rinses. Tables C-3 and C-4 summarize the analytes detected in field QC samples collected during the OU 11 RFI/RI surficial soil and subsurface geologic material sampling. Results are presented as the "frequency of hits" (i.e., the number of detectable results per total number of QC blanks analyzed). Representativeness data for the QC samples collected as part of the sitewide ground-water monitoring program from 1990 to 1994 are summarized from the Groundwater Geochemistry Report (EG&G, 1995).

Surficial-Soils Assessment

Three equipment rinses were collected in conjunction with surficial-soil sampling. Table C-3 summarizes the analytical results.

Metals

Metals detected include aluminum, barium, calcium, chromium, copper, iron, lead, magnesium, manganese, sodium, strontium, and zinc. With the possible exception of lead and zinc, these metals are probable components of the distilled water used to rinse sampling equipment. There is no analytical data available to describe the distilled water used to prepare the equipment rinses. These metals were detected infrequently and at concentrations that should not affect the representativeness of the surficial-soil samples.

Radionuclides

Equipment rinses were also analyzed for radionuclides. Because of the nature of reporting requirements, all radionuclide results are reported as hits.

Cyanide and Major Ions

The three equipment rinses collected were also analyzed for nitrate/nitrite and cyanide. There were no hits reported, indicating that the surficial-soil samples collected and analyzed for these constituents are representative of site conditions and were not affected by cross contamination.

Subsurface Geologic Materials Assessment

Thirty equipment rinses and 30 trip blanks were collected during sampling of subsurface geologic materials. Table C-4 presents the analytical results.

Metals

Metals detected in equipment rinses include aluminum, barium, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, potassium, sodium, strontium, and zinc. With the possible exception of cadmium, lead, and zinc, these metals are major-ion constituents of natural waters and may have originated from the distilled water used to rinse sampling equipment. These metals were detected infrequently and at concentrations that should not affect the representativeness of subsurface geologic material samples.

Radionuclides

Seventeen of the 30 equipment rinses collected during subsurface geologic material sampling were analyzed for radionuclides. Due to the nature of reporting requirements, all radionuclide results are reported as hits.

VOCs

All 30 equipment rinses were analyzed for VOCs. The only VOC detected was tetrachloroethene (PCE). PCE was detected in one equipment rinse at a very low concentration (3 micrograms per liter [µg/L]), indicating that its presence is an isolated occurrence and does not affect the data quality. Based on these data, it appears that decontamination procedures were adequate to prevent cross contamination and that analytical results for VOCs in subsurface geologic material samples are representative of actual site concentrations.

Thirty trip blanks were also analyzed for VOCs. There were no VOCs detected, indicating that subsurface geologic material samples were not subject to cross contamination during storage or transport to the laboratory. Based on the trip blank data, subsurface geologic material samples are representative of actual environmental conditions.

SVOCs

All equipment rinses were also analyzed for SVOCs. Two SVOCs, bis(2-ethylhexyl)phthalate and diethyl phthalate, which are considered common laboratory contaminants, were detected in several equipment rinses. Some real samples collected on the same day as these equipment rinses did not contain either of these phthalates. In addition, although several real samples contained bis(2-ethylhexyl)phthalate and

diethyl phthalate, corresponding equipment rinses collected the same day did not contain either of these analytes. Therefore, detectable amounts of phthalates in real samples do not appear related to cross contamination during sampling.

Cyanide and Major Ions

The only major ion detected in the 30 equipment rinses was nitrate/nitrite, which was detected in 9 of the 30 equipment rinse samples. The minimum concentration detected was 20 µg/L and the maximum detected was 40 µg/L. Nitrate/nitrite is not present in equipment rinses at concentrations that adversely affect the representativeness of the subsurface geologic material samples.

Ground-Water Assessment

The quality of ground-water analyses was determined and described in the Groundwater Geochemistry Report (EG&G, 1995). The following description of data quality for ground-water samples is from that report and refers to all ground-water samples collected between the first quarter of 1990 through the first quarter 1994.

Metals

For field blanks, 829 records were reported for the suite of dissolved metals. Of these records, 202 (24.4 percent) were reported as detected (primarily between the IDL and CRDL), 626 (75.5 percent) were reported as undetected at the IDL, and 1 (0.1 percent) was rejected. Of the data reviewed, results for field blanks were reported for the period from 1990 to first quarter 1994. The highest detection frequencies were for aluminum, barium, calcium, iron, magnesium, manganese, silver, sodium, strontium, and zinc. With the possible exception of silver and zinc, these metals are major-ion constituents of natural waters and may have originated from the distilled water used to prepare the field blanks. These metals were detected at concentrations that should not affect the representativeness of ground-water samples.

No records for trip blanks were reported for the suite of dissolved metals during the 1990 to 1994 period.

A total of 5,551 records was reported for the suite of dissolved metals in equipment rinses. Of these results, 865 (15.6 percent) were reported as detected (primarily between the IDL and CRDL), 4,638 (83.6 percent) were reported as undetected at the IDL, and 48 (approximately 0.9 percent) were rejected. The rejected data are associated with equipment-rinse analyses performed in 1990, 1991, 1992, and 1993. The highest detection frequencies were for aluminum, barium, calcium, iron, magnesium, manganese, sodium, strontium, and zinc. As described above for field blanks, with the possible exception of zinc, these metals may have originated from the

distilled water that was used to prepare field blanks as well as rinse sampling equipment. These metals were detected at concentrations that should not affect the representativeness of ground-water samples.

A total of 314 records was reported for the suite of total metals in field blanks. Of these results, 64 (20.4 percent) were reported as detected (primarily between the IDL and CRDL), 248 (79 percent) were reported as undetected at the IDL, and 2 (0.6 percent) were rejected. The rejected data are associated with field-blank measurements performed in 1990. Results for field blanks were reported only for 1990 and 1993. The highest detection frequencies were for aluminum, barium, calcium, iron, magnesium, manganese, sodium, strontium, and zinc. With the possible exception of zinc, these metals may have originated from the distilled water used to prepare field blanks.

No records for trip blanks were reported in the database for the suite of total metals.

A total of 2,894 records was reported for total metals in equipment rinses. Of these results, 493 (17 percent) were reported as detected (primarily between the IDL and CRDL), 2,362 (81.6 percent) were reported as undetected at the IDL, and 39 (1.3 percent) were rejected. The rejected data are associated with analysis of equipment rinses from 1991 and 1992. The highest detection frequencies were for aluminum, barium, calcium, iron, magnesium, manganese, sodium, strontium, and zinc. With the possible exception of zinc, these metals may have originated from the distilled water used to rinse sampling equipment.

Radionuclides

A total of 140 records was reported for field-blank samples for dissolved radionuclides. Of these results, 124 (88.6 percent) were reported as accepted, and 16 (11.4 percent) were rejected. Results for field blanks were reported only for 1990 and 1993.

No records for trip blanks were reported in the database for the suite of dissolved radionuclides for the 1990 to 1994 period.

A total of 1,317 records was reported for the suite of dissolved radionuclides in equipment rinses. Of these results, 1,245 (94.5 percent) were reported as accepted, and 72 (5.5 percent) were rejected. Results for equipment rinses were reported for the entire 1990 to 1994 period.

A total of 335 analytical results was reported for the suite of total radionuclides in field-blank samples. Of these results, 297 (88.6 percent) were reported as accepted, and 38 (11.3 percent) were rejected. Results for field blanks were reported only for 1990 and 1993.

No records for trip blanks were reported in the database for the suite of total radionuclides for the 1990 to 1994 period.

A total of 821 records was reported for the suite of total radionuclides in equipment rinses. Of these results, 758 (92.3 percent) were reported as accepted, and 63 (7.7 percent) were rejected. Results for equipment rinses were reported for 1990, 1991, 1992, and 1993.

SVOCs

No field-blank records were reported for SVOCs for the 1990 to 1994 time period. Results for field blanks are reported in Rocky Flats Environmental Database System (RFEDS) only for 1986; these historic data were not evaluated for this report.

No trip-blank records were reported for SVOCs for the 1990 to 1994 time period.

A total of 690 records was reported for SVOCs in rinses collected from 1990 to 1994. Of these results, 7 (1 percent) were reported as detected, 672 (97.4 percent) were reported as undetected, and 11 (1.6 percent) were rejected. SVOC results for equipment rinses were reported only for 1992 and 1993.

VOCs

Several VOCs were detected in each type of blank sample. Typically, these detected analytes are associated with common laboratory contaminants (e.g., methylene chloride, acetone, 2-butanone, and toluene). Several of the other VOCs detected may be indicative of breakdown associated with the VOC absorbent trap used in the analysis. Caution should be used in determining whether a VOC detected in both a blank sample and any associated natural sample is actually present at the sampling location. Specific assessment of this problem could not be performed during this review because detailed information (e.g., original laboratory data and field logs) was not available.

A total of 1,879 records was reported for the target VOCs in field-blank samples. Of these results, 72 (3.8 percent) were reported as detected, 1,786 (95.1 percent) were reported as undetected, and 21 (1.1 percent) were rejected. Results for field blanks were reported for 1990, 1991, 1993, and 1994.

A total of 7,670 records was reported for the target VOCs in trip-blank samples. Of these results, 296 (3.9 percent) were reported as detected, 7,355 (95.9 percent) were reported as undetected, and 19 (0.2 percent) were rejected. Results for trip blanks were reported for 1990, 1991, and 1993.

A total of 7,903 records was reported for the target VOCs in equipment rinses. Of these results, 178 (2.2 percent) were reported as detected, 7,507 (95 percent) were reported as undetected, and 218 (2.8 percent) were rejected. Results for equipment rinses were reported for 1990 to 1994.

Water-Quality Parameters

In general, target analytes associated with water-quality parameters (e.g., cyanide) were undetected at concentrations above the method detection limit (MDL).

A total of 320 records was reported for water-quality parameters in field-blank samples. Of these records, 49 (15.3 percent) were reported as detected, 271 (84.7 percent) were reported as undetected, and 0 (0 percent) were rejected. Results for field blanks were reported only for 1990 and 1993.

No records for trip blanks were reported in the database for the suite of water-quality parameters for the 1990 to 1994 period.

A total of 2,258 records was reported for water-quality parameters in equipment rinses. Of these results, 335 (14.8 percent) were reported as detected, 1,907 (84.5 percent) were reported as undetected, and 16 (0.7 percent) were rejected. Results for equipment rinses were reported throughout 1990 to 1994.

In accordance with Administrative Procedure ADM-08.02 (EG&G, 1991b), representativeness also includes a comparison between actual sample types and quantities collected with those stated in a work plan. A discussion of this comparison is included in the completeness section, which follows.

Completeness

Completeness is a measure of the amount of usable data resulting from a data collection activity. The target completeness objective for the OU 11 RFI/RI field and analytical data is 100 percent with a minimum acceptable limit of 90 percent (EG&G, 1994). The completeness of field activities is defined by the actual number of samples or measurements collected relative to the number of samples or measurements specified in the work plan. Completeness of analytical data is defined as the percentage of measurements made that are judged to be usable.

The completeness of field activities is described in Section 2.2 of this report. Completeness for the OU 11 RFI/RI was evaluated by comparing the planned to the actual number of samples collected and analyzed. Table 2.2-1 presents this comparison. In general, the number of samples collected and types of analyses performed at each sampling location exceeded those specified in the work plan.

Samples not collected were due to extenuating circumstances related to field conditions (such as non-producing wells).

Section 4 of the OU 11 FSP TM specifically states the analytes for which the OU 11 samples will be analyzed (EG&G, 1994). Several analytes were not analyzed for as discussed below. None of the surficial soil samples collected was analyzed for tritium, and one sample was not analyzed for cesium. According to RFEDS, all tritium analyses for surficial soils failed. However, because the risk assessment was calculated based on an aggregation of all surficial soil and subsurface geologic material results, any risk from tritium in surficial soils has been included in the risk calculations because of its identification as a PCOC in subsurface geologic materials. For the subsurface geologic material samples, there were several analytes that were not analyzed for. Analytes for which there are no results for at least 50 percent of the samples collected include the VOC trans-1,2-dichloroethene and the SVOC 4-bromophenyl-phenylether. Similarly, there were several analytes not analyzed for in the 18 ground-water samples collected from OU 11. Because several of the OU 11 wells did not produce sufficient volumes for full analytical suites, samples were analyzed on a priority basis (e.g., nitrates, radionuclides, metals, VOCs, and SVOCs [in order of decreasing priority]). In addition, the OU 11 ground-water samples were collected as part of the sitewide ground-water monitoring program and may have been subject to different analytical requirements. For example, although the OU 11 FSP TM requires that ground-water samples were analyzed for target compound list (TCL) VOCs and SVOCs, samples collected in conjunction with the sitewide program were analyzed for these compounds using EPA Method 524.2. Analytes that were not analyzed for in at least 50 percent of the ground-water samples collected from OU 11 include total and dissolved metals, dissolved tritium, all SVOCs, all VOCs, and cyanide.

Based on the information presented in Section 2.2, the OU 11 RFI/RI data are approximately 128 percent complete. Field activities that met the target of 90 percent include surficial soil sampling (38 samples planned, 53 collected), subsurface geologic material sampling (120 samples planned, 145 collected), and monitoring well installation (10 wells planned, 17 installed). Specific field activities for which completeness did not exceed 90 percent (based on data available as of December 21, 1994 - date of RFEDS extraction) include ground-water sampling for metals, VOCs, and SVOCs.

Analytical results should be validated to determine their usability and to assess the completeness of the database. Table 2.3-5 presents a summary of the data validation results as of December 21, 1994, including the percent valid, percent acceptable, percent rejected, percent unvalidated, and percent remaining. Percentages were calculated from the total number of results. A percentage rejected of more than approximately 10 percent is used as an indicator of poor completeness. The percentage

valid varies by medium and by analyte group. Percentage of results considered valid by medium ranges from 62 percent (surficial soils) to 71 percent (ground water) of the total number of results reviewed. Of the total number of results available as of December 21, 1994, less than 1 percent have been rejected.

Table 2.3-8 presents the data usability by media. Usable data includes valid results, estimated results, and unvalidated results (anticipated to be qualified as usable upon completion of the validation process). In general, the usability of the OU 11 data is excellent. Usability ranges from a low of 97 percent for ground water to a high of 100 percent for surficial soils. As of December 1994, approximately 98 percent of the OU 11 data is considered usable.

Comparability

Comparability expresses the confidence with which data are considered comparable. Because data are collected over a period of months or years and may be collected by different methods, comparability of different data sets is critical to data analysis. Comparability is a qualitative parameter that is ensured by implementation of an approved sampling and analysis plan, standardized analytical protocols, and standard operating procedures for field investigations.

To achieve comparability, fieldwork performed for the combined phases RFI/RI has been performed in accordance with an approved work plan (EG&G, 1994), standard analytical protocols outlined in the GRRASP (EG&G, 1991a), and approved SOPs for data collection (EG&G, 1992). OU 11 RFI/RI data are reported in uniform units: milligrams per liter (mg/L), milligrams per kilogram (mg/kg), µg/L, micrograms per kilogram (µg/kg), picocuries per liter (pCi/L), and picocuries per gram (pCi/g).

Data from soil samples collected during test-pit investigations in 1988 are not considered comparable to data collected during 1994 (combined phases RFI/RI) because the 1988 samples were composites of soil from 0 to 2 feet. Samples collected in 1994 were composites of soil from 0 to 2 inches. Subsurface-soil samples collected during the 1988 investigation were from the 3 to 5 foot depth interval. The sample collection procedures used were not documented and the analytical data were never validated for these samples. Therefore, data from the 1988 subsurface-soil samples are not considered comparable to the combined phases RFI/RI subsurface-soil samples.

According to Administrative Procedure ADM-08.02 (EG&G, 1991b), comparability also includes a comparison of environmental sample results with QC blank results (i.e., field blanks, trip blanks). This discussion is presented as part of the representativeness section presented earlier.

References

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Appendix C
Tables

Table C-1
Relative Percent Differences for Real/Duplicate Sample Pairs of Surficial Soils

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUP SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
SS101094	23-JUN-94	SS00040EG	SS00041EG	ALUMINUM	MG/KG	10300.00	*	40.0000	7800.00	*	40.0000	27.62								
SS102394	29-JUN-94	SS00054EG	SS00055EG	ALUMINUM	MG/KG	8620.00		40.0000	9690.00		40.0000	11.69								
SS103294	21-JUL-94	SS00064EG	SS00065EG	ALUMINUM	MG/KG	12000.00		40.0000	13400.00		40.0000	11.02								
SS140294	22-JUL-94	SS00077EG	SS00076EG	ALUMINUM	MG/KG	15900.00		40.0000	12000.00		40.0000	27.96								
SS141094	25-JUL-94	SS00085EG	SS00088EG	ALUMINUM	MG/KG	13200.00		40.0000	12500.00		40.0000	5.45	16.75	10.37	61.90	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	ANTIMONY	MG/KG	2.90	UN	12.0000	3.00	UN	12.0000	0								
SS102394	29-JUN-94	SS00054EG	SS00055EG	ANTIMONY	MG/KG	3.50	UN	12.0000	2.70	UN	12.0000	0								
SS103294	21-JUL-94	SS00064EG	SS00065EG	ANTIMONY	MG/KG	2.60	UN	12.0000	2.60	UN	12.0000	0								
SS140294	22-JUL-94	SS00077EG	SS00076EG	ANTIMONY	MG/KG	2.50	UN	12.0000	3.20	BN	12.0000	115.79								
SS141094	25-JUL-94	SS00085EG	SS00088EG	ANTIMONY	MG/KG	2.60	UN	12.0000	2.50	UN	12.0000	0	23.16	51.78	223.61	5	1	20.00	80.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	ARSENIC	MG/KG	7.60		2.0000	7.40		2.0000	2.67								
SS102394	29-JUN-94	SS00054EG	SS00055EG	ARSENIC	MG/KG	7.20		2.0000	7.00		2.0000	2.82								
SS103294	21-JUL-94	SS00064EG	SS00065EG	ARSENIC	MG/KG	7.40		2.0000	8.70		2.0000	16.15								
SS140294	22-JUL-94	SS00077EG	SS00076EG	ARSENIC	MG/KG	8.10		2.0000	7.20		2.0000	11.76								
SS141094	25-JUL-94	SS00085EG	SS00088EG	ARSENIC	MG/KG	5.70		2.0000	7.50		2.0000	27.27	12.13	10.27	84.62	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	BARIUM	MG/KG	116.00		40.0000	112.00		40.0000	3.51								
SS102394	29-JUN-94	SS00054EG	SS00055EG	BARIUM	MG/KG	112.00		40.0000	110.00		40.0000	1.8								
SS103294	21-JUL-94	SS00064EG	SS00065EG	BARIUM	MG/KG	124.00		40.0000	129.00		40.0000	3.95								
SS140294	22-JUL-94	SS00077EG	SS00076EG	BARIUM	MG/KG	146.00		40.0000	131.00		40.0000	10.83								
SS141094	25-JUL-94	SS00085EG	SS00088EG	BARIUM	MG/KG	126.00		40.0000	114.00		40.0000	10	6.02	4.10	68.19	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	BERYLLIUM	MG/KG	0.61	B	1.0000	0.55	B	1.0000	10.34								
SS102394	29-JUN-94	SS00054EG	SS00055EG	BERYLLIUM	MG/KG	0.54	B	1.0000	0.55	B	1.0000	1.83								
SS103294	21-JUL-94	SS00064EG	SS00065EG	BERYLLIUM	MG/KG	0.57	B	1.0000	0.64	B	1.0000	11.57								
SS140294	22-JUL-94	SS00077EG	SS00076EG	BERYLLIUM	MG/KG	0.69	B	1.0000	0.62	B	1.0000	10.69								
SS141094	25-JUL-94	SS00085EG	SS00088EG	BERYLLIUM	MG/KG	0.78	B	1.0000	0.73	B	1.0000	6.62	8.21	4.04	49.18	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	CADMIUM	MG/KG	0.74	B	1.0000	0.71	B	1.0000	4.14								
SS102394	29-JUN-94	SS00054EG	SS00055EG	CADMIUM	MG/KG	0.60	U	1.0000	0.60	U	1.0000	0								
SS103294	21-JUL-94	SS00064EG	SS00065EG	CADMIUM	MG/KG	0.60	B	1.0000	0.73	B	1.0000	19.55								
SS140294	22-JUL-94	SS00077EG	SS00076EG	CADMIUM	MG/KG	0.80	B	1.0000	0.94	B	1.0000	16.09								
SS141094	25-JUL-94	SS00085EG	SS00088EG	CADMIUM	MG/KG	0.75	B	1.0000	0.58	U	1.0000	28.57	13.67	11.62	85.01	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	CALCIUM	MG/KG	2280.00		1000.0000	2270.00		1000.0000	0.44								
SS102394	29-JUN-94	SS00054EG	SS00055EG	CALCIUM	MG/KG	2230.00		1000.0000	2110.00		1000.0000	5.53								
SS103294	21-JUL-94	SS00064EG	SS00065EG	CALCIUM	MG/KG	2470.00		1000.0000	2570.00		1000.0000	3.97								
SS140294	22-JUL-94	SS00077EG	SS00076EG	CALCIUM	MG/KG	2670.00		1000.0000	2590.00		1000.0000	3.04								
SS141094	25-JUL-94	SS00085EG	SS00088EG	CALCIUM	MG/KG	2490.00		1000.0000	2210.00		1000.0000	11.91	4.98	4.29	86.24	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	CESIUM	MG/KG	9.60	U	200.0000	10.00	U	200.0000	0								
SS102394	29-JUN-94	SS00054EG	SS00055EG	CESIUM	MG/KG	8.60	U	200.0000	8.70	U	200.0000	0								
SS103294	21-JUL-94	SS00064EG	SS00065EG	CESIUM	MG/KG	8.60	U	200.0000	8.50	U	200.0000	0								
SS140294	22-JUL-94	SS00077EG	SS00076EG	CESIUM	MG/KG	8.40	U	200.0000	8.40	U	200.0000	0								
SS141094	25-JUL-94	SS00085EG	SS00088EG	CESIUM	MG/KG	8.50	U	200.0000	8.40	U	200.0000	0				5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	CHROMIUM	MG/KG	14.00		2.0000	9.90		2.0000	34.31								
SS102394	29-JUN-94	SS00054EG	SS00055EG	CHROMIUM	MG/KG	10.30		2.0000	10.80		2.0000	4.74								
SS103294	21-JUL-94	SS00064EG	SS00065EG	CHROMIUM	MG/KG	12.30		2.0000	13.40		2.0000	8.56								
SS140294	22-JUL-94	SS00077EG	SS00076EG	CHROMIUM	MG/KG	16.40		2.0000	12.70		2.0000	25.43								
SS141094	25-JUL-94	SS00085EG	SS00088EG	CHROMIUM	MG/KG	13.50		2.0000	12.60		2.0000	6.9	15.99	13.13	82.10	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	COBALT	MG/KG	5.40	B	10.0000	5.40	B	10.0000	0								
SS102394	29-JUN-94	SS00054EG	SS00055EG	COBALT	MG/KG	4.90	B	10.0000	5.30	B	10.0000	7.84								
SS103294	21-JUL-94	SS00064EG	SS00065EG	COBALT	MG/KG	5.80	B	10.0000	6.30	B	10.0000	8.26								
SS140294	22-JUL-94	SS00077EG	SS00076EG	COBALT	MG/KG	7.30	B	10.0000	6.50	B	10.0000	11.59								
SS141094	25-JUL-94	SS00085EG	SS00088EG	COBALT	MG/KG	6.30	B	10.0000	5.50	B	10.0000	13.56	8.25	5.19	62.86	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	COPPER	MG/KG	11.40		5.0000	10.40		5.0000	9.17								
SS102394	29-JUN-94	SS00054EG	SS00055EG	COPPER	MG/KG	10.50		5.0000	10.40		5.0000	0.96								
SS103294	21-JUL-94	SS00064EG	SS00065EG	COPPER	MG/KG	12.20		5.0000	13.00		5.0000	6.35								
SS140294	22-JUL-94	SS00077EG	SS00076EG	COPPER	MG/KG	20.10		5.0000	13.80		5.0000	37.17								
SS141094	25-JUL-94	SS00085EG	SS00088EG	COPPER	MG/KG	12.60		5.0000	11.10		5.0000	12.66	13.26	14.03	105.82	5	1	20.00	80.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	IRON	MG/KG	12700.00		20.0000	11300.00		20.0000	11.67								

Table C-1

Relative Percent Differences for Real/Duplicate Sample Pairs of Surficial Soils

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUP SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
SS102394	29-JUN-94	SS00054EG	SS00055EG	IRON	MG/KG	11100.00		20.0000	11900.00		20.0000	6.96								
SS103294	21-JUL-94	SS00064EG	SS00065EG	IRON	MG/KG	12600.00		20.0000	13700.00		20.0000	8.37								
SS140294	22-JUL-94	SS00077EG	SS00076EG	IRON	MG/KG	17700.00		20.0000	13300.00		20.0000	28.39								
SS141094	25-JUL-94	SS00085EG	SS00088EG	IRON	MG/KG	13300.00		20.0000	12500.00		20.0000	6.2	12.32	9.23	74.90	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	LEAD	MG/KG	41.60		0.6000	40.50		0.6000	2.68								
SS102394	29-JUN-94	SS00054EG	SS00055EG	LEAD	MG/KG	41.40		0.6000	39.00		0.6000	5.97								
SS103294	21-JUL-94	SS00064EG	SS00065EG	LEAD	MG/KG	42.90		0.6000	44.40		0.6000	3.44								
SS140294	22-JUL-94	SS00077EG	SS00076EG	LEAD	MG/KG	45.80		0.6000	47.10		0.6000	2.8								
SS141094	25-JUL-94	SS00085EG	SS00088EG	LEAD	MG/KG	39.20		0.6000	34.30		0.6000	13.33	5.64	4.50	79.69	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	LITHIUM	MG/KG	8.00	B	20.0000	6.20	B	20.0000	25.35								
SS102394	29-JUN-94	SS00054EG	SS00055EG	LITHIUM	MG/KG	7.20	BE	20.0000	8.10	BE	20.0000	11.76								
SS103294	21-JUL-94	SS00064EG	SS00065EG	LITHIUM	MG/KG	9.70	B	20.0000	11.30	B	20.0000	15.24								
SS140294	22-JUL-94	SS00077EG	SS00076EG	LITHIUM	MG/KG	11.80	B	20.0000	8.80	B	20.0000	29.13								
SS141094	25-JUL-94	SS00085EG	SS00088EG	LITHIUM	MG/KG	10.30	B	20.0000	9.60	B	20.0000	7.04	17.70	9.28	52.39	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	MAGNESIUM	MG/KG	1620.00		1000.0000	1400.00		1000.0000	14.57								
SS102394	29-JUN-94	SS00054EG	SS00055EG	MAGNESIUM	MG/KG	1380.00		1000.0000	1450.00		1000.0000	4.95								
SS103294	21-JUL-94	SS00064EG	SS00065EG	MAGNESIUM	MG/KG	1730.00		1000.0000	1840.00		1000.0000	6.16								
SS140294	22-JUL-94	SS00077EG	SS00076EG	MAGNESIUM	MG/KG	2020.00		1000.0000	1720.00		1000.0000	16.04								
SS141094	25-JUL-94	SS00085EG	SS00088EG	MAGNESIUM	MG/KG	1760.00		1000.0000	1610.00		1000.0000	8.9	10.12	4.97	49.08	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	MANGANESE	MG/KG	282.00		3.0000	284.00		3.0000	0.71								
SS102394	29-JUN-94	SS00054EG	SS00055EG	MANGANESE	MG/KG	273.00	N	3.0000	284.00	N	3.0000	3.95								
SS103294	21-JUL-94	SS00064EG	SS00065EG	MANGANESE	MG/KG	288.00		3.0000	306.00		3.0000	6.06								
SS140294	22-JUL-94	SS00077EG	SS00076EG	MANGANESE	MG/KG	339.00		3.0000	326.00		3.0000	3.91								
SS141094	25-JUL-94	SS00085EG	SS00088EG	MANGANESE	MG/KG	276.00		3.0000	248.00		3.0000	10.69	5.06	3.68	72.67	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	MERCURY	MG/KG	0.12	U	0.1000	0.12	U	0.1000	0								
SS102394	29-JUN-94	SS00054EG	SS00055EG	MERCURY	MG/KG	0.10	U	0.1000	0.09	U	0.1000	0								
SS103294	21-JUL-94	SS00064EG	SS00065EG	MERCURY	MG/KG	0.09	U	0.1000	0.09	U	0.1000	0								
SS140294	22-JUL-94	SS00077EG	SS00076EG	MERCURY	MG/KG	0.10	U	0.1000	0.09	U	0.1000	0								
SS141094	25-JUL-94	SS00085EG	SS00088EG	MERCURY	MG/KG	0.10	U	0.1000	0.09	U	0.1000	0				5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	MOLYBDENUM	MG/KG	1.20	U	40.0000	1.10	U	40.0000	0								
SS102394	29-JUN-94	SS00054EG	SS00055EG	MOLYBDENUM	MG/KG	0.83	B	40.0000	1.40	B	40.0000	51.12								
SS103294	21-JUL-94	SS00064EG	SS00065EG	MOLYBDENUM	MG/KG	1.40	U	40.0000	1.40	U	40.0000	0								
SS140294	22-JUL-94	SS00077EG	SS00076EG	MOLYBDENUM	MG/KG	1.70	U	40.0000	0.64	U	40.0000	0								
SS141094	25-JUL-94	SS00085EG	SS00088EG	MOLYBDENUM	MG/KG	0.95	U	40.0000	0.83	U	40.0000	0	10.22	22.86	223.61	5	1	20.00	80.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	NICKEL	MG/KG	8.90	B	8.0000	6.70	B	8.0000	28.21								
SS102394	29-JUN-94	SS00054EG	SS00055EG	NICKEL	MG/KG	7.50	B	8.0000	7.80	B	8.0000	3.92								
SS103294	21-JUL-94	SS00064EG	SS00065EG	NICKEL	MG/KG	8.50		8.0000	10.70		8.0000	22.92								
SS140294	22-JUL-94	SS00077EG	SS00076EG	NICKEL	MG/KG	12.80		8.0000	8.60		8.0000	39.25								
SS141094	25-JUL-94	SS00085EG	SS00088EG	NICKEL	MG/KG	10.40		8.0000	8.40		8.0000	21.28	23.12	12.83	55.49	5	1	20.00	80.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	POTASSIUM	MG/KG	1820.00		1000.0000	1520.00		1000.0000	17.96								
SS102394	29-JUN-94	SS00054EG	SS00055EG	POTASSIUM	MG/KG	1600.00		1000.0000	1680.00		1000.0000	4.88								
SS103294	21-JUL-94	SS00064EG	SS00065EG	POTASSIUM	MG/KG	2150.00		1000.0000	2330.00		1000.0000	8.04								
SS140294	22-JUL-94	SS00077EG	SS00076EG	POTASSIUM	MG/KG	2390.00		1000.0000	1950.00		1000.0000	20.28								
SS141094	25-JUL-94	SS00085EG	SS00088EG	POTASSIUM	MG/KG	2090.00		1000.0000	1890.00		1000.0000	10.05	12.24	6.59	53.87	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	SELENIUM	MG/KG	0.46	U	1.0000	0.46	UW	1.0000	0								
SS102394	29-JUN-94	SS00054EG	SS00055EG	SELENIUM	MG/KG	0.39	UW	1.0000	0.41	B	1.0000	83.69								
SS103294	21-JUL-94	SS00064EG	SS00065EG	SELENIUM	MG/KG	0.41	UW	1.0000	0.49	B	1.0000	68.46								
SS140294	22-JUL-94	SS00077EG	SS00076EG	SELENIUM	MG/KG	0.41	B	1.0000	0.42	B	1.0000	2.41								
SS141094	25-JUL-94	SS00085EG	SS00088EG	SELENIUM	MG/KG	0.40	UW	1.0000	0.42	B	1.0000	81.69	47.25	42.45	89.84	5	3	60.00	40.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	SILVER	MG/KG	0.45	U	2.0000	0.46	U	2.0000	0								
SS102394	29-JUN-94	SS00054EG	SS00055EG	SILVER	MG/KG	0.40	U	2.0000	0.40	U	2.0000	0								
SS103294	21-JUL-94	SS00064EG	SS00065EG	SILVER	MG/KG	0.40	U	2.0000	0.39	U	2.0000	0								
SS140294	22-JUL-94	SS00077EG	SS00076EG	SILVER	MG/KG	0.39	U	2.0000	0.39	U	2.0000	0								
SS141094	25-JUL-94	SS00085EG	SS00088EG	SILVER	MG/KG	0.40	U	2.0000	0.39	U	2.0000	0				5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	SODIUM	MG/KG	51.40	B	1000.0000	58.80	B	1000.0000	13.43								
SS102394	29-JUN-94	SS00054EG	SS00055EG	SODIUM	MG/KG	80.30	B	1000.0000	84.10	B	1000.0000	4.62								

Table C-1
Relative Percent Differences for Real/Duplicate Sample Pairs of Surficial Soils

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUP SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
SS103294	21-JUL-94	SS00064EG	SS00065EG	SODIUM	MG/KG	75.10	B	1000.0000	80.30	B	1000.0000	6.69								
SS140294	22-JUL-94	SS00077EG	SS00076EG	SODIUM	MG/KG	73.10	B	1000.0000	57.30	B	1000.0000	24.23								
SS141094	25-JUL-94	SS00085EG	SS00088EG	SODIUM	MG/KG	76.00	B	1000.0000	61.90	B	1000.0000	20.45	13.88	8.48	61.11	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	STRONTIUM	MG/KG	21.20	B	40.0000	19.70	B	40.0000	7.33								
SS102394	29-JUN-94	SS00054EG	SS00055EG	STRONTIUM	MG/KG	20.80	B	40.0000	20.40	B	40.0000	1.94								
SS103294	21-JUL-94	SS00064EG	SS00065EG	STRONTIUM	MG/KG	22.10	B	40.0000	23.30	B	40.0000	5.29								
SS140294	22-JUL-94	SS00077EG	SS00076EG	STRONTIUM	MG/KG	25.00	B	40.0000	21.80	B	40.0000	13.68								
SS141094	25-JUL-94	SS00085EG	SS00088EG	STRONTIUM	MG/KG	22.20	B	40.0000	20.50	B	40.0000	7.96	7.24	4.30	59.37	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	THALLIUM	MG/KG	0.23	U	2.0000	0.23	U	2.0000	0								
SS102394	29-JUN-94	SS00054EG	SS00055EG	THALLIUM	MG/KG	0.20	U	2.0000	0.20	U	2.0000	0								
SS103294	21-JUL-94	SS00064EG	SS00065EG	THALLIUM	MG/KG	0.20	B	2.0000	0.20	U	2.0000	163.64								
SS140294	22-JUL-94	SS00077EG	SS00076EG	THALLIUM	MG/KG	0.25	BW	2.0000	0.20	U	2.0000	155.56								
SS141094	25-JUL-94	SS00085EG	SS00088EG	THALLIUM	MG/KG	0.20	U	2.0000	0.24	BW	2.0000	157.14	95.27	87.02	91.34	5	3	60.00	40.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	TIN	MG/KG	2.70	U	40.0000	3.80	U	40.0000	0								
SS102394	29-JUN-94	SS00054EG	SS00055EG	TIN	MG/KG	3.70	U	40.0000	3.00	U	40.0000	0								
SS103294	21-JUL-94	SS00064EG	SS00065EG	TIN	MG/KG	2.40	U	40.0000	4.00	B	40.0000	163.64								
SS140294	22-JUL-94	SS00077EG	SS00076EG	TIN	MG/KG	2.70	B	40.0000	3.10	B	40.0000	13.79								
SS141094	25-JUL-94	SS00085EG	SS00088EG	TIN	MG/KG	4.50	B	40.0000	2.30	U	40.0000	159.55	67.40	86.19	127.88	5	2	40.00	60.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	VANADIUM	MG/KG	28.30		10.0000	25.70		10.0000	9.63								
SS102394	29-JUN-94	SS00054EG	SS00055EG	VANADIUM	MG/KG	24.00	E	10.0000	25.00	E	10.0000	4.08								
SS103294	21-JUL-94	SS00064EG	SS00065EG	VANADIUM	MG/KG	27.60		10.0000	29.70		10.0000	7.33								
SS140294	22-JUL-94	SS00077EG	SS00076EG	VANADIUM	MG/KG	33.90		10.0000	29.50		10.0000	13.88								
SS141094	25-JUL-94	SS00085EG	SS00088EG	VANADIUM	MG/KG	30.40		10.0000	28.50		10.0000	6.45	8.27	3.71	44.85	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	ZINC	MG/KG	40.60		4.0000	38.30		4.0000	5.83								
SS102394	29-JUN-94	SS00054EG	SS00055EG	ZINC	MG/KG	34.80	E	4.0000	35.90	E	4.0000	3.11								
SS103294	21-JUL-94	SS00064EG	SS00065EG	ZINC	MG/KG	47.90	E	4.0000	48.90	E	4.0000	2.07								
SS140294	22-JUL-94	SS00077EG	SS00076EG	ZINC	MG/KG	55.40	E	4.0000	48.60	E	4.0000	13.08								
SS141094	25-JUL-94	SS00085EG	SS00088EG	ZINC	MG/KG	40.60	E	4.0000	35.80	E	4.0000	12.57	7.33	5.20	70.95	5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	AMERICIUM-241	PCI/G	0.025		0.021	0.035	X	0.016	43.902								
SS102394	29-JUN-94	SS00054EG	SS00055EG	AMERICIUM-241	PCI/G	0.014	U	0.020	0.028	U	0.030	72.727								
SS103294	21-JUL-94	SS00064EG	SS00065EG	AMERICIUM-241	PCI/G	0.042		0.037	0.030		0.011	116.981								
SS140294	22-JUL-94	SS00077EG	SS00076EG	AMERICIUM-241	PCI/G	0.019	U	0.026	0.045		0.027	34.783								
SS141094	25-JUL-94	SS00085EG	SS00088EG	AMERICIUM-241	PCI/G	0.037	U	0.047	0.015	U	0.087	80.645	69.81	32.59	46.69	5	4	80.00	20.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	PLUTONIUM-239/240	PCI/G	0.11		0.007	0.11		0.002	192.86								
SS102394	29-JUN-94	SS00054EG	SS00055EG	PLUTONIUM-239/240	PCI/G	0.082		0.003	0.095		0.008	164.444								
SS103294	21-JUL-94	SS00064EG	SS00065EG	PLUTONIUM-239/240	PCI/G	0.21		0.012	0.14		0.005	190.7								
SS140294	22-JUL-94	SS00077EG	SS00076EG	PLUTONIUM-239/240	PCI/G	0.15		0.020	0.19		0.007	182.17								
SS141094	25-JUL-94	SS00085EG	SS00088EG	PLUTONIUM-239/240	PCI/G	0.080		0.003	0.11		0.011	151.648	176.36	17.78	10.08	5	5	100.00	0.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	URANIUM-233,-234	PCI/G	1.3		0.083	1.9		0.062	181.8								
SS102394	29-JUN-94	SS00054EG	SS00055EG	URANIUM-233,-234	PCI/G	2.0		0.053	1.5		0.050	190.2								
SS103294	21-JUL-94	SS00064EG	SS00065EG	URANIUM-233,-234	PCI/G	1.8	B	0.067	1.5		0.075	184								
SS140294	22-JUL-94	SS00077EG	SS00076EG	URANIUM-233,-234	PCI/G	1.7		0.063	2.3		0.21	156								
SS141094	25-JUL-94	SS00085EG	SS00088EG	URANIUM-233,-234	PCI/G	1.9	B	0.061	1.7	B	0.062	187.4	179.88	13.73	7.63	5	5	100.00	0.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	URANIUM-235	PCI/G	0.073	J	0.040	0.059	J	0.040	58.407								
SS102394	29-JUN-94	SS00054EG	SS00055EG	URANIUM-235	PCI/G	0.10	J	0.035	0.072	J	0.033	100.75								
SS103294	21-JUL-94	SS00064EG	SS00065EG	URANIUM-235	PCI/G	0.051	J	0.034	0.055	U	0.060	16.216								
SS140294	22-JUL-94	SS00077EG	SS00076EG	URANIUM-235	PCI/G	0.043	U	0.063	0.036	U	0.26	143.23								
SS141094	25-JUL-94	SS00085EG	SS00088EG	URANIUM-235	PCI/G	0.042	U	0.061	0.032	U	0.062	38.462	71.41	50.79	71.13	5	4	80.00	20.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	URANIUM-238	PCI/G	1.6		0.11	1.9	B	0.062	185.1								
SS102394	29-JUN-94	SS00054EG	SS00055EG	URANIUM-238	PCI/G	2.3		0.053	1.9		0.050	191.5								
SS103294	21-JUL-94	SS00064EG	SS00065EG	URANIUM-238	PCI/G	1.9	B	0.067	1.4		0.039	192								
SS140294	22-JUL-94	SS00077EG	SS00076EG	URANIUM-238	PCI/G	1.9		0.041	2.2		0.26	151.9								
SS141094	25-JUL-94	SS00085EG	SS00088EG	URANIUM-238	PCI/G	1.5	B	0.061	2.0	B	0.071	181.9	180.48	16.54	9.16	5	5	100.00	0.00	estimates
SS101094	23-JUN-94	SS00040EG	SS00041EG	CYANIDE	MG/KG	2.9	U	2.5	2.9	U	2.5	0								
SS102394	29-JUN-94	SS00054EG	SS00055EG	CYANIDE	MG/KG	2.6	U	2.5	2.6	U	2.5	0								

Table C-1
Relative Percent Differences for Real/Duplicate Sample Pairs of Surficial Soils

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUP SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
SS103294	21-JUL-94	SS00064EG	SS00065EG	CYANIDE	MG/KG	2.6	U	2.5	2.6	U	2.5	0								
SS140294	22-JUL-94	SS00077EG	SS00076EG	CYANIDE	MG/KG	2.5	U	2.5	2.5	U	2.5	0								
SS141094	25-JUL-94	SS00085EG	SS00088EG	CYANIDE	MG/KG	2.6	U	2.5	2.6	U	2.5	0				5	0	0.00	100.00	
SS101094	23-JUN-94	SS00040EG	SS00041EG	NITRATE/NITRITE	MG/KG	22		0.1	23		0.1	4								
SS102394	29-JUN-94	SS00054EG	SS00055EG	NITRATE/NITRITE	MG/KG	15		0.1	12		0.1	22								
SS103294	21-JUL-94	SS00064EG	SS00065EG	NITRATE/NITRITE	MG/KG	29		0.1	23		0.1	23								
SS140294	22-JUL-94	SS00077EG	SS00076EG	NITRATE/NITRITE	MG/KG	3		0.1	2		0.1	40								
SS141094	25-JUL-94	SS00085EG	SS00088EG	NITRATE/NITRITE	MG/KG	2		0.1	1		0.1	67	31.20	23.72	76.03	5	2	40.00	60.00	estimates

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50194	08-JUL-94	BH00125ST	BH00126ST	ALUMINUM	MG/KG	7350.00	*	40.0000	7320.00	*	40.0000	0.41								
50394	26-JUL-94	BH00194ST	BH00195ST	ALUMINUM	MG/KG	10900.00	*	40.0000	10200.00	*	40.0000	6.64								
50394	26-JUL-94	BH00196ST	BH00197ST	ALUMINUM	MG/KG	8910.00	*	40.0000	8550.00	*	40.0000	4.12								
50394	26-JUL-94	BH00198ST	BH00199ST	ALUMINUM	MG/KG	9180.00	*	40.0000	7220.00	*	40.0000	23.9								
50394	26-JUL-94	BH00200ST	BH00201ST	ALUMINUM	MG/KG	14400.00	*	40.0000	8610.00	*	40.0000	50.33								
50394	21-JUL-94	BH00176ST	BH00177ST	ALUMINUM	MG/KG	6500.00	*	40.0000	8350.00	*	40.0000	24.92								
50694	29-JUL-94	BH00217ST	BH00218ST	ALUMINUM	MG/KG	4690.00		40.0000	4550.00		40.0000	3.03								
50694	28-JUL-94	BH00205ST	BH00206ST	ALUMINUM	MG/KG	6650.00		40.0000	7600.00		40.0000	13.33								
50694	28-JUL-94	BH00207ST	BH00208ST	ALUMINUM	MG/KG	7430.00		40.0000	9110.00		40.0000	20.31								
50694	28-JUL-94	BH00212ST	BH00213ST	ALUMINUM	MG/KG	7980.00		40.0000	6700.00		40.0000	17.44								
50894	29-JUL-94	BH00223ST	BH00224ST	ALUMINUM	MG/KG	9260.00		40.0000	7300.00		40.0000	23.67								
50894	01-AUG-94	BH00230ST	BH00231ST	ALUMINUM	MG/KG	13000.00		40.0000	13200.00		40.0000	1.53								
50894	01-AUG-94	BH00232ST	BH00233ST	ALUMINUM	MG/KG	11700.00	*	40.0000	8940.00	*	40.0000	26.74								
51194	16-AUG-94	BH00280ST	BH00281ST	ALUMINUM	MG/KG	6390.00		40.0000	7130.00		40.0000	10.95								
51194	11-AUG-94	BH00258ST	BH00259ST	ALUMINUM	MG/KG	7740.00		40.0000	9970.00		40.0000	25.18								
51494	23-JUN-94	BH00080ST	BH00081ST	ALUMINUM	MG/KG	2690.00	*	40.0000	3950.00	*	40.0000	37.95								
51694	22-AUG-94	BH00288ST	BH00289ST	ALUMINUM	MG/KG	4370.00		40.0000	5810.00		40.0000	28.29								
51694	22-AUG-94	BH00291ST	BH00292ST	ALUMINUM	MG/KG	4600.00		40.0000	7080.00		40.0000	42.47								
51694	22-AUG-94	BH00294ST	BH00295ST	ALUMINUM	MG/KG	9340.00		40.0000	9740.00		40.0000	4.19	19.23	14.45	75.11	19	3	15.79	84.21	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	ANTIMONY	MG/KG	2.60	UN	12.0000	2.90	UN	12.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	ANTIMONY	MG/KG	2.80	UN	12.0000	2.80	UN	12.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	ANTIMONY	MG/KG	2.70	UN	12.0000	2.70	UN	12.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	ANTIMONY	MG/KG	2.80	UN	12.0000	2.70	UN	12.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	ANTIMONY	MG/KG	2.70	UN	12.0000	2.80	UN	12.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	ANTIMONY	MG/KG	2.80	UN	12.0000	2.70	UN	12.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	ANTIMONY	MG/KG	2.70	UN	12.0000	2.80	UN	12.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	ANTIMONY	MG/KG	2.60	UN	12.0000	2.60	UN	12.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	ANTIMONY	MG/KG	2.70	UN	12.0000	2.60	UN	12.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	ANTIMONY	MG/KG	3.10	U	12.0000	3.10	U	12.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	ANTIMONY	MG/KG	2.70	UN	12.0000	2.90	U	12.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	ANTIMONY	MG/KG	2.70	UN	12.0000	2.80	UN	12.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	ANTIMONY	MG/KG	2.70	UN	12.0000	2.80	UN	12.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	ANTIMONY	MG/KG	2.80	UN	12.0000	2.80	UN	12.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	ANTIMONY	MG/KG	5.70	U	12.0000	2.70	UN	12.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	ANTIMONY	MG/KG	2.70	UN	12.0000	2.70	UN	12.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	ANTIMONY	MG/KG	2.70	UN	12.0000	2.70	UN	12.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	ANTIMONY	MG/KG	2.90	UN	12.0000	2.90	UN	12.0000	0				18	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	ARSENIC	MG/KG	1.70	B	2.0000	2.60		2.0000	41.86								
50394	26-JUL-94	BH00194ST	BH00195ST	ARSENIC	MG/KG	1.30	B	2.0000	1.50	B	2.0000	14.29								
50394	26-JUL-94	BH00196ST	BH00197ST	ARSENIC	MG/KG	3.60		2.0000	3.10		2.0000	14.93								
50394	26-JUL-94	BH00198ST	BH00199ST	ARSENIC	MG/KG	2.20		2.0000	1.90	B	2.0000	14.63								
50394	26-JUL-94	BH00200ST	BH00201ST	ARSENIC	MG/KG	2.80		2.0000	1.80	B	2.0000	43.48								
50394	21-JUL-94	BH00176ST	BH00177ST	ARSENIC	MG/KG	5.70		2.0000	3.90		2.0000	37.5								
50694	29-JUL-94	BH00217ST	BH00218ST	ARSENIC	MG/KG	1.30	B	2.0000	1.30	B	2.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	ARSENIC	MG/KG	5.90		2.0000	4.40		2.0000	29.13								
50694	28-JUL-94	BH00207ST	BH00208ST	ARSENIC	MG/KG	4.20		2.0000	2.90		2.0000	36.62								
50694	28-JUL-94	BH00212ST	BH00213ST	ARSENIC	MG/KG	2.60		2.0000	3.00		2.0000	14.29								
50894	29-JUL-94	BH00223ST	BH00224ST	ARSENIC	MG/KG	2.20		2.0000	2.20		2.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	ARSENIC	MG/KG	2.10	B	2.0000	2.10	B	2.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	ARSENIC	MG/KG	1.40	B	2.0000	1.50	B	2.0000	6.9								
51194	16-AUG-94	BH00280ST	BH00281ST	ARSENIC	MG/KG	1.30	B	2.0000	1.80	B	2.0000	32.26								
51194	11-AUG-94	BH00258ST	BH00259ST	ARSENIC	MG/KG	3.30		2.0000	3.00		2.0000	9.52								
51494	23-JUN-94	BH00080ST	BH00081ST	ARSENIC	MG/KG	2.30		2.0000	2.20		2.0000	4.44								
51694	22-AUG-94	BH00288ST	BH00289ST	ARSENIC	MG/KG	2.60		2.0000	2.20		2.0000	16.67								
51694	22-AUG-94	BH00291ST	BH00292ST	ARSENIC	MG/KG	2.20		2.0000	2.90		2.0000	27.45								
51694	22-AUG-94	BH00294ST	BH00295ST	ARSENIC	MG/KG	2.00	B	2.0000	2.20		2.0000	9.52	18.60	14.58	78.38	19	4	21.05	78.95	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	BARIUM	MG/KG	48.70		40.0000	49.70		40.0000	2.03								
50394	26-JUL-94	BH00194ST	BH00195ST	BARIUM	MG/KG	53.30		40.0000	46.90		40.0000	12.77								
50394	26-JUL-94	BH00196ST	BH00197ST	BARIUM	MG/KG	52.30		40.0000	43.10		40.0000	19.29								
50394	26-JUL-94	BH00198ST	BH00199ST	BARIUM	MG/KG	55.20		40.0000	54.80		40.0000	0.73								
50394	26-JUL-94	BH00200ST	BH00201ST	BARIUM	MG/KG	66.90		40.0000	66.10		40.0000	1.2								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50394	21-JUL-94	BH00176ST	BH00177ST	BARIUM	MG/KG	50.40		40.0000	61.80		40.0000	20.32								
50694	29-JUL-94	BH00217ST	BH00218ST	BARIUM	MG/KG	32.70	B	40.0000	31.20	B	40.0000	4.69								
50694	28-JUL-94	BH00205ST	BH00206ST	BARIUM	MG/KG	39.90	B	40.0000	65.10		40.0000	48								
50694	28-JUL-94	BH00207ST	BH00208ST	BARIUM	MG/KG	44.50		40.0000	61.90		40.0000	32.71								
50694	28-JUL-94	BH00212ST	BH00213ST	BARIUM	MG/KG	55.80		40.0000	48.60		40.0000	13.79								
50894	29-JUL-94	BH00223ST	BH00224ST	BARIUM	MG/KG	47.70		40.0000	44.10		40.0000	7.84								
50894	01-AUG-94	BH00230ST	BH00231ST	BARIUM	MG/KG	58.90		40.0000	58.70		40.0000	0.34								
50894	01-AUG-94	BH00232ST	BH00233ST	BARIUM	MG/KG	91.00		40.0000	73.20		40.0000	21.68								
51194	16-AUG-94	BH00280ST	BH00281ST	BARIUM	MG/KG	34.40	B	40.0000	37.70	B	40.0000	9.15								
51194	11-AUG-94	BH00258ST	BH00259ST	BARIUM	MG/KG	53.20		40.0000	69.10		40.0000	26								
51494	23-JUN-94	BH00080ST	BH00081ST	BARIUM	MG/KG	35.50	B	40.0000	27.50	B	40.0000	25.4								
51694	22-AUG-94	BH00288ST	BH00289ST	BARIUM	MG/KG	41.70		40.0000	51.30		40.0000	20.65								
51694	22-AUG-94	BH00291ST	BH00292ST	BARIUM	MG/KG	30.30	B	40.0000	40.60	B	40.0000	29.06								
51694	22-AUG-94	BH00294ST	BH00295ST	BARIUM	MG/KG	116.00		40.0000	114.00		40.0000	1.74	15.65	13.11	83.79	19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BERYLLIUM	MG/KG	0.55	B	1.0000	0.53	B	1.0000	3.7								
50394	26-JUL-94	BH00194ST	BH00195ST	BERYLLIUM	MG/KG	0.75	B	1.0000	0.65	B	1.0000	14.29								
50394	26-JUL-94	BH00196ST	BH00197ST	BERYLLIUM	MG/KG	0.69	B	1.0000	0.60	B	1.0000	13.95								
50394	26-JUL-94	BH00198ST	BH00199ST	BERYLLIUM	MG/KG	0.63	B	1.0000	0.61	B	1.0000	3.23								
50394	26-JUL-94	BH00200ST	BH00201ST	BERYLLIUM	MG/KG	0.81	B	1.0000	0.67	B	1.0000	18.92								
50394	21-JUL-94	BH00176ST	BH00177ST	BERYLLIUM	MG/KG	0.47	B	1.0000	0.66	B	1.0000	33.63								
50694	29-JUL-94	BH00217ST	BH00218ST	BERYLLIUM	MG/KG	0.42	B	1.0000	0.40	B	1.0000	4.88								
50694	28-JUL-94	BH00205ST	BH00206ST	BERYLLIUM	MG/KG	0.52	B	1.0000	0.64	B	1.0000	20.69								
50694	28-JUL-94	BH00207ST	BH00208ST	BERYLLIUM	MG/KG	0.87	B	1.0000	0.93	B	1.0000	6.67								
50694	28-JUL-94	BH00212ST	BH00213ST	BERYLLIUM	MG/KG	0.78	B	1.0000	0.65	B	1.0000	18.18								
50894	29-JUL-94	BH00223ST	BH00224ST	BERYLLIUM	MG/KG	0.67	B	1.0000	0.56	B	1.0000	17.89								
50894	01-AUG-94	BH00230ST	BH00231ST	BERYLLIUM	MG/KG	0.93	B	1.0000	0.94	B	1.0000	1.07								
50894	01-AUG-94	BH00232ST	BH00233ST	BERYLLIUM	MG/KG	0.80	B	1.0000	0.74	B	1.0000	7.79								
51194	16-AUG-94	BH00280ST	BH00281ST	BERYLLIUM	MG/KG	0.46	B	1.0000	0.47	B	1.0000	2.15								
51194	11-AUG-94	BH00258ST	BH00259ST	BERYLLIUM	MG/KG	0.50	B	1.0000	0.67	B	1.0000	29.06								
51494	23-JUN-94	BH00080ST	BH00081ST	BERYLLIUM	MG/KG	0.28	B	1.0000	0.29	B	1.0000	3.51								
51694	22-AUG-94	BH00288ST	BH00289ST	BERYLLIUM	MG/KG	0.51	B	1.0000	0.55	B	1.0000	7.55								
51694	22-AUG-94	BH00291ST	BH00292ST	BERYLLIUM	MG/KG	0.50	B	1.0000	0.60	B	1.0000	18.18								
51694	22-AUG-94	BH00294ST	BH00295ST	BERYLLIUM	MG/KG	0.79	B	1.0000	0.75	B	1.0000	5.19	12.13	9.43	77.69	19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	CADMIUM	MG/KG	0.61	U	1.0000	0.68	U	1.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	CADMIUM	MG/KG	0.65	U	1.0000	0.64	U	1.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	CADMIUM	MG/KG	0.62	U	1.0000	0.62	U	1.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	CADMIUM	MG/KG	0.65	U	1.0000	0.61	U	1.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	CADMIUM	MG/KG	0.63	U	1.0000	0.65	U	1.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	CADMIUM	MG/KG	0.65	U	1.0000	0.63	U	1.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	CADMIUM	MG/KG	0.62	U	1.0000	0.65	U	1.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	CADMIUM	MG/KG	0.60	U	1.0000	0.60	U	1.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	CADMIUM	MG/KG	0.63	U	1.0000	0.61	U	1.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	CADMIUM	MG/KG	0.66	U	1.0000	0.63	U	1.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	CADMIUM	MG/KG	0.63	U	1.0000	0.66	U	1.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	CADMIUM	MG/KG	0.62	U	1.0000	0.64	U	1.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	CADMIUM	MG/KG	0.63	U	1.0000	0.64	U	1.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	CADMIUM	MG/KG	0.64	U	1.0000	0.65	U	1.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	CADMIUM	MG/KG	0.62	U	1.0000	0.63	U	1.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	CADMIUM	MG/KG	0.64	U	1.0000	0.63	U	1.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	CADMIUM	MG/KG	0.68	B	1.0000	0.63	U	1.0000	38.1								
51694	22-AUG-94	BH00291ST	BH00292ST	CADMIUM	MG/KG	0.62	U	1.0000	0.62	U	1.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	CADMIUM	MG/KG	0.67	U	1.0000	0.66	U	1.0000	0	2.01	8.74	435.89	19	1	5.26	94.74	
50194	08-JUL-94	BH00125ST	BH00126ST	CALCIUM	MG/KG	1360.00		1000.0000	1410.00		1000.0000	3.61								
50394	26-JUL-94	BH00194ST	BH00195ST	CALCIUM	MG/KG	1460.00		1000.0000	1240.00		1000.0000	16.3								
50394	26-JUL-94	BH00196ST	BH00197ST	CALCIUM	MG/KG	1110.00		1000.0000	975.00	B	1000.0000	12.95								
50394	26-JUL-94	BH00198ST	BH00199ST	CALCIUM	MG/KG	1180.00		1000.0000	1350.00		1000.0000	13.44								
50394	26-JUL-94	BH00200ST	BH00201ST	CALCIUM	MG/KG	1450.00		1000.0000	1340.00		1000.0000	7.89								
50394	21-JUL-94	BH00176ST	BH00177ST	CALCIUM	MG/KG	1030.00	B	1000.0000	1600.00		1000.0000	43.35								
50694	29-JUL-94	BH00217ST	BH00218ST	CALCIUM	MG/KG	692.00	B	1000.0000	701.00	B	1000.0000	1.29								
50694	28-JUL-94	BH00205ST	BH00206ST	CALCIUM	MG/KG	870.00	B	1000.0000	1160.00		1000.0000	28.57								
50694	28-JUL-94	BH00207ST	BH00208ST	CALCIUM	MG/KG	1240.00		1000.0000	1360.00		1000.0000	9.23								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50894	28-JUL-94	BH00212ST	BH00213ST	CALCIUM	MG/KG	1180.00		1000.0000	1040.00	B	1000.0000	12.61								
50894	29-JUL-94	BH00223ST	BH00224ST	CALCIUM	MG/KG	1390.00		1000.0000	1290.00		1000.0000	7.46								
50894	01-AUG-94	BH00230ST	BH00231ST	CALCIUM	MG/KG	1540.00		1000.0000	1640.00		1000.0000	6.29								
50894	01-AUG-94	BH00232ST	BH00233ST	CALCIUM	MG/KG	2280.00		1000.0000	2080.00		1000.0000	9.17								
51194	16-AUG-94	BH00280ST	BH00281ST	CALCIUM	MG/KG	1150.00		1000.0000	1050.00	B	1000.0000	9.09								
51194	11-AUG-94	BH00258ST	BH00259ST	CALCIUM	MG/KG	924.00	B	1000.0000	1260.00		1000.0000	30.77								
51494	23-JUN-94	BH00080ST	BH00081ST	CALCIUM	MG/KG	613.00	B	1000.0000	574.00	B	1000.0000	6.57								
51694	22-AUG-94	BH00288ST	BH00289ST	CALCIUM	MG/KG	924.00	B	1000.0000	1040.00	B	1000.0000	11.81								
51694	22-AUG-94	BH00291ST	BH00292ST	CALCIUM	MG/KG	934.00	B	1000.0000	1270.00		1000.0000	30.49								
51694	22-AUG-94	BH00294ST	BH00295ST	CALCIUM	MG/KG	1710.00		1000.0000	1630.00		1000.0000	4.79	13.98	11.20	80.13	19	1	5.26	94.74	
50194	08-JUL-94	BH00125ST	BH00126ST	CESIUM	MG/KG	8.70	U	200.0000	9.70	U	200.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	CESIUM	MG/KG	9.40	U	200.0000	9.20	U	200.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	CESIUM	MG/KG	8.90	U	200.0000	9.00	U	200.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	CESIUM	MG/KG	9.30	U	200.0000	8.80	U	200.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	CESIUM	MG/KG	9.10	U	200.0000	9.30	U	200.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	CESIUM	MG/KG	9.30	U	200.0000	9.00	U	200.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	CESIUM	MG/KG	8.90	U	200.0000	9.30	U	200.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	CESIUM	MG/KG	9.50	U	200.0000	9.00	U	200.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	CESIUM	MG/KG	9.10	U	200.0000	9.40	U	200.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	CESIUM	MG/KG	8.80	U	200.0000	9.20	U	200.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	CESIUM	MG/KG	9.00	U	200.0000	9.10	U	200.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	CESIUM	MG/KG	9.10	U	200.0000	9.30	U	200.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	CESIUM	MG/KG	8.90	U	200.0000	9.10	U	200.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	CESIUM	MG/KG	9.20	U	200.0000	9.00	U	200.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	CESIUM	MG/KG	10.40	B	200.0000	9.00	U	200.0000	180.23								
51694	22-AUG-94	BH00291ST	BH00292ST	CESIUM	MG/KG	9.00	U	200.0000	8.90	U	200.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	CESIUM	MG/KG	9.60	U	200.0000	9.40	U	200.0000	0	11.34	41.49	365.82	17	1	5.88	94.12	
50194	08-JUL-94	BH00125ST	BH00126ST	CHROMIUM	MG/KG	11.10	*	2.0000	17.80	*	2.0000	46.37								
50394	26-JUL-94	BH00194ST	BH00195ST	CHROMIUM	MG/KG	25.10		2.0000	28.30		2.0000	11.99								
50394	26-JUL-94	BH00196ST	BH00197ST	CHROMIUM	MG/KG	15.20		2.0000	14.10		2.0000	7.51								
50394	26-JUL-94	BH00198ST	BH00199ST	CHROMIUM	MG/KG	13.40		2.0000	9.10		2.0000	38.22								
50394	26-JUL-94	BH00200ST	BH00201ST	CHROMIUM	MG/KG	18.30		2.0000	10.40		2.0000	55.05								
50394	21-JUL-94	BH00176ST	BH00177ST	CHROMIUM	MG/KG	86.70	N	2.0000	11.30	N	2.0000	153.88								
50694	29-JUL-94	BH00217ST	BH00218ST	CHROMIUM	MG/KG	22.00	*	2.0000	14.80	*	2.0000	39.13								
50694	28-JUL-94	BH00205ST	BH00206ST	CHROMIUM	MG/KG	34.60	*	2.0000	38.60	*	2.0000	10.93								
50694	28-JUL-94	BH00207ST	BH00208ST	CHROMIUM	MG/KG	9.80	*	2.0000	11.20	*	2.0000	13.33								
50694	28-JUL-94	BH00212ST	BH00213ST	CHROMIUM	MG/KG	33.10	*	2.0000	8.50	*	2.0000	118.27								
50894	29-JUL-94	BH00223ST	BH00224ST	CHROMIUM	MG/KG	8.90	*	2.0000	7.20	*	2.0000	21.12								
50894	01-AUG-94	BH00230ST	BH00231ST	CHROMIUM	MG/KG	11.40		2.0000	10.90		2.0000	4.48								
50894	01-AUG-94	BH00232ST	BH00233ST	CHROMIUM	MG/KG	17.80		2.0000	49.30		2.0000	93.89								
51194	16-AUG-94	BH00280ST	BH00281ST	CHROMIUM	MG/KG	8.90	N*	2.0000	8.70	N*	2.0000	2.27								
51194	11-AUG-94	BH00258ST	BH00259ST	CHROMIUM	MG/KG	2040.00	N*	2.0000	19.10	N*	2.0000	196.29								
51494	23-JUN-94	BH00080ST	BH00081ST	CHROMIUM	MG/KG	4.40		2.0000	7.80		2.0000	55.74								
51694	22-AUG-94	BH00288ST	BH00289ST	CHROMIUM	MG/KG	12.90		2.0000	12.70		2.0000	1.56								
51694	22-AUG-94	BH00291ST	BH00292ST	CHROMIUM	MG/KG	9.70		2.0000	9.10		2.0000	6.38								
51694	22-AUG-94	BH00294ST	BH00295ST	CHROMIUM	MG/KG	10.80		2.0000	9.40		2.0000	13.86	46.86	55.67	118.81	19	9	47.37	52.63	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	COBALT	MG/KG	5.50	B	10.0000	5.10	B	10.0000	7.55								
50394	26-JUL-94	BH00194ST	BH00195ST	COBALT	MG/KG	4.50	B	10.0000	3.40	B	10.0000	27.85								
50394	26-JUL-94	BH00196ST	BH00197ST	COBALT	MG/KG	4.20	B	10.0000	3.10	B	10.0000	30.14								
50394	26-JUL-94	BH00198ST	BH00199ST	COBALT	MG/KG	4.30	B	10.0000	4.30	B	10.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	COBALT	MG/KG	5.20	B	10.0000	5.40	B	10.0000	3.77								
50394	21-JUL-94	BH00176ST	BH00177ST	COBALT	MG/KG	6.90	B	10.0000	5.10	B	10.0000	30								
50694	29-JUL-94	BH00217ST	BH00218ST	COBALT	MG/KG	2.90	B	10.0000	2.90	B	10.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	COBALT	MG/KG	4.00	B	10.0000	4.20	B	10.0000	4.88								
50694	28-JUL-94	BH00207ST	BH00208ST	COBALT	MG/KG	6.10	B	10.0000	13.00		10.0000	72.25								
50694	28-JUL-94	BH00212ST	BH00213ST	COBALT	MG/KG	6.10	B	10.0000	5.10	B	10.0000	17.86								
50894	29-JUL-94	BH00223ST	BH00224ST	COBALT	MG/KG	5.30	B	10.0000	5.90	B	10.0000	10.71								
50894	01-AUG-94	BH00230ST	BH00231ST	COBALT	MG/KG	4.10	B	10.0000	4.60	B	10.0000	11.49								
50894	01-AUG-94	BH00232ST	BH00233ST	COBALT	MG/KG	6.40	B	10.0000	6.80	B	10.0000	6.06								
51194	16-AUG-94	BH00280ST	BH00281ST	COBALT	MG/KG	2.70	B	10.0000	2.60	B	10.0000	3.77								
51194	11-AUG-94	BH00258ST	BH00259ST	COBALT	MG/KG	8.60	B	10.0000	6.00	B	10.0000	35.62								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
51494	23-JUN-94	BH00080ST	BH00081ST	COBALT	MG/KG	1.90	B	10.0000	3.50	B	10.0000	59.26								
51694	22-AUG-94	BH00288ST	BH00289ST	COBALT	MG/KG	3.40	B	10.0000	4.50	B	10.0000	27.85								
51694	22-AUG-94	BH00291ST	BH00292ST	COBALT	MG/KG	2.30	B	10.0000	2.80	B	10.0000	19.61								
51694	22-AUG-94	BH00294ST	BH00295ST	COBALT	MG/KG	6.30	B	10.0000	5.80	B	10.0000	8.26	19.84	19.79	99.74	19	3	15.79	84.21	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	COPPER	MG/KG	10.70		5.0000	10.90		5.0000	1.85								
50394	26-JUL-94	BH00194ST	BH00195ST	COPPER	MG/KG	9.40		5.0000	8.50		5.0000	10.06								
50394	26-JUL-94	BH00196ST	BH00197ST	COPPER	MG/KG	15.00		5.0000	12.70		5.0000	16.61								
50394	26-JUL-94	BH00198ST	BH00199ST	COPPER	MG/KG	10.40		5.0000	10.00		5.0000	3.92								
50394	26-JUL-94	BH00200ST	BH00201ST	COPPER	MG/KG	13.00		5.0000	11.60		5.0000	11.38								
50394	21-JUL-94	BH00176ST	BH00177ST	COPPER	MG/KG	7.80	N	5.0000	7.00	N	5.0000	10.81								
50694	29-JUL-94	BH00217ST	BH00218ST	COPPER	MG/KG	6.90		5.0000	6.60		5.0000	4.44								
50694	28-JUL-94	BH00205ST	BH00206ST	COPPER	MG/KG	5.60		5.0000	6.70		5.0000	17.89								
50694	28-JUL-94	BH00207ST	BH00208ST	COPPER	MG/KG	7.20		5.0000	8.20		5.0000	12.99								
50694	28-JUL-94	BH00212ST	BH00213ST	COPPER	MG/KG	17.30		5.0000	10.80		5.0000	46.26								
50894	29-JUL-94	BH00223ST	BH00224ST	COPPER	MG/KG	9.60		5.0000	8.80		5.0000	8.7								
50894	01-AUG-94	BH00230ST	BH00231ST	COPPER	MG/KG	8.80		5.0000	8.60		5.0000	2.3								
50894	01-AUG-94	BH00232ST	BH00233ST	COPPER	MG/KG	11.40		5.0000	18.70		5.0000	48.5								
51194	16-AUG-94	BH00280ST	BH00281ST	COPPER	MG/KG	9.90		5.0000	9.40		5.0000	5.18								
51194	11-AUG-94	BH00258ST	BH00259ST	COPPER	MG/KG	25.90		5.0000	12.50		5.0000	69.79								
51494	23-JUN-94	BH00080ST	BH00081ST	COPPER	MG/KG	5.60		5.0000	5.70		5.0000	1.77								
51694	22-AUG-94	BH00288ST	BH00289ST	COPPER	MG/KG	9.40		5.0000	10.00		5.0000	6.19								
51694	22-AUG-94	BH00291ST	BH00292ST	COPPER	MG/KG	8.30		5.0000	10.50		5.0000	23.4								
51694	22-AUG-94	BH00294ST	BH00295ST	COPPER	MG/KG	11.00		5.0000	11.40		5.0000	3.57	16.08	18.72	116.38	19	3	15.79	84.21	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	IRON	MG/KG	8140.00		20.0000	9190.00		20.0000	12.12								
50394	26-JUL-94	BH00194ST	BH00195ST	IRON	MG/KG	10100.00	*	20.0000	9450.00	*	20.0000	6.65								
50394	26-JUL-94	BH00196ST	BH00197ST	IRON	MG/KG	10900.00	*	20.0000	10400.00	*	20.0000	4.69								
50394	26-JUL-94	BH00198ST	BH00199ST	IRON	MG/KG	10800.00	*	20.0000	9180.00	*	20.0000	16.22								
50394	26-JUL-94	BH00200ST	BH00201ST	IRON	MG/KG	13400.00	*	20.0000	9740.00	*	20.0000	31.63								
50394	21-JUL-94	BH00176ST	BH00177ST	IRON	MG/KG	15100.00	*	20.0000	10100.00	*	20.0000	39.68								
50694	29-JUL-94	BH00217ST	BH00218ST	IRON	MG/KG	6140.00	*	20.0000	5480.00	*	20.0000	11.36								
50694	28-JUL-94	BH00205ST	BH00206ST	IRON	MG/KG	8020.00	*	20.0000	10100.00	*	20.0000	22.96								
50694	28-JUL-94	BH00207ST	BH00208ST	IRON	MG/KG	9780.00	*	20.0000	10900.00	*	20.0000	10.83								
50694	28-JUL-94	BH00212ST	BH00213ST	IRON	MG/KG	12900.00	*	20.0000	9030.00	*	20.0000	35.29								
50894	29-JUL-94	BH00223ST	BH00224ST	IRON	MG/KG	9040.00	*	20.0000	7230.00	*	20.0000	22.25								
50894	01-AUG-94	BH00230ST	BH00231ST	IRON	MG/KG	10400.00		20.0000	10400.00		20.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	IRON	MG/KG	12100.00	*	20.0000	14900.00	*	20.0000	20.74								
51194	16-AUG-94	BH00280ST	BH00281ST	IRON	MG/KG	8000.00		20.0000	7360.00		20.0000	8.33								
51194	11-AUG-94	BH00258ST	BH00259ST	IRON	MG/KG	25000.00		20.0000	11900.00		20.0000	71								
51494	23-JUN-94	BH00080ST	BH00081ST	IRON	MG/KG	4100.00	*	20.0000	5060.00	*	20.0000	20.96								
51694	22-AUG-94	BH00288ST	BH00289ST	IRON	MG/KG	7620.00	*	20.0000	8620.00	*	20.0000	12.32								
51694	22-AUG-94	BH00291ST	BH00292ST	IRON	MG/KG	7270.00	*	20.0000	8520.00	*	20.0000	15.83								
51694	22-AUG-94	BH00294ST	BH00295ST	IRON	MG/KG	10900.00	*	20.0000	10200.00	*	20.0000	6.64	19.45	16.34	84.02	19	2	10.53	89.47	
50194	08-JUL-94	BH00125ST	BH00126ST	LEAD	MG/KG	3.90		0.6000	6.00		0.6000	42.42								
50394	26-JUL-94	BH00194ST	BH00195ST	LEAD	MG/KG	4.30		0.6000	4.50		0.6000	4.55								
50394	26-JUL-94	BH00196ST	BH00197ST	LEAD	MG/KG	4.60		0.6000	4.70		0.6000	2.15								
50394	26-JUL-94	BH00198ST	BH00199ST	LEAD	MG/KG	4.80	S	0.6000	5.40		0.6000	11.76								
50394	26-JUL-94	BH00200ST	BH00201ST	LEAD	MG/KG	6.30		0.6000	4.70		0.6000	29.09								
50394	21-JUL-94	BH00176ST	BH00177ST	LEAD	MG/KG	8.20	N	0.6000	4.50	N	0.6000	58.27								
50694	29-JUL-94	BH00217ST	BH00218ST	LEAD	MG/KG	2.80		0.6000	3.00		0.6000	6.9								
50694	28-JUL-94	BH00205ST	BH00206ST	LEAD	MG/KG	8.40		0.6000	6.20		0.6000	30.14								
50694	28-JUL-94	BH00207ST	BH00208ST	LEAD	MG/KG	5.60		0.6000	7.10		0.6000	23.62								
50694	28-JUL-94	BH00212ST	BH00213ST	LEAD	MG/KG	4.00		0.6000	5.00		0.6000	22.22								
50894	29-JUL-94	BH00223ST	BH00224ST	LEAD	MG/KG	4.70		0.6000	5.50		0.6000	15.69								
50894	01-AUG-94	BH00230ST	BH00231ST	LEAD	MG/KG	5.10	N	0.6000	5.20	SN	0.6000	1.94								
50894	01-AUG-94	BH00232ST	BH00233ST	LEAD	MG/KG	4.70		0.6000	4.90		0.6000	4.17								
51194	16-AUG-94	BH00280ST	BH00281ST	LEAD	MG/KG	3.10		0.6000	3.00		0.6000	3.28								
51194	11-AUG-94	BH00258ST	BH00259ST	LEAD	MG/KG	6.50		0.6000	6.10	S	0.6000	6.35								
51494	23-JUN-94	BH00080ST	BH00081ST	LEAD	MG/KG	3.70		0.6000	3.60		0.6000	2.74								
51694	22-AUG-94	BH00288ST	BH00289ST	LEAD	MG/KG	4.20		0.6000	4.30		0.6000	2.35								
51694	22-AUG-94	BH00291ST	BH00292ST	LEAD	MG/KG	3.30		0.6000	4.00		0.6000	19.18								
51694	22-AUG-94	BH00294ST	BH00295ST	LEAD	MG/KG	8.00		0.6000	5.20		0.6000	42.42	17.33	16.68	96.24	19	3	15.79	84.21	estimates

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50194	08-JUL-94	BH00125ST	BH00126ST	LITHIUM	MG/KG	4.40	B	20.0000	5.90	B	20.0000	29.13								
50394	26-JUL-94	BH00194ST	BH00195ST	LITHIUM	MG/KG	13.30	B	20.0000	11.60	B	20.0000	13.65								
50394	26-JUL-94	BH00196ST	BH00197ST	LITHIUM	MG/KG	6.20	B	20.0000	5.60	B	20.0000	10.17								
50394	26-JUL-94	BH00198ST	BH00199ST	LITHIUM	MG/KG	6.10	B	20.0000	4.50	B	20.0000	30.19								
50394	26-JUL-94	BH00200ST	BH00201ST	LITHIUM	MG/KG	10.50	B	20.0000	5.90	B	20.0000	56.1								
50394	21-JUL-94	BH00176ST	BH00177ST	LITHIUM	MG/KG	3.60	B	20.0000	4.40	B	20.0000	20								
50694	29-JUL-94	BH00217ST	BH00218ST	LITHIUM	MG/KG	2.40	B	20.0000	2.50	B	20.0000	4.08								
50694	28-JUL-94	BH00205ST	BH00206ST	LITHIUM	MG/KG	3.80	B	20.0000	4.00	B	20.0000	5.13								
50694	28-JUL-94	BH00207ST	BH00208ST	LITHIUM	MG/KG	4.70	B	20.0000	5.90	B	20.0000	22.64								
50694	28-JUL-94	BH00212ST	BH00213ST	LITHIUM	MG/KG	4.30	B	20.0000	3.40	B	20.0000	23.38								
50894	29-JUL-94	BH00223ST	BH00224ST	LITHIUM	MG/KG	4.80	B	20.0000	3.60	B	20.0000	28.57								
50894	01-AUG-94	BH00230ST	BH00231ST	LITHIUM	MG/KG	6.40	B	20.0000	6.50	B	20.0000	1.55								
50894	01-AUG-94	BH00232ST	BH00233ST	LITHIUM	MG/KG	10.60	B	20.0000	10.00	B	20.0000	5.83								
51194	16-AUG-94	BH00280ST	BH00281ST	LITHIUM	MG/KG	3.60	B	20.0000	4.20	B	20.0000	15.38								
51194	11-AUG-94	BH00258ST	BH00259ST	LITHIUM	MG/KG	4.90	B	20.0000	6.40	B	20.0000	26.55								
51494	23-JUN-94	BH00080ST	BH00081ST	LITHIUM	MG/KG	1.30	B	20.0000	2.20	B	20.0000	51.43								
51694	22-AUG-94	BH00288ST	BH00289ST	LITHIUM	MG/KG	2.90	B	20.0000	3.40	B	20.0000	15.87								
51694	22-AUG-94	BH00291ST	BH00292ST	LITHIUM	MG/KG	2.40	B	20.0000	3.50	B	20.0000	37.29								
51694	22-AUG-94	BH00294ST	BH00295ST	LITHIUM	MG/KG	6.30	B	20.0000	5.90	B	20.0000	6.56	21.24	15.37	72.39	19	3	15.79	84.21	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	MAGNESIUM	MG/KG	1320.00		1000.0000	1520.00		1000.0000	14.08								
50394	26-JUL-94	BH00194ST	BH00195ST	MAGNESIUM	MG/KG	1870.00		1000.0000	1700.00		1000.0000	9.52								
50394	26-JUL-94	BH00196ST	BH00197ST	MAGNESIUM	MG/KG	1280.00		1000.0000	1200.00		1000.0000	6.45								
50394	26-JUL-94	BH00198ST	BH00199ST	MAGNESIUM	MG/KG	1500.00		1000.0000	1400.00		1000.0000	6.9								
50394	26-JUL-94	BH00200ST	BH00201ST	MAGNESIUM	MG/KG	2170.00		1000.0000	1690.00		1000.0000	24.87								
50394	21-JUL-94	BH00176ST	BH00177ST	MAGNESIUM	MG/KG	893.00	B	1000.0000	1340.00		1000.0000	40.04								
50694	29-JUL-94	BH00217ST	BH00218ST	MAGNESIUM	MG/KG	571.00	B	1000.0000	622.00	B	1000.0000	8.55								
50694	28-JUL-94	BH00205ST	BH00206ST	MAGNESIUM	MG/KG	620.00	B	1000.0000	727.00	B	1000.0000	15.89								
50694	28-JUL-94	BH00207ST	BH00208ST	MAGNESIUM	MG/KG	1270.00		1000.0000	1390.00		1000.0000	9.02								
50694	28-JUL-94	BH00212ST	BH00213ST	MAGNESIUM	MG/KG	1250.00		1000.0000	1050.00	B	1000.0000	17.39								
50894	29-JUL-94	BH00223ST	BH00224ST	MAGNESIUM	MG/KG	1300.00		1000.0000	1160.00		1000.0000	11.38								
50894	01-AUG-94	BH00230ST	BH00231ST	MAGNESIUM	MG/KG	1710.00		1000.0000	1790.00		1000.0000	4.57								
50894	01-AUG-94	BH00232ST	BH00233ST	MAGNESIUM	MG/KG	2900.00		1000.0000	2850.00		1000.0000	1.74								
51194	16-AUG-94	BH00280ST	BH00281ST	MAGNESIUM	MG/KG	1110.00		1000.0000	1080.00		1000.0000	2.74								
51194	11-AUG-94	BH00258ST	BH00259ST	MAGNESIUM	MG/KG	1070.00		1000.0000	1460.00		1000.0000	30.83								
51494	23-JUN-94	BH00080ST	BH00081ST	MAGNESIUM	MG/KG	430.00	B	1000.0000	510.00	B	1000.0000	17.02								
51694	22-AUG-94	BH00288ST	BH00289ST	MAGNESIUM	MG/KG	1020.00	B	1000.0000	1140.00		1000.0000	11.11								
51694	22-AUG-94	BH00291ST	BH00292ST	MAGNESIUM	MG/KG	883.00	B	1000.0000	1200.00		1000.0000	30.44								
51694	22-AUG-94	BH00294ST	BH00295ST	MAGNESIUM	MG/KG	1790.00		1000.0000	1720.00		1000.0000	3.99	14.03	10.64	75.84	19	1	5.26	94.74	
50194	08-JUL-94	BH00125ST	BH00126ST	MANGANESE	MG/KG	140.00	*	3.0000	201.00	*	3.0000	35.78								
50394	26-JUL-94	BH00194ST	BH00195ST	MANGANESE	MG/KG	172.00	N*	3.0000	144.00	N*	3.0000	17.72								
50394	26-JUL-94	BH00196ST	BH00197ST	MANGANESE	MG/KG	189.00	N*	3.0000	126.00	N*	3.0000	40								
50394	26-JUL-94	BH00198ST	BH00199ST	MANGANESE	MG/KG	160.00	N*	3.0000	147.00	N*	3.0000	8.47								
50394	26-JUL-94	BH00200ST	BH00201ST	MANGANESE	MG/KG	226.00	N*	3.0000	216.00	N*	3.0000	4.52								
50394	21-JUL-94	BH00176ST	BH00177ST	MANGANESE	MG/KG	197.00	N*	3.0000	108.00	N*	3.0000	58.36								
50694	29-JUL-94	BH00217ST	BH00218ST	MANGANESE	MG/KG	90.70	N*	3.0000	84.90	N*	3.0000	6.61								
50694	28-JUL-94	BH00205ST	BH00206ST	MANGANESE	MG/KG	69.10	N*	3.0000	89.30	N*	3.0000	25.51								
50694	28-JUL-94	BH00207ST	BH00208ST	MANGANESE	MG/KG	134.00	N*	3.0000	340.00	N*	3.0000	86.92								
50694	28-JUL-94	BH00212ST	BH00213ST	MANGANESE	MG/KG	277.00	N*	3.0000	172.00	N*	3.0000	46.77								
50894	29-JUL-94	BH00223ST	BH00224ST	MANGANESE	MG/KG	136.00	N*	3.0000	159.00	N*	3.0000	15.59								
50894	01-AUG-94	BH00230ST	BH00231ST	MANGANESE	MG/KG	135.00		3.0000	137.00		3.0000	1.47								
50894	01-AUG-94	BH00232ST	BH00233ST	MANGANESE	MG/KG	318.00	N*	3.0000	242.00	N*	3.0000	27.14								
51194	16-AUG-94	BH00280ST	BH00281ST	MANGANESE	MG/KG	60.10		3.0000	70.60		3.0000	16.07								
51194	11-AUG-94	BH00258ST	BH00259ST	MANGANESE	MG/KG	416.00		3.0000	358.00		3.0000	14.99								
51494	23-JUN-94	BH00080ST	BH00081ST	MANGANESE	MG/KG	110.00	N*	3.0000	99.50	N*	3.0000	10.02								
51694	22-AUG-94	BH00288ST	BH00289ST	MANGANESE	MG/KG	170.00	*	3.0000	244.00	*	3.0000	35.75								
51694	22-AUG-94	BH00291ST	BH00292ST	MANGANESE	MG/KG	103.00	*	3.0000	112.00	*	3.0000	8.37								
51694	22-AUG-94	BH00294ST	BH00295ST	MANGANESE	MG/KG	491.00	*	3.0000	465.00	*	3.0000	5.44	24.50	21.94	89.57	19	5	26.32	73.68	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	MERCURY	MG/KG	0.10	UN	0.1000	0.11	UN	0.1000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	MERCURY	MG/KG	0.10	U	0.1000	0.10	U	0.1000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	MERCURY	MG/KG	0.10	U	0.1000	0.10	U	0.1000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	MERCURY	MG/KG	0.11	U	0.1000	0.10	U	0.1000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50394	26-JUL-94	BH00200ST	BH00201ST	MERCURY	MG/KG	0.09	U	0.1000	0.10	U	0.1000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	MERCURY	MG/KG	0.10	U	0.1000	0.11	U	0.1000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	MERCURY	MG/KG	0.09	U	0.1000	0.10	U	0.1000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	MERCURY	MG/KG	0.10	U	0.1000	0.08	U	0.1000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	MERCURY	MG/KG	0.10	U	0.1000	0.09	U	0.1000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	MERCURY	MG/KG	0.10	U	0.1000	0.09	U	0.1000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	MERCURY	MG/KG	0.09	U	0.1000	0.11	U	0.1000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	MERCURY	MG/KG	0.09	UN*	0.1000	0.11	UN*	0.1000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	MERCURY	MG/KG	0.10	U	0.1000	0.09	U	0.1000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	MERCURY	MG/KG	0.11	U*	0.1000	0.11	U*	0.1000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	MERCURY	MG/KG	0.11	U*	0.1000	0.11	U*	0.1000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	MERCURY	MG/KG	0.09	U	0.1000	0.09	U	0.1000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	MERCURY	MG/KG	0.10	U	0.1000	0.09	U	0.1000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	MERCURY	MG/KG	0.10	U	0.1000	0.09	U	0.1000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	MERCURY	MG/KG	0.12	U	0.1000	0.11	U	0.1000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	MOLYBDENUM	MG/KG	1.20	U	40.0000	3.00	U	40.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	MOLYBDENUM	MG/KG	4.10	B	40.0000	4.30	B	40.0000	4.76								
50394	26-JUL-94	BH00196ST	BH00197ST	MOLYBDENUM	MG/KG	2.10	B	40.0000	1.30	B	40.0000	47.06								
50394	26-JUL-94	BH00198ST	BH00199ST	MOLYBDENUM	MG/KG	1.30	B	40.0000	0.66	B	40.0000	65.31								
50394	26-JUL-94	BH00200ST	BH00201ST	MOLYBDENUM	MG/KG	2.00	B	40.0000	0.77	B	40.0000	88.81								
50394	21-JUL-94	BH00176ST	BH00177ST	MOLYBDENUM	MG/KG	18.70	B	40.0000	1.10	B	40.0000	177.78								
50694	29-JUL-94	BH00217ST	BH00218ST	MOLYBDENUM	MG/KG	2.80	B	40.0000	1.90	B	40.0000	38.3								
50694	28-JUL-94	BH00205ST	BH00206ST	MOLYBDENUM	MG/KG	5.00	B	40.0000	5.10	B	40.0000	1.98								
50694	28-JUL-94	BH00207ST	BH00208ST	MOLYBDENUM	MG/KG	0.95	B	40.0000	1.40	B	40.0000	38.3								
50694	28-JUL-94	BH00212ST	BH00213ST	MOLYBDENUM	MG/KG	6.00	B	40.0000	1.20	B	40.0000	133.33								
50894	29-JUL-94	BH00223ST	BH00224ST	MOLYBDENUM	MG/KG	0.63	U	40.0000	0.66	U	40.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	MOLYBDENUM	MG/KG	0.65	U	40.0000	0.64	U	40.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	MOLYBDENUM	MG/KG	1.70	B	40.0000	11.00	B	40.0000	146.46								
51194	16-AUG-94	BH00280ST	BH00281ST	MOLYBDENUM	MG/KG	1.20	B	40.0000	1.10	B	40.0000	8.7								
51194	11-AUG-94	BH00258ST	BH00259ST	MOLYBDENUM	MG/KG	241.00		40.0000	1.90	B	40.0000	196.87								
51494	23-JUN-94	BH00080ST	BH00081ST	MOLYBDENUM	MG/KG	1.00	U	40.0000	1.10	U	40.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	MOLYBDENUM	MG/KG	1.90	U	40.0000	2.30	U	40.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	MOLYBDENUM	MG/KG	0.69	U	40.0000	0.73	U	40.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	MOLYBDENUM	MG/KG	1.90	U	40.0000	1.90	U	40.0000	0	49.88	66.55	133.44	19	9	47.37	52.63	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	NICKEL	MG/KG	6.50	B	8.0000	9.40		8.0000	36.48								
50394	26-JUL-94	BH00194ST	BH00195ST	NICKEL	MG/KG	10.20		8.0000	11.30		8.0000	10.23								
50394	26-JUL-94	BH00196ST	BH00197ST	NICKEL	MG/KG	8.60		8.0000	7.10	B	8.0000	19.11								
50394	26-JUL-94	BH00198ST	BH00199ST	NICKEL	MG/KG	7.40	B	8.0000	7.20	B	8.0000	2.74								
50394	26-JUL-94	BH00200ST	BH00201ST	NICKEL	MG/KG	7.90	B	8.0000	7.90	B	8.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	NICKEL	MG/KG	15.20	N*	8.0000	10.80	N*	8.0000	33.85								
50694	29-JUL-94	BH00217ST	BH00218ST	NICKEL	MG/KG	5.00	B	8.0000	5.20	B	8.0000	3.92								
50694	28-JUL-94	BH00205ST	BH00206ST	NICKEL	MG/KG	6.80	B	8.0000	7.90	B	8.0000	14.97								
50694	28-JUL-94	BH00207ST	BH00208ST	NICKEL	MG/KG	9.70		8.0000	12.80		8.0000	27.56								
50694	28-JUL-94	BH00212ST	BH00213ST	NICKEL	MG/KG	13.70		8.0000	7.90	B	8.0000	53.7								
50894	29-JUL-94	BH00223ST	BH00224ST	NICKEL	MG/KG	8.20	B	8.0000	7.80	B	8.0000	5								
50894	01-AUG-94	BH00230ST	BH00231ST	NICKEL	MG/KG	8.30		8.0000	7.00	B	8.0000	16.99								
50894	01-AUG-94	BH00232ST	BH00233ST	NICKEL	MG/KG	15.40		8.0000	81.60		8.0000	136.49								
51194	16-AUG-94	BH00280ST	BH00281ST	NICKEL	MG/KG	5.70	B	8.0000	5.70	B	8.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	NICKEL	MG/KG	38.30		8.0000	10.50		8.0000	113.93								
51494	23-JUN-94	BH00080ST	BH00081ST	NICKEL	MG/KG	3.00	B	8.0000	4.30	B	8.0000	35.62								
51694	22-AUG-94	BH00288ST	BH00289ST	NICKEL	MG/KG	5.70	B	8.0000	8.20	B	8.0000	35.97								
51694	22-AUG-94	BH00291ST	BH00292ST	NICKEL	MG/KG	6.50	B	8.0000	6.30	B	8.0000	3.13								
51694	22-AUG-94	BH00294ST	BH00295ST	NICKEL	MG/KG	13.60		8.0000	13.40		8.0000	1.48	29.01	37.52	129.36	19	6	31.58	68.42	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	POTASSIUM	MG/KG	962.00	B	1000.0000	1050.00	B	1000.0000	8.75								
50394	26-JUL-94	BH00194ST	BH00195ST	POTASSIUM	MG/KG	2090.00		1000.0000	1820.00		1000.0000	13.81								
50394	26-JUL-94	BH00196ST	BH00197ST	POTASSIUM	MG/KG	1200.00		1000.0000	1140.00		1000.0000	5.13								
50394	26-JUL-94	BH00198ST	BH00199ST	POTASSIUM	MG/KG	1360.00		1000.0000	1350.00		1000.0000	0.74								
50394	26-JUL-94	BH00200ST	BH00201ST	POTASSIUM	MG/KG	1840.00		1000.0000	1370.00		1000.0000	29.28								
50394	21-JUL-94	BH00176ST	BH00177ST	POTASSIUM	MG/KG	782.00	B	1000.0000	1080.00		1000.0000	32.01								
50694	29-JUL-94	BH00217ST	BH00218ST	POTASSIUM	MG/KG	621.00	U	1000.0000	668.00	U	1000.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	POTASSIUM	MG/KG	683.00	B	1000.0000	699.00	B	1000.0000	2.32								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50694	28-JUL-94	BH00207ST	BH00208ST	POTASSIUM	MG/KG	985.00	B	1000.0000	1120.00		1000.0000	12.83								
50694	28-JUL-94	BH00212ST	BH00213ST	POTASSIUM	MG/KG	906.00	B	1000.0000	756.00	B	1000.0000	18.05								
50894	29-JUL-94	BH00223ST	BH00224ST	POTASSIUM	MG/KG	890.00	B	1000.0000	753.00	B	1000.0000	16.68								
50894	01-AUG-94	BH00230ST	BH00231ST	POTASSIUM	MG/KG	1470.00		1000.0000	1550.00		1000.0000	5.3								
50894	01-AUG-94	BH00232ST	BH00233ST	POTASSIUM	MG/KG	1430.00		1000.0000	1300.00		1000.0000	9.52								
51194	16-AUG-94	BH00280ST	BH00281ST	POTASSIUM	MG/KG	953.00	B	1000.0000	991.00	B	1000.0000	3.91								
51194	11-AUG-94	BH00258ST	BH00259ST	POTASSIUM	MG/KG	974.00	B	1000.0000	1220.00		1000.0000	22.42								
51494	23-JUN-94	BH00080ST	BH00081ST	POTASSIUM	MG/KG	385.00	U	1000.0000	534.00	B	1000.0000	60.76								
51694	22-AUG-94	BH00288ST	BH00289ST	POTASSIUM	MG/KG	787.00	B	1000.0000	842.00	B	1000.0000	6.75								
51694	22-AUG-94	BH00291ST	BH00292ST	POTASSIUM	MG/KG	598.00	B	1000.0000	915.00	B	1000.0000	41.9								
51694	22-AUG-94	BH00294ST	BH00295ST	POTASSIUM	MG/KG	1450.00		1000.0000	1410.00		1000.0000	2.8	15.42	15.93	103.34	19	2	10.53	89.47	
50194	08-JUL-94	BH00125ST	BH00126ST	SELENIUM	MG/KG	0.41	U	1.0000	0.47	U	1.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	SELENIUM	MG/KG	0.44	U	1.0000	0.43	U	1.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	SELENIUM	MG/KG	0.41	U	1.0000	0.40	U	1.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	SELENIUM	MG/KG	0.41	UW	1.0000	0.41	U	1.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	SELENIUM	MG/KG	0.42	U	1.0000	0.43	U	1.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	SELENIUM	MG/KG	0.44	UW	1.0000	0.44	U	1.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	SELENIUM	MG/KG	0.42	U	1.0000	0.43	U	1.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	SELENIUM	MG/KG	0.47	B	1.0000	0.40	UW	1.0000	72.11								
50694	28-JUL-94	BH00207ST	BH00208ST	SELENIUM	MG/KG	0.42	U	1.0000	0.41	U	1.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	SELENIUM	MG/KG	0.44	U	1.0000	0.43	U	1.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	SELENIUM	MG/KG	0.43	U	1.0000	0.44	U	1.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	SELENIUM	MG/KG	0.42	U	1.0000	0.43	U	1.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	SELENIUM	MG/KG	0.42	U	1.0000	0.42	U	1.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	SELENIUM	MG/KG	0.42	U	1.0000	0.43	U	1.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	SELENIUM	MG/KG	0.42	U	1.0000	0.43	U	1.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	SELENIUM	MG/KG	0.43	U	1.0000	0.41	U	1.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	SELENIUM	MG/KG	0.40	UN	1.0000	0.42	UN	1.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	SELENIUM	MG/KG	0.40	UN	1.0000	0.41	UN	1.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	SELENIUM	MG/KG	0.45	UN	1.0000	0.43	UN	1.0000	0	3.80	16.54	435.89	19	1	5.26	94.74	
50194	08-JUL-94	BH00125ST	BH00126ST	SILVER	MG/KG	0.41	U	2.0000	0.45	U	2.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	SILVER	MG/KG	0.44	U	2.0000	0.43	U	2.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	SILVER	MG/KG	3.80		2.0000	1.60	U	2.0000	62.07								
50394	26-JUL-94	BH00198ST	BH00199ST	SILVER	MG/KG	0.87	U	2.0000	0.79	U	2.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	SILVER	MG/KG	0.42	U	2.0000	0.43	U	2.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	SILVER	MG/KG	0.43	U	2.0000	0.42	U	2.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	SILVER	MG/KG	0.41	U	2.0000	0.43	U	2.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	SILVER	MG/KG	0.40	U	2.0000	0.40	U	2.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	SILVER	MG/KG	0.42	U	2.0000	0.41	U	2.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	SILVER	MG/KG	0.44	U	2.0000	0.42	U	2.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	SILVER	MG/KG	0.42	U	2.0000	0.44	U	2.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	SILVER	MG/KG	0.41	U	2.0000	0.56	B	2.0000	112.5								
50894	01-AUG-94	BH00232ST	BH00233ST	SILVER	MG/KG	0.42	U	2.0000	0.42	U	2.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	SILVER	MG/KG	0.42	U	2.0000	0.43	U	2.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	SILVER	MG/KG	0.41	U	2.0000	0.42	U	2.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	SILVER	MG/KG	0.43	U	2.0000	0.42	U	2.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	SILVER	MG/KG	0.41	U	2.0000	0.42	U	2.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	SILVER	MG/KG	0.42	U	2.0000	0.41	U	2.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	SILVER	MG/KG	0.45	U	2.0000	0.44	U	2.0000	0	9.19	28.78	313.19	19	2	10.53	89.47	
50194	08-JUL-94	BH00125ST	BH00126ST	SODIUM	MG/KG	84.20	B	1000.0000	84.40	B	1000.0000	0.24								
50394	26-JUL-94	BH00194ST	BH00195ST	SODIUM	MG/KG	103.00	B	1000.0000	87.30	B	1000.0000	16.5								
50394	26-JUL-94	BH00196ST	BH00197ST	SODIUM	MG/KG	72.30	B	1000.0000	65.40	B	1000.0000	10.02								
50394	26-JUL-94	BH00198ST	BH00199ST	SODIUM	MG/KG	62.30	B	1000.0000	63.90	B	1000.0000	2.54								
50394	26-JUL-94	BH00200ST	BH00201ST	SODIUM	MG/KG	83.30	B	1000.0000	71.70	B	1000.0000	14.97								
50394	21-JUL-94	BH00176ST	BH00177ST	SODIUM	MG/KG	54.30	B	1000.0000	160.00	B	1000.0000	98.65								
50694	29-JUL-94	BH00217ST	BH00218ST	SODIUM	MG/KG	57.50	B	1000.0000	53.40	B	1000.0000	7.39								
50694	28-JUL-94	BH00205ST	BH00206ST	SODIUM	MG/KG	48.90	B	1000.0000	50.50	B	1000.0000	3.22								
50694	28-JUL-94	BH00207ST	BH00208ST	SODIUM	MG/KG	62.90	B	1000.0000	74.80	B	1000.0000	17.28								
50694	28-JUL-94	BH00212ST	BH00213ST	SODIUM	MG/KG	64.90	B	1000.0000	58.50	B	1000.0000	10.37								
50894	29-JUL-94	BH00223ST	BH00224ST	SODIUM	MG/KG	56.30	B	1000.0000	54.50	B	1000.0000	3.25								
50894	01-AUG-94	BH00230ST	BH00231ST	SODIUM	MG/KG	72.60	B	1000.0000	71.00	B	1000.0000	2.23								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50894	01-AUG-94	BH00232ST	BH00233ST	SODIUM	MG/KG	104.00	B	1000.0000	99.10	B	1000.0000	4.83								
51194	16-AUG-94	BH00280ST	BH00281ST	SODIUM	MG/KG	45.10	B	1000.0000	48.20	B	1000.0000	6.65								
51194	11-AUG-94	BH00258ST	BH00259ST	SODIUM	MG/KG	61.30	B	1000.0000	74.70	B	1000.0000	19.71								
51494	23-JUN-94	BH00080ST	BH00081ST	SODIUM	MG/KG	47.50	B	1000.0000	57.50	B	1000.0000	19.05								
51694	22-AUG-94	BH00288ST	BH00289ST	SODIUM	MG/KG	57.80	B	1000.0000	59.70	B	1000.0000	3.23								
51694	22-AUG-94	BH00291ST	BH00292ST	SODIUM	MG/KG	55.10	B	1000.0000	67.40	B	1000.0000	20.08								
51694	22-AUG-94	BH00294ST	BH00295ST	SODIUM	MG/KG	85.30	B	1000.0000	81.20	B	1000.0000	4.92	13.95	21.58	154.61	19	1	5.26	94.74	
50194	08-JUL-94	BH00125ST	BH00126ST	STRONTIUM	MG/KG	10.40	B	40.0000	13.10	B	40.0000	22.98								
50394	26-JUL-94	BH00194ST	BH00195ST	STRONTIUM	MG/KG	12.50	B	40.0000	12.00	B	40.0000	4.08								
50394	26-JUL-94	BH00196ST	BH00197ST	STRONTIUM	MG/KG	12.10	B	40.0000	11.50	B	40.0000	5.08								
50394	26-JUL-94	BH00198ST	BH00199ST	STRONTIUM	MG/KG	9.00	B	40.0000	7.80	B	40.0000	14.29								
50394	26-JUL-94	BH00200ST	BH00201ST	STRONTIUM	MG/KG	12.70	B	40.0000	9.10	B	40.0000	33.03								
50394	21-JUL-94	BH00176ST	BH00177ST	STRONTIUM	MG/KG	9.60	B	40.0000	12.20	B	40.0000	23.85								
50694	29-JUL-94	BH00217ST	BH00218ST	STRONTIUM	MG/KG	6.80	B	40.0000	6.50	B	40.0000	4.51								
50694	28-JUL-94	BH00205ST	BH00206ST	STRONTIUM	MG/KG	12.00	B	40.0000	13.30	B	40.0000	10.28								
50694	28-JUL-94	BH00207ST	BH00208ST	STRONTIUM	MG/KG	10.90	B	40.0000	11.30	B	40.0000	3.6								
50694	28-JUL-94	BH00212ST	BH00213ST	STRONTIUM	MG/KG	8.50	B	40.0000	8.30	B	40.0000	2.38								
50894	29-JUL-94	BH00223ST	BH00224ST	STRONTIUM	MG/KG	10.20	B	40.0000	8.80	B	40.0000	14.74								
50894	01-AUG-94	BH00230ST	BH00231ST	STRONTIUM	MG/KG	11.20	B	40.0000	12.30	B	40.0000	9.36								
50894	01-AUG-94	BH00232ST	BH00233ST	STRONTIUM	MG/KG	13.70	B	40.0000	11.20	B	40.0000	20.08								
51194	16-AUG-94	BH00280ST	BH00281ST	STRONTIUM	MG/KG	7.60	B	40.0000	9.20	B	40.0000	19.05								
51194	11-AUG-94	BH00258ST	BH00259ST	STRONTIUM	MG/KG	7.90	B	40.0000	11.50	B	40.0000	37.11								
51494	23-JUN-94	BH00080ST	BH00081ST	STRONTIUM	MG/KG	4.80	B	40.0000	6.20	B	40.0000	25.45								
51694	22-AUG-94	BH00288ST	BH00289ST	STRONTIUM	MG/KG	6.60	B	40.0000	7.30	B	40.0000	10.07								
51694	22-AUG-94	BH00291ST	BH00292ST	STRONTIUM	MG/KG	7.00	B	40.0000	8.80	B	40.0000	22.78								
51694	22-AUG-94	BH00294ST	BH00295ST	STRONTIUM	MG/KG	9.90	B	40.0000	10.70	B	40.0000	7.77	15.29	10.31	67.45	19	1	5.26	94.74	
50194	08-JUL-94	BH00125ST	BH00126ST	THALLIUM	MG/KG	0.21	U	2.0000	0.24	U	2.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	THALLIUM	MG/KG	0.26	B	2.0000	0.21	U	2.0000	153.98								
50394	26-JUL-94	BH00196ST	BH00197ST	THALLIUM	MG/KG	0.21	U	2.0000	0.20	U	2.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	THALLIUM	MG/KG	0.21	U	2.0000	0.21	U	2.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	THALLIUM	MG/KG	0.21	U	2.0000	0.22	U	2.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	THALLIUM	MG/KG	0.22	U	2.0000	0.22	U	2.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	THALLIUM	MG/KG	0.42	U	2.0000	0.43	U	2.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	THALLIUM	MG/KG	0.39	U	2.0000	0.40	U	2.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	THALLIUM	MG/KG	0.42	U	2.0000	0.41	U	2.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	THALLIUM	MG/KG	0.44	U	2.0000	0.43	U	2.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	THALLIUM	MG/KG	0.43	U	2.0000	0.44	U	2.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	THALLIUM	MG/KG	0.21	UW	2.0000	0.21	U	2.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	THALLIUM	MG/KG	0.21	U	2.0000	0.21	U	2.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	THALLIUM	MG/KG	0.21	U	2.0000	0.22	U	2.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	THALLIUM	MG/KG	0.21	U	2.0000	0.21	U	2.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	THALLIUM	MG/KG	0.21	U	2.0000	0.21	U	2.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	THALLIUM	MG/KG	0.20	U	2.0000	0.21	U	2.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	THALLIUM	MG/KG	0.20	U	2.0000	0.21	U	2.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	THALLIUM	MG/KG	0.22	U	2.0000	0.21	U	2.0000	0	8.10	35.33	435.89	19	1	5.26	94.74	
50194	08-JUL-94	BH00125ST	BH00126ST	TIN	MG/KG	2.40	U	40.0000	3.90	U	40.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	TIN	MG/KG	2.60	U	40.0000	2.60	U	40.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	TIN	MG/KG	2.50	U	40.0000	2.50	U	40.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	TIN	MG/KG	2.60	U	40.0000	2.50	U	40.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	TIN	MG/KG	2.50	U	40.0000	2.60	U	40.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	TIN	MG/KG	2.70	B	40.0000	3.20	B	40.0000	16.95								
50694	29-JUL-94	BH00217ST	BH00218ST	TIN	MG/KG	2.50	U	40.0000	2.60	U	40.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	TIN	MG/KG	2.40	U	40.0000	2.40	U	40.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	TIN	MG/KG	2.50	U	40.0000	2.40	U	40.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	TIN	MG/KG	2.60	U	40.0000	2.50	U	40.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	TIN	MG/KG	2.50	U	40.0000	2.60	U	40.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	TIN	MG/KG	2.50	U	40.0000	2.60	U	40.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	TIN	MG/KG	2.50	U	40.0000	2.50	U	40.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	TIN	MG/KG	2.50	U	40.0000	4.00	U	40.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	TIN	MG/KG	6.90	U	40.0000	3.70	U	40.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	TIN	MG/KG	2.10	U	40.0000	2.10	U	40.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
51694	22-AUG-94	BH00288ST	BH00289ST	TIN	MG/KG	2.70	B	40.0000	2.50	U	40.0000	174.71								
51694	22-AUG-94	BH00291ST	BH00292ST	TIN	MG/KG	2.50	B	40.0000	2.90	B	40.0000	14.81								
51694	22-AUG-94	BH00294ST	BH00295ST	TIN	MG/KG	2.70	U	40.0000	2.90	B	40.0000	172.96	19.97	54.45	272.66	19	2	10.53	89.47	
50194	08-JUL-94	BH00125ST	BH00126ST	VANADIUM	MG/KG	14.60		10.0000	14.40		10.0000	1.38								
50394	26-JUL-94	BH00194ST	BH00195ST	VANADIUM	MG/KG	16.60		10.0000	13.70		10.0000	19.14								
50394	26-JUL-94	BH00196ST	BH00197ST	VANADIUM	MG/KG	24.90		10.0000	23.00		10.0000	7.93								
50394	26-JUL-94	BH00198ST	BH00199ST	VANADIUM	MG/KG	21.90		10.0000	19.10		10.0000	13.66								
50394	26-JUL-94	BH00200ST	BH00201ST	VANADIUM	MG/KG	25.80		10.0000	19.90		10.0000	25.82								
50394	21-JUL-94	BH00176ST	BH00177ST	VANADIUM	MG/KG	17.40		10.0000	24.30		10.0000	33.09								
50694	29-JUL-94	BH00217ST	BH00218ST	VANADIUM	MG/KG	10.20	B	10.0000	9.20	B	10.0000	10.31								
50694	28-JUL-94	BH00205ST	BH00206ST	VANADIUM	MG/KG	19.30		10.0000	24.20		10.0000	22.53								
50694	28-JUL-94	BH00207ST	BH00208ST	VANADIUM	MG/KG	21.20		10.0000	24.40		10.0000	14.04								
50694	28-JUL-94	BH00212ST	BH00213ST	VANADIUM	MG/KG	23.60		10.0000	19.40		10.0000	19.53								
50894	29-JUL-94	BH00223ST	BH00224ST	VANADIUM	MG/KG	15.90		10.0000	14.60		10.0000	8.52								
50894	01-AUG-94	BH00230ST	BH00231ST	VANADIUM	MG/KG	20.30		10.0000	19.70		10.0000	3								
50894	01-AUG-94	BH00232ST	BH00233ST	VANADIUM	MG/KG	21.60		10.0000	20.30		10.0000	6.21								
51194	16-AUG-94	BH00280ST	BH00281ST	VANADIUM	MG/KG	17.90		10.0000	13.90		10.0000	25.16								
51194	11-AUG-94	BH00258ST	BH00259ST	VANADIUM	MG/KG	19.60		10.0000	21.80		10.0000	10.63								
51494	23-JUN-94	BH00080ST	BH00081ST	VANADIUM	MG/KG	8.30	B	10.0000	7.70	B	10.0000	7.5								
51694	22-AUG-94	BH00288ST	BH00289ST	VANADIUM	MG/KG	15.40		10.0000	17.60		10.0000	13.33								
51694	22-AUG-94	BH00291ST	BH00292ST	VANADIUM	MG/KG	17.30		10.0000	21.50		10.0000	21.65								
51694	22-AUG-94	BH00294ST	BH00295ST	VANADIUM	MG/KG	23.50		10.0000	23.30		10.0000	0.85	13.91	9.02	64.87	19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	ZINC	MG/KG	13.40		4.0000	15.70		4.0000	15.81								
50394	26-JUL-94	BH00194ST	BH00195ST	ZINC	MG/KG	22.70		4.0000	20.30		4.0000	11.16								
50394	26-JUL-94	BH00196ST	BH00197ST	ZINC	MG/KG	16.90		4.0000	15.20		4.0000	10.59								
50394	26-JUL-94	BH00198ST	BH00199ST	ZINC	MG/KG	17.10		4.0000	14.60		4.0000	15.77								
50394	26-JUL-94	BH00200ST	BH00201ST	ZINC	MG/KG	24.10		4.0000	18.60		4.0000	25.76								
50394	21-JUL-94	BH00176ST	BH00177ST	ZINC	MG/KG	9.60	N*	4.0000	13.10	N*	4.0000	30.84								
50694	29-JUL-94	BH00217ST	BH00218ST	ZINC	MG/KG	8.70		4.0000	9.00		4.0000	3.39								
50694	28-JUL-94	BH00205ST	BH00206ST	ZINC	MG/KG	9.30		4.0000	10.90		4.0000	15.84								
50694	28-JUL-94	BH00207ST	BH00208ST	ZINC	MG/KG	10.50		4.0000	12.10		4.0000	14.16								
50694	28-JUL-94	BH00212ST	BH00213ST	ZINC	MG/KG	14.30		4.0000	12.00		4.0000	17.49								
50894	29-JUL-94	BH00223ST	BH00224ST	ZINC	MG/KG	13.30		4.0000	11.60		4.0000	13.65								
50894	01-AUG-94	BH00230ST	BH00231ST	ZINC	MG/KG	19.60		4.0000	20.00		4.0000	2.02								
50894	01-AUG-94	BH00232ST	BH00233ST	ZINC	MG/KG	25.80		4.0000	23.80		4.0000	8.06								
51194	16-AUG-94	BH00280ST	BH00281ST	ZINC	MG/KG	12.90		4.0000	19.90		4.0000	42.68								
51194	11-AUG-94	BH00258ST	BH00259ST	ZINC	MG/KG	14.00		4.0000	18.20		4.0000	26.09								
51494	23-JUN-94	BH00080ST	BH00081ST	ZINC	MG/KG	6.00		4.0000	7.50		4.0000	22.22								
51694	22-AUG-94	BH00288ST	BH00289ST	ZINC	MG/KG	12.50		4.0000	13.70		4.0000	9.16								
51694	22-AUG-94	BH00291ST	BH00292ST	ZINC	MG/KG	10.80		4.0000	13.60		4.0000	22.95								
51694	22-AUG-94	BH00294ST	BH00295ST	ZINC	MG/KG	18.70		4.0000	18.60		4.0000	0.54	16.22	10.49	64.70	19	1	5.26	94.74	
50194	08-JUL-94	BH00125ST	BH00126ST	AMERICIUM-241	PCI/G	-0.004	U	0.084	0	U	0.036	250								
50394	26-JUL-94	BH00194ST	BH00195ST	AMERICIUM-241	PCI/G	0.004	U	0.011	0.038		0.017	123.81								
50394	26-JUL-94	BH00196ST	BH00197ST	AMERICIUM-241	PCI/G	0.001	U	0.019	0.008	U	0.011	166.667								
50394	26-JUL-94	BH00198ST	BH00199ST	AMERICIUM-241	PCI/G	0.008	U	0.009	-0.003	U	0.015	60.87								
50394	26-JUL-94	BH00200ST	BH00201ST	AMERICIUM-241	PCI/G	0.084		0.025	0	U	0.020	123.077								
50394	21-JUL-94	BH00176ST	BH00177ST	AMERICIUM-241	PCI/G	0.003	U	0.035	0.008	J	0.004	28.571								
50694	29-JUL-94	BH00217ST	BH00218ST	AMERICIUM-241	PCI/G	-0.003	U	0.024	-0.019	U	0.091	213.636								
50694	28-JUL-94	BH00205ST	BH00206ST	AMERICIUM-241	PCI/G	0.015	U	0.028	0.003	U	0.038	86.792								
50694	28-JUL-94	BH00207ST	BH00208ST	AMERICIUM-241	PCI/G	-0.014	U	0.063	0.019	U	0.025	709.091								
50694	28-JUL-94	BH00212ST	BH00213ST	AMERICIUM-241	PCI/G	0.007	U	0.023	0.006	U	0.031	126.316								
50894	29-JUL-94	BH00223ST	BH00224ST	AMERICIUM-241	PCI/G	0.012	U	0.038	0.011	U	0.035	97.872								
50894	01-AUG-94	BH00230ST	BH00231ST	AMERICIUM-241	PCI/G	0.007	U	0.019	0.042	U	0.16	183.23								
50894	01-AUG-94	BH00232ST	BH00233ST	AMERICIUM-241	PCI/G	0.016	U	0.029	-0.004	U	0.039	83.636								
51194	16-AUG-94	BH00280ST	BH00281ST	AMERICIUM-241	PCI/G	0.006	U	0.037	0.044	U	0.067	167.123								
51194	11-AUG-94	BH00258ST	BH00259ST	AMERICIUM-241	PCI/G	0.002	U	0.025	0.007	U	0.056	186.207								
51494	23-JUN-94	BH00080ST	BH00081ST	AMERICIUM-241	PCI/G	0.022		0.015	0.009	U	0.031	33.962								
51694	22-AUG-94	BH00288ST	BH00289ST	AMERICIUM-241	PCI/G	0.010	U	0.037	0.019	U	0.069	149.367								
51694	22-AUG-94	BH00291ST	BH00292ST	AMERICIUM-241	PCI/G	0.003	U	0.012	0.026	U	0.34	196.5								
51694	22-AUG-94	BH00294ST	BH00295ST	AMERICIUM-241	PCI/G	0.002	U	0.028	0.010	U	0.11	192.86	167.35	144.75	86.50	19	17	89.47	10.53	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	PLUTONIUM-239/240	PCI/G	0.008	U	0.013	0.001	U	0.014	54.545								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N > 35%	% Pairs > 35%	Overall Precision Compliance (%)	Usability
50394	26-JUL-94	BH00194ST	BH00195ST	PLUTONIUM-239/240	PCI/G	0	U	0.004	0.002	U	0.006	200								
50394	26-JUL-94	BH00196ST	BH00197ST	PLUTONIUM-239/240	PCI/G	0.004	U	0.035	0.001	U	0.013	105.882								
50394	26-JUL-94	BH00198ST	BH00199ST	PLUTONIUM-239/240	PCI/G	0.010	U	0.028	0.003	U	0.009	10.526								
50394	26-JUL-94	BH00200ST	BH00201ST	PLUTONIUM-239/240	PCI/G	0.005	J	0.004	0.003	U	0.004	22.222								
50394	21-JUL-94	BH00176ST	BH00177ST	PLUTONIUM-239/240	PCI/G	0.003	J	0.002	-0.002	U	0.018	142.857								
50694	29-JUL-94	BH00217ST	BH00218ST	PLUTONIUM-239/240	PCI/G	0.001	U	0.010	0	U	0.002	66.667								
50694	28-JUL-94	BH00205ST	BH00206ST	PLUTONIUM-239/240	PCI/G	0.001	U	0.013	0.012	J	0.003	100								
50694	28-JUL-94	BH00207ST	BH00208ST	PLUTONIUM-239/240	PCI/G	0.003	U	0.012	0.001	U	0.008	90.909								
50694	28-JUL-94	BH00212ST	BH00213ST	PLUTONIUM-239/240	PCI/G	-0.002	U	0.016	0	U	0.025	234.783								
50894	29-JUL-94	BH00223ST	BH00224ST	PLUTONIUM-239/240	PCI/G	0.002	U	0.006	0.001	U	0.005	85.714								
50894	01-AUG-94	BH00230ST	BH00231ST	PLUTONIUM-239/240	PCI/G	0.001	U	0.007	0.001	U	0.006	142.857								
50894	01-AUG-94	BH00232ST	BH00233ST	PLUTONIUM-239/240	PCI/G	0.004	J	0.002	-0.001	U	0.008	66.667								
51194	16-AUG-94	BH00280ST	BH00281ST	PLUTONIUM-239/240	PCI/G	0.001	U	0.013	0	U	0.013	171.429								
51194	11-AUG-94	BH00258ST	BH00259ST	PLUTONIUM-239/240	PCI/G	-0.002	U	0.015	0	U	0.030	228.571								
51494	23-JUN-94	BH00080ST	BH00081ST	PLUTONIUM-239/240	PCI/G	0.001	U	0.008	0.002	U	0.015	175								
51694	22-AUG-94	BH00288ST	BH00289ST	PLUTONIUM-239/240	PCI/G	0.001	U	0.027	0.001	U	0.015	175								
51694	22-AUG-94	BH00291ST	BH00292ST	PLUTONIUM-239/240	PCI/G	0.004	U	0.005	-0.001	U	0.013	105.882								
51694	22-AUG-94	BH00294ST	BH00295ST	PLUTONIUM-239/240	PCI/G	0.015	U	0.035	-0.011	U	0.063	123.077	121.19	64.73	53.41	19	17	89.47	10.53	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	TRITIUM	PCI/L	350	U	370	310	U	360	3								
50394	26-JUL-94	BH00194ST	BH00195ST	TRITIUM	PCI/L	170	U	340	140	U	340	67								
50394	26-JUL-94	BH00196ST	BH00197ST	TRITIUM	PCI/L	190	U	340	190	U	340	57								
50394	26-JUL-94	BH00198ST	BH00199ST	TRITIUM	PCI/L	-10	U	340	-7.4	U	340	212								
50394	26-JUL-94	BH00200ST	BH00201ST	TRITIUM	PCI/L	89	U	370	-110	U	370	122								
50394	21-JUL-94	BH00176ST	BH00177ST	TRITIUM	PCI/L	420		310	210	U	310	30								
50694	29-JUL-94	BH00217ST	BH00218ST	TRITIUM	PCI/L	140	U	380	290	U	340	83								
50694	28-JUL-94	BH00207ST	BH00208ST	TRITIUM	PCI/L	200	U	380	160	U	380	62								
50694	28-JUL-94	BH00212ST	BH00213ST	TRITIUM	PCI/L	290	U	370	370	J	370	24								
50894	29-JUL-94	BH00223ST	BH00224ST	TRITIUM	PCI/L	420		340	420		340	21								
50894	01-AUG-94	BH00230ST	BH00231ST	TRITIUM	PCI/L	360	J	340	290	U	340	6								
50894	01-AUG-94	BH00232ST	BH00233ST	TRITIUM	PCI/L	250	U	340	420		340	31								
51194	16-AUG-94	BH00280ST	BH00281ST	TRITIUM	PCI/L	190	U	350	340	U	350	59								
51194	11-AUG-94	BH00258ST	BH00259ST	TRITIUM	PCI/L	520		360	240	U	360	36								
51494	23-JUN-94	BH00080ST	BH00081ST	TRITIUM	PCI/L	420	B	360	280	U	370	13								
51694	22-AUG-94	BH00288ST	BH00289ST	TRITIUM	PCI/L	420		350	430		350	18								
51694	22-AUG-94	BH00291ST	BH00292ST	TRITIUM	PCI/L	330	U	350	180	U	350	6								
51694	22-AUG-94	BH00294ST	BH00295ST	TRITIUM	PCI/L	330	U	350	270	U	350	6	51.53	53.36	103.56	18	8	44.44	55.56	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	URANIUM-233,-234	PCI/G	1.9		0.054	2.1		0.089	182.1								
50394	26-JUL-94	BH00194ST	BH00195ST	URANIUM-233,-234	PCI/G	2.5	B	0.072	2.4	B	0.10	184.6								
50394	26-JUL-94	BH00196ST	BH00197ST	URANIUM-233,-234	PCI/G	2.2	B	0.090	2.8	B	0.095	183.4								
50394	26-JUL-94	BH00198ST	BH00199ST	URANIUM-233,-234	PCI/G	2.8	B	0.13	2.9	B	0.17	177.1								
50394	26-JUL-94	BH00200ST	BH00201ST	URANIUM-233,-234	PCI/G	3.2		0.12	3.5		0.13	184.4								
50394	21-JUL-94	BH00176ST	BH00177ST	URANIUM-233,-234	PCI/G	1.6		0.065	1.8		0.084	180								
50694	29-JUL-94	BH00217ST	BH00218ST	URANIUM-233,-234	PCI/G	2.0		0.036	1.7	B	0.068	186.8								
50694	28-JUL-94	BH00205ST	BH00206ST	URANIUM-233,-234	PCI/G	1.1		0.072	1.0		0.078	173.5								
50694	28-JUL-94	BH00207ST	BH00208ST	URANIUM-233,-234	PCI/G	1.5		0.036	1.6		0.085	178.5								
50694	28-JUL-94	BH00212ST	BH00213ST	URANIUM-233,-234	PCI/G	2.1		0.081	2.4		0.077	185.9								
50894	29-JUL-94	BH00223ST	BH00224ST	URANIUM-233,-234	PCI/G	1.8		0.11	2.2		0.089	181.2								
50894	01-AUG-94	BH00230ST	BH00231ST	URANIUM-233,-234	PCI/G	2.9	B	0.081	3.3	B	0.084	188.7								
50894	01-AUG-94	BH00232ST	BH00233ST	URANIUM-233,-234	PCI/G	2.9	B	0.086	3.3		0.18	176.6								
51194	16-AUG-94	BH00280ST	BH00281ST	URANIUM-233,-234	PCI/G	2.6	B	0.044	2.4	B	0.050	192.5								
51194	11-AUG-94	BH00258ST	BH00259ST	URANIUM-233,-234	PCI/G	2.2	B	0.096	1.9	B	0.074	187								
51494	23-JUN-94	BH00080ST	BH00081ST	URANIUM-233,-234	PCI/G	2.2		0.062	1.8		0.060	189.4								
51694	22-AUG-94	BH00288ST	BH00289ST	URANIUM-233,-234	PCI/G	3.5	B	0.087	3.6	B	0.10	188.9								
51694	22-AUG-94	BH00291ST	BH00292ST	URANIUM-233,-234	PCI/G	4.0	B	0.083	3.9	B	0.095	190.7								
51694	22-AUG-94	BH00294ST	BH00295ST	URANIUM-233,-234	PCI/G	4.3	B	0.11	4.0	B	0.13	188.3	184.19	5.28	2.87	19	19	100.00	0.00	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	URANIUM-235	PCI/G	0.023	U	0.068	0.19	J	0.046	66.667								
50394	26-JUL-94	BH00194ST	BH00195ST	URANIUM-235	PCI/G	0.069	J	0.046	0.14	J	0.076	9.655								
50394	26-JUL-94	BH00196ST	BH00197ST	URANIUM-235	PCI/G	0.30		0.058	0.18	J	0.076	119.15								
50394	26-JUL-94	BH00198ST	BH00199ST	URANIUM-235	PCI/G	0.17	J	0.12	0.13	J	0.13	26.67								
50394	26-JUL-94	BH00200ST	BH00201ST	URANIUM-235	PCI/G	0.17	J	0.11	0.058	U	0.12	34.48								
50394	21-JUL-94	BH00176ST	BH00177ST	URANIUM-235	PCI/G	0.14	J	0.082	0.058	U	0.084	50								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N > 35%	% Pairs > 35%	Overall Precision Compliance (%)	Usability
50694	29-JUL-94	BH00217ST	BH00218ST	URANIUM-235	PCI/G	0.048	U	0.076	0.035	U	0.068	34.483								
50694	28-JUL-94	BH00205ST	BH00206ST	URANIUM-235	PCI/G	0.013	U	0.035	0.026	U	0.058	126.761								
50694	28-JUL-94	BH00207ST	BH00208ST	URANIUM-235	PCI/G	0.035	U	0.075	0.11	U	0.14	120								
50694	28-JUL-94	BH00212ST	BH00213ST	URANIUM-235	PCI/G	0.084	J	0.060	0.14	J	0.037	77.686								
50894	29-JUL-94	BH00223ST	BH00224ST	URANIUM-235	PCI/G	0.11	J	0.068	0.021	U	0.058	61.9								
50894	01-AUG-94	BH00230ST	BH00231ST	URANIUM-235	PCI/G	0.15	J	0.064	0.18	J	0.054	94.12								
50894	01-AUG-94	BH00232ST	BH00233ST	URANIUM-235	PCI/G	0.063	U	0.068	0.072	U	0.16	87								
51194	16-AUG-94	BH00280ST	BH00281ST	URANIUM-235	PCI/G	0.13	J	0.067	0.11	J	0.050	88.89								
51194	11-AUG-94	BH00258ST	BH00259ST	URANIUM-235	PCI/G	0.052	U	0.076	0.036	U	0.048	8								
51494	23-JUN-94	BH00080ST	BH00081ST	URANIUM-235	PCI/G	0.059	J	0.040	0.014	U	0.039	40.816								
51694	22-AUG-94	BH00288ST	BH00289ST	URANIUM-235	PCI/G	0.15	J	0.069	0.11	J	0.088	52.1								
51694	22-AUG-94	BH00291ST	BH00292ST	URANIUM-235	PCI/G	0.17	J	0.043	0.17	J	0.043	119.25								
51694	22-AUG-94	BH00294ST	BH00295ST	URANIUM-235	PCI/G	0.18	J	0.099	0.29	J	0.12	40	66:19	38.01	57.43	19	14	73.68	26.32	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	URANIUM-238	PCI/G	1.9		0.086	1.9		0.071	185.6								
50394	26-JUL-94	BH00194ST	BH00195ST	URANIUM-238	PCI/G	2.0	B	0.046	2.2	B	0.049	190.4								
50394	26-JUL-94	BH00196ST	BH00197ST	URANIUM-238	PCI/G	2.2	B	0.058	2.9	B	0.049	191.3								
50394	26-JUL-94	BH00198ST	BH00199ST	URANIUM-238	PCI/G	2.4	B	0.14	2.6	B	0.20	169.2								
50394	26-JUL-94	BH00200ST	BH00201ST	URANIUM-238	PCI/G	3.7		0.14	3.2	B	0.11	188.5								
50394	21-JUL-94	BH00176ST	BH00177ST	URANIUM-238	PCI/G	1.6		0.082	1.6		0.11	174.3								
50694	29-JUL-94	BH00217ST	BH00218ST	URANIUM-238	PCI/G	2.0	B	0.070	1.9	B	0.077	185.2								
50694	28-JUL-94	BH00205ST	BH00206ST	URANIUM-238	PCI/G	1.4	B	0.077	1.2	B	0.058	184.1								
50694	28-JUL-94	BH00207ST	BH00208ST	URANIUM-238	PCI/G	2.0	B	0.070	1.8	B	0.11	179.1								
50694	28-JUL-94	BH00212ST	BH00213ST	URANIUM-238	PCI/G	2.3	B	0.081	2.7	B	0.081	186.4								
50894	29-JUL-94	BH00223ST	BH00224ST	URANIUM-238	PCI/G	2.2	B	0.091	2.6		0.11	181								
50894	01-AUG-94	BH00230ST	BH00231ST	URANIUM-238	PCI/G	2.8	B	0.042	2.8	B	0.054	192.4								
50894	01-AUG-94	BH00232ST	BH00233ST	URANIUM-238	PCI/G	3.5	B	0.044	3.5		0.19	179.4								
51194	16-AUG-94	BH00280ST	BH00281ST	URANIUM-238	PCI/G	2.2	B	0.085	2.4	B	0.050	191.1								
51194	11-AUG-94	BH00258ST	BH00259ST	URANIUM-238	PCI/G	2.0	B	0.049	1.7	B	0.048	190.6								
51494	23-JUN-94	BH00080ST	BH00081ST	URANIUM-238	PCI/G	1.7		0.040	1.7		0.076	182.9								
51694	22-AUG-94	BH00288ST	BH00289ST	URANIUM-238	PCI/G	3.2	B	0.087	3.7	B	0.12	185.5								
51694	22-AUG-94	BH00291ST	BH00292ST	URANIUM-238	PCI/G	3.7	B	0.043	3.4	B	0.083	191.2								
51694	22-AUG-94	BH00294ST	BH00295ST	URANIUM-238	PCI/G	4.3	B	0.13	4.2	B	0.15	186.5	184.98	6.23	3.37	19	19	100.00	0.00	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	1,2,4-TRICHLOROBENZENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	1,2,4-TRICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	1,2,4-TRICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	1,2,4-TRICHLOROBENZENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	1,2,4-TRICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	1,2,4-TRICHLOROBENZENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	1,2,4-TRICHLOROBENZENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	1,2,4-TRICHLOROBENZENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	1,2,4-TRICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	1,2,4-TRICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	1,2,4-TRICHLOROBENZENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	1,2,4-TRICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	1,2,4-TRICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	1,2,4-TRICHLOROBENZENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	1,2,4-TRICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	1,2,4-TRICHLOROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	1,2,4-TRICHLOROBENZENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	1,2,4-TRICHLOROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	1,2,4-TRICHLOROBENZENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	1,2-DICHLOROBENZENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	1,2-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	1,2-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	1,2-DICHLOROBENZENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	1,2-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	1,2-DICHLOROBENZENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	1,2-DICHLOROBENZENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	1,2-DICHLOROBENZENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	1,2-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	1,2-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50894	29-JUL-94	BH00223ST	BH00224ST	1,2-DICHLOROBENZENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	1,2-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	1,2-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	1,2-DICHLOROBENZENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	1,2-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	1,2-DICHLOROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	1,2-DICHLOROBENZENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	1,2-DICHLOROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	1,2-DICHLOROBENZENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	1,3-DICHLOROBENZENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	1,3-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	1,3-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	1,3-DICHLOROBENZENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	1,3-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	1,3-DICHLOROBENZENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	1,3-DICHLOROBENZENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	1,3-DICHLOROBENZENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	1,3-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	1,3-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	1,3-DICHLOROBENZENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	1,3-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	1,3-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	1,3-DICHLOROBENZENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	1,3-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	1,3-DICHLOROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	1,3-DICHLOROBENZENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	1,3-DICHLOROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	1,3-DICHLOROBENZENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	1,4-DICHLOROBENZENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	1,4-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	1,4-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	1,4-DICHLOROBENZENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	1,4-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	1,4-DICHLOROBENZENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	1,4-DICHLOROBENZENE	UG/KG	350	U	330.0000	20	J	330.0000	177								
50694	28-JUL-94	BH00205ST	BH00206ST	1,4-DICHLOROBENZENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	1,4-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	1,4-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	1,4-DICHLOROBENZENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	1,4-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	1,4-DICHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	1,4-DICHLOROBENZENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	1,4-DICHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	1,4-DICHLOROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	1,4-DICHLOROBENZENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	1,4-DICHLOROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	1,4-DICHLOROBENZENE	UG/KG	390	U	330.0000	370	U	330.0000	0	9.32	40.61	435.89	19	1	5.26	94.74	
50194	08-JUL-94	BH00125ST	BH00126ST	2,4,5-TRICHLOROPHENOL	UG/KG	1700	U	1600.0000	2000	U	1600.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2,4,5-TRICHLOROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	790	U	1600.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2,4,5-TRICHLOROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
51194	11-AUG-94	BH00258ST	BH00259ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2,4,5-TRICHLOROPHENOL	UG/KG	1800	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2,4,5-TRICHLOROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2,4,5-TRICHLOROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2,4,5-TRICHLOROPHENOL	UG/KG	1900	U	1600.0000	1800	U	1600.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2,4,6-TRICHLOROPHENOL	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2,4,6-TRICHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2,4,6-TRICHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2,4,6-TRICHLOROPHENOL	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2,4,6-TRICHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2,4,6-TRICHLOROPHENOL	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2,4,6-TRICHLOROPHENOL	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2,4,6-TRICHLOROPHENOL	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2,4,6-TRICHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2,4,6-TRICHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2,4,6-TRICHLOROPHENOL	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2,4,6-TRICHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2,4,6-TRICHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2,4,6-TRICHLOROPHENOL	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2,4,6-TRICHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2,4,6-TRICHLOROPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2,4,6-TRICHLOROPHENOL	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2,4,6-TRICHLOROPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2,4,6-TRICHLOROPHENOL	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2,4-DICHLOROPHENOL	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2,4-DICHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2,4-DICHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2,4-DICHLOROPHENOL	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2,4-DICHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2,4-DICHLOROPHENOL	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2,4-DICHLOROPHENOL	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2,4-DICHLOROPHENOL	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2,4-DICHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2,4-DICHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2,4-DICHLOROPHENOL	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2,4-DICHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2,4-DICHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2,4-DICHLOROPHENOL	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2,4-DICHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2,4-DICHLOROPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2,4-DICHLOROPHENOL	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2,4-DICHLOROPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2,4-DICHLOROPHENOL	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2,4-DIMETHYLPHENOL	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2,4-DIMETHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2,4-DIMETHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2,4-DIMETHYLPHENOL	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2,4-DIMETHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2,4-DIMETHYLPHENOL	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2,4-DIMETHYLPHENOL	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2,4-DIMETHYLPHENOL	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2,4-DIMETHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2,4-DIMETHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2,4-DIMETHYLPHENOL	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2,4-DIMETHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2,4-DIMETHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2,4-DIMETHYLPHENOL	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2,4-DIMETHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2,4-DIMETHYLPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2,4-DIMETHYLPHENOL	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2,4-DIMETHYLPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
51694	22-AUG-94	BH00294ST	BH00295ST	2,4-DIMETHYLPHENOL	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2,4-DINITROPHENOL	UG/KG	1700	U	1600.0000	2000	U	1600.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2,4-DINITROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	790	U	1600.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2,4-DINITROPHENOL	UG/KG	1800	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2,4-DINITROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2,4-DINITROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2,4-DINITROPHENOL	UG/KG	1900	U	1600.0000	1800	U	1600.0000	0				16	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2,4-DINITROTOLUENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2,4-DINITROTOLUENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2,4-DINITROTOLUENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2,4-DINITROTOLUENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2,4-DINITROTOLUENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2,4-DINITROTOLUENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2,4-DINITROTOLUENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2,4-DINITROTOLUENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2,4-DINITROTOLUENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2,4-DINITROTOLUENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2,4-DINITROTOLUENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2,4-DINITROTOLUENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2,4-DINITROTOLUENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2,4-DINITROTOLUENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2,4-DINITROTOLUENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2,4-DINITROTOLUENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2,4-DINITROTOLUENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2,4-DINITROTOLUENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2,4-DINITROTOLUENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2,6-DINITROTOLUENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2,6-DINITROTOLUENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2,6-DINITROTOLUENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2,6-DINITROTOLUENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2,6-DINITROTOLUENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2,6-DINITROTOLUENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2,6-DINITROTOLUENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2,6-DINITROTOLUENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2,6-DINITROTOLUENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2,6-DINITROTOLUENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2,6-DINITROTOLUENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2,6-DINITROTOLUENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2,6-DINITROTOLUENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2,6-DINITROTOLUENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2,6-DINITROTOLUENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2,6-DINITROTOLUENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2,6-DINITROTOLUENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2,6-DINITROTOLUENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2,6-DINITROTOLUENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2-CHLORONAPHTHALENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2-CHLORONAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2-CHLORONAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2-CHLORONAPHTHALENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2-CHLORONAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2-CHLORONAPHTHALENE	UG/KG	370	U	330.0000	360	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50694	29-JUL-94	BH00217ST	BH00218ST	2-CHLORONAPHTHALENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2-CHLORONAPHTHALENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2-CHLORONAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2-CHLORONAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2-CHLORONAPHTHALENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2-CHLORONAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2-CHLORONAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2-CHLORONAPHTHALENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2-CHLORONAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2-CHLORONAPHTHALENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2-CHLORONAPHTHALENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2-CHLORONAPHTHALENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2-CHLORONAPHTHALENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2-CHLOROPHENOL	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2-CHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2-CHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2-CHLOROPHENOL	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2-CHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2-CHLOROPHENOL	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2-CHLOROPHENOL	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2-CHLOROPHENOL	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2-CHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2-CHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2-CHLOROPHENOL	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2-CHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2-CHLOROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2-CHLOROPHENOL	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2-CHLOROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2-CHLOROPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2-CHLOROPHENOL	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2-CHLOROPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2-CHLOROPHENOL	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2-METHYLNAPHTHALENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2-METHYLNAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2-METHYLNAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2-METHYLNAPHTHALENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2-METHYLNAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2-METHYLNAPHTHALENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2-METHYLNAPHTHALENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2-METHYLNAPHTHALENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2-METHYLNAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2-METHYLNAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2-METHYLNAPHTHALENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2-METHYLNAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2-METHYLNAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2-METHYLNAPHTHALENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2-METHYLNAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2-METHYLNAPHTHALENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2-METHYLNAPHTHALENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2-METHYLNAPHTHALENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2-METHYLNAPHTHALENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2-METHYLPHENOL	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2-METHYLPHENOL	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2-METHYLPHENOL	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2-METHYLPHENOL	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50894	01-AUG-94	BH00232ST	BH00233ST	2-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2-METHYLPHENOL	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2-METHYLPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2-METHYLPHENOL	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2-METHYLPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2-METHYLPHENOL	UG/KG	390	U	330.0000	370	U	330.0000	0				17	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2-NITROANILINE	UG/KG	1700	U	1600.0000	2000	U	1600.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	790	U	1600.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2-NITROANILINE	UG/KG	1800	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2-NITROANILINE	UG/KG	1900	U	1600.0000	1800	U	1600.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	2-NITROPHENOL	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	2-NITROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	2-NITROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	2-NITROPHENOL	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	2-NITROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	2-NITROPHENOL	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	2-NITROPHENOL	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	2-NITROPHENOL	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	2-NITROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	2-NITROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	2-NITROPHENOL	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	2-NITROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	2-NITROPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	2-NITROPHENOL	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	2-NITROPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	2-NITROPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	2-NITROPHENOL	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	2-NITROPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	2-NITROPHENOL	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	3,3'-DICHLOROBENZIDINE	UG/KG	680	U	660.0000	770	U	660.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	3,3'-DICHLOROBENZIDINE	UG/KG	720	U	660.0000	730	U	660.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	3,3'-DICHLOROBENZIDINE	UG/KG	690	U	660.0000	690	U	660.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	3,3'-DICHLOROBENZIDINE	UG/KG	720	U	660.0000	710	U	660.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	3,3'-DICHLOROBENZIDINE	UG/KG	720	U	660.0000	720	U	660.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	3,3'-DICHLOROBENZIDINE	UG/KG	720	U	660.0000	710	U	660.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	3,3'-DICHLOROBENZIDINE	UG/KG	670	U	660.0000	670	U	660.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	3,3'-DICHLOROBENZIDINE	UG/KG	710	U	660.0000	700	U	660.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	3,3'-DICHLOROBENZIDINE	UG/KG	730	U	660.0000	720	U	660.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	3,3'-DICHLOROBENZIDINE	UG/KG	710	U	660.0000	710	U	660.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	3,3'-DICHLOROBENZIDINE	UG/KG	720	U	660.0000	720	U	660.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	3,3'-DICHLOROBENZIDINE	UG/KG	710	U	660.0000	730	U	660.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	3,3'-DICHLOROBENZIDINE	UG/KG	700	U	660.0000	710	U	660.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	3,3'-DICHLOROBENZIDINE	UG/KG	690	U	660.0000	680	U	660.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	3,3'-DICHLOROBENZIDINE	UG/KG	690	U	660.0000	690	U	660.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	3,3'-DICHLOROBENZIDINE	UG/KG	690	U	660.0000	690	U	660.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
51694	22-AUG-94	BH00294ST	BH00295ST	3,3'-DICHLOROBENZIDINE	UG/KG	780	U	660.0000	730	U	660.0000	0				17	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	3-NITROANILINE	UG/KG	1700	U	1600.0000	2000	U	1600.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	3-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	3-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	3-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	3-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	3-NITROANILINE	UG/KG	1800	U	1600.0000	790	U	1600.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	3-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	3-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	3-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	3-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	3-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	3-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	3-NITROANILINE	UG/KG	1800	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	3-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	3-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	3-NITROANILINE	UG/KG	1900	U	1600.0000	1800	U	1600.0000	0				16	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1700	U	1600.0000	2000	U	1600.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	790	U	1600.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1800	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	4,6-DINITRO-2-METHYLPHENOL	UG/KG	1900	U	1600.0000	1800	U	1600.0000	0				18	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	4-CHLORO-3-METHYLPHENOL	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	4-CHLORO-3-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	4-CHLORO-3-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	4-CHLORO-3-METHYLPHENOL	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	4-CHLORO-3-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	4-CHLORO-3-METHYLPHENOL	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	4-CHLORO-3-METHYLPHENOL	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	4-CHLORO-3-METHYLPHENOL	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	4-CHLORO-3-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	4-CHLORO-3-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	4-CHLORO-3-METHYLPHENOL	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	4-CHLORO-3-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	4-CHLORO-3-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	4-CHLORO-3-METHYLPHENOL	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	4-CHLORO-3-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	4-CHLORO-3-METHYLPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	4-CHLORO-3-METHYLPHENOL	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	4-CHLORO-3-METHYLPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	4-CHLORO-3-METHYLPHENOL	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	4-CHLOROANILINE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	4-CHLOROANILINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	4-CHLOROANILINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	4-CHLOROANILINE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	4-CHLOROANILINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	4-CHLOROANILINE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	4-CHLOROANILINE	UG/KG	340	U	330.0000	340	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50694	28-JUL-94	BH00207ST	BH00208ST	4-CHLOROANILINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	4-CHLOROANILINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	4-CHLOROANILINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	4-CHLOROANILINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	4-CHLOROANILINE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	4-CHLOROANILINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	4-CHLOROANILINE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	4-CHLOROANILINE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	4-CHLOROANILINE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	4-CHLOROANILINE	UG/KG	390	U	330.0000	370	U	330.0000	0				17	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	4-CHLOROPHENYL PHENYL ETHER	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	4-METHYLPHENOL	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	4-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	4-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	4-METHYLPHENOL	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	4-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	4-METHYLPHENOL	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	4-METHYLPHENOL	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	4-METHYLPHENOL	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	4-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	4-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	4-METHYLPHENOL	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	4-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	4-METHYLPHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	4-METHYLPHENOL	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	4-METHYLPHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	4-METHYLPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	4-METHYLPHENOL	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	4-METHYLPHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	4-METHYLPHENOL	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	4-NITROANILINE	UG/KG	1700	U	1600.0000	2000	U	1600.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	4-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	790	U	1600.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	4-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N > 35%	% Pairs > 35%	Overall Precision Compliance (%)	Usability
51494	23-JUN-94	BH00080ST	BH00081ST	4-NITROANILINE	UG/KG	1800	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	4-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	4-NITROANILINE	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	4-NITROANILINE	UG/KG	1900	U	1600.0000	1800	U	1600.0000	0				17	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	4-NITROPHENOL	UG/KG	1700	U	1600.0000	2000	U	1600.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	4-NITROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	790	U	1600.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	4-NITROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	4-NITROPHENOL	UG/KG	1800	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	4-NITROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	4-NITROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	4-NITROPHENOL	UG/KG	1900	U	1600.0000	1800	U	1600.0000	0				18	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	ACENAPHTHENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	ACENAPHTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	ACENAPHTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	ACENAPHTHENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	ACENAPHTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	ACENAPHTHENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	ACENAPHTHENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	ACENAPHTHENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	ACENAPHTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	ACENAPHTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	ACENAPHTHENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	ACENAPHTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	ACENAPHTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	ACENAPHTHENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	ACENAPHTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	ACENAPHTHENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	ACENAPHTHENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	ACENAPHTHENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	ACENAPHTHENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	ACENAPHTHYLENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	ACENAPHTHYLENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	ACENAPHTHYLENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	ACENAPHTHYLENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	ACENAPHTHYLENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	ACENAPHTHYLENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	ACENAPHTHYLENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	ACENAPHTHYLENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	ACENAPHTHYLENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	ACENAPHTHYLENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	ACENAPHTHYLENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	ACENAPHTHYLENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	ACENAPHTHYLENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	ACENAPHTHYLENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	ACENAPHTHYLENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	ACENAPHTHYLENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	ACENAPHTHYLENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	ACENAPHTHYLENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	ACENAPHTHYLENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	ANTHRACENE	UG/KG	340	U	330.0000	390	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50394	26-JUL-94	BH00194ST	BH00195ST	ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	ANTHRACENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	ANTHRACENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	ANTHRACENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	ANTHRACENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	ANTHRACENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	ANTHRACENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	ANTHRACENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	ANTHRACENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	ANTHRACENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	ANTHRACENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BENZO(a)ANTHRACENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BENZO(a)ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BENZO(a)ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BENZO(a)ANTHRACENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BENZO(a)ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BENZO(a)ANTHRACENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	BENZO(a)ANTHRACENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BENZO(a)ANTHRACENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BENZO(a)ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BENZO(a)ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	BENZO(a)ANTHRACENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BENZO(a)ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BENZO(a)ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BENZO(a)ANTHRACENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BENZO(a)ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BENZO(a)ANTHRACENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BENZO(a)ANTHRACENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BENZO(a)ANTHRACENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BENZO(a)ANTHRACENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BENZO(a)PYRENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BENZO(a)PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BENZO(a)PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BENZO(a)PYRENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BENZO(a)PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BENZO(a)PYRENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	BENZO(a)PYRENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BENZO(a)PYRENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BENZO(a)PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BENZO(a)PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	BENZO(a)PYRENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BENZO(a)PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BENZO(a)PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BENZO(a)PYRENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BENZO(a)PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BENZO(a)PYRENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BENZO(a)PYRENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BENZO(a)PYRENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BENZO(a)PYRENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BENZO(b)FLUORANTHENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BENZO(b)FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BENZO(b)FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BENZO(b)FLUORANTHENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BENZO(b)FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								

Table C-2
Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50394	21-JUL-94	BH00176ST	BH00177ST	BENZO(b)FLUORANTHENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	BENZO(b)FLUORANTHENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BENZO(b)FLUORANTHENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BENZO(b)FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BENZO(b)FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	BENZO(b)FLUORANTHENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BENZO(b)FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BENZO(b)FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BENZO(b)FLUORANTHENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BENZO(b)FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BENZO(b)FLUORANTHENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BENZO(b)FLUORANTHENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BENZO(b)FLUORANTHENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BENZO(b)FLUORANTHENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BENZO(ghi)PERYLENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BENZO(ghi)PERYLENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BENZO(ghi)PERYLENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BENZO(ghi)PERYLENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BENZO(ghi)PERYLENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BENZO(ghi)PERYLENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	BENZO(ghi)PERYLENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BENZO(ghi)PERYLENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BENZO(ghi)PERYLENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BENZO(ghi)PERYLENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	BENZO(ghi)PERYLENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BENZO(ghi)PERYLENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BENZO(ghi)PERYLENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BENZO(ghi)PERYLENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BENZO(ghi)PERYLENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BENZO(ghi)PERYLENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BENZO(ghi)PERYLENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BENZO(ghi)PERYLENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BENZO(ghi)PERYLENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BENZO(k)FLUORANTHENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BENZO(k)FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BENZO(k)FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BENZO(k)FLUORANTHENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BENZO(k)FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BENZO(k)FLUORANTHENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	BENZO(k)FLUORANTHENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BENZO(k)FLUORANTHENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BENZO(k)FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BENZO(k)FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	BENZO(k)FLUORANTHENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BENZO(k)FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BENZO(k)FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BENZO(k)FLUORANTHENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BENZO(k)FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BENZO(k)FLUORANTHENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BENZO(k)FLUORANTHENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BENZO(k)FLUORANTHENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BENZO(k)FLUORANTHENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BENZOIC ACID	UG/KG	1700	U	1600.0000	2000	U	1600.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BENZOIC ACID	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BENZOIC ACID	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50894	01-AUG-94	BH00230ST	BH00231ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BENZOIC ACID	UG/KG	1800	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BENZOIC ACID	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BENZOIC ACID	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BENZOIC ACID	UG/KG	1900	U	1600.0000	1800	U	1600.0000	0				17	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BENZYL ALCOHOL	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BENZYL ALCOHOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BENZYL ALCOHOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BENZYL ALCOHOL	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BENZYL ALCOHOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BENZYL ALCOHOL	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BENZYL ALCOHOL	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BENZYL ALCOHOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BENZYL ALCOHOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BENZYL ALCOHOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BENZYL ALCOHOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BENZYL ALCOHOL	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BENZYL ALCOHOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BENZYL ALCOHOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BENZYL ALCOHOL	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BENZYL ALCOHOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BENZYL ALCOHOL	UG/KG	390	U	330.0000	370	U	330.0000	0				17	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BIS(2-CHLOROETHOXY)METHANE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	340	U	330.0000	350	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
51694	22-AUG-94	BH00291ST	BH00292ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BIS(2-CHLOROETHYL)ETHER	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BIS(2-CHLOROISOPROPYL)ETHER	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	350	U	330.0000	32	J	330.0000	165								
50694	28-JUL-94	BH00205ST	BH00206ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	350	U	330.0000	43	J	330.0000	154								
51694	22-AUG-94	BH00288ST	BH00289ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	390	U	330.0000	370	U	330.0000	0	16.79	50.32	299.74	19	2	10.53	89.47	
50194	08-JUL-94	BH00125ST	BH00126ST	BUTYL BENZYL PHTHALATE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	BUTYL BENZYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	BUTYL BENZYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	BUTYL BENZYL PHTHALATE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	BUTYL BENZYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	BUTYL BENZYL PHTHALATE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	BUTYL BENZYL PHTHALATE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	BUTYL BENZYL PHTHALATE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	BUTYL BENZYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	BUTYL BENZYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	BUTYL BENZYL PHTHALATE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	BUTYL BENZYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	BUTYL BENZYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	BUTYL BENZYL PHTHALATE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	BUTYL BENZYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	BUTYL BENZYL PHTHALATE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	BUTYL BENZYL PHTHALATE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	BUTYL BENZYL PHTHALATE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	BUTYL BENZYL PHTHALATE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	CHRYSENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	CHRYSENE	UG/KG	360	U	330.0000	360	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50394	26-JUL-94	BH00196ST	BH00197ST	CHRYSENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	CHRYSENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	CHRYSENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	CHRYSENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	CHRYSENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	CHRYSENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	CHRYSENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	CHRYSENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	CHRYSENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	CHRYSENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	CHRYSENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	CHRYSENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	CHRYSENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	CHRYSENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	CHRYSENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	CHRYSENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	CHRYSENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	DI-n-BUTYL PHTHALATE	UG/KG	550	U	330.0000	770	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	DI-n-BUTYL PHTHALATE	UG/KG	220	J	330.0000	100	J	330.0000	75								
50394	26-JUL-94	BH00196ST	BH00197ST	DI-n-BUTYL PHTHALATE	UG/KG	310	J	330.0000	310	J	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	DI-n-BUTYL PHTHALATE	UG/KG	400		330.0000	230	J	330.0000	54								
50394	26-JUL-94	BH00200ST	BH00201ST	DI-n-BUTYL PHTHALATE	UG/KG	510		330.0000	270	J	330.0000	62								
50394	21-JUL-94	BH00176ST	BH00177ST	DI-n-BUTYL PHTHALATE	UG/KG	110	BJ	330.0000	360	U	330.0000	100								
50694	29-JUL-94	BH00217ST	BH00218ST	DI-n-BUTYL PHTHALATE	UG/KG	350	U	330.0000	22	J	330.0000	175								
50694	28-JUL-94	BH00205ST	BH00206ST	DI-n-BUTYL PHTHALATE	UG/KG	440		330.0000	210	J	330.0000	71								
50694	28-JUL-94	BH00207ST	BH00208ST	DI-n-BUTYL PHTHALATE	UG/KG	180	J	330.0000	400		330.0000	76								
50694	28-JUL-94	BH00212ST	BH00213ST	DI-n-BUTYL PHTHALATE	UG/KG	350	J	330.0000	370		330.0000	6								
50894	29-JUL-94	BH00223ST	BH00224ST	DI-n-BUTYL PHTHALATE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	DI-n-BUTYL PHTHALATE	UG/KG	130	J	330.0000	210	J	330.0000	47								
50894	01-AUG-94	BH00232ST	BH00233ST	DI-n-BUTYL PHTHALATE	UG/KG	180	J	330.0000	71	J	330.0000	87								
51194	16-AUG-94	BH00280ST	BH00281ST	DI-n-BUTYL PHTHALATE	UG/KG	130	J	330.0000	140	J	330.0000	7								
51194	11-AUG-94	BH00258ST	BH00259ST	DI-n-BUTYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	DI-n-BUTYL PHTHALATE	UG/KG	400	U	330.0000	390	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	DI-n-BUTYL PHTHALATE	UG/KG	100	J	330.0000	65	J	330.0000	42								
51694	22-AUG-94	BH00291ST	BH00292ST	DI-n-BUTYL PHTHALATE	UG/KG	110	J	330.0000	340	U	330.0000	100								
51694	22-AUG-94	BH00294ST	BH00295ST	DI-n-BUTYL PHTHALATE	UG/KG	59	J	330.0000	120	J	330.0000	68	51.05	47.47	92.98	19	12	63.16	36.84	estimates
50194	08-JUL-94	BH00125ST	BH00126ST	DI-n-OCTYL PHTHALATE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	DI-n-OCTYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	DI-n-OCTYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	DI-n-OCTYL PHTHALATE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	DI-n-OCTYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	DI-n-OCTYL PHTHALATE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	DI-n-OCTYL PHTHALATE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	DI-n-OCTYL PHTHALATE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	DI-n-OCTYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	DI-n-OCTYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	DI-n-OCTYL PHTHALATE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	DI-n-OCTYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	DI-n-OCTYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	DI-n-OCTYL PHTHALATE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	DI-n-OCTYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	DI-n-OCTYL PHTHALATE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	DI-n-OCTYL PHTHALATE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	DI-n-OCTYL PHTHALATE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	DI-n-OCTYL PHTHALATE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	DIBENZO(a,h)ANTHRACENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	DIBENZO(a,h)ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	DIBENZO(a,h)ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	DIBENZO(a,h)ANTHRACENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	DIBENZO(a,h)ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	DIBENZO(a,h)ANTHRACENE	UG/KG	370	U	330.0000	360	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50694	29-JUL-94	BH00217ST	BH00218ST	DIBENZO(a,h)ANTHRACENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	DIBENZO(a,h)ANTHRACENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	DIBENZO(a,h)ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	DIBENZO(a,h)ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	DIBENZO(a,h)ANTHRACENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	DIBENZO(a,h)ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	DIBENZO(a,h)ANTHRACENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	DIBENZO(a,h)ANTHRACENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	DIBENZO(a,h)ANTHRACENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	DIBENZO(a,h)ANTHRACENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	DIBENZO(a,h)ANTHRACENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	DIBENZO(a,h)ANTHRACENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	DIBENZO(a,h)ANTHRACENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	DIBENZOFURAN	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	DIBENZOFURAN	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	DIBENZOFURAN	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	DIBENZOFURAN	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	DIBENZOFURAN	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	DIBENZOFURAN	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	DIBENZOFURAN	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	DIBENZOFURAN	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	DIBENZOFURAN	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	DIBENZOFURAN	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	DIBENZOFURAN	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	DIBENZOFURAN	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	DIBENZOFURAN	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	DIBENZOFURAN	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	DIBENZOFURAN	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	DIBENZOFURAN	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	DIBENZOFURAN	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	DIBENZOFURAN	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	DIBENZOFURAN	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	DIETHYL PHTHALATE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	DIETHYL PHTHALATE	UG/KG	44	J	330.0000	360	U	330.0000	153								
50394	26-JUL-94	BH00196ST	BH00197ST	DIETHYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	DIETHYL PHTHALATE	UG/KG	47	J	330.0000	350	U	330.0000	150								
50394	26-JUL-94	BH00200ST	BH00201ST	DIETHYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	DIETHYL PHTHALATE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	DIETHYL PHTHALATE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	DIETHYL PHTHALATE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	DIETHYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	DIETHYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	DIETHYL PHTHALATE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	DIETHYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	DIETHYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	DIETHYL PHTHALATE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	DIETHYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	DIETHYL PHTHALATE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	DIETHYL PHTHALATE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	DIETHYL PHTHALATE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	DIETHYL PHTHALATE	UG/KG	390	U	330.0000	370	U	330.0000	0	15.95	47.77	299.55	19	2	10.53	89.47	
50194	08-JUL-94	BH00125ST	BH00126ST	DIMETHYL PHTHALATE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	DIMETHYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	DIMETHYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	DIMETHYL PHTHALATE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	DIMETHYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	DIMETHYL PHTHALATE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	DIMETHYL PHTHALATE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	DIMETHYL PHTHALATE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	DIMETHYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	DIMETHYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50894	29-JUL-94	BH00223ST	BH00224ST	DIMETHYL PHTHALATE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	DIMETHYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	DIMETHYL PHTHALATE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	DIMETHYL PHTHALATE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	DIMETHYL PHTHALATE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	DIMETHYL PHTHALATE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	DIMETHYL PHTHALATE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	DIMETHYL PHTHALATE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	DIMETHYL PHTHALATE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	FLUORANTHENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	FLUORANTHENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	FLUORANTHENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	FLUORANTHENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	FLUORANTHENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	FLUORANTHENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	FLUORANTHENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	FLUORANTHENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	FLUORANTHENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	FLUORANTHENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	FLUORANTHENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	FLUORANTHENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	FLUORANTHENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	FLUORENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	FLUORENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	FLUORENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	FLUORENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	FLUORENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	FLUORENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	FLUORENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	FLUORENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	FLUORENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	FLUORENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	FLUORENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	FLUORENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	FLUORENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	FLUORENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	FLUORENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	FLUORENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	FLUORENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	FLUORENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	FLUORENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	HEXACHLOROBENZENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	HEXACHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	HEXACHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	HEXACHLOROBENZENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	HEXACHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	HEXACHLOROBENZENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	HEXACHLOROBENZENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	HEXACHLOROBENZENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	HEXACHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	HEXACHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	HEXACHLOROBENZENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	HEXACHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	HEXACHLOROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	HEXACHLOROBENZENE	UG/KG	350	U	330.0000	360	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
51194	11-AUG-94	BH00258ST	BH00259ST	HEXACHLOROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	HEXACHLOROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	HEXACHLOROBENZENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	HEXACHLOROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	HEXACHLOROBENZENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	HEXACHLOROBUTADIENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	HEXACHLOROBUTADIENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	HEXACHLOROBUTADIENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	HEXACHLOROBUTADIENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	HEXACHLOROBUTADIENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	HEXACHLOROBUTADIENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	HEXACHLOROBUTADIENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	HEXACHLOROBUTADIENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	HEXACHLOROBUTADIENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	HEXACHLOROBUTADIENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	HEXACHLOROBUTADIENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	HEXACHLOROBUTADIENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	HEXACHLOROBUTADIENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	HEXACHLOROBUTADIENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	HEXACHLOROBUTADIENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	HEXACHLOROBUTADIENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	HEXACHLOROBUTADIENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	HEXACHLOROBUTADIENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	HEXACHLOROBUTADIENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	HEXACHLOROCYCLOPENTADIENE	UG/KG	390	U	330.0000	370	U	330.0000	0				17	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	HEXACHLOROETHANE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	HEXACHLOROETHANE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	HEXACHLOROETHANE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	HEXACHLOROETHANE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	HEXACHLOROETHANE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	HEXACHLOROETHANE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	HEXACHLOROETHANE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	HEXACHLOROETHANE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	HEXACHLOROETHANE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	HEXACHLOROETHANE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	HEXACHLOROETHANE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	HEXACHLOROETHANE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	HEXACHLOROETHANE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	HEXACHLOROETHANE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	HEXACHLOROETHANE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	HEXACHLOROETHANE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	HEXACHLOROETHANE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	HEXACHLOROETHANE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	HEXACHLOROETHANE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	INDENO(1,2,3-cd)PYRENE	UG/KG	340	U	330.0000	390	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50394	26-JUL-94	BH00194ST	BH00195ST	INDENO(1,2,3-cd)PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	INDENO(1,2,3-cd)PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	INDENO(1,2,3-cd)PYRENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	INDENO(1,2,3-cd)PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	INDENO(1,2,3-cd)PYRENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	INDENO(1,2,3-cd)PYRENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	INDENO(1,2,3-cd)PYRENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	INDENO(1,2,3-cd)PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	INDENO(1,2,3-cd)PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	INDENO(1,2,3-cd)PYRENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	INDENO(1,2,3-cd)PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	INDENO(1,2,3-cd)PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	INDENO(1,2,3-cd)PYRENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	INDENO(1,2,3-cd)PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	INDENO(1,2,3-cd)PYRENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	INDENO(1,2,3-cd)PYRENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	INDENO(1,2,3-cd)PYRENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	INDENO(1,2,3-cd)PYRENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	ISOPHORONE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	ISOPHORONE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	ISOPHORONE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	ISOPHORONE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	ISOPHORONE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	ISOPHORONE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	ISOPHORONE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	ISOPHORONE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	ISOPHORONE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	ISOPHORONE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	ISOPHORONE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	ISOPHORONE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	ISOPHORONE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	ISOPHORONE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	ISOPHORONE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	ISOPHORONE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	ISOPHORONE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	ISOPHORONE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	ISOPHORONE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	N-NITROSO-DI-n-PROPYLAMINE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	N-NITROSODIPHENYLAMINE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	N-NITROSODIPHENYLAMINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	N-NITROSODIPHENYLAMINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	N-NITROSODIPHENYLAMINE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	N-NITROSODIPHENYLAMINE	UG/KG	360	U	330.0000	360	U	330.0000	0								

Table C-2
Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50394	21-JUL-94	BH00176ST	BH00177ST	N-NITROSODIPHENYLAMINE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	N-NITROSODIPHENYLAMINE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	N-NITROSODIPHENYLAMINE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	N-NITROSODIPHENYLAMINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	N-NITROSODIPHENYLAMINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	N-NITROSODIPHENYLAMINE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	N-NITROSODIPHENYLAMINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	N-NITROSODIPHENYLAMINE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	N-NITROSODIPHENYLAMINE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	N-NITROSODIPHENYLAMINE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	N-NITROSODIPHENYLAMINE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	N-NITROSODIPHENYLAMINE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	N-NITROSODIPHENYLAMINE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	N-NITROSODIPHENYLAMINE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	NAPHTHALENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	NAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	NAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	NAPHTHALENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	NAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	NAPHTHALENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	NAPHTHALENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	NAPHTHALENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	NAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	NAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	NAPHTHALENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	NAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	NAPHTHALENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	NAPHTHALENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	NAPHTHALENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	NAPHTHALENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	NAPHTHALENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	NAPHTHALENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	NAPHTHALENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	NITROBENZENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	NITROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	NITROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	NITROBENZENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	NITROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	NITROBENZENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	NITROBENZENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	NITROBENZENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	NITROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	NITROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	NITROBENZENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	NITROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	NITROBENZENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	NITROBENZENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	NITROBENZENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	NITROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	NITROBENZENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	NITROBENZENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	NITROBENZENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	PENTACHLOROPHENOL	UG/KG	1700	U	1600.0000	2000	U	1600.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	PENTACHLOROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	790	U	1600.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	PENTACHLOROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
50694	28-JUL-94	BH00212ST	BH00213ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1800	U	1600.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	PENTACHLOROPHENOL	UG/KG	1800	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	PENTACHLOROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	PENTACHLOROPHENOL	UG/KG	1700	U	1600.0000	1700	U	1600.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	PENTACHLOROPHENOL	UG/KG	1900	U	1600.0000	1800	U	1600.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	PHENANTHRENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	PHENANTHRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	PHENANTHRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	PHENANTHRENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	PHENANTHRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	PHENANTHRENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	PHENANTHRENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	PHENANTHRENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	PHENANTHRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	PHENANTHRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	PHENANTHRENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	PHENANTHRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	PHENANTHRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	PHENANTHRENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	PHENANTHRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	PHENANTHRENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	PHENANTHRENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	PHENANTHRENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	PHENANTHRENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	PHENOL	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	PHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	PHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	PHENOL	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	PHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	PHENOL	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	PHENOL	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	PHENOL	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	PHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	PHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	PHENOL	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	PHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	PHENOL	UG/KG	360	U	330.0000	360	U	330.0000	0								
51194	16-AUG-94	BH00280ST	BH00281ST	PHENOL	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	PHENOL	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	PHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	PHENOL	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	PHENOL	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	PHENOL	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	PYRENE	UG/KG	340	U	330.0000	390	U	330.0000	0								
50394	26-JUL-94	BH00194ST	BH00195ST	PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	26-JUL-94	BH00196ST	BH00197ST	PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00198ST	BH00199ST	PYRENE	UG/KG	360	U	330.0000	350	U	330.0000	0								
50394	26-JUL-94	BH00200ST	BH00201ST	PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50394	21-JUL-94	BH00176ST	BH00177ST	PYRENE	UG/KG	370	U	330.0000	360	U	330.0000	0								
50694	29-JUL-94	BH00217ST	BH00218ST	PYRENE	UG/KG	350	U	330.0000	160	U	330.0000	0								
50694	28-JUL-94	BH00205ST	BH00206ST	PYRENE	UG/KG	340	U	330.0000	340	U	330.0000	0								
50694	28-JUL-94	BH00207ST	BH00208ST	PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50694	28-JUL-94	BH00212ST	BH00213ST	PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								
50894	29-JUL-94	BH00223ST	BH00224ST	PYRENE	UG/KG	360	U	330.0000	370	U	330.0000	0								
50894	01-AUG-94	BH00230ST	BH00231ST	PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
50894	01-AUG-94	BH00232ST	BH00233ST	PYRENE	UG/KG	360	U	330.0000	360	U	330.0000	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N>35%	% Pairs >35%	Overall Precision Compliance (%)	Usability
51194	16-AUG-94	BH00280ST	BH00281ST	PYRENE	UG/KG	350	U	330.0000	360	U	330.0000	0								
51194	11-AUG-94	BH00258ST	BH00259ST	PYRENE	UG/KG	350	U	330.0000	350	U	330.0000	0								
51494	23-JUN-94	BH00080ST	BH00081ST	PYRENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00288ST	BH00289ST	PYRENE	UG/KG	340	U	330.0000	350	U	330.0000	0								
51694	22-AUG-94	BH00291ST	BH00292ST	PYRENE	UG/KG	350	U	330.0000	340	U	330.0000	0								
51694	22-AUG-94	BH00294ST	BH00295ST	PYRENE	UG/KG	390	U	330.0000	370	U	330.0000	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	% SOLIDS BY WEIGHT	%	95.6		0.1	84.2		0.1	12.7								
50394	26-JUL-94	BH00194ST	BH00195ST	% SOLIDS BY WEIGHT	%	91.0		0.1	91.2		0.1	0.2								
50394	26-JUL-94	BH00196ST	BH00197ST	% SOLIDS BY WEIGHT	%	95.1		0.1	95.1		0.1	0								
50394	26-JUL-94	BH00198ST	BH00199ST	% SOLIDS BY WEIGHT	%	91.8		0.1	93.2		0.1	1.5								
50394	26-JUL-94	BH00200ST	BH00201ST	% SOLIDS BY WEIGHT	%	92.1		0.1	91.6		0.1	0.5								
50394	21-JUL-94	BH00176ST	BH00177ST	% SOLIDS BY WEIGHT	%	90.5		0.1	91.2		0.1	0.8								
50694	29-JUL-94	BH00217ST	BH00218ST	% SOLIDS BY WEIGHT	%	94.0		0.1	92.6		0.1	1.5								
50694	28-JUL-94	BH00205ST	BH00206ST	% SOLIDS BY WEIGHT	%	97.6		0.1	98.3		0.1	0.7								
50694	28-JUL-94	BH00207ST	BH00208ST	% SOLIDS BY WEIGHT	%	93.3		0.1	93.7		0.1	0.4								
50694	28-JUL-94	BH00212ST	BH00213ST	% SOLIDS BY WEIGHT	%	91.0		0.1	91.8		0.1	0.9								
50894	29-JUL-94	BH00223ST	BH00224ST	% SOLIDS BY WEIGHT	%	92.0		0.1	90.3		0.1	1.9								
50894	01-AUG-94	BH00230ST	BH00231ST	% SOLIDS BY WEIGHT	%	92.6		0.1	92.9		0.1	0.3								
50894	01-AUG-94	BH00232ST	BH00233ST	% SOLIDS BY WEIGHT	%	91.8		0.1	92.5		0.1	0.8								
51194	16-AUG-94	BH00280ST	BH00281ST	% SOLIDS BY WEIGHT	%	93.3		0.1	91.1		0.1	2.4								
51194	11-AUG-94	BH00258ST	BH00259ST	% SOLIDS BY WEIGHT	%	93.6		0.1	93.0		0.1	0.6								
51494	23-JUN-94	BH00080ST	BH00081ST	% SOLIDS BY WEIGHT	%	93.6		0.1	95.7		0.1	2.2								
51694	22-AUG-94	BH00288ST	BH00289ST	% SOLIDS BY WEIGHT	%	95.6		0.1	95.2		0.1	0.4								
51694	22-AUG-94	BH00291ST	BH00292ST	% SOLIDS BY WEIGHT	%	95.1		0.1	96.4		0.1	1.4								
51694	22-AUG-94	BH00294ST	BH00295ST	% SOLIDS BY WEIGHT	%	85.3		0.1	90.3		0.1	5.7	1.84	2.92	159.23	19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	CYANIDE	MG/KG	2.6	U	2.5	3.0	U	2.5	0								
50394	26-JUL-94	BH00194ST	BH00195ST	CYANIDE	MG/KG	2.7	U	2.5	2.7	U	2.5	0								
50394	26-JUL-94	BH00196ST	BH00197ST	CYANIDE	MG/KG	2.6	U	2.5	2.6	U	2.5	0								
50394	26-JUL-94	BH00198ST	BH00199ST	CYANIDE	MG/KG	2.7	U	2.5	2.7	U	2.5	0								
50394	26-JUL-94	BH00200ST	BH00201ST	CYANIDE	MG/KG	2.7	U	2.5	2.7	U	2.5	0								
50394	21-JUL-94	BH00176ST	BH00177ST	CYANIDE	MG/KG	2.8	U	2.5	2.7	U	2.5	0								
50694	29-JUL-94	BH00217ST	BH00218ST	CYANIDE	MG/KG	2.7	U	2.5	2.7	U	2.5	0								
50694	28-JUL-94	BH00205ST	BH00206ST	CYANIDE	MG/KG	2.6	U	2.5	2.5	U	2.5	0								
50694	28-JUL-94	BH00207ST	BH00208ST	CYANIDE	MG/KG	2.7	U	2.5	2.7	U	2.5	0								
50694	28-JUL-94	BH00212ST	BH00213ST	CYANIDE	MG/KG	2.7	U	2.5	2.7	U	2.5	0								
50894	29-JUL-94	BH00223ST	BH00224ST	CYANIDE	MG/KG	2.7	U	2.5	2.8	U	2.5	0								
50894	01-AUG-94	BH00230ST	BH00231ST	CYANIDE	MG/KG	2.7	U	2.5	2.7	U	2.5	0								
50894	01-AUG-94	BH00232ST	BH00233ST	CYANIDE	MG/KG	2.7	U	2.5	2.7	U	2.5	0								
51194	16-AUG-94	BH00280ST	BH00281ST	CYANIDE	MG/KG	2.7	U	2.5	2.7	U	2.5	0								
51194	11-AUG-94	BH00258ST	BH00259ST	CYANIDE	MG/KG	2.7	U	2.5	2.7	U	2.5	0								
51494	23-JUN-94	BH00080ST	BH00081ST	CYANIDE	MG/KG	2.7	U	2.5	2.6	U	2.5	0								
51694	22-AUG-94	BH00288ST	BH00289ST	CYANIDE	MG/KG	2.6	U	2.5	2.6	U	2.5	0								
51694	22 AUG-94	BH00291ST	BH00292ST	CYANIDE	MG/KG	2.6	U	2.5	2.6	U	2.5	0								
51694	22-AUG-94	BH00294ST	BH00295ST	CYANIDE	MG/KG	2.9	U	2.5	2.8	U	2.5	0				19	0	0.00	100.00	
50194	08-JUL-94	BH00125ST	BH00126ST	NITRATE/NITRITE	MG/KG	0.6		0.1	0.7		0.1	15.4								
50394	26-JUL-94	BH00194ST	BH00195ST	NITRATE/NITRITE	MG/KG	0.2		0.1	0.1		0.1	66.7								
50394	26-JUL-94	BH00196ST	BH00197ST	NITRATE/NITRITE	MG/KG	0.3		0.1	0.2		0.1	40								
50394	26-JUL-94	BH00198ST	BH00199ST	NITRATE/NITRITE	MG/KG	0.2		0.1	0.2		0.1	0								
50394	26-JUL-94	BH00200ST	BH00201ST	NITRATE/NITRITE	MG/KG	0.3		0.1	0.2		0.1	40								
50394	21-JUL-94	BH00176ST	BH00177ST	NITRATE/NITRITE	MG/KG	0.4		0.1	0.3		0.1	28.6								
50694	29-JUL-94	BH00217ST	BH00218ST	NITRATE/NITRITE	MG/KG	0.2		0.1	0.2		0.1	0								
50694	28-JUL-94	BH00205ST	BH00206ST	NITRATE/NITRITE	MG/KG	2		0.1	1		0.1	67								
50694	28-JUL-94	BH00207ST	BH00208ST	NITRATE/NITRITE	MG/KG	0.2		0.1	2		0.1	164								
50694	28-JUL-94	BH00212ST	BH00213ST	NITRATE/NITRITE	MG/KG	0.2		0.1	0.3		0.1	40								
50894	29-JUL-94	BH00223ST	BH00224ST	NITRATE/NITRITE	MG/KG	2		0.1	2		0.1	0								
50894	01-AUG-94	BH00230ST	BH00231ST	NITRATE/NITRITE	MG/KG	1		0.1	0.4		0.1	86								
50894	01-AUG-94	BH00232ST	BH00233ST	NITRATE/NITRITE	MG/KG	0.5		0.1	0.5		0.1	0								
51194	16-AUG-94	BH00280ST	BH00281ST	NITRATE/NITRITE	MG/KG	0.1		0.1	0.2		0.1	66.7								
51194	11-AUG-94	BH00258ST	BH00259ST	NITRATE/NITRITE	MG/KG	0.3		0.1	0.2		0.1	40								
51494	23-JUN-94	BH00080ST	BH00081ST	NITRATE/NITRITE	MG/KG	0.1		0.1	0.1	U	0.1	0								
51694	22-AUG-94	BH00288ST	BH00289ST	NITRATE/NITRITE	MG/KG	2		0.1	2.0		0.1	0								

Table C-2

Relative Percent Differences for Real/Duplicate Sample Pairs of Subsurface Geologic Materials

SAMPLE LOCATION	SAMPLING DATE	REAL SAMPLE ID	DUPLICATE SAMPLE ID	ANALYTE	UNITS	REAL RESULT	REAL QUAL	REAL DL	DUP RESULT	DUP QUAL	DUP DL	RPD (%)	Avg	StDev	%CV	N	N > 35%	% Pairs > 35%	Overall Precision Compliance (%)	Usability
51694	22-AUG-94	BH00291ST	BH00292ST	NITRATE/NITRITE	MG/KG	0.2		0.1	0.1		0.1	66.7								
51694	22-AUG-94	BH00294ST	BH00295ST	NITRATE/NITRITE	MG/KG	0.3		0.1	0.2		0.1	40	40.06	41.29	103.09	19	11	57.89	42.11	estimates

Table C-3
Analytical Results for Equipment Rinses Collected During Surficial Soil Sampling

SAMPLE TYPE	QC SAMPLE TYPE	TOTAL/ DISSOLVED	ANALYTE	FREQ. OF HITS	UNITS	MINIMUM RESULT	MAXIMUM RESULT	MEAN RESULT
SS	Eqt. Rinse	Total	ALUMINUM	2/3	UG/L	12.00	102.00	44.33
SS	Eqt. Rinse	Total	ANTIMONY	0/3				
SS	Eqt. Rinse	Total	ARSENIC	0/3				
SS	Eqt. Rinse	Total	BARIUM	3/3	UG/L	1.20	1.90	1.67
SS	Eqt. Rinse	Total	BERYLLIUM	0/3				
SS	Eqt. Rinse	Total	CADMIUM	0/3				
SS	Eqt. Rinse	Total	CALCIUM	3/3	UG/L	76.40	270.00	170.13
SS	Eqt. Rinse	Total	CESIUM	0/3				
SS	Eqt. Rinse	Total	CHROMIUM	1/3	UG/L	2.00	3.90	1.97
SS	Eqt. Rinse	Total	COBALT	0/3				
SS	Eqt. Rinse	Total	COPPER	3/3	UG/L	2.40	27.30	10.83
SS	Eqt. Rinse	Total	IRON	2/3	UG/L	11.30	76.10	39.35
SS	Eqt. Rinse	Total	LEAD	1/3	UG/L	1.00	1.20	1.40
SS	Eqt. Rinse	Total	LITHIUM	0/3				
SS	Eqt. Rinse	Total	MAGNESIUM	1/3	UG/L	14.00	16.60	12.08
SS	Eqt. Rinse	Total	MANGANESE	2/3	UG/L	1.00	2.10	1.30
SS	Eqt. Rinse	Total	MERCURY	0/3				
SS	Eqt. Rinse	Total	MOLYBDENUM	0/3				
SS	Eqt. Rinse	Total	NICKEL	0/3				
SS	Eqt. Rinse	Total	POTASSIUM	0/3				
SS	Eqt. Rinse	Total	SELENIUM	0/3				
SS	Eqt. Rinse	Total	SILVER	0/3				
SS	Eqt. Rinse	Total	SODIUM	2/3	UG/L	47.60	1530.00	549.40
SS	Eqt. Rinse	Total	STRONTIUM	1/3	UG/L	1.00	3.00	1.33
SS	Eqt. Rinse	Total	THALLIUM	0/3				
SS	Eqt. Rinse	Total	TIN	0/3				
SS	Eqt. Rinse	Total	VANADIUM	0/3				
SS	Eqt. Rinse	Total	ZINC	1/3	UG/L	11.10	20.60	12.13
SS	Eqt. Rinse	Total	AMERICIUM-241	1/1	PCI/L	0.003	0.003	0.003
SS	Eqt. Rinse	Total	PLUTONIUM-239/240	1/1	PCI/L	0	0	
SS	Eqt. Rinse	Total	TRITIUM	1/1	PCI/L	84	84	84
SS	Eqt. Rinse	Total	URANIUM-233,-234	1/1	PCI/L	0.056	0.056	0.056

Table C-3
Analytical Results for Equipment Rinses Collected During Surficial Soil Sampling

SAMPLE TYPE	QC SAMPLE TYPE	TOTAL/ DISSOLVED	ANALYTE	FREQ. OF HITS	UNITS	MINIMUM RESULT	MAXIMUM RESULT	MEAN RESULT
SS	Eqt. Rinse	Total	URANIUM-235	1/1	PCI/L	0.017	0.017	0.017
SS	Eqt. Rinse	Total	URANIUM-238	1/1	PCI/L	0.12	0.12	0.12
SS	Eqt. Rinse	Total	CYANIDE	0/3				
SS	Eqt. Rinse	Total	NITRATE/NITRITE	0/3				

Table C-4
Analytical Results for Equipment Rinses and Trip Blanks Collected During Subsurface Geologic Material Sampling

SAMPLE TYPE	QC SAMPLE TYPE	TOTAL/ DISSOLVED	ANALYTE	FREQ. OF HITS	UNITS	MINIMUM RESULT	MAXIMUM RESULT	MEAN RESULT
BH	Eqt. Rinse	Total	ALUMINUM	9/29	UG/L	11.00	152.00	15.64
BH	Eqt. Rinse	Total	ANTIMONY	0/30				
BH	Eqt. Rinse	Total	ARSENIC	0/30				
BH	Eqt. Rinse	Total	BARIUM	7/30	UG/L	1.00	2.70	0.73
BH	Eqt. Rinse	Total	BERYLLIUM	0/30				
BH	Eqt. Rinse	Total	CADMIUM	2/30	UG/L	3.00	11.00	2.11
BH	Eqt. Rinse	Total	CALCIUM	17/30	UG/L	15.60	187.00	44.17
BH	Eqt. Rinse	Total	CESIUM	0/30				
BH	Eqt. Rinse	Total	CHROMIUM	3/30	UG/L	2.00	5.70	1.31
BH	Eqt. Rinse	Total	COBALT	0/30				
BH	Eqt. Rinse	Total	COPPER	7/29	UG/L	1.00	3.80	1.34
BH	Eqt. Rinse	Total	IRON	22/30	UG/L	2.00	640.00	95.09
BH	Eqt. Rinse	Total	LEAD	1/30	UG/L	1.00	1.90	1.51
BH	Eqt. Rinse	Total	LITHIUM	0/30				
BH	Eqt. Rinse	Total	MAGNESIUM	5/30	UG/L	13.00	66.10	11.89
BH	Eqt. Rinse	Total	MANGANESE	19/30	UG/L	1.00	8.10	2.01
BH	Eqt. Rinse	Total	MERCURY	0/30				
BH	Eqt. Rinse	Total	MOLYBDENUM	0/30				
BH	Eqt. Rinse	Total	NICKEL	0/30				
BH	Eqt. Rinse	Total	POTASSIUM	2/30	UG/L	244.00	548.00	205.42
BH	Eqt. Rinse	Total	SELENIUM	0/30				
BH	Eqt. Rinse	Total	SILVER	0/30				
BH	Eqt. Rinse	Total	SODIUM	16/29	UG/L	11.90	161.00	43.94
BH	Eqt. Rinse	Total	STRONTIUM	1/30	UG/L	1.00	1.30	0.53
BH	Eqt. Rinse	Total	THALLIUM	0/30				
BH	Eqt. Rinse	Total	TIN	0/30				
BH	Eqt. Rinse	Total	VANADIUM	0/30				
BH	Eqt. Rinse	Total	ZINC	2/30	UG/L	2.50	23.20	4.43
BH	Eqt. Rinse	Total	AMERICIUM-241	17/17	PCI/L	-0.002	0.019	0.004
BH	Eqt. Rinse	Total	PLUTONIUM-239/240	17/17	PCI/L	-0.003	0.021	0.003
BH	Eqt. Rinse	Total	TRITIUM	17/17	PCI/L	-42	370	146
BH	Eqt. Rinse	Total	URANIUM-233,-234	17/17	PCI/L	-0.008	0.22	0.11

Table C-4

Analytical Results for Equipment Rinses and Trip Blanks Collected During Subsurface Geologic Material Sampling

SAMPLE TYPE	QC SAMPLE TYPE	TOTAL/ DISSOLVED	ANALYTE	FREQ. OF HITS	UNITS	MINIMUM RESULT	MAXIMUM RESULT	MEAN RESULT
BH	Eqt. Rinse	Total	URANIUM-235	17/17	PCI/L	-0.019	0.12	0.02
BH	Eqt. Rinse	Total	URANIUM-238	17/17	PCI/L	0.032	0.18	0.10
BH	Eqt. Rinse	Total	1,2,4-TRICHLOROBENZENE	0/30				
BH	Eqt. Rinse	Total	1,2-DICHLOROBENZENE	0/30				
BH	Eqt. Rinse	Total	1,3-DICHLOROBENZENE	0/30				
BH	Eqt. Rinse	Total	1,4-DICHLOROBENZENE	0/30				
BH	Eqt. Rinse	Total	2,4,5-TRICHLOROPHENOL	0/30				
BH	Eqt. Rinse	Total	2,4,6-TRICHLOROPHENOL	0/30				
BH	Eqt. Rinse	Total	2,4-DICHLOROPHENOL	0/30				
BH	Eqt. Rinse	Total	2,4-DIMETHYLPHENOL	0/30				
BH	Eqt. Rinse	Total	2,4-DINITROPHENOL	0/21				
BH	Eqt. Rinse	Total	2,4-DINITROTOLUENE	0/30				
BH	Eqt. Rinse	Total	2,6-DINITROTOLUENE	0/30				
BH	Eqt. Rinse	Total	2-CHLORONAPHTHALENE	0/30				
BH	Eqt. Rinse	Total	2-CHLOROPHENOL	0/30				
BH	Eqt. Rinse	Total	2-METHYLNAPHTHALENE	0/30				
BH	Eqt. Rinse	Total	2-METHYLPHENOL	0/28				
BH	Eqt. Rinse	Total	2-NITROANILINE	0/30				
BH	Eqt. Rinse	Total	2-NITROPHENOL	0/30				
BH	Eqt. Rinse	Total	3,3'-DICHLOROBENZIDINE	0/28				
BH	Eqt. Rinse	Total	3-NITROANILINE	0/22				
BH	Eqt. Rinse	Total	4,6-DINITRO-2-METHYLPHENOL	0/30				
BH	Eqt. Rinse	Total	4-CHLORO-3-METHYLPHENOL	0/30				
BH	Eqt. Rinse	Total	4-CHLOROANILINE	0/27				
BH	Eqt. Rinse	Total	4-CHLOROPHENYL PHENYL ETHER	0/30				
BH	Eqt. Rinse	Total	4-METHYLPHENOL	0/30				
BH	Eqt. Rinse	Total	4-NITROANILINE	0/28				
BH	Eqt. Rinse	Total	4-NITROPHENOL	0/29				
BH	Eqt. Rinse	Total	ACENAPHTHENE	0/30				
BH	Eqt. Rinse	Total	ACENAPHTHYLENE	0/30				
BH	Eqt. Rinse	Total	ANTHRACENE	0/30				
BH	Eqt. Rinse	Total	BENZO(a)ANTHRACENE	0/30				

Table C-4
Analytical Results for Equipment Rinses and Trip Blanks Collected During Subsurface Geologic Material Sampling

SAMPLE TYPE	QC SAMPLE TYPE	TOTAL/ DISSOLVED	ANALYTE	FREQ. OF HITS	UNITS	MINIMUM RESULT	MAXIMUM RESULT	MEAN RESULT
BH	Eqt. Rinse	Total	BENZO(a)PYRENE	0/29				
BH	Eqt. Rinse	Total	BENZO(b)FLUORANTHENE	0/29				
BH	Eqt. Rinse	Total	BENZO(ghi)PERYLENE	0/29				
BH	Eqt. Rinse	Total	BENZO(k)FLUORANTHENE	0/29				
BH	Eqt. Rinse	Total	BENZOIC ACID	0/27				
BH	Eqt. Rinse	Total	BENZYL ALCOHOL	0/22				
BH	Eqt. Rinse	Total	BIS(2-CHLOROETHOXY)METHANE	0/30				
BH	Eqt. Rinse	Total	BIS(2-CHLOROETHYL)ETHER	0/30				
BH	Eqt. Rinse	Total	BIS(2-CHLOROISOPROPYL)ETHER	0/30				
BH	Eqt. Rinse	Total	BIS(2-ETHYLHEXYL)PHTHALATE	7/30	UG/L	2	36	6
BH	Eqt. Rinse	Total	BUTYL BENZYL PHTHALATE	0/30				
BH	Eqt. Rinse	Total	CHRYSENE	0/30				
BH	Eqt. Rinse	Total	DI-n-BUTYL PHTHALATE	0/30				
BH	Eqt. Rinse	Total	DI-n-OCTYL PHTHALATE	0/29				
BH	Eqt. Rinse	Total	DIBENZO(a,h)ANTHRACENE	0/29				
BH	Eqt. Rinse	Total	DIBENZOFURAN	0/30				
BH	Eqt. Rinse	Total	DIETHYL PHTHALATE	5/30	UG/L	3	14	5
BH	Eqt. Rinse	Total	DIMETHYL PHTHALATE	0/30				
BH	Eqt. Rinse	Total	FLUORANTHENE	0/30				
BH	Eqt. Rinse	Total	FLUORENE	0/30				
BH	Eqt. Rinse	Total	HEXACHLOROBENZENE	0/30				
BH	Eqt. Rinse	Total	HEXACHLOROBUTADIENE	0/30				
BH	Eqt. Rinse	Total	HEXACHLOROCYCLOPENTADIENE	0/26				
BH	Eqt. Rinse	Total	HEXACHLOROETHANE	0/30				
BH	Eqt. Rinse	Total	INDENO(1,2,3-cd)PYRENE	0/29				
BH	Eqt. Rinse	Total	ISOPHORONE	0/30				
BH	Eqt. Rinse	Total	N-NITROSO-DI-n-PROPYLAMINE	0/30				
BH	Eqt. Rinse	Total	N-NITROSODIPHENYLAMINE	0/30				
BH	Eqt. Rinse	Total	NAPHTHALENE	0/30				
BH	Eqt. Rinse	Total	NITROBENZENE	0/30				
BH	Eqt. Rinse	Total	PENTACHLOROPHENOL	0/30				
BH	Eqt. Rinse	Total	PHENANTHRENE	0/30				

Table C-4

Analytical Results for Equipment Rinses and Trip Blanks Collected During Subsurface Geologic Material Sampling

SAMPLE TYPE	QC SAMPLE TYPE	TOTAL/ DISSOLVED	ANALYTE	FREQ. OF HITS	UNITS	MINIMUM RESULT	MAXIMUM RESULT	MEAN RESULT
BH	Eqt. Rinse	Total	PHENOL	0/30				
BH	Eqt. Rinse	Total	PYRENE	0/30				
BH	Eqt. Rinse	Total	1,1,1-TRICHLOROETHANE	0/30				
BH	Eqt. Rinse	Total	1,1,2,2-TETRACHLOROETHANE	0/30				
BH	Eqt. Rinse	Total	1,1,2-TRICHLOROETHANE	0/30				
BH	Eqt. Rinse	Total	1,1-DICHLOROETHENE	0/30				
BH	Eqt. Rinse	Total	1,2-DICHLOROETHENE	0/30				
BH	Eqt. Rinse	Total	1,2-DICHLOROPROPANE	0/30				
BH	Eqt. Rinse	Total	2-BUTANONE	0/9				
BH	Eqt. Rinse	Total	2-HEXANONE	0/27				
BH	Eqt. Rinse	Total	4-METHYL-2-PENTANONE	0/30				
BH	Eqt. Rinse	Total	ACETONE	0/24				
BH	Eqt. Rinse	Total	BENZENE	0/30				
BH	Eqt. Rinse	Total	BROMODICHLOROMETHANE	0/30				
BH	Eqt. Rinse	Total	BROMOFORM	0/30				
BH	Eqt. Rinse	Total	BROMOMETHANE	0/30				
BH	Eqt. Rinse	Total	CARBON DISULFIDE	0/30				
BH	Eqt. Rinse	Total	CARBON TETRACHLORIDE	0/30				
BH	Eqt. Rinse	Total	CHLOROBENZENE	0/30				
BH	Eqt. Rinse	Total	CHLOROETHANE	0/30				
BH	Eqt. Rinse	Total	CHLOROFORM	0/30				
BH	Eqt. Rinse	Total	CHLOROMETHANE	0/30				
BH	Eqt. Rinse	Total	DIBROMOCHLOROMETHANE	0/30				
BH	Eqt. Rinse	Total	ETHYLBENZENE	0/30				
BH	Eqt. Rinse	Total	METHYLENE CHLORIDE	0/30				
BH	Eqt. Rinse	Total	STYRENE	0/30				
BH	Eqt. Rinse	Total	TETRACHLOROETHENE	1/30	UG/L	3	3	3
BH	Eqt. Rinse	Total	TOLUENE	0/30				
BH	Eqt. Rinse	Total	TOTAL XYLENES	0/30				
BH	Eqt. Rinse	Total	TRICHLOROETHENE	0/30				
BH	Eqt. Rinse	Total	VINYL ACETATE	0/30				
BH	Eqt. Rinse	Total	VINYL CHLORIDE	0/30				

Table C-4

Analytical Results for Equipment Rinses and Trip Blanks Collected During Subsurface Geologic Material Sampling

SAMPLE TYPE	QC SAMPLE TYPE	TOTAL/ DISSOLVED	ANALYTE	FREQ. OF HITS	UNITS	MINIMUM RESULT	MAXIMUM RESULT	MEAN RESULT
BH	Eqt. Rinse	Total	cis-1,3-DICHLOROPROPENE	0/30				
BH	Eqt. Rinse	Total	trans-1,3-DICHLOROPROPENE	0/30				
BH	Eqt. Rinse	Total	CYANIDE	0/30				
BH	Eqt. Rinse	Total	NITRATE/NITRITE	9/30	UG/L	20.00	40.00	16.00
BH	Trip Blank	Total	1,1,1-TRICHLOROETHANE	0/30				
BH	Trip Blank	Total	1,1,2,2-TETRACHLOROETHANE	0/30				
BH	Trip Blank	Total	1,1,2-TRICHLOROETHANE	0/30				
BH	Trip Blank	Total	1,1-DICHLOROETHENE	0/30				
BH	Trip Blank	Total	1,2-DICHLOROETHENE	0/30				
BH	Trip Blank	Total	1,2-DICHLOROPROPANE	0/30				
BH	Trip Blank	Total	2-BUTANONE	0/9				
BH	Trip Blank	Total	2-HEXANONE	0/27				
BH	Trip Blank	Total	4-METHYL-2-PENTANONE	0/30				
BH	Trip Blank	Total	ACETONE	0/24				
BH	Trip Blank	Total	BENZENE	0/30				
BH	Trip Blank	Total	BROMODICHLOROMETHANE	0/30				
BH	Trip Blank	Total	BROMOFORM	0/30				
BH	Trip Blank	Total	BROMOMETHANE	0/30				
BH	Trip Blank	Total	CARBON DISULFIDE	0/30				
BH	Trip Blank	Total	CARBON TETRACHLORIDE	0/30				
BH	Trip Blank	Total	CHLOROBENZENE	0/30				
BH	Trip Blank	Total	CHLOROETHANE	0/30				
BH	Trip Blank	Total	CHLOROFORM	0/30				
BH	Trip Blank	Total	CHLOROMETHANE	0/30				
BH	Trip Blank	Total	DIBROMOCHLOROMETHANE	0/30				
BH	Trip Blank	Total	ETHYLBENZENE	0/30				
BH	Trip Blank	Total	METHYLENE CHLORIDE	0/30				
BH	Trip Blank	Total	STYRENE	0/30				
BH	Trip Blank	Total	TETRACHLOROETHENE	0/30				
BH	Trip Blank	Total	TOLUENE	0/30				
BH	Trip Blank	Total	TOTAL XYLENES	0/30				
BH	Trip Blank	Total	TRICHLOROETHENE	0/30				

Table C-4
Analytical Results for Equipment Rinses and Trip Blanks Collected During Subsurface Geologic Material Sampling

SAMPLE TYPE	QC SAMPLE TYPE	TOTAL/ DISSOLVED	ANALYTE	FREQ. OF HITS	UNITS	MINIMUM RESULT	MAXIMUM RESULT	MEAN RESULT
BH	Trip Blank	Total	VINYL ACETATE	0/30				
BH	Trip Blank	Total	VINYL CHLORIDE	0/30				
BH	Trip Blank	Total	cis-1,3-DICHLOROPROPENE	0/30				
BH	Trip Blank	Total	trans-1,3-DICHLOROPROPENE	0/30				

Appendix D
CDPHE Conservative Screen Final Letter Report

Colorado Department of Public Health and Environment Source Area Delineation and Risk-Based Conservative Screen and Environmental Protection Agency Area of Concern Delineation

FINAL LETTER REPORT

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT SOURCE AREA DELINEATION AND RISK-BASED CONSERVATIVE SCREEN AND ENVIRONMENTAL PROTECTION AGENCY AREA OF CONCERN DELINEATION

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
OPERABLE UNIT NO. 11
WEST SPRAY FIELD

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

JUNE 1995

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AOC	area of concern
ARARs	applicable or relevant and appropriate requirements
CDPHE	Colorado Department of Public Health and Environment
COC	contaminant of concern
CSF	cancer slope factor
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FS	feasibility study
HHRA	human health risk assessment
IHSS	individual hazardous substance site
LHSU	lower hydrostratigraphic unit
OU	operable unit
PCOC	potential contaminant of concern
PPRG	Programmatic Preliminary Remediation Goal
QC	quality control
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RFEDS	Rocky Flats Environmental Database System
RFETS	Rocky Flats Environmental Technology Site
RFI	RCRA Facility Investigation
RI	Remedial Investigation
STP	Sewage Treatment Plant
SVOC	semivolatile organic compound
TIC	tentatively identified compound
UHSU	upper hydrostratigraphic unit
UTL	upper tolerance limit
VOC	volatile organic compound
WSF	West Spray Field

This document presents the results of the Colorado Department of Public Health and Environment (CDPHE) Risk-Based Conservative Screen for Operable Unit No. 11 (OU 11), West Spray Field (WSF), at the U.S. Department of Energy (DOE) Rocky Flats Environmental Technology Site (RFETS) in Golden, Colorado. The WSF includes one individual hazardous substance site (IHSS), IHSS 168, where periodic spray application of excess liquids pumped from Solar Evaporation Ponds took place between April 1982 and October 1985.

The CDPHE Risk-Based Conservative Screen was developed to support the CDPHE evaluation of contaminant source area(s), which may be classified as low-hazard areas that warrant no further action, areas that require further evaluation in a baseline Human Health Risk Assessment (HHRA), or high-hazard areas that warrant potential early action. The source area(s) in the CDPHE screen are used to identify area(s) of concern (AOC) for evaluation in the HHRA portion of the Combined Phases Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)/Remedial Investigation (RI) for OU 11. In the RFI/RI report, a baseline HHRA is conducted for each AOC.

The CDPHE Risk-Based Conservative Screen includes the following six steps:

- Step 1—Identify potential contaminants of concern (PCOCs)
- Step 2—Identify source area(s)
- Step 3—Identify risk-based concentrations (RBCs)
- Step 4—Calculate RBC ratio sums for each source area
- Step 5—Compare RBC ratio sums to CDPHE Conservative Screen decision criteria
- Step 6—Identify AOC(s) for HHRA

In Step 1 of the CDPHE screen for OU 11, PCOCs were identified using soil data from the surface to a depth of 12 feet and upper hydrostratigraphic unit (UHSU) ground water data. Candidate PCOCs are defined as metals, inorganic compounds, and radionuclides significantly

above background levels as determined by statistical tests described in Gilbert (1993) and organic target analytes detected above analytical detection limits. The final identification of PCOCs is subject to professional review of the test results and graphic presentations of the data.

The PCOCs identified in soil (0 to 12 feet) were americium-241, plutonium-239/240, tritium, and nitrate/nitrite. No PCOCs were identified in UHSU ground water.

In Step 2, inorganic PCOC concentrations or activities above the background arithmetic mean plus two standard deviations were plotted on maps and a source area was identified based on the distribution of the PCOCs (Figures 3-1, 3-2, 3-3, and 3-4). (No organic analytes were identified as PCOCs.) A source area is defined as any area containing concentrations or activities of inorganic PCOCs above the background arithmetic mean plus two standard deviations and/or organic PCOC concentrations above reporting limits. One source area was identified in OU 11. The OU 11 source area is outlined on Figure 3-5 based on PCOC distributions.

In Step 3, carcinogenic and noncarcinogenic RBCs were identified for each PCOC. Chemical-specific RBCs, referred to as Programmatic Preliminary Remediation Goals (PPRGs), are presented in the Final Rocky Flats Programmatic Risk-Based Preliminary Remediation Goals Revision 2 (DOE 1995). The RBCs [PPRGs] identified for the OU 11 CDPHE screen are based on residential exposure to soil.

In Step 4, maximum detected concentrations or activities of PCOCs were compared to RBCs. The following ratio was calculated for each PCOC in the OU 11 source area:

$$RBC\ Ratio = \frac{maximum\ detected\ concentration/activity}{risk\text{-}based\ concentration\ [PPRG]}$$

PCOC-specific ratios were then summed to yield carcinogenic and noncarcinogenic total ratio sums. A summary of the total ratio sums for the OU 11 source area is shown in Table ES-1.

Table ES-1
Summary of Total Ratio Sums for OU 11

Source Area	Medium	Carcinogenic Ratio Sum	Noncarcinogenic Ratio Sum
OU 11	Soil (0 to 12 feet)	0.82	0.000084
TOTAL RATIO SUM*		**0.82**	**0.000084**

*Assuming long-term residential exposure to maximum detected concentrations/activities

In Step 5, the following CDPHE Conservative Screen decision criteria were used to classify the OU 11 source area:

- If the ratio sum ≥ 100, indicating a potential health hazard assuming long-term exposure to maximum detected concentrations/activities, a voluntary corrective action (early action) or a baseline HHRA will be conducted.

- If $1 <$ ratio sum < 100, a baseline HHRA must be conducted.

- If the ratio sum ≤ 1, indicating a low-hazard source area, no further action may be recommended, pending evaluation of incremental risk from dermal exposure.

The OU 11 source area had a carcinogenic total ratio sum less than 1 (0.82) and a noncarcinogenic total ratio sum less than 1 (0.000084). Therefore, the OU 11 source area is a candidate for no action based on the CDPHE Conservative Screen decision criteria. An evaluation of dermal contact with PCOCs in surface soil in the OU 11 source area is presented in Appendix E. Results of this evaluation confirm that dermal exposure is not a significant exposure pathway for OU 11 and that OU 11 is a candidate for no action in accordance with the CDPHE/EPA/DOE Risk Assessment Agreement (CDPHE/EPA/DOE 1994) (Figure 1-2).

In Step 6, AOCs are identified as one or several source areas located close together that exceed the CDPHE Conservative Screen decision criteria. AOCs are identified to support the HHRA in the RFI/RI Report. Results of the comparison of OU 11 total ratio sums to CDPHE Conservative Screen decision criteria indicate no action at OU 11; therefore, no AOCs are identified at OU 11 and a baseline risk assessment is not warranted.

1.0
INTRODUCTION

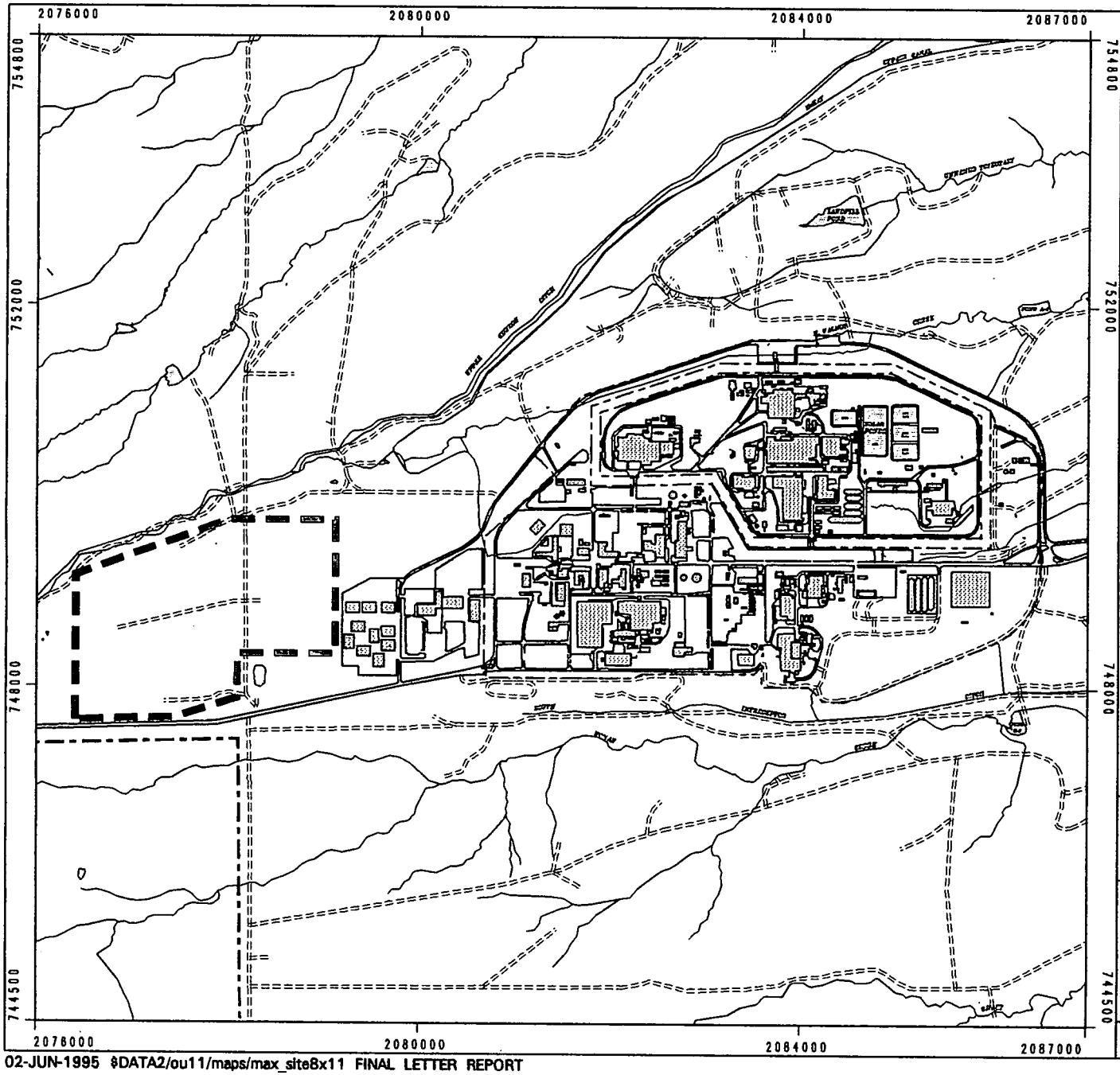
This document presents the results of the Colorado Department of Public Health and Environment (CDPHE) Risk-Based Conservative Screen for Operable Unit No. 11 (OU 11), West Spray Field (WSF), at the U.S. Department of Energy (DOE) Rocky Flats Environmental Technology Site (RFETS) in Golden, Colorado.

The WSF includes one individual hazardous substance site (IHSS): IHSS 168. The WSF (IHSS 168) is located on the west side of RFETS and covers an area of approximately 105.1 acres (Figure 1-1). Between April 1982 and October 1985, three areas of the WSF were used for periodic spray application of excess liquids pumped from Solar Evaporation Ponds 207-B Center and 207-B North. Pond 207-B Center was a repository for effluent from the Sewage Treatment Plant (STP), which processes sanitary waste from the Industrial Area. Pond 207-B North was a repository for water from the STP and the interceptor trench system. The interceptor trench system was installed to collect ground water and seepage from the hillside north of the Solar Evaporation Ponds and water from Building 771 and 774 footing drains. The approximate combined spray area was 41.3 acres (DOE 1994a).

Aerial photos indicate that a fourth area on the eastern edge of the WSF received occasional spray applications between April 1982 and October 1982. Construction of the 130 Series buildings began in October 1982 and ended all spraying in this area. As suggested by the spray volumes prior to October 1982, this fourth area received relatively minor spray applications (OU 11 Combined Phases RFI/RI, draft in progress).

The CDPHE Risk-Based Conservative Screen was developed to support the CDPHE evaluation of source area(s) which may be classified as:

- low hazard areas that warrant no further action
- areas that require further evaluation in a baseline Human Health Risk Assessment (HHRA)
- high hazard areas that warrant potential early action



EXPLANATION

- Streams and Drainages
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

Scale = 1 : 19200
1 inch = 1600 feet

800 0 1600ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Operable Unit No. 11
West Spray Field
Site Location

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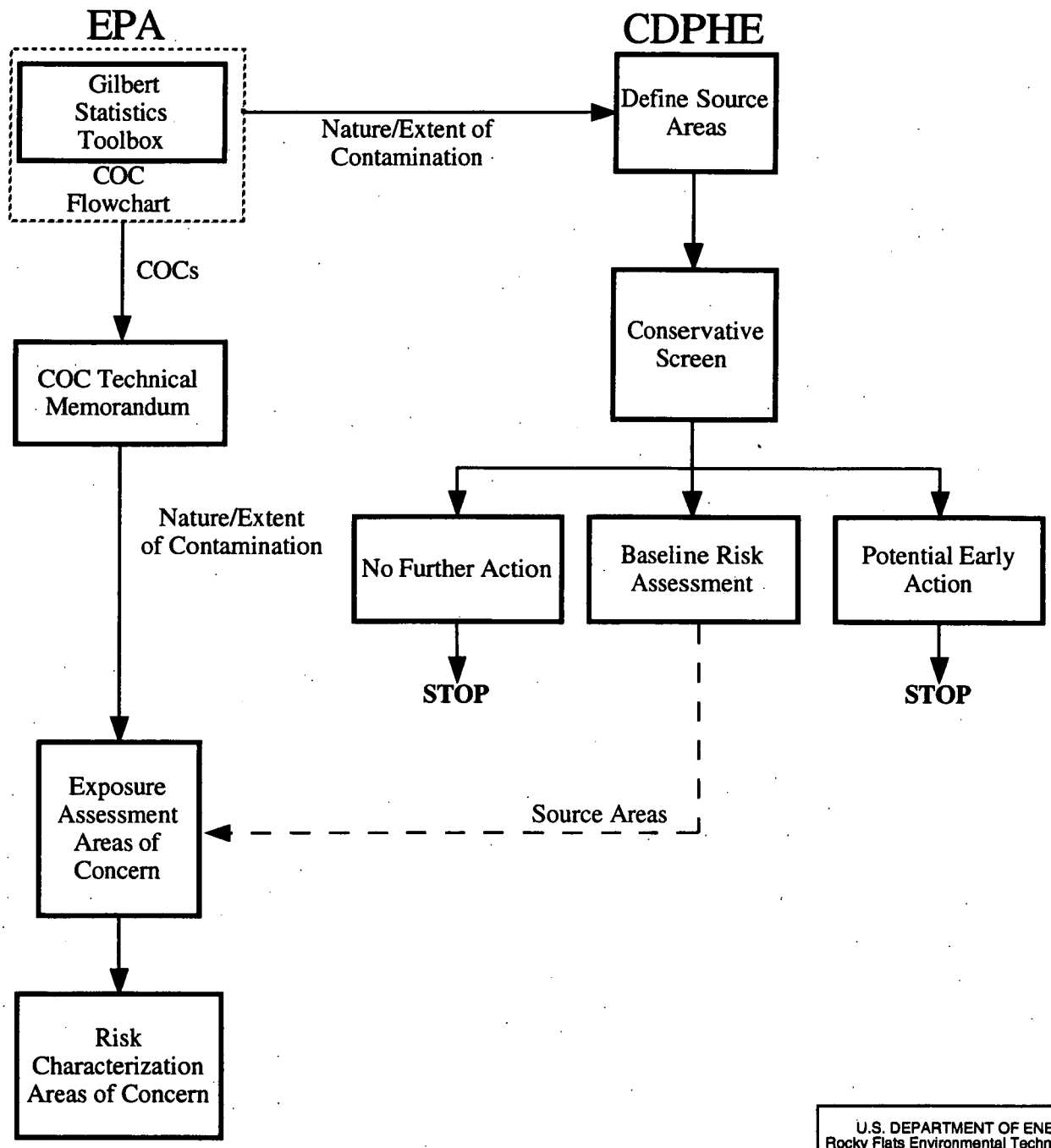
The source area(s) in the CDPHE screen are used to identify area(s) of concern (AOC), which are defined as one or several source areas located close together that exceed the CDPHE Conservative Screen decision criteria. Each AOC is evaluated in the baseline HHRA portion of the Combined Phases Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)/Remedial Investigation (RI) for OU 11. In the RFI/RI report, a baseline HHRA will be conducted for each AOC.

Guidance for data aggregation for risk assessment and for the CDPHE screen is provided in a memorandum from DOE (1994b) and in documents prepared jointly by CDPHE, U.S. Environmental Protection Agency (EPA), and DOE (CDPHE/EPA/DOE 1994). The CDPHE screen compares maximum detected concentrations or activities of potential contaminants of concern (PCOCs) in each source area to health risk-based concentrations (RBCs) for contaminants in applicable media. The resulting PCOC-specific ratios are then summed. If the sum of the ratios is less than or equal to 1, the source area is a candidate for no further action. If the ratio sum exceeds 1, the source area is subject to further evaluation, either in a baseline HHRA or as a candidate for early action. Therefore, the CDPHE Risk-Based Conservative Screen can be used to identify no-further-action source areas, potential early action source areas, and source areas that can be combined into AOCs for evaluation in the baseline HHRA.

The CDPHE Risk-Based Conservative Screen does not replace contaminant of concern (COC) selection, exposure pathway analysis, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis that are required in an HHRA and are used to support risk management decisions. The relationship of the HHRA to the CDPHE screen is illustrated in Figure 1-2. The COC Technical Memorandum for OU 11 will not be written due to the results of the OU 11 CDPHE Conservative Screen, which show that a Baseline Risk Assessment is not warranted.

The process used to conduct the CDPHE Risk-Based Conservative Screen is illustrated in Figure 1-3. Steps in the screen are listed below.

Step 1—Identify PCOCs. PCOCs are identified as organic target analytes detected above reporting limits and metals, inorganic compounds, and radionuclides significantly above background levels based on statistical evaluation (Gilbert 1993). The PCOC determination is made on the basis of statistical comparison of OU 11 soil and ground water sample data to background data and on professional judgment and geochemical analyses.



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CDPHE/EPA/DOE
Risk Assessment Agreement

June 1995 | Figure 1-2

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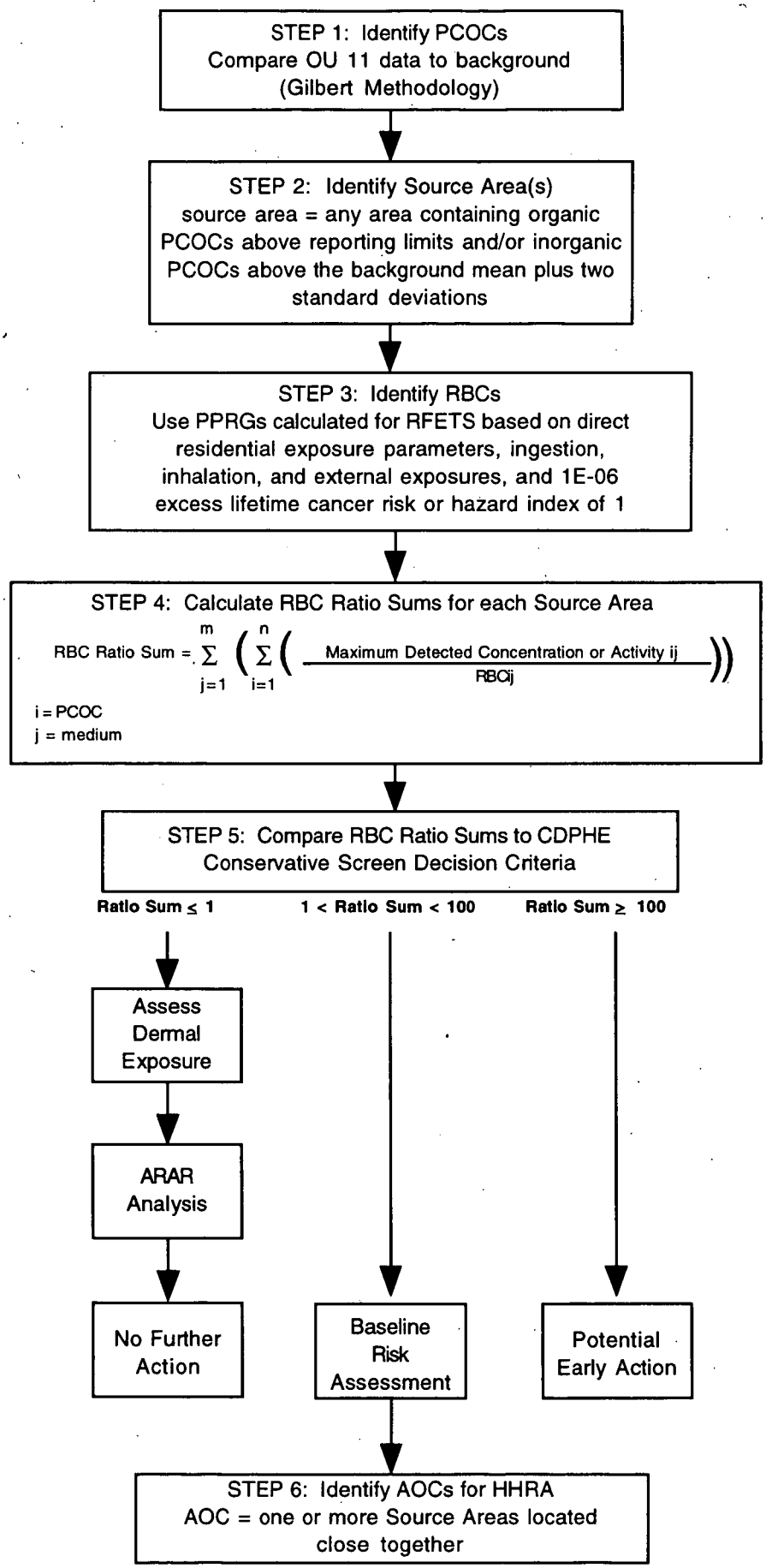

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Final Letter Report

CDPHE Conservative Screen Process

June 1995 | Figure 1-3

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Step 2—Identify Source Area(s). A source area is defined as any area containing organic PCOCs above reporting limits and/or inorganic PCOCs at concentrations or activities above the background arithmetic mean plus two standard deviations.

Step 3—Identify RBCs. Carcinogenic and noncarcinogenic RBCs are identified for each PCOC. RBCs are health-protective contaminant concentrations in a medium, calculated using conservative assumptions regarding exposure, toxicity, and acceptable risk. RBCs have been calculated specifically for RFETS and are presented in DOE (1995). These values, referred to as Programmatic Preliminary Remediation Goals (PPRGs), are used in the OU 11 CDPHE Risk-Based Conservative Screen.

Step 4—Calculate RBC Ratio Sums for Each Source Area. The ratio of the maximum detected concentration or activity to the corresponding RBC [PPRG] is calculated for each PCOC that occurs in the source area at concentrations or activities above background arithmetic mean plus two standard deviations (inorganics) or above detection limits (organics). Maximum detected concentrations or activities in soil are identified from samples collected to a depth of 12 feet, which is the depth recommended for use by CDPHE (CDPHE/EPA/DOE 1994). Maximum detected concentrations or activities in ground water are identified from unfiltered samples collected from the upper hydrostratigraphic unit (UHSU). The contaminant-specific ratios are then summed for each medium, resulting in a carcinogenic and noncarcinogenic subtotal ratio sum for each medium. Subtotal ratio sums are then added to yield a carcinogenic and noncarcinogenic total ratio sum for residential exposure.

Step 5—Compare RBC Ratio Sums to CDPHE Conservative Screen Decision Criteria. The ratio sums calculated in Step 4 are used to designate each source area as a candidate for no further action, for further evaluation in the baseline HHRA, or for possible early action. For source areas with ratio sums less than or equal to 1, DOE may pursue a no-further-action alternative. Source areas with ratio sums between 1 and 100 will be evaluated in the baseline HHRA. For source areas with ratio sums greater than or equal to 100, DOE may pursue a voluntary early action alternative or evaluate the source area further in the baseline HHRA.

Step 6—Identify AOCs for HHRA. As stated earlier, an AOC is a source area or group of source areas located close together that exceed the CDPHE Conservative Screen decision criteria. A baseline HHRA will be conducted for each AOC. EPA then reviews

and approves AOC delineation. The baseline HHRA will assess exposure to COCs that are identified following EPA- and CDPHE-approved procedures.

The following sections describe the application and results of each step of the OU 11 CDPHE Risk-Based Conservative Screen.

Step 1 of the CDPHE Risk-Based Conservative Screen identifies PCOCs for OU 11. PCOCs are defined as (1) metals, inorganic compounds, and radionuclides present at significantly higher concentrations or activities on the site than in media from background locations and (2) organic compounds present at detectable concentrations. Comparisons with the background media were performed using the statistical methods described in Statistical Comparisons of Site-to-Background Data in Support of RFI/RI Investigations (EG&G 1994a) and summarized briefly below (Section 2.3).

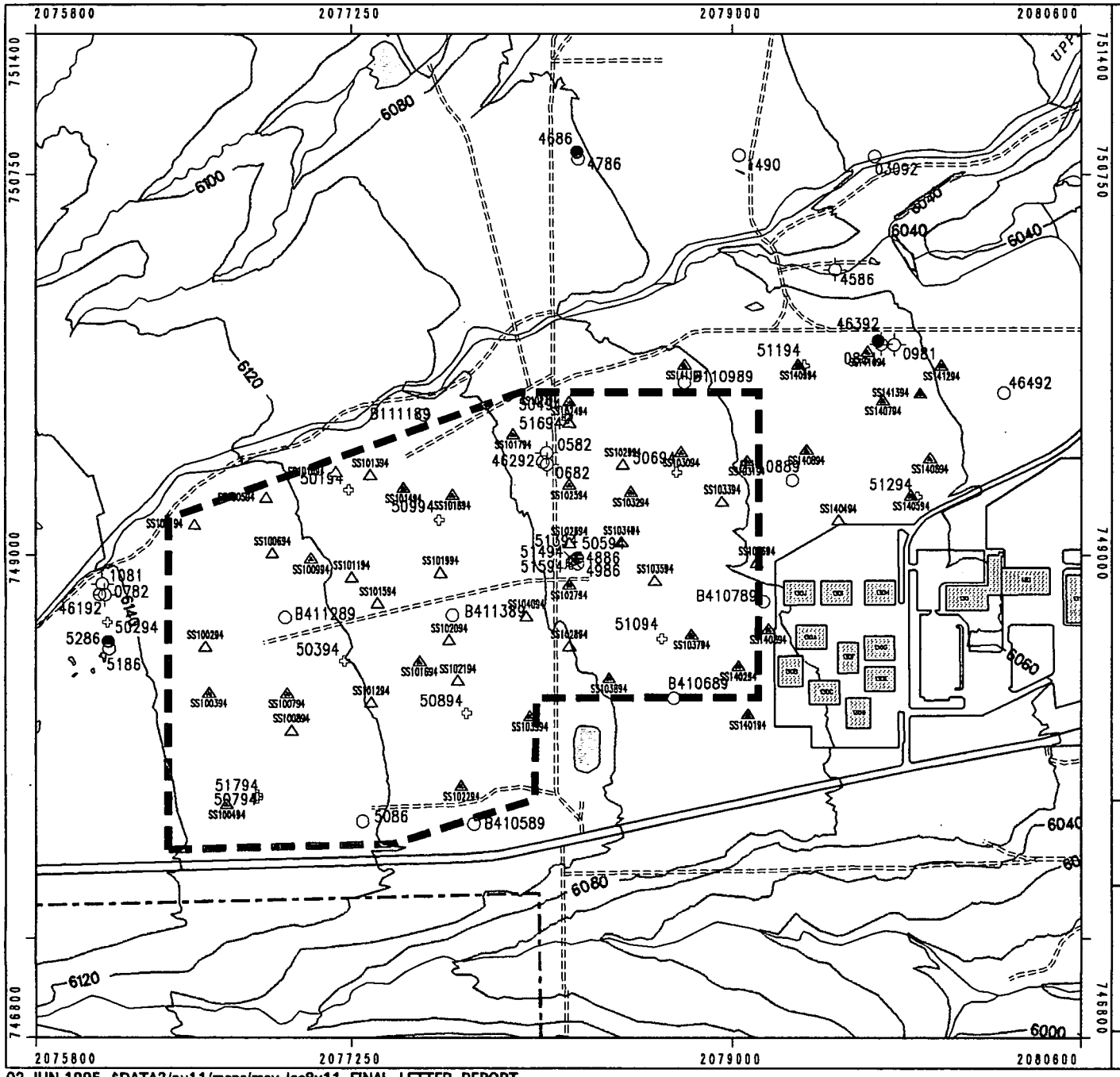
The following section describes the data analysis and background comparison methods used to identify PCOCs for OU 11 and the resultant list of PCOCs.

2.1 Data Used for Comparisons to Background

Analytical data from environmental samples collected during the OU 11 Combined Phases RFI/RI and from samples collected during sitewide monitoring programs were used to characterize contamination at OU 11. Three media were sampled during the OU 11 Combined Phases investigation: surficial soils, subsurface geologic materials, and ground water. Sampling locations are shown on Figure 2-1. The number of samples, sampling locations, and other features of the sampling and analytical program are discussed in the Technical Memorandum Revised Field Sampling Plan and Data Quality Objectives OU 11 (DOE 1994b). The following is a brief summary of the sampling and analytical programs and the types of data used for comparison to background.

2.1.1 Surficial Soil

Soil samples were collected from 53 locations during June and July of 1994. Most of these locations are within IHSS 168, but 12 are downgradient (east) of the IHSS boundary. All samples were collected in areas of potential spray contact, along discharge channels, or at pipeline junctures. The sampled areas were selected through review of historical information, including aerial photographs, and a field reconnaissance.



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OU 11--West Spray Field

Sampling Locations

June 1995 | Figure 2-1

02-JUN-1995 $DATA2/ou11/maps/max_loc8x11 FINAL LETTER REPORT

The soil samples were collected from depths of 0 to 2 inches by the modified "Rocky Flats Method" described in the EG&G SOP GT.08, Surface Soil Sampling (EG&G 1991). Use of this method was consistent with other soil sampling programs conducted at RFETS, including background soil sampling programs (EG&G 1994b).

Soil samples collected from test pits during a 1988 investigation were not used because these samples were not comparable to the 1994 samples or background soil samples. The 1988 samples were collected from the 0- to 2-foot-depth interval; the 1994 and background soil samples were collected from the 0- to 2-inch interval.

The soil samples were analyzed for radionuclides, metals, and nitrate. Although volatile and semivolatile organic compounds (VOCs and SVOCs) may also have been present in sprayed liquids, the properties of these compounds combined with the application method used (spraying) make their current detection in surface soils unlikely. In addition, previous sampling and analysis of soils within IHSS 168 showed no evidence for the presence of VOCs in those samples (DOE 1994b).

An analysis of the quality of data was performed and determined that data from the surface soil samples collected during 1994 are fully usable per the data quality objectives stated in the Technical Memorandum Revised Field Sampling Plan and Data Quality Objectives OU 11 (DOE 1994b). The precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters of the data were assessed with the following results. Precision of metal and radionuclide analyses varies. Antimony, copper, molybdenum, nickel, selenium, thallium, tin, and all the radionuclide results have been further qualified as estimated results because precision goals for these analytes were not met. Results for surface soil samples are considered accurate, representative, complete, and fully comparable given the data quality objectives for the OU 11 RFI/RI.

2.1.2 Subsurface Geologic Materials

Seventeen boreholes were drilled within and adjacent to IHSS 168 during the RFI/RI (July through September 1994). Borehole samples from Rocky Flats Alluvium were collected during drilling at each of these locations. Samples were collected at 2-foot increments at depths of less than 12 feet below ground surface and at 6-foot increments from 12 feet to the depth of the water table (saturated geologic materials). Two types of samples were collected: (1) 3-inch-long discrete samples collected in stainless-steel sleeves for analyses of VOCs and (2)

composited samples (2- and 6-foot increments) collected from the core barrel for analyses of radionuclides, metals, SVOCs, and other parameters. Previous drilling and borehole sampling in the vicinity of OU 11 provided additional analytical data from boreholes 46292, 46392, and 46492. Over 120 samples from Rocky Flats Alluvium were analyzed for SVOCs and VOCs, and over 200 samples were analyzed for other parameters (metals, radionuclides).

An analysis of the quality of data was performed and determined that data from the subsurface soil samples collected during the OU 11 RFI/RI are fully usable per the data quality objectives given in the Technical Memorandum Revised Field Sampling Plan and Data Quality Objectives (DOE 1994b). The PARCC parameters were assessed with the following results. Precision was evaluated for metals, radionuclides, and SVOCs and was variable. Results for aluminum, arsenic, chromium, cobalt, copper, lead, lithium, manganese, molybdenum, nickel, and all radionuclides have been further qualified as estimated results because precision goals for these analytes were not met. Results for nitrate/nitrite and di-n-butyl phthalate were also qualified as estimates based on their poor precision. Results for subsurface soil samples are considered accurate, representative, complete, and fully comparable given the data quality objectives for the OU 11 RFI/RI.

2.1.3 Ground Water

Ground water samples were collected during the Combined Phases RFI/RI and also during ongoing quarterly monitoring of existing wells in the vicinity of OU 11. Quarterly samples of UHSU ground water collected from the first quarter of 1990 through the third quarter of 1994 were included in the data set. Data from 14 wells within IHSS 168, including 9 wells installed during the fall of 1994, and from 10 wells downgradient of IHSS 168, including 2 wells installed in 1994, were included in the data set used to describe ground water from the UHSU.

Criteria for selecting the locations for new well installations included locating wells within areas that received direct spray application, proximity to previously detected contaminants, and projections of shallow ground water.

One objective of the OU 11 RFI/RI was to investigate and identify perched zones of ground water present above the UHSU water table. A number of boreholes were drilled in areas where perched ground water was thought to be present. No saturated zones were encountered at depths above the water table but geologic materials were found to be variably saturated and capable of yielding ground water to a monitoring well. Three monitoring wells were installed at shallow

depths to monitor and access variably saturated zones above the water table. Eight monitoring wells were installed in saturated portions of the UHSU. The new wells were sampled once following their installation; additional samples are being collected quarterly for analysis. Only a few samples were collected from the variably saturated zone due to the low production of these wells. Review of the chemical data from the variably saturated zone indicated that this water is not, in general, chemically distinct from ground water from the saturated portions of the UHSU. The number of samples available from the variably saturated zone is not sufficient to perform statistical comparisons to the background data for ground water. Therefore, data from the samples collected in the variably saturated zone have been added to the larger data set from samples collected in saturated portions of the UHSU. Over 250 samples of UHSU ground water were included in the data evaluated for OU 11.

The majority of ground water samples used in the OU 11 RFI/RI and in background comparisons were collected during sitewide ground water monitoring programs and not during the OU 11 investigation. The quality of ground water data collected between 1990 and 1994 was described in the Groundwater Geochemistry Report (EG&G 1995). The PARCC parameters reported in that document were compared to the data quality objectives for the OU 11 RFI/RI to determine the usability of ground water data. The precision of metal, radionuclide, and water-quality parameter analyses is fair and in some cases does not meet the precision goals for OU 11. However, these data are considered usable as estimated results. Precision for SVOCs and VOCs was not evaluated given the high percentage of non-detectable values in the database. Representativeness of ground water data is good and meets OU 11 goals. Analyses of trip blanks and field blanks reveal that acetone, carbon disulfide, dichloromethane, methylene chloride, toluene, and 2-butanone were present. These compounds may have been introduced during shipping, handling, or preparation of samples. The ground water data are complete and fully comparable.

2.1.4 Background Data

Background data from locations given in the Background Geochemical Characterization Report (DOE 1993) made up the background database used for UHSU ground water and subsurface geologic materials. Background ground water samples collected from first quarter 1990 through second quarter 1993 were extracted from the Rocky Flats Environmental Database System (RFEDS) and compose the background data set. Samples of geologic materials were collected from background locations in 1991.

Background surficial soils were not described in the Background Geochemical Characterization Report (DOE 1993). Background soils were collected and analyzed separately in support of remedial investigations at OU 1 and OU 2. These soils were collected during 1991 and 1992 from 18 locations in the Rock Creek drainage north of the Industrial Area (EG&G 1994b). Analytical results from these samples were extracted from RFEDS and compose the background-soil data set.

2.2 Data Review and Cleanup

Data collected during the OU 11 RFI/RI, quarterly ground water monitoring programs, and background characterization programs were received in electronic format from RFEDS and systematically reviewed and organized to achieve a standard format for each record. Identical data-cleanup routines were used to format data from the site and from the background locations. These routines, described in detail in Appendix A, are based in part from guidance received from EG&G (1994c). The OU 11 data-cleanup routines are briefly summarized below.

Site data used in the OU 11 CDPHE screen were extracted from RFEDS on December 21, 1994. In addition to the analytical data from environmental samples, the RFEDS data includes information such as field measurements, quality control (QC) samples, and analytical results for sample dilutions. RFEDS contains all validated and unvalidated results. Prior to evaluating the data, the entire database was reformatted and made internally consistent by the following steps:

1. Records reported with undefined units, laboratory qualifiers, or validation codes; blank results or unit fields; and non-radionuclide results equal to zero were researched. If a resolution was not possible, these records were labeled as unusable.

2. Tentatively identified compound (TIC) records were labeled based on a result type of TIC or laboratory qualifier of "A" or "N."

3. Unvalidated result values, detection limits, and units were replaced with validated result values, detection limits, and units if validated data were included with the record.

4. Result values were converted to consistent units of measurement for each group of analytes of each media type.

5. A usability category was assigned based on validation codes and laboratory qualifiers (refer to Appendix A).

6. Results that indicated detection of an analyte and results that indicated nondetections were labeled.

An internally consistent database of supportable data, standardized units of measure, and unique records for each analyte for each sample was developed using these cleanup steps. Detection and nondetection criteria, quantity summaries, validation status, and usability status of the records were compiled from this database.

The following additional formatting steps were performed to produce the final "project" database for OU 11:

1. TIC records and records for analytes not included on the list of target analytes in the OU 11 Field Sampling Plan were removed.

2. Records labeled as unusable or rejected were removed.

3. Location descriptions and hydrostratigraphic and geologic unit labels were added to each record for use in aggregating comparable data.

The end result is the project database from which all data used in site characterization, risk assessment, or data-quality evaluations are extracted. Two separate files, the "working" database (real-sample results) and the QC database (QC-sample results), were created from the project database as follows:

1. Records of real and duplicate sample pairs were identified and copied to the QC database; duplicate sample records were removed from the working database.

2. Records for field blanks, trip blanks, equipment rinses, and matrix spikes were moved from the working database to the QC database.

For each of these databases, duplicate records were identified and researched to determine which record to use based on the result type (for example, TRG [target], DIL [dilution], REP

[replicate], REX [re-extraction]), laboratory qualifier, and validation code. Records not used were labeled as unusable.

Data from the working database were used to perform statistical comparisons of site data to background data and to evaluate the nature and extent of contamination. Data from the QC database were used to describe the quality of data collected for the Combined Phases RFI/RI in terms of data-quality indicators.

Background data used for comparisons to OU 11 data were extracted from RFEDS in January 1995. These data were identical to the data used in the Background Geochemical Characterization Report (DOE 1993) except that some records previously identified as unusable due to missing information had been updated. The updated records were more complete and therefore could be included in the database used to calculate summary statistics for background media (including upper tolerance limits [UTLs]). The background data were subject to the same cleanup routines as were the data collected at OU 11.

Prior to performing the statistical comparisons, data from the working database were systematically reviewed to identify records for nondetections. A new result value was assigned to the non-detection records for use in statistical summaries or comparison tests. For use in statistical summaries (mean, standard deviation, etc.) and in the statistical comparison tests (Gehan, Slippage, etc.), this value is one-half the reported detection limit and one-half the result when the CRDL is the reported detection limit (EG&G 1994c, Gilbert 1993).

2.3 Background Comparison

Data from OU 11 samples collected during the Combined Phases RFI/RI were compared to data from background samples of like media. The data from each media type were aggregated in comparable subsets for comparison to background data in order to meet each specific investigation objective and to identify PCOCs. Summary statistics for site and background data sets are included in Appendix B.

Qualitative comparisons of site data to background data were made for each media type sampled at OU 11. Graphic presentations of the data were used to evaluate the magnitude, variability, and distribution of concentrations for each analyte (Appendix D).

Chemical concentration data from various media sampled at OU 11 were statistically evaluated to identify analytes present at concentrations elevated relative to concentrations in the same media from background locations. Analytes with elevated concentrations in media from OU 11 were considered PCOCs as defined in EG&G (1994a). PCOCs were identified by comparison to background data using the statistical and qualitative methods outlined in Statistical Comparisons of Site-to-Background Data in Support of RFI/RI Investigations (EG&G 1994a). The site-to-background comparison methods were used to identify inorganic analytes and radionuclide PCOCs. Organic compounds were considered PCOCs if detected in samples from OU 11.

2.3.1 Data Aggregation for Background Comparison at OU 11

Prior to performing the statistical comparisons, data from each medium were aggregated so that the comparison results would address the specific objectives of the OU 11 RFI/RI, including providing a list of PCOCs. Data aggregation was based on the statistical assumption that all samples within a data set were independent but comparable and represented by a single population characterized by a fixed mean and variance.

Surficial soil samples from OU 11 comprise samples collected from two areas: within IHSS 168 and east of IHSS 168. In both of these areas, surficial soil samples were collected from the 0- to 2-inch depth interval. Soil samples from these two areas are comparable to each other and directly comparable to background soils which were also collected from the 0- to 2-inch depth interval. To identify the PCOCs used in evaluations of risk to human health, the statistical comparison included all soil samples collected during the Combined Phases RFI/RI (IHSS 168 plus east of IHSS 168). Although the samples east of IHSS 168 are outside the boundaries of OU 11, the samples were included in the evaluation for PCOCs for the OU 11 CDPHE screen because they represent soils potentially affected by contaminants. Soils at the ground surface may have been contacted by wind-dispersed spray or dust, and soils at depth (less than 12 feet) may have received leakage from the historic pipelines.

Borehole samples were collected from 0 to 12 feet from 11 locations within IHSS 168 and 4 locations outside IHSS 168. The samples are from Rocky Flats Alluvium. To identify the PCOCs for the OU 11 CDPHE screen, analytical results from these samples were compared to results from analyses of samples of Rocky Flats Alluvium collected from background locations.

Ground water samples have been collected from wells screened in the UHSU and lower hydrostratigraphic unit (LHSU). Because these units comprise separate flow systems, the data were divided by hydrostratigraphic unit. Wells that screen the UHSU have been further subdivided into two areas: upgradient wells and wells within and downgradient of IHSS 168. Ground water samples from these areas are comparable but also constitute two populations: one not affected by sources at IHSS 168 and one potentially affected by sources at IHSS 168. PCOCs in UHSU ground water were identified for the OU 11 CDPHE screen by comparing unfiltered UHSU data from wells within and downgradient of IHSS 168 to sitewide background data.

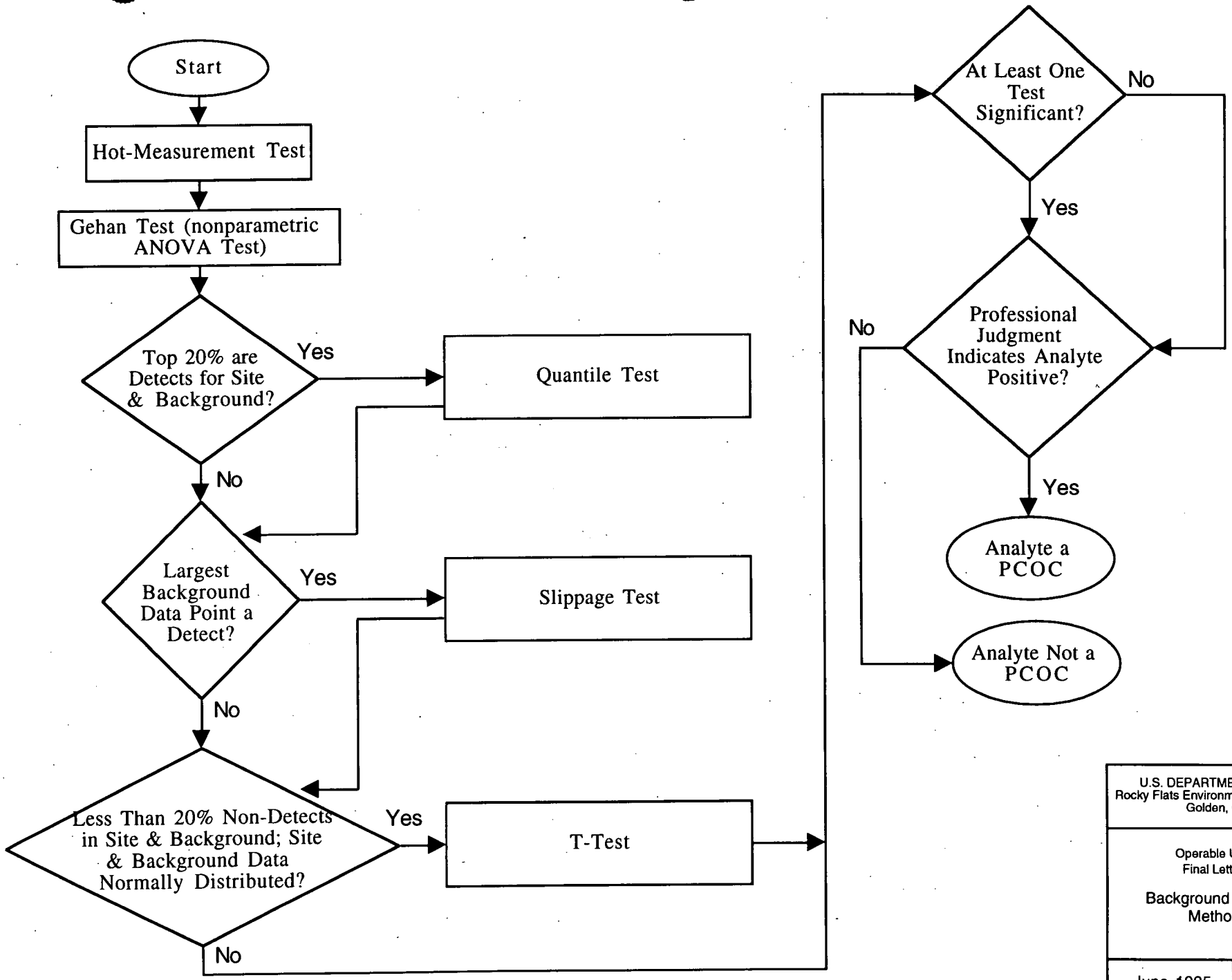
Table 2-1 presents the data sets used to perform background comparisons and identify the PCOCs in each medium.

Table 2-1
Data Aggregation for Background Comparisons to Support Site Characterization and Risk Assessment

Media	OU 11 Data Set	Background Data Set
Surficial Soil	All samples collected within and east of IHSS 168 (0 to 2 inches)	OU 1 and OU 2 background soils (Rock Creek)
Subsurface Geologic Materials	Borehole samples of Rocky Flats Alluvium collected within and east of IHSS 168 (0 to 12 feet)	Sitewide background data for Rocky Flats Alluvium
Ground Water	UHSU samples from saturated media within and downgradient of IHSS 168	Sitewide background data for UHSU ground water

2.3.2 Statistical Analysis Procedures for PCOC Identification

The flow chart presented in Figure 2-2 illustrates the process for identifying PCOCs. The statistical methodology for site-to-background comparisons for inorganic analytes and radionuclides followed the procedures outlined in Statistical Comparisons of Site-to-Background Data in Support of RFI/RI Investigations (EG&G 1994a). This method, known as the "Gilbert methodology" (from Gilbert 1993), was used by mutual agreement among EPA, CDPHE, and DOE. The PCOC identification process for inorganic analytes consisted of the following steps: a hot-measurement test, the Gehan test, the Quantile test, the Slippage test, the t-test, and



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Background Comparison Methodology

June 1995 | Figure 2-2

G95\ES\Background Comp. OU 11-2509.flw

professional judgment. Inorganic analytes having concentrations elevated relative to background concentrations, as indicated by the hot-measurement test or any one of the inferential statistical tests (Gehan, Quantile, Slippage, and t-test), are considered candidate PCOCs. Background comparison summaries for analytes in each medium are included in Appendix C. The five comparison tests are described below.

Chemical data from OU 11 were evaluated using a hot-measurement test, which compares each measurement with an upper tolerance limit (UTL) value for the corresponding analyte in the background data. The hot-measurement test is useful as a screening tool to ensure that unusually large measurements are adequately evaluated regardless of the output of the more formal inferential statistical tests. The UTL concentration used during comparison of site to background data was the $UTL_{99/99}$ value in accordance with Rocky Flats guidance on statistical comparisons (EG&G 1994b). This UTL represents a value for which there is 99-percent confidence that the UTL is equal to or greater than the true 99th percentile of the background population. The UTL values for background data were calculated from the background data extracted from RFEDS in January 1995. The hot-measurement test is an indicator of possible hot spots (Gilbert 1993); however, with large sample sizes (100 to 300 samples) from the site, occasional UTL exceedances are expected because the UTL value includes only the 99th percentile of the background data.

In some cases, the concentrations of an analyte in the background population was not normally distributed. In these cases a log-normal $UTL_{99/99}$ value was calculated and compared to the site data. This comparison resulted in the exclusion of some analytes as PCOCs (as noted in Appendix C).

Statistical inference tests (Gehan, Quantile, Slippage, and t-test) were used to compare the means and medians of the OU 11 and background populations. The null (H_0) and alternative (H_a) hypotheses used during the statistical analyses are as follows (Gilbert 1993):

> H_0: Chemical concentrations within OU 11 are not significantly greater than those in the background area.
>
> H_a: Chemical concentrations within OU 11 are significantly greater than those in the background area.

The nonparametric Gehan test (Palachek *et al.* 1993, Gehan 1965) can be used to evaluate data sets with multiple detection limits and nondetects and can be used regardless of the distribution of the data. The Gehan test is a generalization of the more common non-parametric ANOVA Wilcoxon Rank-Sum test. The Gehan test was performed for all analytes. The parametric ANOVA t-test was used only when background and site data contained less than 20 percent nondetects and normality assumptions based on the Shapiro-Wilk test were satisfied.

Other nonparametric tests used to compare background and site data included the Quantile and Slippage tests. The Slippage test consists of counting the number of OU measurements that exceed the maximum background measurement. If the number of measurements exceeding the maximum background measurement was greater than a critical value obtained from tables in Rosenbaum (1954), then the analyte was considered a candidate PCOC.

The Quantile test is similar to the Slippage test and was performed by listing the combined background and OU measurements from smallest to largest. The test counts the number of measurements from the OU that are among the largest measurements of the combined data sets. If the number of measurements is greater than a critical value, the analyte was considered a candidate PCOC. The largest measurement and critical values were determined from tables in Gilbert and Simpson (1992).

The inferential statistical tests (Gehan, Slippage, Quantile, and t-test) compare background and OU-wide concentration distributions. An analyte is considered to be present at significantly higher concentrations at the site than in the background media if any comparison test failed at the 0.05 significance level ($p \leq 0.05$). The hot-measurement test compares each measurement to a corresponding $UTL_{99/99}$ value. An analyte is considered a candidate PCOC if any site measurement exceeds the value of the background UTL. The difference in the two methods is that the inferential tests compare differences between population distributions and the hot-measurement test compares individual measurements to a single value. The hot-measurement test is not considered a formal statistical test because false positive and power requirements are not considered.

Organic analytes are considered candidate PCOCs if detected in media from the site. The error rates associated with PCOC identification for organic analytes are not known but they are dependent on the precision, accuracy, and representativeness of analytical data and will vary by analyte.

The final identification of PCOCs was subject to professional review of the test results and graphic presentations of the data. The professional judgment of the reviewer is required to consider other factors such as the spatial and temporal distribution of analytes; historic information regarding past operations at the site; inter-element correlations; mass-balance calculations; and knowledge of the hydrology, geochemistry, and geology of the site. The rationale for inclusion or exclusion of PCOCs based on professional judgment is provided in Appendix D.

2.4 Summary of PCOCs for OU 11

Table 2-2 presents the PCOCs at OU 11. For the purpose of the OU 11 CDPHE screen, the surficial soil samples and subsurface geologic materials samples collected from 0 to 12 feet were combined as "soils."

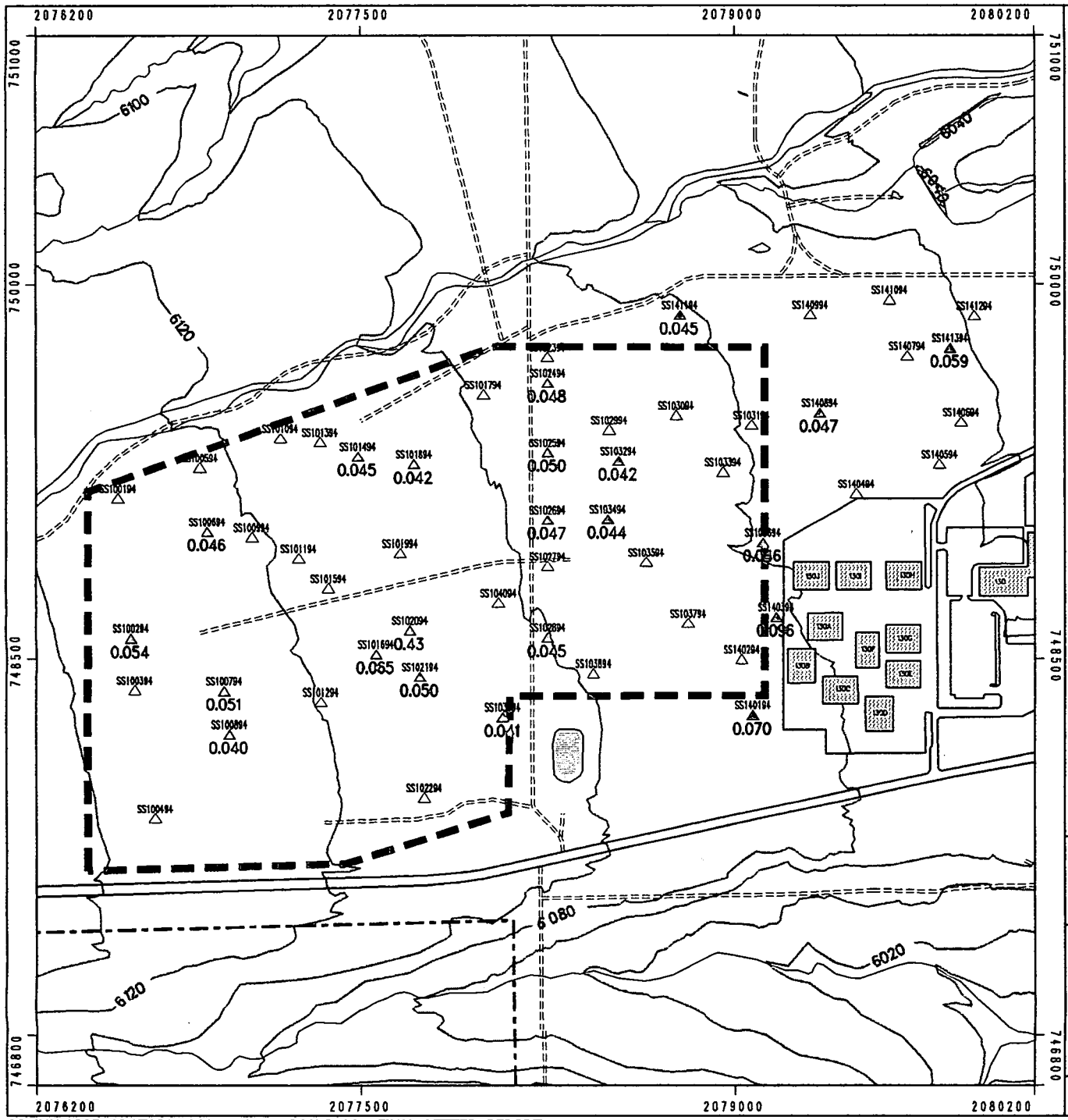
Table 2-2
List of PCOCs at OU 11

Surficial Soil (0 to 2 inches)	Subsurface Geologic Materials (0 to 12 feet)
Americium-241 Plutonium-239/240 Nitrate/Nitrite	Tritium Nitrate/Nitrite

3.0
IDENTIFICATION OF CONTAMINANT SOURCE AREA(S)

A source area is defined as any area where concentrations or activities of PCOCs in any medium exceed an upper-bound estimate of the background range. The upper-bound estimate of the background range for metals, inorganic compounds, and radionuclides is defined as the background mean plus two standard deviations; detected organics are considered to be above background levels. The data analysis and background comparison methodology used to identify PCOCs for OU 11 are described in Section 2.0. Additional detail on the number of samples, sampling locations, and other features of the sampling and analytical program are discussed in the Technical Memorandum Revised Field Sampling Plan and Data Quality Objectives OU 11 (DOE 1994b) and in the Nature and Extent of Contamination section of the OU 11 Combined Phases RFI/RI (draft in progress).

The concentrations and distribution of PCOCs in OU 11 were evaluated to identify any source areas in OU 11. Based on the PCOC distributions, one OU 11 source area was identified. To identify the OU 11 source area, concentrations and activities of inorganic PCOCs above the background mean plus two standard deviations were plotted by medium. Figures 3-1, 3-2, and 3-3 delineate concentrations/activities of PCOCs (americium-241, plutonium-239/240, and nitrate/nitrite) in surficial soil (0 to 2 inches). Figures 3-4 and 3-5 present concentrations/ activities and sample depths of PCOCs (nitrate/nitrite and tritium) in subsurface geologic materials (0 to 12 feet). The OU 11 source area is outlined on Figure 3-6.



EXPLANATION

- △ Sample Location
- ▲ Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Activities are in pCi/g
BM+2SD = 0.039

Scale = 1 : 7200
1 inch = 600 feet

300 0 600ft

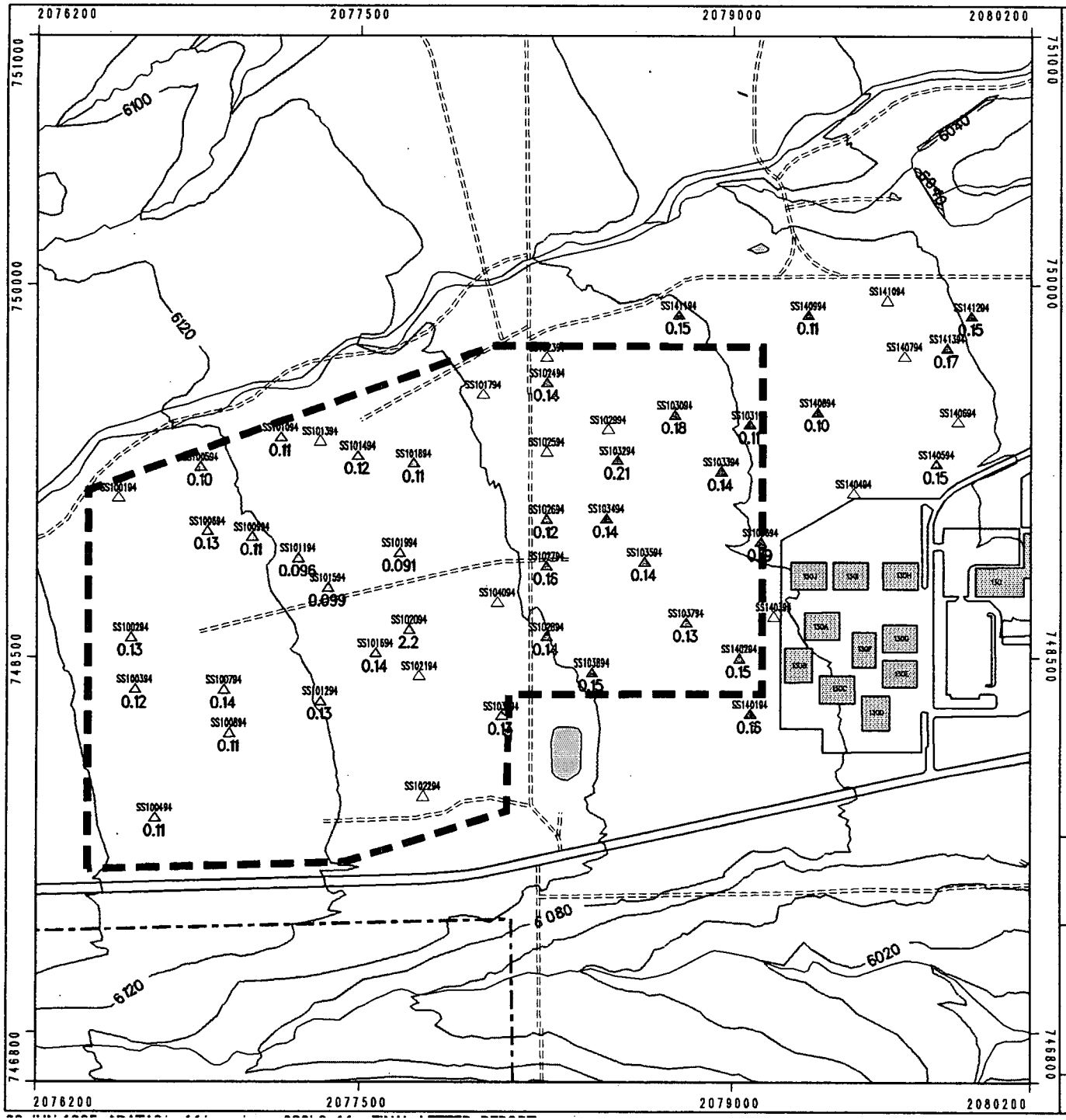
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
AMERICIUM-241
Activities*
at the
OU 11--West Spray Field

June 1995 | Figure 3-1

02-JUN-1995 $DATA2/ou11/maps/ss_am241b8x11 FINAL LETTER REPORT



EXPLANATION

- Sample Location
- Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Activities are in pCi/g
BM+2SD = 0.090

Scale = 1 : 7200
1 inch = 600 feet

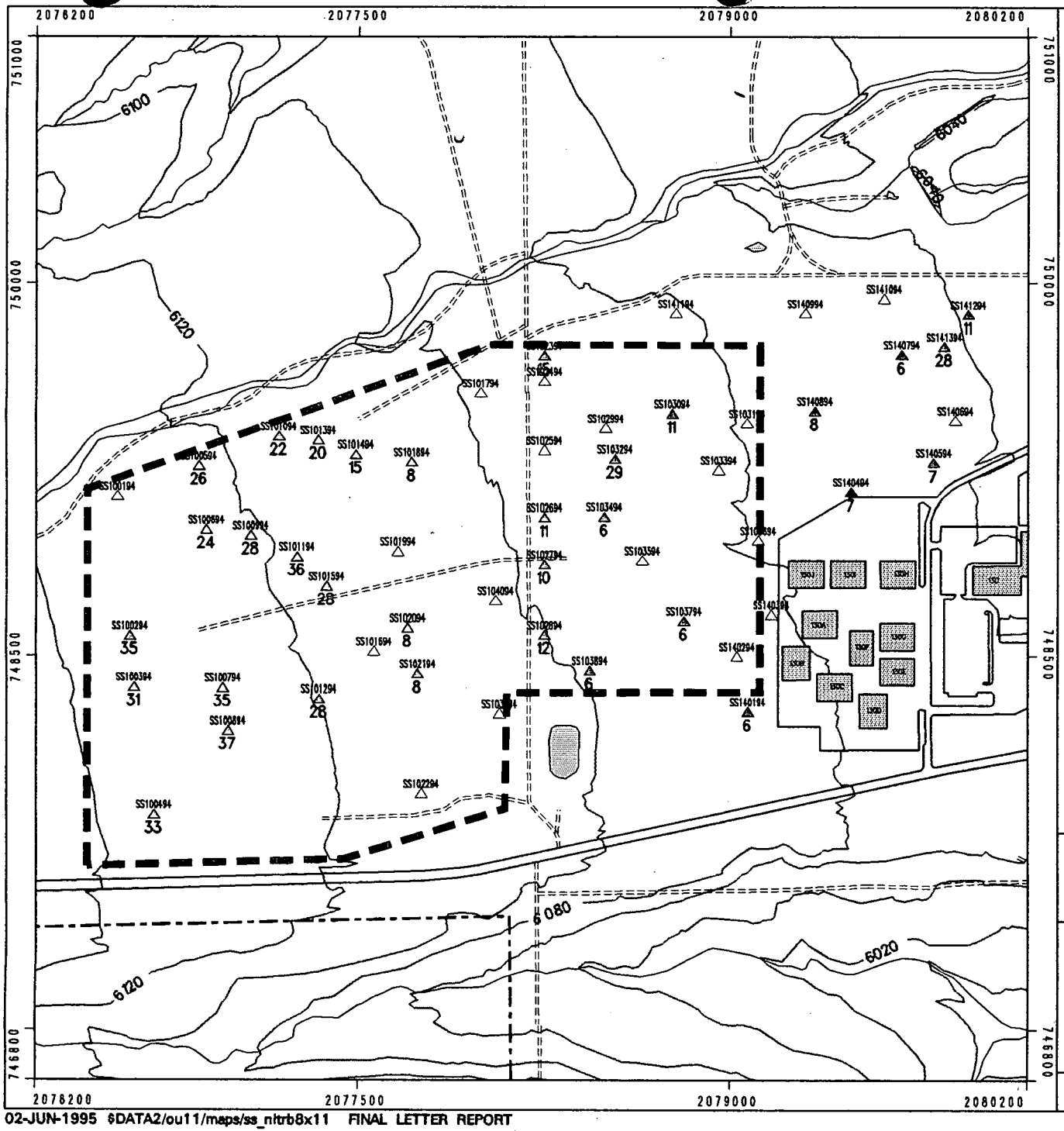
300 0 600ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
PLUTONIUM-239/240
Activities*
at the
OU 11--West Spray Field

June 1995 | Figure 3-2



EXPLANATION

- Sample Location
- Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Concentrations are in mg/kg
BM+2SD = 5

Scale = 1 : 7200
1 inch = 600 feet

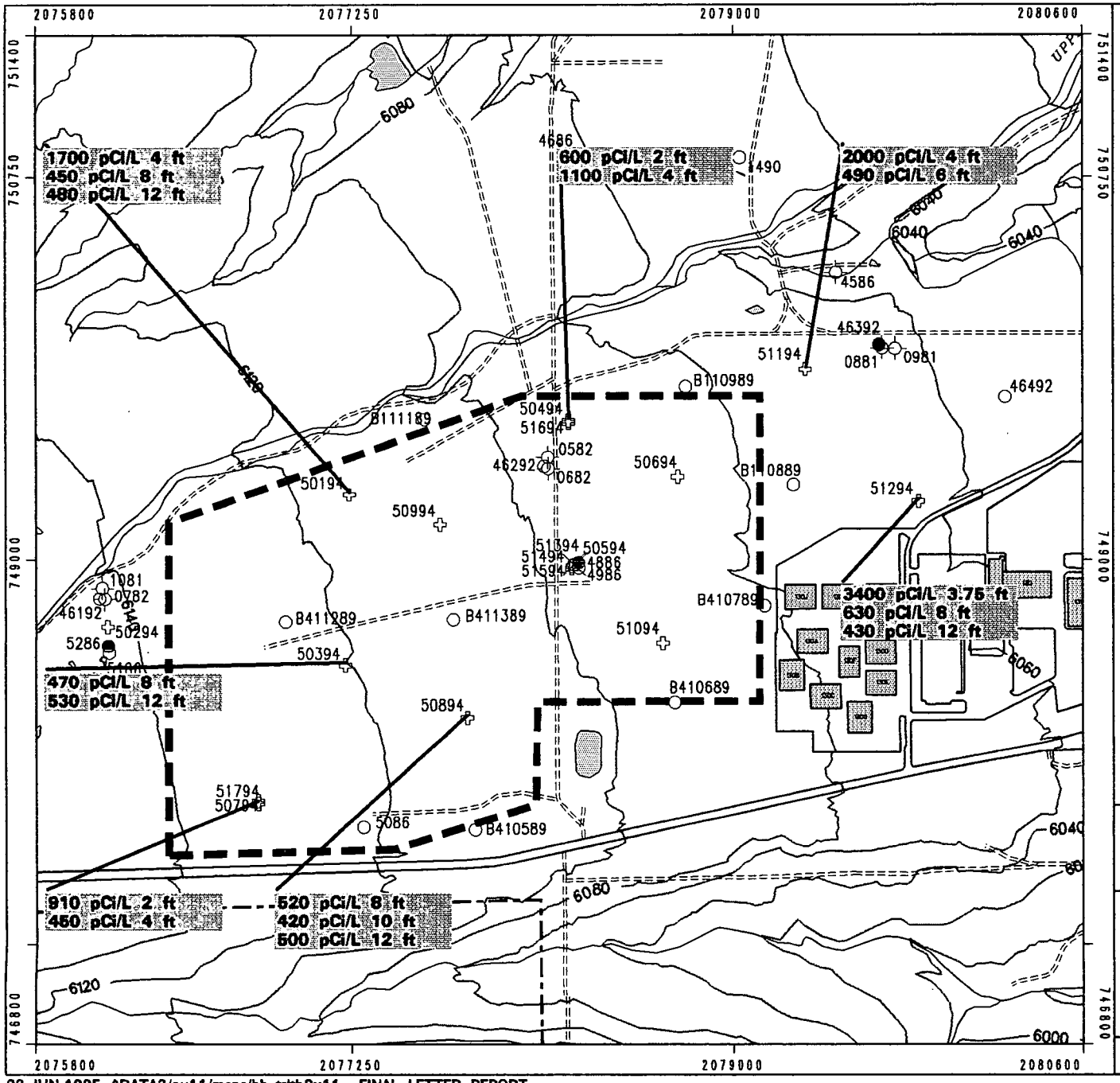
200 0 600ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
NITRATE/NITRITE
Concentrations*
at the
OU 11--West Spray Field

June 1995 | Figure 3-3



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 383 pCi/L

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

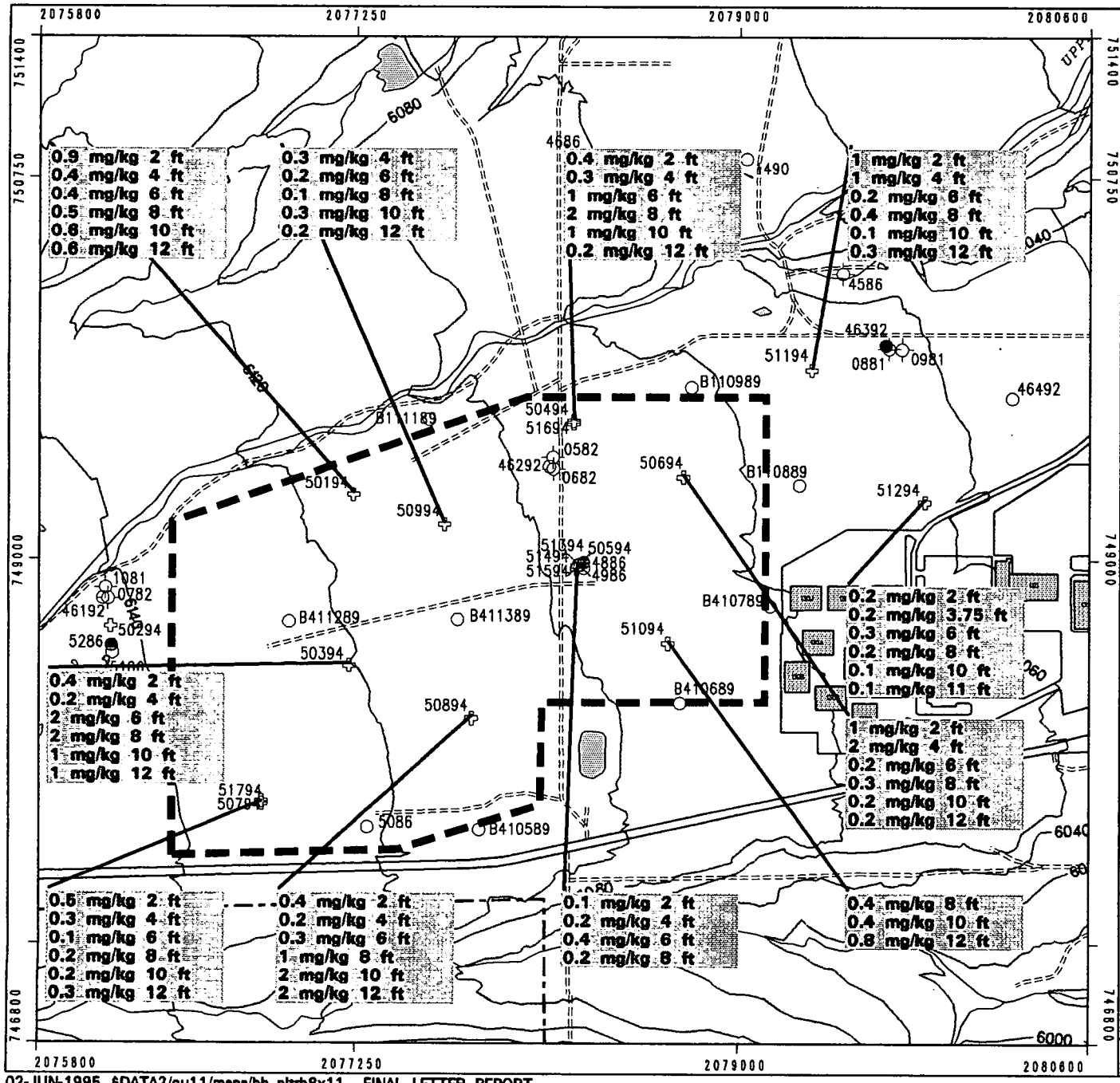
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
TRITIUM
Activities*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure 3-4

02-JUN-1995 $DATA2/ou11/maps/bh_tritb8x11 FINAL LETTER REPORT



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

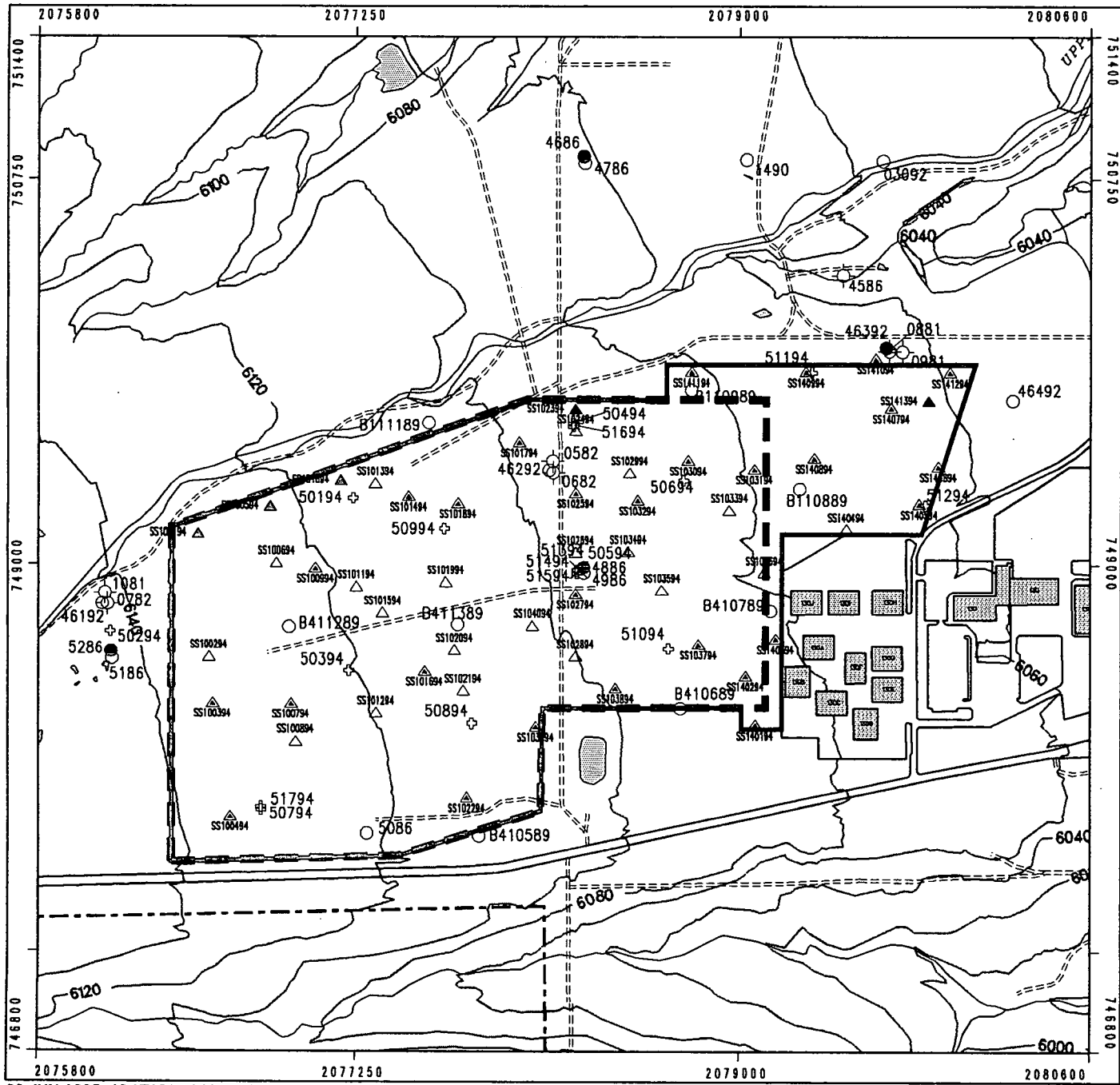
350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
NITRATE/NITRITE
Concentrations*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure 3-5



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- OU 11 Source Area
- Lakes and Ponds
- Buildings
- Channel (20)
- Non-Channel (28)
- Pipeline Junctures (5)

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field

Source Area

June 1995 | Figure 3-6

4.0
IDENTIFICATION OF RISK-BASED CONCENTRATIONS

RBCs are contaminant concentrations in media that are not expected to pose a health risk even under long-term exposure. They are calculated using conservative assumptions regarding exposure, toxicity, and acceptable risk. The purpose of developing contaminant-specific RBCs and comparing them to concentrations of PCOCs at each source area is to provide preliminary screening-level information on the relative magnitude of contaminant risk assuming long-term exposure to maximum detected concentrations. This information can be used in the preliminary selection of remedial alternatives prior to the completion of the HHRA and also can identify source areas where no further action is warranted. RBCs should not be used as a substitute for a complete HHRA, as stand-alone decision-making tools, or as site-specific cleanup levels.

RBCs specific to RFETS have been calculated assuming long-term residential exposure to different media (DOE 1995). These values, referred to as PPRGs, were used in the OU 11 CDPHE screen. PPRGs for contaminants in soil were calculated for residential receptors assuming multiple pathway exposure (ingestion, inhalation of particulates, and external radiation).

Separate PPRGs were calculated for carcinogenic and noncarcinogenic effects. PPRGs for carcinogens were calculated based on a one in one million (1E-06) excess cancer risk level. PPRGs for noncarcinogens were calculated based on a hazard quotient of 1 (DOE 1995). General equations for calculating PPRGs are:

$$\textit{Carcinogenic PPRG} = \frac{\textit{Target Cancer Risk Level}}{\textit{Intake Factor} \;\; x \;\; \textit{Cancer Slope Factor}}$$

$$\textit{Noncarcinogenic PPRG} = \frac{\textit{Target Hazard Index} \;\; x \;\; \textit{Reference Dose}}{\textit{Intake Factor}}$$

The target cancer risk is equal to 1E-06 and the target hazard index is equal to 1. The reference doses (RfDs) and cancer slope factors (CSFs) are contaminant-specific EPA-established toxicity factors; they are presented in DOE (1995). Intake factors are an assumption of daily intake of a medium per kilogram body weight. The exposure parameters and other factors used to derive the intake factors for calculating PPRGs are discussed in detail in DOE (1995). All exposure assumptions are EPA standard default values (EPA 1991a) except where indicated in the PPRG document (DOE 1995).

5.0
CALCULATION OF RISK-BASED CONCENTRATION RATIO SUMS

The fourth step in the CDPHE screen is to divide the maximum concentration or activity of each PCOC in each medium in each source area by the contaminant-specific RBC [PPRG] for residential exposure to yield an RBC ratio, as shown in the following equation:

$$RBC\ Ratio = \frac{Maximum\ detected\ concentration/activity}{Risk\text{-}based\ concentration\ [PPRG]}$$

The contaminant-specific ratios in each source area and medium are then summed to provide a ratio sum (multiple-contaminant) for each medium. If a receptor is assumed to be exposed to more than one medium in a source area (for example, hypothetical residents are assumed to be simultaneously exposed to soil and ground water), the ratio sums for all relevant media are combined to provide a total ratio sum (multiple-contaminant, multiple-media) for that exposure scenario. PCOCs in OU 11 were identified in only one medium, soil; therefore, only one ratio sum was calculated. The residential scenario assumes that excavation has taken place prior to residential development and the resident may be exposed to soil to a depth of 12 feet (CDPHE/EPA/DOE 1994). Therefore, maximum detected concentrations or activities of PCOCs in soil were identified from samples collected from the surface to a depth of 12 feet.

The total ratio sums for carcinogenic or noncarcinogenic effects are an indication of potential risks to receptors, assuming long-term exposure to maximum detected concentrations or activities of PCOCs. For carcinogens, a total ratio sum less than or equal to 1 indicates a total excess lifetime cancer risk less than 1E-06 (one in one million) from long-term exposure to the maximum detected concentrations or activities of PCOCs in that source area. A total ratio sum for carcinogens that is greater than 1 but less than 100 indicates a total excess lifetime cancer risk between 1E-04 (one in 10 thousand) and 1E-06, which is the target cancer risk range that EPA has adopted to guide remedial decisions at hazardous waste sites (40 CFR 300). Where cancer risks estimated in a baseline HHRA do not exceed 1E-04, remediation is not generally warranted unless noncarcinogenic effects or ecological risks are significant (EPA 1991b). A total ratio sum for carcinogens that is greater than or equal to 100 indicates a potentially unacceptable cancer risk from long-term exposure to maximum detected concentrations or activities. For noncarcinogens, a ratio sum less than or equal to 1 indicates no toxic effects are

expected. A noncarcinogenic total ratio sum greater than 1 indicates that there may be cause for concern for noncarcinogenic effects.

The CDPHE Risk-Based Conservative Screen assumes that a long-term resident will be routinely exposed to the maximum concentrations or activities of contaminants found in each medium. The screen does not confirm that an actual risk exists. Ratio sums greater than 1 or 100 indicate that the area warrants further evaluation, but the ratio sums do not indicate that an actual health threat is present.

If either the carcinogenic or noncarcinogenic total ratio sum is greater than or equal to 100 for a source area, that source area may be identified by DOE as a candidate for an early action. Source areas with ratio sums between 1 and 100 will be evaluated further in a baseline HHRA. If both the carcinogenic and noncarcinogenic total ratio sums are less than or equal to 1, the source area is a candidate for no further action based on human health risk. In this case, the incremental risk from dermal exposure is evaluated to confirm that the total ratio sums including dermal exposure are still less than 1.

Ratios from the RBC screen for the OU 11 source area based on residential exposure are presented for carcinogens and noncarcinogens in Table 5-1. The total ratio sums are shown at the bottom of the table. The carcinogenic total ratio sum for soil (0 to 12 feet) was 0.82, and the noncarcinogenic total ratio sum was 0.000084.

Table 5-1

Risk-Based Concentration Screen for the OU 11 Source Area—Residential Exposure

Potential Contaminant of Concern	Maximum Concentration or Activity (Max)	Location of Max	Residential PPRG[1]		Ratio of Max to PPRG	
			Carcinogen	Noncarcinogen	Carcinogen	Noncarcinogen
SOIL (0 to 12 feet)						
Radionuclides (pCi/g)						
AMERICIUM-241	0.43	SS102094	2.37E+00	---	0.18	---
PLUTONIUM-239/240[2]	2.2	SS102094	3.42E+00	---	0.64	---
TRITIUM	3.4	51294	1.47E+04	---	0.00023	---
Other Parameters (mg/kg)						
NITRATE/NITRITE[3]	37	SS100894	---	4.39E+05	---	0.000084
				TOTAL RATIO SUM	**0.82**	**0.000084**

[1] Programmatic Preliminary Remediation Goals (PPRGs) are from DOE (February 1995). Residential soil PPRGs were used for analytes in soil (0 to 12 feet). PPRGs are reported in the units used for each analyte group.

[2] The PPRG for plutonium-240 was used because it is more conservative than the PPRG for plutonium-239.

[3] The PPRG for nitrate was used because nitrate is the dominant species present.

6.0
COMPARISON OF RATIO SUMS TO CDPHE CONSERVATIVE SCREEN DECISION CRITERIA

The results of the CDPHE Risk-Based Conservative Screen are compared to decision criteria to determine the appropriate course of action for each medium in each source area. The decision criteria are:

- If the ratio sum ≥ 100, a voluntary corrective action (or early action) or a baseline HHRA will be performed.
- If $1 <$ ratio sum < 100, a baseline HHRA in accordance with Risk Assessment Guidance for Superfund (RAGS) (EPA 1989) will be conducted.
- If the ratio sum ≤ 1, no further action may be warranted pending evaluation of potential risk from dermal exposure.

Table 6-1 summarizes the total ratio sums for the OU 11 source area, assuming long-term residential exposure to maximum detected concentrations or activities of PCOCs. The OU 11 source area had a carcinogenic total ratio sum less than 1 (0.82) and a noncarcinogenic total ratio sum less than 1 (0.000084). Therefore, the OU 11 source area is a candidate for no action based on the CDPHE Conservative Screen decision criteria.

Table 6-1
Summary of Total Ratio Sums for OU 11

Source Area	Medium	Carcinogenic Ratio Sum	Noncarcinogenic Ratio Sum
OU 11	Soil (0 to 12 feet)	0.82	0.000084
TOTAL RATIO SUM*		**0.82**	**0.000084**

*Assuming long-term residential exposure to maximum detected concentrations/activities

As required for source areas for which no further action is indicated, the potential risk from dermal contact with soil must be evaluated (CDPHE/EPA/DOE 1994). Because no action is recommended for OU 11, an evaluation of dermal contact with PCOCs in soil in the OU 11 source area is included in Appendix E. In the evaluation of dermal contact, all maximum

concentrations or activities for PCOCs in surface soil (0 to 12 feet) in the OU 11 source area were below the dermal RBCs. Results of the comparison of concentrations and activities of PCOCs in OU 11 source area surface soil to dermal RBCs confirm that dermal exposure is not a significant exposure pathway for OU 11 and that OU 11 is a candidate for no action in accordance with the CDPHE/EPA/DOE risk assessment agreement (CDPHE/EPA/DOE 1994) (Figure 1-2).

7.0
IDENTIFICATION OF AREA(S) OF CONCERN

An AOC is defined as one or several source areas located close together that exceed the CDPHE Conservative Screen decision criteria. AOCs are identified to support the HHRA in the RFI/RI Report.

Results of the comparison of OU 11 total ratio sums to CDPHE Conservative Screen decision criteria indicate no action for the OU 11 source area; therefore, no AOCs are identified at OU 11, and a baseline risk assessment is not warranted.

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APPENDIX A

Cleanup Routines for Analytical Data

APPENDIX A
DATA MANIPULATION FOR RFI/RI REPORTS
OU 11 RFI/RI - Combined Phases

I. RFEDS EXTRACTION

A. Run data_chk.prg to get an overview of the data. Modifications to other programs (notably cleangen.prg) may be necessary if there are new/unusual data.

1. Assigns an analytical group based on test group code: M for metals; P for pesticides; R for radionuclides; S for semivolatile organic compounds; V for volatile organic compounds; and W for water quality parameters.

2. Creates text files with the results of data checks.

   a. Unique sample types.
   b. Unique analyte names, by analytical group. Used to identify multiple spellings of the same analyte.
   c. Unique QC codes for each sample type.
   d. Unique test group codes for each analytical group.
   e. Unique units for each analytical group and test group code.
   f. Unique result types for each analytical group and test group code.
   g. Unique lab qualifiers for each analytical group and test group code.
   h. Unique validation codes for each analytical group and test group code.
   i. The total number of records and the total number of unique RFEDS sequence ids to check for duplicated records.
   j. Count the number of, and identify the records that have a blank result field.
   k. Count the number of, and identify the non-rads records that have a blank detection limit field.

3. Make any necessary changes to cleangen.prg.

B. Run generic cleanup routines program cleangen.prg

1. Appends basic records into the final format structures: 94data\94final and historic\hstfinal

2. Assigns total/dissolved, organic/inorganic based on test group code.

3. Filters out unusable data by assigning "reject" category.

   a. Blank results
   b. Blank units

c. Blank detection limit and non-rads analysis
d. Unknown validation codes (C,P,S,B,N)
e. Unknown units (DPM/SA,PCI/SA,ROM BA,UNKN)
f. Unknown lab qualifiers (L,R,rad UE,organic E)
g. Alpha characters in numeric field
h. Tentatively identified compound (TIC) lab qualifiers (A, organic N)

4. Assigns a usability category based on validation codes and lab qualifiers

a. VALID:
   validation codes A,V
   lab qualifiers blank,U
b. ESTIMATE:
   validation codes A,J,V,JA
   lab qualifiers +, *, B, C, D, E(inorganic), F, G, H, I, J, N, S, UJ, UN, UW, UX, W, X, Y, Z
c. REJECT:
   validation codes B,C,N,P,R,S
   lab qualifiers E(organic),L,R,UE(rads)
d. BLNK/Y VAL:
   validation codes Y,blank
   lab qualifiers blank, +, *, B, C, D, E(inorganic), F, G, H, I, J, N, S, U, UJ, UN, UW, UX, W, X, Y, Z
e. CHECK:
   validation codes Z
   lab qualifiers all except rejection qualifiers

5. Converts units so that all units for a given analyte will be consistent

a. Solids:
   metals or WQP MG/KG
   radionuclides PCI/G
   vocs, svocs, pest, herbs, pcbs,... UG/KG
b. Liquids:
   rads PCI/L
   all other analytical groups UG/L
c. Convert DPM/L to PCI/L for "historical" rads results.

6. Assigns detect/non-detect

a. Y(yes):
   all rads
   other analytical groups:
      validation codes blank,Y,J,A,V
      lab qualifiers all except U, and those that reject the record

b. N (no):

All rejected records
Validation codes all
lab qualifiers U,JB

C. Run new_dlim.prg to handle records with detection limits reported as CRDL (especially metals) instead of IDL. Paul Gomez said that if the CRDL is reported as the detection limit, usually the IDL is reported in the result field. Therefore when summing values for mean calculations, the non-detects should be 1/2 the result, not 1/2 the reported detection limit.

1. If the reported detection limit is the CRDL for that analyte, the new detection limit field is filled with the converted result (nresult). Otherwise, the new detection limit field is filled with the reported, converted result.

D. Remove records for analytes not in the Target Analyte List in the OU 11 Work Plan using non_tal.prg.

1. Marks non-tal records in the final structure files.

2. Creates non-tal files containing those records removed: 94data\non_tal.dbf and historic\non_tal.dbf

3. Creates 94data and historic tal files to check the y_n field to see if all analytes are represented: 94data\94_tal and historic\hst_tal

4. Checks those non_tal analytes that aren't labeled as TICs for detects.

a. Creates a list of detected analytes: 94data\non_tal.txt and historic\non_tal.txt. Includes the following fields: location, s_no, t_g_c, analyte, result, d_limit, qual, valid.

II. PROJECT DATABASE

A. Run project.prg to build the Project Database by appending records from 94data\94final.dbf and historic\hstfinal.dbf into ou11proj.dbf.

B. Run ou11 specific cleanup program ou11_cln.prg

1. Labels hydrostratigraphic units for wells based on completion lithology.

2. Identifies a location as within or outside of the IHSS boundaries.

3. Labels the geologic unit for each borehole sample. (All samples from 1994 Field Season are Qrf.)

C. Run split.prg to split the project database.

1. Records labeled "CHECK" are removed to check\ou11_chk.dbf. These records are checked by hand to see if they should be included in the "RI" database. The Z validation code is assigned to those records which Quantalex is not under contract to validate, or (it appears) lab qa/qc records for which there is a target. (I am still looking into this as sometimes this code is filled in by RFEDS before the record is validated.)

2. Unusable records (category REJECT; usability REJECT) are removed to unusable\ou11_rej.dbf

3. Records labeled as "TIC" in the project database and in each of the non_tal files (94data\non_tal and historic\non_tal) are removed to tic\ou11_tic.dbf.

4. Records labeled as category QC and those real records that correspond to real/dup pairs with a usability code of VALID, ESTIMATE, or BLNK/Y VAL are removed to qc\ou11_qc.dbf.

5. Records labeled as category REAL with a usability code of VALID, ESTIMATE, or BLNK/Y VAL are removed to ou11_ri.dbf.

D. The "RI" and "QC" databases are checked for lab qa/qc records that, if there is an associated target record, could make duplicate records for a given analyte. The records not chosen are removed to lab_qa.dbf. Run lab_qa.prg iteratively to remove duplicate records to lab_qa.dbf.

1. Sorts file on s_no+t_g_c+analyte+r_type.

2. If none of the records are validated:
   keep the TRG record
   remove the other(s)

3. If one record is validated and the other(s) are not (i.e. valid is blank or Y):
   keep the validated record
   remove the other(s)

E. If more than one record is validated the records are checked by hand and the decision to keep or remove is made on a record by record basis. Those records removed from the data set using these steps are also stored in lab_qa.dbf.

1. The simplest decision is made on the basis of validation code hierarchy. The record with the "lowest" validation code is removed, assuming the results are reasonable (i.e. have reasonable number of digits after the decimal place, no zero concentrations, etc.).

V	Highest rank
A, JA	Second highest
Y	Third highest
Z,R	Lowest rank. (Note: split.prg removes these records from the ou11_ri data set.)

2. If the results look "reasonable" and the validation codes are identical, the record with the highest concentration is kept and the other removed, to be most conservative.

3. If the results are very different, the most acceptable record is used and the other(s) are removed. For example, there is a trg and dup record for americium 241, both validated with V, trg result = 0, dup result = .00517 pci/g. The dup record is kept, and the trg record removed.

F. Run dupe.prg to find those analytes that have 2 TRG, DUP, etc records for the same sample number.

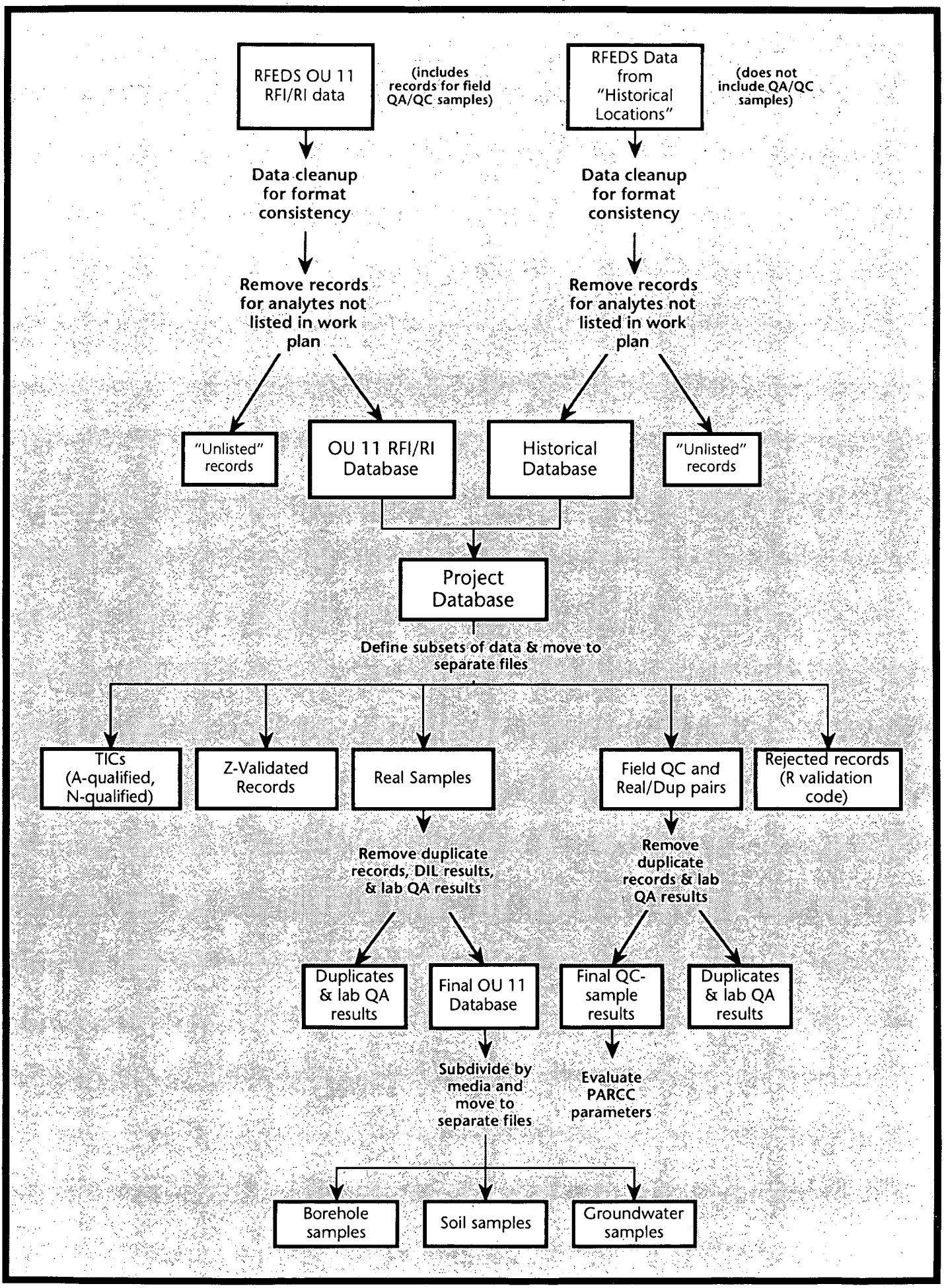
1. Flag the duped records.

2. Set the filter to use only the flagged records.

3. Use the same criteria as above to make decisions on the appropriate record to keep.

G. Run difunits.prg to identify non-rads records where the detection limit is >= 1000 times the result. This situation suggests that the result and detection limit were reported in different units.

Figure A-1
Cleanup Routine for Analytical Data: Operable Unit No. 11



G95\ES\Dbase Flow-2509

APPENDIX B

Summary Statistics

Table B-1a
Summary Statistics for Surficial Soils in OU 11

Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det	Units	Min Result	Max Detect	Mean Result	Std Dev	Max Locn
Metals										
TOTAL	ALUMINUM	40.0000 - 40.0000	53/53	100.0	MG/KG	7340.00	19400.00	11700.00	3008.32	SS102994
TOTAL	ANTIMONY	12.0000 - 12.0000	3/53	5.7	MG/KG	2.50	3.50	1.68	0.78	SS103694
TOTAL	ARSENIC	2.0000 - 2.0000	53/53	100.0	MG/KG	4.00	13.10	7.58	1.58	SS102894
TOTAL	BARIUM	40.0000 - 40.0000	53/53	100.0	MG/KG	86.80	199.00	124.71	21.64	SS102994
TOTAL	BERYLLIUM	1.0000 - 1.0000	53/53	100.0	MG/KG	0.50	1.10	0.66	0.14	SS140394
TOTAL	CADMIUM	1.0000 - 1.0000	28/53	52.8	MG/KG	0.58	1.40	0.61	0.31	SS102994
TOTAL	CALCIUM	1000.0000 - 1000.0000	53/53	100.0	MG/KG	1540.00	6360.00	2520.38	700.35	SS140494
TOTAL	CHROMIUM	2.0000 - 2.0000	53/53	100.0	MG/KG	9.30	22.70	12.95	3.16	SS102994
TOTAL	COBALT	10.0000 - 10.0000	53/53	100.0	MG/KG	4.90	11.20	6.45	1.29	SS102994
TOTAL	COPPER	5.0000 - 5.0000	53/53	100.0	MG/KG	9.60	88.10	13.95	10.74	SS140194
TOTAL	IRON	20.0000 - 20.0000	53/53	100.0	MG/KG	10800.00	23700.00	13488.68	2553.55	SS102994
TOTAL	LEAD	0.6000 - 0.6000	53/53	100.0	MG/KG	15.40	82.90	43.04	12.53	SS102894
TOTAL	LITHIUM	20.0000 - 20.0000	53/53	100.0	MG/KG	5.50	19.40	9.59	2.72	SS102894
TOTAL	MAGNESIUM	1000.0000 - 1000.0000	53/53	100.0	MG/KG	1280.00	2780.00	1696.42	338.34	SS102994
TOTAL	MANGANESE	3.0000 - 3.0000	53/53	100.0	MG/KG	206.00	558.00	316.26	65.31	SS102994
TOTAL	MOLYBDENUM	40.0000 - 40.0000	11/53	20.8	MG/KG	0.63	2.60	0.80	0.48	SS102994
TOTAL	NICKEL	8.0000 - 8.0000	53/53	100.0	MG/KG	5.10	19.50	8.89	2.58	SS140494
TOTAL	POTASSIUM	1000.0000 - 1000.0000	53/53	100.0	MG/KG	1270.00	3960.00	1960.57	510.03	SS102994
TOTAL	SELENIUM	1.0000 - 1.0000	29/53	54.7	MG/KG	0.39	0.68	0.37	0.15	SS100194
TOTAL	SILVER	2.0000 - 2.0000	1/53	1.9	MG/KG	0.39	0.60	0.24	0.10	SS140194
TOTAL	SODIUM	1000.0000 - 1000.0000	53/53	100.0	MG/KG	39.30	172.00	74.61	24.85	SS140494
TOTAL	STRONTIUM	40.0000 - 40.0000	53/53	100.0	MG/KG	14.80	41.60	22.56	4.47	SS102894
TOTAL	THALLIUM	2.0000 - 2.0000	23/53	43.4	MG/KG	0.19	0.27	0.16	0.06	SS140894
TOTAL	TIN	40.0000 - 40.0000	17/53	32.1	MG/KG	2.40	4.90	2.16	1.06	SS103994
TOTAL	VANADIUM	10.0000 - 10.0000	53/53	100.0	MG/KG	23.20	50.80	29.54	5.76	SS102994
TOTAL	ZINC	4.0000 - 4.0000	53/53	100.0	MG/KG	22.40	70.00	42.94	9.09	SS102894
Radionuclides										
TOTAL	AMERICIUM-241	0.006 - 0.097	53/53	100.0	PCI/G	0.009	0.43	0.04	0.06	SS102094
TOTAL	PLUTONIUM-239/240	0.002 - 0.041	53/53	100.0	PCI/G	0.013	2.2	0.2	0.3	SS102094
TOTAL	URANIUM-233,-234	0.010 - 0.13	53/53	100.0	PCI/G	1.3	4.3	2.0	0.6	SS140194
TOTAL	URANIUM-235	0.009 - 0.15	53/53	100.0	PCI/G	0.013	0.30	0.09	0.06	SS100894
TOTAL	URANIUM-238	0.020 - 0.18	53/53	100.0	PCI/G	1.4	4.5	2.0	0.5	SS140194
Other Parameters										
TOTAL	% SOLIDS BY WEIGHT	0.1 - 0.1	1/1	100.0	%	89.0	89.0	89.0	NC	SS141394
TOTAL	NITRATE/NITRITE	0.1 - 0.1	53/53	100.0	MG/KG	2	37	13	11	SS100894

Table B-1b
Analytes Not Detected in Surficial Soils in OU 11

Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
Metals				
TOTAL	CESIUM	200.0000 - 200.0000	0/52	0.0
TOTAL	MERCURY	0.1000 - 0.1000	0/53	0.0
Other Parameters				
TOTAL	CYANIDE	2.5 - 2.5	0/53	0.0

Table B-2a
Summary Statistics for Background Surficial Soils

Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det	Units	Min Result	Max Detect	Mean Result	Std Dev	Mean+2Std	UTL99	Max Locn
Metals												
TOTAL	ALUMINUM	40 - 50	20/20	100.0	MG/KG	7420	21800	13339	3273	19884	25879	RA004
TOTAL	ARSENIC	2 - 3	20/20	100.0	MG/KG	2.2	8.7	6	2	10	13	RA002
TOTAL	BARIUM	10 - 40	20/20	100.0	MG/KG	120	470	200	87	373	532	SS204693
TOTAL	BERYLLIUM	1 - 5	11/20	55.0	MG/KG	0.44	1.1	1.5	0.9	3.3	5.0	RA002
TOTAL	CADMIUM	1 - 5	6/18	33.3	MG/KG	0.6	1.8	1	1	3.	5	SS204493
TOTAL	CALCIUM	1000 - 1000	20/20	100.0	MG/KG	2260	13600	5412	2935	11283	16659	RA004
TOTAL	CESIUM	200 - 500	11/20	55.0	MG/KG	1.7	3	114	126	367	598	RA005
TOTAL	CHROMIUM	2 - 10	20/20	100.0	MG/KG	9	22	15	3	22	28	RA004
TOTAL	COBALT	10 - 10	20/20	100.0	MG/KG	4.8	24	8	4	16	24	SS204693
TOTAL	COPPER	5 - 10	20/20	100.0	MG/KG	7.7	22.2	13	4	22	30	RA002
TOTAL	IRON	20 - 20	20/20	100.0	MG/KG	10400	24900	15605	3509	22624	29052	RA001
TOTAL	LEAD	1 - 2	20/20	100.0	MG/KG	26.6	51	37	6	50	62	SS204393
TOTAL	LITHIUM	10 - 20	20/20	100.0	MG/KG	6.8	17.7	11	3	17	22	RA004
TOTAL	MAGNESIUM	1000 - 1000	20/20	100.0	MG/KG	1440	6380	2984	1236	5455	7718	RA004
TOTAL	MANGANESE	3 - 10	20/20	100.0	MG/KG	210	2220	433	435	1303	2100	SS204693
TOTAL	MOLYBDENUM	20 - 40	1/20	5.0	MG/KG	1.4	2.7	5	5	14	23	RA003
TOTAL	NICKEL	8 - 20	19/20	95.0	MG/KG	7.8	18.7	12	3	19	26	SS204693
TOTAL	POTASSIUM	1000 - 1000	20/20	100.0	MG/KG	1950	5310	3085	810	4706	6190	RA002
TOTAL	SELENIUM	1 - 2	15/20	75.0	MG/KG	0.21	0.76	0.6	0.3	1.1	1.5	SS204193
TOTAL	SODIUM	1000 - 1000	11/20	55.0	MG/KG	56.9	249	291	198	688	1052	RA004
TOTAL	STRONTIUM	5 - 40	20/20	100.0	MG/KG	20.9	109	38	20	77	113	RA004
TOTAL	THALLIUM	2 - 2	6/20	30.0	MG/KG	0.21	0.41	0.2	0.1	0.4	0.6	RA003
TOTAL	TIN	40 - 100	8/20	40.0	MG/KG	21.5	41.9	30	11	51	70	RA004
TOTAL	VANADIUM	10 - 10	20/20	100.0	MG/KG	21.1	46.2	32	7	47	60	RA002
TOTAL	ZINC	4 - 10	20/20	100.0	MG/KG	41.4	90.2	57	11	79	99	RA002
Radionuclides												
TOTAL	AMERICIUM-241	0.000 - 0.020	20/20	100.0	PCI/G	-0.003	0.04046	0.019	0.010	0.039	0.058	RA002
TOTAL	GROSS ALPHA	1.6 - 2.5	10/10	100.0	PCI/G	14	28	21	4	30	43	SS204793
TOTAL	GROSS BETA	3.2 - 5.0	10/10	100.0	PCI/G	24	40	31	4	39	53	SS204293
TOTAL	PLUTONIUM-239/240	0.000 - 0.016	23/23	100.0	PCI/G	0.02518	0.10	0.05	0.02	0.09	0.13	SS204393
TOTAL	URANIUM-233,-234	0.000 - 0.049	16/16	100.0	PCI/G	0.9219	1.472	1.1	0.2	1.5	1.8	RA009
TOTAL	URANIUM-235	0.000 - 0.057	16/16	100.0	PCI/G	0.01062	0.1393	0.047	0.034	0.115	0.187	RA002
TOTAL	URANIUM-238	0.000 - 0.045	16/16	100.0	PCI/G	0.8989	1.521	1.2	0.2	1.6	2.0	RA001
Semivolatile Organic Compounds												
TOTAL	BENZOIC ACID	1600 - 1600	7/12	58.3	UG/KG	43	230	451	411	1273	2355	SS204293
TOTAL	BIS(2-ETHYLHEXYL)PHTHALATE	330 - 480	4/18	22.2	UG/KG	35	140	165	57	280	391	RA007
TOTAL	DI-n-BUTYL PHTHALATE	330 - 480	2/18	11.1	UG/KG	39	44	177	53	284	388	RA007
Other Parameters												
TOTAL	% SOLIDS BY WEIGHT	0.10 - 0.10	14/14	100.0	%	69.2	97.0	87.9	9.5	107.0	129.3	RA008
TOTAL	NITRATE/NITRITE	0.2 - 0.2	9/9	100.0	MG/KG	0.705	4.79	2.3	1.4	5.0	9.6	RA006

Table B-2b
Analytes Not Detected in Background Surficial Soils

Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
Metals				
TOTAL	ANTIMONY	12 - 50	0/20	0.0
TOTAL	MERCURY	0.1 - 0.2	0/18	0.0
TOTAL	SILVER	2 - 10	0/20	0.0
Semivolatile Organic Compounds				
TOTAL	1,2,4-TRICHLOROBENZENE	330 - 480	0/18	0.0
TOTAL	1,2-DICHLOROBENZENE	330 - 480	0/18	0.0
TOTAL	1,3-DICHLOROBENZENE	330 - 480	0/18	0.0
TOTAL	1,4-DICHLOROBENZENE	330 - 480	0/18	0.0
TOTAL	2,4,5-TRICHLOROPHENOL	1600 - 1600	0/12	0.0
TOTAL	2,4,6-TRICHLOROPHENOL	330 - 330	0/12	0.0
TOTAL	2,4-DICHLOROPHENOL	330 - 330	0/12	0.0
TOTAL	2,4-DIMETHYLPHENOL	330 - 330	0/12	0.0
TOTAL	2,4-DINITROPHENOL	1600 - 1600	0/12	0.0
TOTAL	2,4-DINITROTOLUENE	330 - 480	0/18	0.0
TOTAL	2,6-DINITROTOLUENE	330 - 480	0/18	0.0
TOTAL	2-CHLORONAPHTHALENE	330 - 480	0/18	0.0
TOTAL	2-CHLOROPHENOL	330 - 330	0/12	0.0
TOTAL	2-METHYLNAPHTHALENE	330 - 480	0/16	0.0
TOTAL	2-METHYLPHENOL	330 - 330	0/12	0.0
TOTAL	2-NITROANILINE	1600 - 2400	0/18	0.0
TOTAL	2-NITROPHENOL	330 - 330	0/12	0.0
TOTAL	3,3'-DICHLOROBENZIDINE	660 - 960	0/18	0.0
TOTAL	3-NITROANILINE	1600 - 2400	0/18	0.0
TOTAL	4,6-DINITRO-2-METHYLPHENOL	1600 - 1600	0/12	0.0
TOTAL	4-CHLORO-3-METHYLPHENOL	330 - 330	0/12	0.0
TOTAL	4-CHLOROANILINE	330 - 480	0/18	0.0
TOTAL	4-CHLOROPHENYL PHENYL ETHER	330 - 480	0/18	0.0
TOTAL	4-METHYLPHENOL	330 - 330	0/12	0.0
TOTAL	4-NITROANILINE	1600 - 2400	0/18	0.0
TOTAL	4-NITROPHENOL	1600 - 1600	0/12	0.0
TOTAL	ACENAPHTHENE	330 - 480	0/18	0.0
TOTAL	ACENAPHTHYLENE	330 - 480	0/18	0.0
TOTAL	ANTHRACENE	330 - 480	0/18	0.0
TOTAL	BENZO(a)ANTHRACENE	330 - 480	0/18	0.0
TOTAL	BENZO(a)PYRENE	330 - 480	0/18	0.0
TOTAL	BENZO(b)FLUORANTHENE	330 - 480	0/18	0.0
TOTAL	BENZO(ghi)PERYLENE	330 - 350	0/14	0.0
TOTAL	BENZO(k)FLUORANTHENE	330 - 480	0/18	0.0
TOTAL	BENZYL ALCOHOL	330 - 330	0/12	0.0
TOTAL	BIS(2-CHLOROETHOXY)METHANE	330 - 480	0/18	0.0
TOTAL	BIS(2-CHLOROETHYL)ETHER	330 - 480	0/18	0.0
TOTAL	BIS(2-CHLOROISOPROPYL)ETHER	330 - 480	0/18	0.0

Table B-2b
Analytes Not Detected in Background Surficial Soils

Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
TOTAL	BUTYL BENZYL PHTHALATE	330 - 480	0/18	0.0
TOTAL	CHRYSENE	330 - 480	0/18	0.0
TOTAL	DI-n-OCTYL PHTHALATE	330 - 480	0/18	0.0
TOTAL	DIBENZO(a,h)ANTHRACENE	330 - 480	0/18	0.0
TOTAL	DIBENZOFURAN	330 - 480	0/18	0.0
TOTAL	DIETHYL PHTHALATE	330 - 480	0/18	0.0
TOTAL	DIMETHYL PHTHALATE	330 - 480	0/18	0.0
TOTAL	FLUORANTHENE	330 - 480	0/18	0.0
TOTAL	FLUORENE	330 - 480	0/18	0.0
TOTAL	HEXACHLOROBENZENE	330 - 480	0/18	0.0
TOTAL	HEXACHLOROBUTADIENE	330 - 480	0/18	0.0
TOTAL	HEXACHLOROCYCLOPENTADIENE	330 - 480	0/18	0.0
TOTAL	HEXACHLOROETHANE	330 - 480	0/18	0.0
TOTAL	INDENO(1,2,3-cd)PYRENE	330 - 480	0/18	0.0
TOTAL	ISOPHORONE	330 - 480	0/18	0.0
TOTAL	N-NITROSO-DI-n-PROPYLAMINE	330 - 480	0/18	0.0
TOTAL	N-NITROSODIPHENYLAMINE	330 - 480	0/18	0.0
TOTAL	NAPHTHALENE	330 - 480	0/18	0.0
TOTAL	NITROBENZENE	330 - 330	0/12	0.0
TOTAL	PENTACHLOROPHENOL	1600 - 1600	0/12	0.0
TOTAL	PHENANTHRENE	330 - 480	0/18	0.0
TOTAL	PHENOL	330 - 330	0/12	0.0
TOTAL	PYRENE	330 - 480	0/18	0.0

Table B-3a
Summary Statistics for Subsurface Geologic Materials in IHSS 168 and Downgradient Wells (0 to 12 feet)

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det	Units	Min Result	Max Detect	Mean Result	Std Dev	Max Locn
Metals											
QRF (RFA)	TOTAL	ALUMINUM	40.0000 - 40.0000	72/73	98.6	MG/KG	2.60	18700	8060	3103	46292
QRF	TOTAL	ANTIMONY	12.0000 - 12.0000	1/73	1.4	MG/KG	2.60	3.30	2	1	50794
QRF	TOTAL	ARSENIC	2.0000 - 2.0000	73/73	100.0	MG/KG	1.3	9.80	4.2	1.8	50994
QRF	TOTAL	BARIUM	40.0000 - 40.0000	72/73	98.6	MG/KG	0.21	147.00	51	21	50194
QRF	TOTAL	BERYLLIUM	1.0000 - 1.0000	70/71	98.6	MG/KG	0.21	1.3	0.6	0.2	46292
QRF	TOTAL	CALCIUM	1000.0000 - 1000.0000	72/73	98.6	MG/KG	1.30	4850	1310	759	46392
QRF	TOTAL	CESIUM	200.0000 - 200.0000	6/67	9.0	MG/KG	1.1	3.7	4.2	0.9	46392
QRF	TOTAL	CHROMIUM	2.0000 - 2.0000	72/73	98.6	MG/KG	0.43	77.50	17.4	12.7	50494
QRF	TOTAL	COBALT	10.0000 - 10.0000	72/73	98.6	MG/KG	0.64	91.60	7	11	50194
QRF	TOTAL	COPPER	5.0000 - 5.0000	72/73	98.6	MG/KG	0.43	19.70	8.9	4.1	50194
QRF	TOTAL	IRON	20.0000 - 20.0000	72/73	98.6	MG/KG	5.40	22100	10131	3219	46292
QRF	TOTAL	LEAD	0.6000 - 1	73/73	100.0	MG/KG	3.5	17.50	7	3	51194
QRF	TOTAL	LITHIUM	20.0000 - 20.0000	70/73	95.9	MG/KG	0.21	10.80	4	2	50494
QRF	TOTAL	MAGNESIUM	1000.0000 - 1000.0000	72/73	98.6	MG/KG	3.00	3840	1056	510	46292
QRF	TOTAL	MANGANESE	3.0000 - 3.0000	72/73	98.6	MG/KG	0.21	885.00	168	128	51094
QRF	TOTAL	MERCURY	0.1000 - 0.1000	7/73	9.6	MG/KG	0.05	25.40	0.40	2.97	51494
QRF	TOTAL	MOLYBDENUM	40.0000 - 40.0000	35/73	47.9	MG/KG	0.63	15.60	2	2	50494
QRF	TOTAL	NICKEL	8.0000 - 8.0000	70/73	95.9	MG/KG	1.40	33.10	10	6	50794
QRF	TOTAL	POTASSIUM	1000.0000 - 1000.0000	64/73	87.7	MG/KG	83.60	1460.00	781	259	50194
QRF	TOTAL	SELENIUM	1.0000 - 1.0000	7/71	9.9	MG/KG	0.22	0.59	0.23	0.08	50694
QRF	TOTAL	SILVER	2.0000 - 2.0000	1/73	1.4	MG/KG	0.40	0.55	0	0	50394
QRF	TOTAL	SODIUM	1000.0000 - 1000.0000	73/73	100.0	MG/KG	20.60	965	116	146	46392
QRF	TOTAL	STRONTIUM	40.0000 - 40.0000	72/73	98.6	MG/KG	0.21	70.9	13.7	9.6	46392
QRF	TOTAL	THALLIUM	2.0000 - 2.0000	5/73	6.8	MG/KG	-0.20	0.32	0.14	0.05	46292
QRF	TOTAL	TIN	40.0000 - 40.0000	16/73	21.9	MG/KG	2.00	46.5	3	7	46292
QRF	TOTAL	VANADIUM	10.0000 - 10.0000	72/73	98.6	MG/KG	0.43	46.30	21.4	7.5	50994
QRF	TOTAL	ZINC	4.0000 - 4.0000	67/73	91.8	MG/KG	0.43	46.4	12.4	6.3	46392
Radionuclides											
QRF (RFA)	TOTAL	AMERICIUM-241	0 - 0.28	72/72	100.0	PCI/G	-0.014	0.077	0.010	0.015	50894
QRF	TOTAL	GROSS ALPHA	2 - 2.7	4/4	100.0	PCI/G	15.2	27.4	19.9	5.6	46292
QRF	TOTAL	GROSS BETA	2.5 - 5.9	5/5	100.0	PCI/G	3.998	26.5	16.7	8.4	46492
QRF	TOTAL	PLUTONIUM-239/240	0.000 - 0.109	72/72	100.0	PCI/G	-0.004	0.69	0.01	0.08	50194
QRF	TOTAL	TRITIUM	310 - 1500	54/54	100.0	PCI/L	-13	3400	441	539	51294
QRF	TOTAL	URANIUM-233,-234	0.013 - 0.17	71/71	100.0	PCI/G	0.444	3.2	1.5	0.5	51094
QRF	TOTAL	URANIUM-235	0.013 - 0.15	71/71	100.0	PCI/G	0	0.22	0.07	0.04	51494
QRF	TOTAL	URANIUM-238	0.013 - 0.17	71/71	100.0	PCI/G	0.432	3.1	1.5	0.5	51094
Semivolatile Organic Compounds											
QRF (RFA)	TOTAL	BIS(2-ETHYLHEXYL)PHTHALATE	10.0000 - 330.0000	27/67	40.3	UG/KG	36	140	119	66	50894
QRF	TOTAL	DI-n-BUTYL PHTHALATE	10.0000 - 330.0000	27/67	40.3	UG/KG	39	520	216	121	50394
QRF	TOTAL	DIETHYL PHTHALATE	10.0000 - 330.0000	2/67	3.0	UG/KG	190	240	166	42	50994

Table B-3a
Summary Statistics for Subsurface Geologic Materials in IHSS 168 and Downgradient Wells (0 to 12 feet)

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det	Units	Min Result	Max Detect	Mean Result	Std Dev	Max Locn
Volatile Organic Compounds											
QRF (RFA)	TOTAL	2-BUTANONE	10.0000 - 10.0000	1/45	2.2	UG/KG	4	4	5	0	51494
QRF	TOTAL	ACETONE	10.0000 - 10.0000	10/44	22.7	UG/KG	1	15	5	2	50994
QRF	TOTAL	METHYLENE CHLORIDE	5.0000 - 5.0000	18/53	34.0	UG/KG	1	16	4	3	51194
QRF	TOTAL	TOLUENE	5.0000 - 5.0000	22/55	40.0	UG/KG	1	25	3	3	51094
Other Parameters											
QRF (RFA)	TOTAL	% SOLIDS BY WEIGHT	0.1 - 0.1	67/67	100.0	%	81.2	99.0	94.4	3.2	50194
QRF	TOTAL	NITRATE/NITRITE	0.1 - 0.1	61/67	91.0	MG/KG	0.1	2	1	1	50394

Table B-3b
Analytes Not Detected in Subsurface Geologic Materials in IHSS 168 and Downgradient Wells (0 to 12 feet)

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
Metals					
QRF (RFA)	TOTAL	CADMIUM	1.0000 - 1.0000	0/73	0.0
Semivolatile Organic Compounds					
QRF (RFA)	TOTAL	1,2,4-TRICHLOROBENZENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	1,2-DICHLOROBENZENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	1,3-DICHLOROBENZENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	1,4-DICHLOROBENZENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	2,4,5-TRICHLOROPHENOL	50.0000 - 1600.0000	0/67	0.0
QRF	TOTAL	2,4,6-TRICHLOROPHENOL	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	2,4-DICHLOROPHENOL	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	2,4-DIMETHYLPHENOL	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	2,4-DINITROPHENOL	50.0000 - 1600.0000	0/60	0.0
QRF	TOTAL	2,4-DINITROTOLUENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	2,6-DINITROTOLUENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	2-CHLORONAPHTHALENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	2-CHLOROPHENOL	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	2-METHYLNAPHTHALENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	2-METHYLPHENOL	10.0000 - 330.0000	0/63	0.0
QRF	TOTAL	2-NITROANILINE	50.0000 - 1600.0000	0/67	0.0
QRF	TOTAL	2-NITROPHENOL	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	3,3'-DICHLOROBENZIDINE	20.0000 - 660.0000	0/63	0.0
QRF	TOTAL	3-NITROANILINE	50.0000 - 1600.0000	0/60	0.0
QRF	TOTAL	4,6-DINITRO-2-METHYLPHENOL	50.0000 - 1600.0000	0/66	0.0
QRF	TOTAL	4-CHLORO-3-METHYLPHENOL	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	4-CHLOROANILINE	10.0000 - 330.0000	0/63	0.0
QRF	TOTAL	4-CHLOROPHENYL PHENYL ETH	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	4-METHYLPHENOL	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	4-NITROANILINE	50.0000 - 1600.0000	0/67	0.0
QRF	TOTAL	4-NITROPHENOL	50.0000 - 1600.0000	0/67	0.0
QRF	TOTAL	ACENAPHTHENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	ACENAPHTHYLENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	ANTHRACENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	BENZO(a)ANTHRACENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	BENZO(a)PYRENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	BENZO(b)FLUORANTHENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	BENZO(ghi)PERYLENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	BENZO(k)FLUORANTHENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	BENZOIC ACID	50.0000 - 1600.0000	0/63	0.0
QRF	TOTAL	BENZYL ALCOHOL	10.0000 - 330.0000	0/63	0.0
QRF	TOTAL	BIS(2-CHLOROETHOXY)METHAN	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	BIS(2-CHLOROETHYL)ETHER	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	BIS(2-CHLOROISOPROPYL)ETHE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	BUTYL BENZYL PHTHALATE	10.0000 - 330.0000	0/67	0.0

Table B-3b
Analytes Not Detected in Subsurface Geologic Materials in IHSS 168 and Downgradient Wells (0 to 12 feet)

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
QRF	TOTAL	CHRYSENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	DI-n-OCTYL PHTHALATE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	DIBENZO(a,h)ANTHRACENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	DIBENZOFURAN	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	DIMETHYL PHTHALATE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	FLUORANTHENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	FLUORENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	HEXACHLOROBENZENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	HEXACHLOROBUTADIENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	HEXACHLOROCYCLOPENTADIE	10.0000 - 330.0000	0/61	0.0
QRF	TOTAL	HEXACHLOROETHANE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	INDENO(1,2,3-cd)PYRENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	ISOPHORONE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	N-NITROSO-DI-n-PROPYLAMINE	330.0000 - 330.0000	0/67	0.0
QRF	TOTAL	N-NITROSODIPHENYLAMINE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	NAPHTHALENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	NITROBENZENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	PENTACHLOROPHENOL	50.0000 - 1600.0000	0/67	0.0
QRF	TOTAL	PHENANTHRENE	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	PHENOL	10.0000 - 330.0000	0/67	0.0
QRF	TOTAL	PYRENE	10.0000 - 330.0000	0/67	0.0
Volatile Organic Compounds					
QRF (RFA)	TOTAL	1,1,1-TRICHLOROETHANE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	1,1,2,2-TETRACHLOROETHANE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	1,1,2-TRICHLOROETHANE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	1,1-DICHLOROETHENE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	1,2-DICHLOROETHENE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	1,2-DICHLOROPROPANE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	2-HEXANONE	10.0000 - 10.0000	0/45	0.0
QRF	TOTAL	4-METHYL-2-PENTANONE	10.0000 - 10.0000	0/45	0.0
QRF	TOTAL	BENZENE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	BROMODICHLOROMETHANE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	BROMOFORM	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	BROMOMETHANE	10.0000 - 10.0000	0/55	0.0
QRF	TOTAL	CARBON DISULFIDE	5.0000 - 5.0000	0/50	0.0
QRF	TOTAL	CARBON TETRACHLORIDE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	CHLOROBENZENE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	CHLOROETHANE	10.0000 - 10.0000	0/55	0.0
QRF	TOTAL	CHLOROFORM	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	CHLOROMETHANE	10.0000 - 10.0000	0/55	0.0
QRF	TOTAL	DIBROMOCHLOROMETHANE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	ETHYLBENZENE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	STYRENE	5.0000 - 5.0000	0/55	0.0

Table B-3b
Analytes Not Detected in Subsurface Geologic Materials in IHSS 168 and Downgradient Wells (0 to 12 feet)

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
QRF	TOTAL	TETRACHLOROETHENE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	TOTAL XYLENES	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	TRICHLOROETHENE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	VINYL ACETATE	10.0000 - 10.0000	0/55	0.0
QRF	TOTAL	VINYL CHLORIDE	10.0000 - 10.0000	0/55	0.0
QRF	TOTAL	cis-1,3-DICHLOROPROPENE	5.0000 - 5.0000	0/55	0.0
QRF	TOTAL	trans-1,3-DICHLOROPROPENE	5.0000 - 5.0000	0/55	0.0
Other Parameters					
QRF (RFA)	TOTAL	CYANIDE	2.5 - 2.5	0/67	0.0

Table B-4a
Summary Statistics for Subsurface Geologic Materials in Background Boreholes

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det	Units	Min Result	Max Detect	Mean Result	Std Dev	Mean+2Std	UTL99	Max Locn
Metals													
QRF (RFA)	TOTAL	ALUMINUM	40 - 504	56/57	98.2	MG/KG	279	102000	13022	13838	40697	55484	B400289
QRF	TOTAL	ANTIMONY	12 - 40	8/46	17.4	MG/KG	1.9	5.2	5	5	14	20	B400389
QRF	TOTAL	ARSENIC	2 - 4.9	38/56	67.9	MG/KG	0.46	41.8	4	6	15	21	B200689
QRF	TOTAL	BARIUM	40 - 96.8	48/57	84.2	MG/KG	14.9	777	82	103	288	398	B400289
QRF	TOTAL	BERYLLIUM	1 - 2.4	47/57	82.5	MG/KG	0.91	23.5	4	4	13	18	B400289
QRF	TOTAL	CADMIUM	1 - 2.4	5/44	11.4	MG/KG	0.16	1.5	1	0	1	2	B200589
QRF	TOTAL	CALCIUM	1060 - 2420	56/57	98.2	MG/KG	1130	157000	6419	20674	47767	69859	B200789
QRF	TOTAL	CHROMIUM	2 - 4.8	57/57	100.0	MG/KG	4	176	22	31	85	118	B400289
QRF	TOTAL	COBALT	10 - 24.2	18/57	31.6	MG/KG	3.8	16.6	7	7	20	27	B200589
QRF	TOTAL	COPPER	5 - 12.1	54/57	94.7	MG/KG	2.2	123	11	16	43	60	B400289
QRF	TOTAL	IRON	20 - 252	57/57	100.0	MG/KG	1300	132000	13968	16651	47270	65064	B400289
QRF	TOTAL	LEAD	1 - 6.1	56/56	100.0	MG/KG	2.6	39.8	9	7	23	30	B400289
QRF	TOTAL	LITHIUM	2.1 - 26.1	29/57	50.9	MG/KG	2	83.2	10	10	31	42	B400289
QRF	TOTAL	MAGNESIUM	1060 - 2420	53/57	93.0	MG/KG	606	32500	2686	4155	10997	15437	B400289
QRF	TOTAL	MANGANESE	3 - 7.3	57/57	100.0	MG/KG	26.6	3330	235	437	1109	1576	B400289
QRF	TOTAL	MERCURY	0.083 - 0.3	21/48	43.8	MG/KG	0.083	0.64	0.2	0.2	0.6	0.8	B200689
QRF	TOTAL	MOLYBDENUM	2.1 - 40	32/57	56.1	MG/KG	2.3	67.6	11	10	32	43	B400289
QRF	TOTAL	NICKEL	8 - 19.4	49/54	90.7	MG/KG	5.9	193	23	26	76	104	B400289
QRF	TOTAL	POTASSIUM	1060 - 2420	32/56	57.1	MG/KG	373	18700	1765	3118	8000	11360	B400289
QRF	TOTAL	SELENIUM	1 - 12.2	1/44	2.3	MG/KG	0.21	2.8	1	1	4	6	B200789
QRF	TOTAL	SILVER	2 - 4.8	14/50	28.0	MG/KG	0.53	40.9	2	6	14	21	B200689
QRF	TOTAL	SODIUM	1060 - 2420	7/57	12.3	MG/KG	102	310	269	291	852	1163	B200689
QRF	TOTAL	STRONTIUM	21.6 - 484	5/57	8.8	MG/KG	20.9	226	57	58	174	236	B200789
QRF	TOTAL	THALLIUM	2 - 20	3/41	7.3	MG/KG	0.21	0.4	0.8	1.6	4.0	6.0	B200689
QRF	TOTAL	TIN	10 - 48.4	10/56	17.9	MG/KG	20.2	312	21	41	103	147	B200689
QRF	TOTAL	VANADIUM	10 - 24.2	56/57	98.2	MG/KG	11.1	283	32	36	104	142	B400289
QRF	TOTAL	ZINC	4 - 9.7	56/56	100.0	MG/KG	0.52	486	30	64	157	226	B400289
Radionuclides													
QRF (RFA)	TOTAL	AMERICIUM-241	0.002 - 0.04	14/14	100.0	PCI/G	-0.01	0.011	0.00	0.00	0.01	0.02	B200589
QRF	TOTAL	GROSS ALPHA	11 - 17	32/32	100.0	PCI/G	3	38	20	9	37	49	B200589
QRF	TOTAL	GROSS BETA	7 - 8	32/32	100.0	PCI/G	6	41	23	6	36	45	B200589
QRF	TOTAL	PLUTONIUM-239/240	0 - 0.009	57/57	100.0	PCI/G	-0.01	0.02	0.00	0.00	0.01	0.02	B200789
QRF	TOTAL	TRITIUM	250000 - 260000	32/32	100.0	PCI/L	-150.00	330.00	129.4	126.8	383.0	560.2	B400289
QRF	TOTAL	URANIUM-233,-234	0.1 - 0.1	44/44	100.0	PCI/G	0.2	1.99	1	0	1	2	B200589
QRF	TOTAL	URANIUM-235	0.1 - 0.1	44/44	100.0	PCI/G	0	0.1	0.0	0.0	0.1	0.1	B400289
QRF	TOTAL	URANIUM-238	0.1 - 0.1	44/44	100.0	PCI/G	0.2	1.1	1	0	1	1	B400389

Table B-4b
Analytes Not Detected in Subsurface Geologic Materials in Background Boreholes

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
Metals					
QRF (RFA)	TOTAL	CESIUM	200 - 484	0/57	0.0

Table B-5a
Summary Statistics for UHSU Ground Water in IHSS 168 and Downgradient Wells

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det	Units	Min Result	Max Detect	Mean Result	Std Dev	Max Locn
Metals											
UHSU	TOTAL	ALUMINUM	18 - 200	78/81	96.3	UG/L	52.20	208000.00	7810	23212	5086
UHSU	TOTAL	ANTIMONY	17 - 60	8/80	10.0	UG/L	7	30.7	11	5	B111189
UHSU	TOTAL	ARSENIC	0.70 - 10	17/78	21.8	UG/L	0.70	5.9	1	1	B410689
UHSU	TOTAL	BARIUM	2.1 - 200	77/81	95.1	UG/L	44.80	1040.00	100	119	5086
UHSU	TOTAL	BERYLLIUM	0.80 - 5	5/79	6.3	UG/L	0.80	16.40	1	2	5086
UHSU	TOTAL	CADMIUM	2 - 5	7/80	8.8	UG/L	1.00	3.50	1	1	B111189
UHSU	TOTAL	CALCIUM	17.4 - 5000	81/81	100.0	UG/L	10500	62200.00	25609	11394	5086
UHSU	TOTAL	CESIUM	500 - 1000	4/71	5.6	UG/L	23.00	80.00	117	128	B110889
UHSU	TOTAL	CHROMIUM	2.4 - 10	33/80	41.3	UG/L	2	208.00	10	24	5086
UHSU	TOTAL	COBALT	3.6 - 50	20/81	24.7	UG/L	2.00	68.00	4	8	5086
UHSU	TOTAL	COPPER	2 - 25	33/81	40.7	UG/L	1.00	191.00	9	21	5086
UHSU	TOTAL	IRON	4.7 - 100	79/81	97.5	UG/L	30.10	198000.00	7979	22169	5086
UHSU	TOTAL	LEAD	1.0 - 5	62/80	77.5	UG/L	1.00	59.80	4	7	5086
UHSU	TOTAL	LITHIUM	2 - 100	34/81	42.0	UG/L	2.80	134.00	6	15	5086
UHSU	TOTAL	MAGNESIUM	29.6 - 5000	79/81	97.5	UG/L	2110	37000.00	6063	4266	5086
UHSU	TOTAL	MANGANESE	1 - 15	78/81	96.3	UG/L	2	2710.00	257	415	5086
UHSU	TOTAL	MERCURY	0.20 - 0.20	6/81	7.4	UG/L	0.20	0.37	0.1	0.0	4986
UHSU	TOTAL	MOLYBDENUM	7 - 200	6/81	7.4	UG/L	2.00	8.20	3	2	B410589
UHSU	TOTAL	NICKEL	11 - 40	36/81	44.4	UG/L	2.00	155.00	11	18	5086
UHSU	TOTAL	POTASSIUM	776 - 5000	65/81	80.2	UG/L	518.00	25200.00	1739	2928	5086
UHSU	TOTAL	SELENIUM	1.1 - 5	11/80	13.8	UG/L	1	1.5	1	0	B410589
UHSU	TOTAL	SILVER	2.6 - 10	5/81	6.2	UG/L	2.00	9.40	2	1	B111189
UHSU	TOTAL	SODIUM	28.3 - 5000	81/81	100.0	UG/L	9570	25000	14440	3509	46392
UHSU	TOTAL	STRONTIUM	0.80 - 200	76/80	95.0	UG/L	55.10	269	144	63	B410789
UHSU	TOTAL	THALLIUM	1.7 - 10	1/81	1.2	UG/L	1	1.00	1	0	B111189
UHSU	TOTAL	TIN	18 - 200	8/80	10.0	UG/L	10.00	48.20	12	9	B111189
UHSU	TOTAL	VANADIUM	3 - 50	44/81	54.3	UG/L	2.00	349.00	15	40	5086
UHSU	TOTAL	ZINC	2.1 - 20	46/81	56.8	UG/L	1.30	405.00	26	46	5086
Radionuclides											
UHSU	TOTAL	AMERICIUM-241	0.000 - 0.038	185/185	100.0	PCI/L	-0.004	0.191	0.006	0.018	B410689
UHSU	TOTAL	GROSS ALPHA	0 - 30	15/15	100.0	PCI/L	0	300	50	91	51094
UHSU	TOTAL	GROSS BETA	0 - 20	15/15	100.0	PCI/L	-0.536	220	37	64	51094
UHSU	TOTAL	PLUTONIUM-239/240	0 - 0.04	187/187	100.0	PCI/L	-0.019	0.2541	0.003	0.019	5086
UHSU	TOTAL	TRITIUM	0 - 850	193/193	100.0	PCI/L	-200	1535	126	185	B111189
UHSU	TOTAL	URANIUM-233,-234	0 - 0.6	16/16	100.0	PCI/L	0.2412	12	3	3	51494
UHSU	TOTAL	URANIUM-235	0 - 0.6	16/16	100.0	PCI/L	-0.0118	0.49	0.17	0.17	51094
UHSU	TOTAL	URANIUM-238	0 - 0.6	16/16	100.0	PCI/L	0	12	3	4	51494
Semivolatile Organic Compounds											
UHSU	TOTAL	BIS(2-ETHYLHEXYL)PHTHALATE	10.0000 - 10.0000	3/9	33.3	UG/L	9	26	8	7	51294
UHSU	TOTAL	DIETHYL PHTHALATE	9.7 - 10.0000	1/9	11.1	UG/L	10	26	7	7	46292

Table B-5a
Summary Statistics for UHSU Ground Water in IHSS 168 and Downgradient Wells

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det	Units	Min Result	Max Detect	Mean Result	Std Dev	Max Locn
Volatile Organic Compounds											
UHSU	TOTAL	2-BUTANONE	10 - 10	2/96	2.1	UG/L	10	19	5	2	B410689
UHSU	TOTAL	ACETONE	10 - 10	10/135	7.4	UG/L	1	31	5	3	B410789
UHSU	TOTAL	BENZENE	0.1 - 10	4/203	2.0	UG/L	0.1	7	2	1	B411389
UHSU	TOTAL	CARBON DISULFIDE	5 - 10	1/142	0.7	UG/L	3	3	3	0	B411289
UHSU	TOTAL	CARBON TETRACHLORIDE	0.1 - 10	1/204	0.5	UG/L	0.1	2	2	1	4986
UHSU	TOTAL	CHLOROFORM	0.1 - 10	10/203	4.9	UG/L	0.1	3	2	1	46392
UHSU	TOTAL	ETHYLBENZENE	0.1 - 10	1/204	0.5	UG/L	0.1	2	2	1	B110889
UHSU	TOTAL	HEXACHLOROBUTADIENE	0.2000 - 0.5	1/60	1.7	UG/L	0.1	0.1	0.1	0.0	46392
UHSU	TOTAL	METHYLENE CHLORIDE	0.1 - 10	26/203	12.8	UG/L	0.1	13	2	2	4986
UHSU	TOTAL	TETRACHLOROETHENE	0.1 - 10	6/204	2.9	UG/L	0.1	2	2	1	4986
UHSU	TOTAL	TOLUENE	0.1 - 10	5/204	2.5	UG/L	0.1	3	2	1	B110889
UHSU	TOTAL	TOTAL XYLENES	0.5 - 10	1/145	0.7	UG/L	0.5	10	3	1	B110889
UHSU	TOTAL	TRICHLOROETHENE	0.1 - 10	2/204	1.0	UG/L	0.1	1	2	1	B110989
Other Parameters											
UHSU	TOTAL	CYANIDE	0.02 - 20000	9/192	4.7	UG/L	0.02	49.000	113	1017	B410689
UHSU	TOTAL	NITRATE/NITRITE	20.00 - 5000	203/209	97.1	UG/L	20.00	9800.0	1568	1604	50794

Table B-5b
Analytes Not Detected in UHSU Ground Water in IHSS 168 and Downgradient Wells

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
Semivolatile Organic Compounds					
UHSU	TOTAL	1,2,4-TRICHLOROBENZENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	1,2-DICHLOROBENZENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	1,3-DICHLOROBENZENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	1,4-DICHLOROBENZENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	2,4,5-TRICHLOROPHENOL	48 - 50.0000	0/9	0.0
UHSU	TOTAL	2,4,6-TRICHLOROPHENOL	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	2,4-DICHLOROPHENOL	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	2,4-DIMETHYLPHENOL	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	2,4-DINITROPHENOL	48 - 50.0000	0/9	0.0
UHSU	TOTAL	2,4-DINITROTOLUENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	2,6-DINITROTOLUENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	2-CHLORONAPHTHALENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	2-CHLOROPHENOL	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	2-METHYLNAPHTHALENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	2-METHYLPHENOL	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	2-NITROANILINE	48 - 50.0000	0/9	0.0
UHSU	TOTAL	2-NITROPHENOL	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	3,3'-DICHLOROBENZIDINE	19 - 20.0000	0/9	0.0
UHSU	TOTAL	3-NITROANILINE	48 - 50.0000	0/9	0.0
UHSU	TOTAL	4,6-DINITRO-2-METHYLPHENOL	48 - 50.0000	0/9	0.0
UHSU	TOTAL	4-CHLORO-3-METHYLPHENOL	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	4-CHLOROANILINE	10.0000 - 10.0000	0/7	0.0
UHSU	TOTAL	4-CHLOROPHENYL PHENYL ETHER	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	4-METHYLPHENOL	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	4-NITROANILINE	48 - 50.0000	0/9	0.0
UHSU	TOTAL	4-NITROPHENOL	48 - 50.0000	0/9	0.0
UHSU	TOTAL	ACENAPHTHENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	ACENAPHTHYLENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	ANTHRACENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	BENZO(a)ANTHRACENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	BENZO(a)PYRENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	BENZO(b)FLUORANTHENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	BENZO(ghi)PERYLENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	BENZO(k)FLUORANTHENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	BENZOIC ACID	48 - 50.0000	0/9	0.0
UHSU	TOTAL	BENZYL ALCOHOL	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	BIS(2-CHLOROETHOXY)METHANE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	BIS(2-CHLOROETHYL)ETHER	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	BIS(2-CHLOROISOPROPYL)ETHER	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	BUTYL BENZYL PHTHALATE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	CHRYSENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	DI-n-BUTYL PHTHALATE	10.0000 - 10.0000	0/9	0.0

Table B-5b
Analytes Not Detected in UHSU Ground Water in IHSS 168 and Downgradient Wells

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
UHSU	TOTAL	DI-n-OCTYL PHTHALATE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	DIBENZO(a,h)ANTHRACENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	DIBENZOFURAN	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	DIMETHYL PHTHALATE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	FLUORANTHENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	FLUORENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	HEXACHLOROBENZENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	HEXACHLOROBUTADIENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	HEXACHLOROCYCLOPENTADIENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	HEXACHLOROETHANE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	INDENO(1,2,3-cd)PYRENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	ISOPHORONE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	N-NITROSO-DI-n-PROPYLAMINE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	N-NITROSODIPHENYLAMINE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	NAPHTHALENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	NITROBENZENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	PENTACHLOROPHENOL	48 - 50.0000	0/9	0.0
UHSU	TOTAL	PHENANTHRENE	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	PHENOL	10.0000 - 10.0000	0/9	0.0
UHSU	TOTAL	PYRENE	10.0000 - 10.0000	0/9	0.0
Volatile Organic Compounds					
UHSU	TOTAL	1,1,1-TRICHLOROETHANE	0.1 - 10	0/204	0.0
UHSU	TOTAL	1,1,2,2-TETRACHLOROETHANE	0.2000 - 10	0/204	0.0
UHSU	TOTAL	1,1,2-TRICHLOROETHANE	0.3 - 10	0/204	0.0
UHSU	TOTAL	1,1-DICHLOROETHENE	0.1 - 10	0/204	0.0
UHSU	TOTAL	1,2,4-TRICHLOROBENZENE	0.2 - 0.5	0/60	0.0
UHSU	TOTAL	1,2-DICHLOROBENZENE	0.1 - 0.5	0/60	0.0
UHSU	TOTAL	1,2-DICHLOROETHENE	5 - 10	0/142	0.0
UHSU	TOTAL	1,2-DICHLOROPROPANE	0.1 - 10	0/204	0.0
UHSU	TOTAL	1,3-DICHLOROBENZENE	0.1 - 0.5	0/60	0.0
UHSU	TOTAL	1,4-DICHLOROBENZENE	0.2 - 0.5	0/60	0.0
UHSU	TOTAL	2-HEXANONE	10 - 10	0/137	0.0
UHSU	TOTAL	4-METHYL-2-PENTANONE	10 - 10	0/139	0.0
UHSU	TOTAL	BROMODICHLOROMETHANE	0.2000 - 10	0/204	0.0
UHSU	TOTAL	BROMOFORM	0.2 - 10	0/202	0.0
UHSU	TOTAL	BROMOMETHANE	0.1 - 10	0/202	0.0
UHSU	TOTAL	CHLOROBENZENE	0.1 - 10	0/204	0.0
UHSU	TOTAL	CHLOROETHANE	0.1 - 10	0/203	0.0
UHSU	TOTAL	CHLOROMETHANE	0.2 - 10	0/202	0.0
UHSU	TOTAL	CYANIDE	10 - 10	0/1	0.0
UHSU	TOTAL	DIBROMOCHLOROMETHANE	0.2000 - 10	0/204	0.0
UHSU	TOTAL	NAPHTHALENE	0.2000 - 0.5	0/59	0.0
UHSU	TOTAL	STYRENE	0.1 - 10	0/204	0.0

Table B-5b
Analytes Not Detected in UHSU Ground Water in IHSS 168 and Downgradient Wells

Geo Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
UHSU	TOTAL	VINYL ACETATE	10 - 10	0/131	0.0
UHSU	TOTAL	VINYL CHLORIDE	0.2000 - 10	0/204	0.0
UHSU	TOTAL	cis-1,3-DICHLOROPROPENE	0.1 - 10	0/198	0.0
UHSU	TOTAL	trans-1,2-DICHLOROETHENE	0.1 - 5.0000	0/61	0.0
UHSU	TOTAL	trans-1,3-DICHLOROPROPENE	0.3 - 10	0/197	0.0

Table B-6a
Summary Statistics for UHSU Ground Water in Background Wells

Hydro Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det	Units	Min Result	Max Detect	Mean Result	Std Dev	Mean+2Std	UTL99	Max Locn
Metals													
UHSU	TOTAL	ALUMINUM	18 - 200.0000	141/165	85.5	UG/L	18	63900.00	3210	7419	18047	25837	B200589
UHSU	TOTAL	ANTIMONY	17 - 60.0000	22/155	14.2	UG/L	7.00	86.60	13	10	32	42	B200589
UHSU	TOTAL	ARSENIC	0.70 - 10.0000	18/162	11.1	UG/L	0.70	3.00	1	0	2	2	B200589
UHSU	TOTAL	BARIUM	2.1 - 200.0000	135/165	81.8	UG/L	25.90	752.00	101	75	252	331	B200589
UHSU	TOTAL	BERYLLIUM	0.60 - 5.0000	7/165	4.2	UG/L	0.80	4.80	1	0	1	2	B200589
UHSU	TOTAL	CADMIUM	2 - 6.2	14/165	8.5	UG/L	1.00	8.7	1	1	3	4	B202589
UHSU	TOTAL	CALCIUM	17.4 - 5000.0000	165/165	100.0	UG/L	13400.00	186000.00	54916	30568	116053	148149	B201289
UHSU	TOTAL	CHROMIUM	2.0 - 10.0000	54/164	32.9	UG/L	2.00	729	11	57	125	185	B201189
UHSU	TOTAL	COBALT	2.7 - 50.0000	22/165	13.3	UG/L	2.00	39.40	3	3	9	13	B200589
UHSU	TOTAL	COPPER	2 - 25.0000	26/164	15.9	UG/L	1.00	105.00	6	10	27	37	B200589
UHSU	TOTAL	IRON	4.7 - 100.0000	146/165	88.5	UG/L	6.50	97000.00	3618	9221	22061	31743	B200589
UHSU	TOTAL	LEAD	0.80 - 5	96/164	58.5	UG/L	1.00	52.50	3	5	14	19	B200589
UHSU	TOTAL	LITHIUM	2.0 - 100.0000	113/165	68.5	UG/L	1.1	266.00	23	48	120	170	B201289
UHSU	TOTAL	MAGNESIUM	29.6 - 5000.0000	162/165	98.2	UG/L	2150.00	47900.00	10175	7652	25479	33514	B201289
UHSU	TOTAL	MANGANESE	1 - 15.0000	141/165	85.5	UG/L	1	1950.00	86	180	446	635	B200589
UHSU	TOTAL	MERCURY	0.2000 - 0.2000	4/165	2.4	UG/L	0.20	0.27	0.1	0.0	0.1	0.2	B200589
UHSU	TOTAL	MOLYBDENUM	3.5 - 200.0000	23/164	14.0	UG/L	2.00	80.50	4	7	17	24	B203489
UHSU	TOTAL	NICKEL	11 - 40.0000	34/162	21.0	UG/L	2.00	334	9	27	62	90	B201189
UHSU	TOTAL	POTASSIUM	674 - 5000.0000	121/165	73.3	UG/L	243.00	8370.00	1308	1139	3587	4783	B200589
UHSU	TOTAL	SELENIUM	1.4 - 5.0000	35/163	21.5	UG/L	1.00	456	7	40	86	127	B201189
UHSU	TOTAL	SILVER	2.1 - 10.0000	14/163	8.6	UG/L	2.00	3.30	2	1	3	4	B401989
UHSU	TOTAL	SODIUM	28.3 - 5000.0000	163/165	98.8	UG/L	4300	194000.00	29441	38577	106594	147100	B201289
UHSU	TOTAL	STRONTIUM	0.80 - 200.0000	145/161	90.1	UG/L	46.30	1770.00	308	264	835	1112	B201289
UHSU	TOTAL	THALLIUM	0.90 - 10.0000	14/165	8.5	UG/L	0.90	1.10	1	0	1	2	B102389
UHSU	TOTAL	TIN	9.4 - 200.0000	12/160	7.5	UG/L	9.4	35.5	12	8	28	36	B400289
UHSU	TOTAL	VANADIUM	3 - 50.0000	94/165	57.0	UG/L	2.00	167.00	9	18	45	63	B200589
UHSU	TOTAL	ZINC	1.7 - 20.0000	80/165	48.5	UG/L	4.20	498.00	31	49	130	182	B400489
Radionuclides													
UHSU	TOTAL	AMERICIUM-241	0.000 - 0.024	251/251	100.0	PCI/L	-0.00706	0.09698	0.01	0.01	0.03	0.04	B302989
UHSU	TOTAL	GROSS ALPHA	0 - 7.6	38/38	100.0	PCI/L	0.6	362	40	88	216	329	B205589
UHSU	TOTAL	GROSS BETA	0 - 7.8	32/32	100.0	PCI/L	-0.3	220	26	51	128	199	B205589
UHSU	TOTAL	PLUTONIUM-239/240	0.000 - 0.03317	264/264	100.0	PCI/L	-0.005	0.2237	0.004	0.017	0.039	0.058	B302989
UHSU	TOTAL	TRITIUM	0 - 780	316/316	100.0	PCI/L	-340	1447	98	165	427	600	B200789
UHSU	TOTAL	URANIUM-233,-234	0 - 0.59	40/40	100.0	PCI/L	0	164	14	38	89	136	B205589
UHSU	TOTAL	URANIUM-235	0 - 0.71	40/40	100.0	PCI/L	-0.01	7.74	0.6	1.7	4.0	6.1	B205589
UHSU	TOTAL	URANIUM-238	0 - 0.75	46/46	100.0	PCI/L	0	108	8	23	54	81	B205589
Volatile Organic Compounds													
UHSU	TOTAL	1,1,1-TRICHLOROETHANE	5 - 5	5/383	1.3	UG/L	2	8	3	0	3	3	5586
UHSU	TOTAL	1,1,2,2-TETRACHLOROETHAN	0.2 - 5	2/390	0.5	UG/L	1	130	3	6	16	23	B200589
UHSU	TOTAL	1,1-DICHLOROETHENE	0.05 - 5	2/391	0.5	UG/L	4	7	2	0	3	4	5586
UHSU	TOTAL	1,2-DICHLOROPROPANE	5 - 5	1/391	0.3	UG/L	1	1	2	0	3	3	B305389

Table B-6a
Summary Statistics for UHSU Ground Water in Background Wells

Hydro Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det	Units	Min Result	Max Detect	Mean Result	Std Dev	Mean+2Std	UTL99	Max Locn
UHSU	TOTAL	2-BUTANONE	5 - 10	1/245	0.4	UG/L	2	2	5	0	6	6	B203189
UHSU	TOTAL	2-HEXANONE	0.02 - 10	1/359	0.3	UG/L	3	3	5	1	6	7	B201289
UHSU	TOTAL	4-METHYL-2-PENTANONE	10 - 10	1/386	0.3	UG/L	3	3	5	0	5	5	B201289
UHSU	TOTAL	ACETONE	5 - 10	32/366	8.7	UG/L	1	43	6	5	15	20	B302089
UHSU	TOTAL	BENZENE	5 - 20	2/391	0.5	UG/L	0.2	0.2	3	1	4	5	B302089
UHSU	TOTAL	BROMOFORM	0.1 - 5	1/388	0.3	UG/L	2	2	2	0	3	3	B200689
UHSU	TOTAL	CARBON DISULFIDE	0.02 - 5	16/380	4.2	UG/L	0.7	31	3	2	7	9	B304889
UHSU	TOTAL	CARBON TETRACHLORIDE	5 - 10	6/380	1.6	UG/L	1	15	3	1	4	5	B400289
UHSU	TOTAL	CHLOROBENZENE	0.02 - 5	2/391	0.5	UG/L	2	2	2	0	3	3	B200789
UHSU	TOTAL	CHLOROFORM	5 - 5	6/391	1.5	UG/L	0.6	4	2	0	3	3	B202489
UHSU	TOTAL	METHYLENE CHLORIDE	0.1 - 5	28/387	7.2	UG/L	1	25	3	2	7	10	B201289
UHSU	TOTAL	TETRACHLOROETHENE	5 - 5	8/385	2.1	UG/L	0.9	42	3	2	7	9	B405489
UHSU	TOTAL	TOLUENE	5 - 5	7/385	1.8	UG/L	0.4	6	2	0	3	3	B400289
UHSU	TOTAL	TRICHLOROETHENE	5 - 5	22/385	5.7	UG/L	0.5	120	3	7	17	25	B305389
UHSU	TOTAL	cis-1,3-DICHLOROPROPENE	5 - 25	1/390	0.3	UG/L	3	3	3	1	5	6	B305389
Other Parameters													
UHSU	TOTAL	CYANIDE	0.0072 - 10000	11/290	3.8	UG/L	0.0072	17.7000	57	506	1069	1601	B102289
UHSU	TOTAL	NITRATE/NITRITE	0 - 5000	306/357	85.7	UG/L	20.00	12000	1080	1735	4551	6373	B201289

Table B-6b
Analytes Not Detected in UHSU Ground Water in Background Wells

Hydro Unit	Tot/Dis	Analyte	Det Lim Range	Freq Det	Percent Det
Metals					
UHSU	TOTAL	CESIUM	500 - 1000.0000	0/158	0.0
Volatile Organic Compounds					
UHSU	TOTAL	1,1,2-TRICHLOROETHANE	0.02 - 5	0/391	0.0
UHSU	TOTAL	1,2-DICHLOROETHENE	5 - 100	0/390	0.0
UHSU	TOTAL	BROMODICHLOROMETHANE	5 - 5	0/389	0.0
UHSU	TOTAL	BROMOMETHANE	10 - 10	0/368	0.0
UHSU	TOTAL	CHLOROETHANE	10 - 10	0/378	0.0
UHSU	TOTAL	CHLOROMETHANE	10 - 10	0/373	0.0
UHSU	TOTAL	DIBROMOCHLOROMETHANE	5 - 10	0/390	0.0
UHSU	TOTAL	ETHYLBENZENE	5 - 10	0/391	0.0
UHSU	TOTAL	STYRENE	5 - 10	0/385	0.0
UHSU	TOTAL	TOTAL XYLENES	5 - 5	0/373	0.0
UHSU	TOTAL	VINYL ACETATE	10 - 10	0/347	0.0
UHSU	TOTAL	VINYL CHLORIDE	10 - 10	0/384	0.0
UHSU	TOTAL	trans-1,2-DICHLOROETHENE	5 - 5	0/26	0.0
UHSU	TOTAL	trans-1,3-DICHLOROPROPENE	5 - 5	0/377	0.0

APPENDIX C

Background Comparison Summaries

Table C-1
West Spray Field (OU 11)
Background Comparison Summary for Surficial Soil (0 to 2 inches)

ANALYTE	N_B	N_S	DTF_B	DTF_S	P_SLIP	P_QUANT	P_GEHAN	P_T	SIGNIFICANT	$UTL_{99/99}$*	NGUTL	CANDIDATE PCOC
Metals												
ALUMINUM	20	53	100	100	1.00E+00	8.18E-01	9.93E-01	9.70E-01	N	25879	0	N
ANTIMONY	20	53	0	5.7	1.00E+00		5.00E-01		N	ND		(Y)
ARSENIC	20	53	100	100	1.91E-01	3.56E-01	6.90E-04	4.04E-04	Y	13	1	Y
BARIUM	20	53	100	100	1.00E+00	1.00E+00	1.00E+00	9.99E-01	N	532	0	N
BERYLLIUM	20	53	55	100	1.00E+00		9.59E-01		N	5	0	N
CADMIUM	18	53	33.3	52.8	1.00E+00		7.62E-01		N	5	0	N
CALCIUM	20	53	100	100	1.00E+00	1.00E+00	1.00E+00	1.00E+00	N	16659	0	N
CESIUM	20	52	55	0	1.00E+00		5.00E-01		N	598	0	N
CHROMIUM	20	53	100	100	7.26E-01	9.36E-01	9.99E-01	9.95E-01	N	28	0	N
COBALT	20	53	100	100	1.00E+00	9.84E-01	9.43E-01	9.18E-01	N	24	0	N
COPPER	20	53	100	100	7.26E-01	9.99E-01	7.96E-01	3.79E-01	N	30	1	Y
IRON	20	53	100	100	1.00E+00	1.00E+00	9.98E-01	9.90E-01	N	29052	0	N
LEAD	20	53	100	100	9.46E-02	1.47E-01	1.02E-02	8.04E-03	Y	62	4	Y
LITHIUM	20	53	100	100	7.26E-01	9.84E-01	9.94E-01	9.85E-01	N	22	0	N
MAGNESIUM	20	53	100	100	1.00E+00	1.00E+00	1.00E+00	1.00E+00	N	7718	0	N
MANGANESE	20	53	100	100	1.00E+00	9.36E-01	8.22E-01	8.76E-01	N	2100	0	N
MERCURY	18	53	0	0	1.00E+00				N	ND		N
MOLYBDENUM	20	53	5	20.8	1.00E+00		6.22E-01		N	23	0	N
NICKEL	20	53	95	100	7.26E-01		1.00E+00	1.00E+00	N	26	0	N
POTASSIUM	20	53	100	100	1.00E+00	1.00E+00	1.00E+00	1.00E+00	N	6190	0	N
SELENIUM	20	53	75	54.7	1.00E+00		9.94E-01		N	1.5	0	N
SILVER	20	53	0	1.9	1.00E+00		5.00E-01		N	ND		(Y)
SODIUM	20	53	55	100	1.00E+00		9.94E-01		N	1052	0	N
STRONTIUM	20	53	100	100	1.00E+00	1.00E+00	1.00E+00	9.99E-01	N	113	0	N
THALLIUM	20	53	30	43.4	1.00E+00		9.82E-01		N	0.6	0	N
TIN	20	53	40	32.1	1.00E+00		1.00E+00		N	70	0	N
VANADIUM	20	53	100	100	7.26E-01	9.08E-01	9.77E-01	9.15E-01	N	60	0	N
ZINC	20	53	100	100	1.00E+00	1.00E+00	1.00E+00	1.00E+00	N	99	0	N

Table C-1
West Spray Field (OU 11)
Background Comparison Summary for Surficial Soil (0 to 2 inches)

ANALYTE	N_B	N_S	DTF_B	DTF_S	P_SLIP	P_QUANT	P_GEHAN	P_T	SIGNIFICANT	$UTL_{99/99}$*	NGUTL	CANDIDATE PCOC
Radionuclides												
AMERICIUM-241	20	53	100	100	2.93E-04	1.83E-03	1.33E-05	1.50E-03	Y	0.058	5	Y
GROSS ALPHA	10		100		1.00E+00	1.00E+00	5.00E-01		N	43	0	N
GROSS BETA	10		100		1.00E+00	1.00E+00	5.00E-01		N	53	0	N
PLUTONIUM-239/240	23	53	100	100	2.62E-08	3.11E-04	5.02E-08	8.35E-03	Y	0.13	24	Y
URANIUM-233,-234	16	53	100	100	2.56E-12	1.10E-02	1.37E-09		Y	1.8	33	Y
URANIUM-235	16	53	100	100	7.82E-02	1.03E-01	4.49E-04	1.56E-03	Y	0.187	4	Y
URANIUM-238	16	53	100	100	1.07E-11	1.10E-02	1.25E-09		Y	2	20	Y
Other Parameters												
CYANIDE	0	53		0						NA		N
NITRATE/NITRITE	9	53	100	100	3.40E-04	1.01E-01	1.29E-04		Y	9.6	22	Y

* Metal and other parameter concentrations reported in milligram per kilogram; radionuclide activities reported in picocuries per gram

Definitions

N_B = Number of background samples
N_S = Number of site samples
DTF_B = Detection frequency in background samples
DTF_S = Detection frequency in site samples
P_SLIP = p-value, Slippage test
P_QUANT = p-value, Quantile test (performed only when the largest 20% of the combined background and site data are detects)
P_GEHAN = p-value, Gehan test
P_T = p-value, Student's t-test (performed only when data contained less than 20% nondetects and normality assumptions based on the Shapiro-Wilk test were satisfied)
[ ] Shading in formal statistical test columns indicates a significant difference between background and OU 11 data ($p \leq 0.05$)
SIGNIFICANT = Significant difference from background based on one or more of the formal statistical tests ($p \leq 0.05$)
$UTL_{99/99}$ = 99 percent upper tolerance limit of background data at the 99 percent confidence level
NGUTL = Number of site sample results > $UTL_{99/99}$
[ ] Shading in the NGUTL column indicates one or more exceedances of the $UTL_{99/99}$
NA = Analyte not included in background, $UTL_{99/99}$ not calculated
ND = Analyte not detected in background, $UTL_{99/99}$ not calculated
PCOC = Potential chemical of concern
(Y) = Analyte not detected or not included in background but was detected at OU 11, therefore analyte identified as a candidate PCOC

Table C-2
West Spray Field (OU 11)
Background Comparison Summary for Subsurface Geologic Material (Qrf, 0 to 12 feet)

ANALYTE	N_B	N_S	DTF_B	DTF_S	P_SLIP	P_QUANT	P_GEHAN	P_T	SIGNIFICANT	$UTL_{99/99}$*	NGUTL	CANDIDATE PCOC
Metals												
ALUMINUM	57	73	98.2	98.6	1.00E+00	1.00E+00	9.99E-01	9.95E-01	N	55484	0	N
ANTIMONY	46	73	17.4	1.4	1.00E+00		9.99E-01		N	20	0	N
ARSENIC	56	73	67.9	100	1.00E+00		2.42E-03		Y	21	0	Y
BARIUM	57	73	84.2	98.6	1.00E+00	9.97E-01	9.99E-01	9.84E-01	N	398	0	N
BERYLLIUM	57	71	82.5	98.6	1.00E+00	1.00E+00	1.00E+00	1.00E+00	N	18	0	N
CADMIUM	44	73	11.4	0	1.00E+00		9.99E-01		N	2	0	N
CALCIUM	57	73	98.2	98.6	1.00E+00	1.00E+00	1.00E+00	9.66E-01	N	69859	0	N
CESIUM	57	67	0	9	1.00E+00		5.00E-01		N	ND		(Y)
CHROMIUM	57	73	100	98.6	1.00E+00	3.47E-01	7.23E-01	8.63E-01	N	118	0	N
COBALT	57	73	31.6	98.6	1.00E+00		2.82E-01		N	27.4	1	Y
COPPER	57	73	94.7	98.6	1.00E+00	3.47E-01	6.87E-01	8.61E-01	N	60	0	N
IRON	57	73	100	98.6	1.00E+00	9.97E-01	9.76E-01	9.54E-01	N	65064	0	N
LEAD	56	73	100	100	1.00E+00	9.89E-01	6.48E-01	9.71E-01	N	30	0	N
LITHIUM	57	7	50.9	95.9	1.00E+00		1.00E+00		N	42	0	N
MAGNESIUM	57	73	93	98.6	1.00E+00	1.00E+00	1.00E+00	9.98E-01	N	15437	0	N
MANGANESE	57	73	100	98.6	1.00E+00	9.65E-01	6.23E-01	8.65E-01	N	1576	0	N
MERCURY	48	73	43.8	9.6	6.03E-01		1.00E+00		N	0.795	1	Y
MOLYBDENUM	57	73	56.1	47.9	1.00E+00		1.00E+00		N	43	0	N
NICKEL	54	73	90.7	95.9	1.00E+00	1.00E+00	1.00E+00	1.00E+00	N	104	0	N
POTASSIUM	56	73	57.1	87.7	1.00E+00	1.00E+00	1.00E+00		N	11360	0	N
SELENIUM	44	71	2.3	9.9	1.00E+00		4.72E-01		N	6	0	N
SILVER	50	73	28	1.4	1.00E+00		1.00E+00		N	21	0	N
SODIUM	57	73	12.3	100	1.00E+00		7.21E-01		N	1163	0	N
STRONTIUM	57	7	8.8	98.6	1.00E+00		8.29E-01		N	236	0	N
THALLIUM	41	7	7.3	6.8	1.00E+00		9.60E-01		N	6	0	N
TIN	56	73	17.9	21.9	1.00E+00		9.93E-01		N	147	0	N
VANADIUM	57	73	98.2	98.6	1.00E+00	9.97E-01	9.98E-01	9.79E-01	N	142	0	N
ZINC	56	73	100	91.8	1.00E+00	1.00E+00	1.00E+00	9.77E-01	N	226	0	N

Table C-2
West Spray Field (OU 11)
Background Comparison Summary for Subsurface Geologic Material (Qrf, 0 to 12 feet)

ANALYTE	N_B	N_S	DTF_B	DTF_S	P_SLIP	P_QUANT	P_GEHAN	P_T	SIGNIFICANT	$UTL_{99/99}$*	NGUTL	CANDIDATE PCOC
Radionuclides												
AMERICIUM-241	14	72	100	100	3.82E-03	2.72E-02	1.73E-05		Y	0.021	5	Y
GROSS ALPHA	32	4	100	100	1.00E+00	7.02E-01	5.20E-01	5.15E-01	N	49	0	N
GROSS BETA	32	5	100	100	1.00E+00	1.00E+00	9.59E-01	9.25E-01	N	45	0	N
PLUTONIUM-239/240	57	72	100	100	1.71E-01	1.90E-01	1.18E-04	1.06E-01	Y	0.016	6	Y
TRITIUM	32	54	100	100	1.13E-06	6.35E-05	2.22E-07	7.03E-05	Y	560.2	8	Y
URANIUM-233,-234	44	71	100	100	6.19E-03	5.56E-06	2.22E-15	0.00E+00	Y	1.66	24	Y
URANIUM-235	44	71	100	100	2.08E-03	3.91E-03	2.70E-11	8.94E-12	Y	0.105	13	Y
URANIUM-238	44	71	100	100	-4.44E-15	2.03E-07	0.00E+00	0.00E+00	Y	1.269	52	Y
Other Parameters												
CYANIDE	0	67		0						NA		N
NITRATE/NITRITE	0	37		91						NA		(Y)

* Metal and other parameter concentrations reported in microgram per liter; radionuclide activities reported in picocuries per liter

Definitions

N_B = Number of background samples
N_S = Number of site samples
DTF_B = Detection frequency in background samples
DTF_S = Detection frequency in site samples
P_SLIP = p-value, Slippage test
P_QUANT = p-value, Quantile test (performed only when the largest 20% of the combined background and site data are detects)
P_GEHAN = p-value, Gehan test
P_T = p-value, Student's t-test (performed only when data contained less than 20% nondetects and normality assumptions based on the Shapiro-Wilk test were satisfied)
[ ] Shading in formal statistical test columns indicates a significant difference between background and OU 11 data ($p \leq 0.05$)
SIGNIFICANT = Significant difference from background based on one or more of the formal statistical tests ($p \leq 0.05$)
$UTL_{99/99}$ = 99 percent upper tolerance limit of background data at the 99 percent confidence level
NGUTL = Number of site sample results > $UTL_{99/99}$
[ ] Shading in the NGUTL column indicates one or more exceedances of the $UTL_{99/99}$
NA = Analyte not included in background, $UTL_{99/99}$ not calculated
ND = Analyte not detected in background, $UTL_{99/99}$ not calculated
PCOC = Potential chemical of concern
(Y) = Analyte not detected or not included in background but was detected at OU 11, therefore analyte identified as a candidate PCOC

Table C-3
West Spray Field (OU 11)
Background Comparison Summary for UHSU Ground Water (Total Analytes)

ANALYTE	N_B	N_S	DTF_B	DTF_S	P_SLIP	P_QUANT	P_GEHAN	P_T	SIGNIFICANT	$UTL_{99/99}$*	NGUTL	CANDIDATE PCOC
Metals												
ALUMINUM	165	81	85.5	96.3	3.29E-01	4.66E-04	1.49E-07	4.26E-02	Y	25837	1	Y
ANTIMONY	155	80	14.2	10	1.00E+00		6.22E-01		N	42	0	N
ARSENIC	162	78	11.1	21.8	1.00E+00		8.39E-02		N	2	3	Y
BARIUM	165	81	81.8	95.1	3.29E-01		9.81E-01	5.37E-01	N	331	2	Y
BERYLLIUM	165	79	4.2	6.3	3.24E-01		1.54E-01		N	2	2	Y
CADMIUM	165	80	8.5	8.8	1.00E+00		8.07E-01		N	4	0	N
CALCIUM	165	81	100	100	1.00E+00	1.00E+00	1.00E+00	1.00E+00	N	148149	0	N
CESIUM	158	71	0	5.6	1.00E+00		1.12E-03		Y	ND		(Y)
CHROMIUM	164	80	32.9	41.3	1.00E+00		1.04E-01		N	185	1	Y
COBALT	165	81	13.3	24.7	3.29E-01		1.24E-02		Y	13	1	Y
COPPER	164	81	15.9	40.7	3.31E-01		7.65E-04		Y	37	1	Y
IRON	165	81	88.5	97.5	3.29E-01	4.66E-04	1.78E-07	4.63E-02	Y	31743	1	Y
LEAD	164	80	58.5	77.5	3.28E-01	3.38E-02	4.19E-02		Y	19	2	Y
LITHIUM	165	81	68.5	42	1.00E+00		1.00E+00		N	170	0	N
MAGNESIUM	165	81	98.2	97.5	1.00E+00	1.00E+00	1.00E+00	1.00E+00	N	33514	1	Y
MANGANESE	165	81	85.5	96.3	3.29E-01	9.11E-06	2.66E-08	2.97E-04	Y	635	9	Y
MERCURY	165	81	2.4	7.4	3.29E-01		3.30E-02		Y	0.2	6	Y
MOLYBDENUM	164	81	14	7.4	1.00E+00		8.48E-01		N	24	0	N
NICKEL	162	81	21	44.4	1.00E+00		3.77E-05		Y	90	1	Y
POTASSIUM	165	81	73.3	80.2	3.29E-01		1.34E-01		N	4783	4	Y
SELENIUM	163	80	21.5	13.8	1.00E+00		1.00E+00		N	127	0	N
SILVER	163	81	8.6	6.2	1.00E+00		5.78E-01		N	4	1	Y
SODIUM	165	81	98.8	100	1.00E+00	1.00E+00	8.75E-01	1.00E+00	N	147100	0	N
STRONTIUM	161	80	90.1	95	1.00E+00	1.00E+00	1.00E+00	1.00E+00	N	1112	0	N
THALLIUM	165	81	8.5	1.2	1.00E+00		9.79E-01		N	2	0	N
TIN	160	80	7.5	10	1.00E+00		4.74E-02		Y	36	3	Y
VANADIUM	165	81	57	54.3	3.29E-01		2.11E-02		Y	63	2	Y
ZINC	165	81	48.5	56.8	1.00E+00	9.80E-01	7.95E-01		N	182	1	Y

Table C-3
West Spray Field (OU 11)
Background Comparison Summary for UHSU Ground Water (Total Analytes)

ANALYTE	N_B	N_S	DTF_B	DTF_S	P_SLIP	P_QUANT	P_GEHAN	P_T	SIGNIFICANT	$UTL_{99/99}$*	NGUTL	CANDIDATE PCOC
Radionuclides												
AMERICIUM-241	251	185	100	100	1.79E-01	9.51E-01	9.79E-01	3.60E-01	N	0.04	4	Y
GROSS ALPHA	38	15	100	100	1.00E+00	3.75E-01	4.10E-01	3.58E-01	N	329	0	N
GROSS BETA	32	15	100	100	1.00E+00	3.97E-01	5.27E-01		N	199	1	Y
PLUTONIUM-239/240	264	187	100	100	4.15E-01	9.32E-01	9.57E-01	7.23E-01	N	0.058	1	Y
TRITIUM	316	193	100	100	3.79E-01	6.04E-01	5.41E-02	4.59E-02	Y	600	3	Y
URANIUM-233,-234	40	16	100	100	1.00E+00	7.42E-01	6.68E-01	8.54E-01	N	136	0	N
URANIUM-235	40	16	100	100	1.00E+00	7.42E-01	4.56E-01		N	6.1	0	N
URANIUM-238	46	16	100	100	1.00E+00	7.20E-01	5.54E-01		N	81	0	N
Other Parameters												
CYANIDE	290	192	3.8	4.7	1.00E+00		3.61E-02		Y	1601	0	Y
NITRATE/NITRITE	357	209	85.7	97.1	1.00E+00		5.56E-01	6.91E-01	N	6373	5	Y

* Metal and other parameter concentrations reported in microgram per liter; radionuclide activities reported in picocuries per liter

Definitions

N_B = Number of background samples

N_S = Number of site samples

DTF_B = Detection frequency in background samples

DTF_S = Detection frequency in site samples

P_SLIP = p-value, Slippage test

P_QUANT = p-value, Quantile test (performed only when the largest 20% of the combined background and site data are detects)

P_GEHAN = p-value, Gehan test

P_T = p-value, Student's t-test (performed only when data contained less than 20% nondetects and normality assumptions based on the Shapiro-Wilk test were satisfied)

[ ] Shading in formal statistical test columns indicates a significant difference between background and OU 11 data ($p \leq 0.05$)

SIGNIFICANT = Significant difference from background based on one or more of the formal statistical tests ($p \leq 0.05$)

$UTL_{99/99}$ = 99 percent upper tolerance limit of background data at the 99 percent confidence level

NGUTL = Number of site sample results > $UTL_{99/99}$

[ ] Shading in the NGUTL column indicates one or more exceedances of the $UTL_{99/99}$

NA = Analyte not included in background, $UTL_{99/99}$ not calculated

ND = Analyte not detected in background, $UTL_{99/99}$ not calculated

PCOC = Potential chemical of concern

(Y) = Analyte not detected or not included in background but was detected at OU 11, therefore analyte identified as a candidate PCOC

APPENDIX D

Use of Professional Judgment and Geochemical Analyses to Identify PCOCs

Appendix D
Use of Professional Judgment and Geochemical Analyses to Identify PCOCs

Introduction

The initial step in identification of PCOCs is to analyze the detections of chemicals at the site through inferential statistical methods. The chemicals identified through statistical tests as different from background were then subjected to professional review of the test results and review of the graphic presentations of the data. The professional judgment of the reviewer is required to consider additional factors such as the spatial and temporal distribution of analytes; historic information regarding past operations at the site; inter-element correlations; mass-balance calculations; and knowledge of the hydrology, geochemistry, and geology of the site. The rationale for the final list of PCOCs based on professional judgment is provided in the following section.

Methodology

In general, the method for identifying chemicals at OU 11 was to compare the concentrations of chemicals in media from the site to their concentrations in media from background locations. The *Background Geochemical Characterization Report* (DOE, 1993) characterizes ground water and subsurface geologic materials from unaffected areas. Background soils are currently described by a suite of soil samples collected from 18 locations within the Rock Creek drainage north of the Industrial Area. The inferential statistical methods described in *Statistical Methods for Site-to-Background Comparisons in Support of RFI/RI Investigations* (EG&G, 1994a) were used to compare the site and background data sets and to identify those chemicals present at significantly higher concentrations in OU 11 media than in the background media.

Following the background comparison tests, chemical data were also reviewed to describe the spatial and temporal distribution of the chemical at OU 11 and to assess whether or not the distributions are indicative of contamination associated with the source at OU 11. The potential for artifact due to false positives (contamination introduced in field or laboratory) and outlier values was also carefully evaluated. These methods are consistent with EPA- and CDPHE-approved guidance from DOE for the identification of PCOCs at Rocky Flats (EG&G, 1994a)

Professional judgment was applied to determine if a chemical should be identified as a PCOC when one or more of the following conditions existed:

1. Statistical tests identify differences in data sets

2. No pattern observed in the distribution (i.e., temporal, spatial) or detection of the chemical that could be related to sources on the site

3. Naturally occurring concentration variations, of similar magnitude, also documented in media from background areas

4. Well construction or sampling effects influence chemical concentrations (samples not representative)

5. False positives or high bias documented in analytical database

6. Lack of association with wastes generated and disposed at Rocky Flats site

Professional judgment was applied on a case-by-case basis for each analyte considered. Figures are located at the end of this appendix and are referenced in the text. Figures are in sequential order as referenced. The rationale used to identify chemicals as PCOCs for OU 11 is presented in the following sections. The PCOCs are listed in Table D-1.

D.1 Metals

Total Aluminum

Total aluminum was detected in 78 of 81 samples in OU 11 ground water, with one UTL exceedance. The mean concentration is 7810 µg/L with a minimum concentration of 52.2 µg/L and a maximum detection of 208,000 µg/L. Statistical comparisons reveal that the distribution of total aluminum in OU 11 ground water is significantly different than in background ground water. Total aluminum failed the Quantile, Gehan, and T-tests (Table C-3). In addition, one value (208,000 µg/L) exceeded the background UTL of 25,837 µg/L for total aluminum. Review of histograms and box-and-whisker plots of total aluminum in ground water reveal that the distributions of total aluminum in the background and OU 11 data sets are similar (Figures D-1 and D-2). It appears that the statistically significant difference is attributable to the presence of one anomalously high value in the OU 11 data set.

Detections of total aluminum in ground water are present throughout OU 11 (Figure D-3). Concentrations of total aluminum are generally well below the background UTL with the exception of one detection at well 5086. Review of total aluminum data from well 5086 indicates that the concentrations measured from the February 1992 sample are anomalous. No other concentrations approaching the same level (208,000 µg/L) have been measured in samples from well 5086 (Figure D-4). This sample also had an extremely high TSS content (1,900 µg/L). The TSS content is more than two orders of magnitude higher than typical TSS contents in samples from well 5086. Because of the high TSS content, this sample is not representative of ground water from the UHSU, and results from the sample should not be used to determine maximum concentrations in the UHSU. Removal of results for this nonrepresentative sample from the database would result in no UTL exceedances for total aluminum in OU 11 UHSU ground water.

Aluminum concentrations are elevated with respect to background only in the ground water media. If elevated aluminum concentrations in ground water were related to OU 11 spray operations, concentrations of total aluminum would be elevated in both surficial soils and subsurface geologic materials. However, the distributions of total aluminum in surficial soils and subsurface geologic materials do not fail any statistical tests when compared to their respective background data sets (Tables C-1 and C-2).

Total aluminum in ground water is not included in the PCOC list because there are no spatial or temporal patterns to the detection of elevated aluminum concentrations; the one UTL exceedance occurs in a nonrepresentative sample; and no other media in OU 11 have elevated concentrations of aluminum.

Antimony

Antimony was detected in three of 53 surficial soil samples (<6 percent) in the OU 11 area. All the detections were at the edge of the OU or downwind. No antimony detections were within spray areas. The detections ranged in value from 3 mg/kg to 3.5 mg/kg. The locations of these detections are shown in Figure D-5. Antimony was not detected in the background data set so the inferential statistical tests were not considered valid (100 percent nondetections). However, the range of detection limits for the background data set was 12 to 50 mg/kg. All the site detections were below the lowest detection limit for the background data.

The low concentrations of the three detected values, supplemented by a lack of spatial correlation with spray activities, do not support antimony as a site contaminant. Antimony is not included on the list of PCOCs.

Arsenic

The background UTL value of 13 mg/kg for arsenic was exceeded in only one of the 53 surficial soil samples at OU 11. The exceedance occurred at a value of 13.1 mg/kg. The locations of all samples and arsenic concentrations are shown in Figure D-6. The one UTL exceedance occurs at the southern end of spray area 2. Arsenic failed the Gehan and T-tests for surficial soils, indicating that the concentrations in OU 11 surficial soils are statistically different from the concentrations in background. However, a DOE map of arsenic occurrences in soils and sediments sitewide supports a conclusion that the OU 11 detections are representative of the normal range of occurrences. The box-and-whisker plot (Figure D-7) graphically illustrates the background versus site comparison. In conclusion, the single UTL exceedance is not indicative of contamination.

In subsurface geologic materials, the distribution of arsenic is consistent with a natural source for the metal and not consistent with spray activities. There are low concentrations of arsenic in every sample, rather than high concentrations in sprayed areas. The Gehan test did identify arsenic as statistically different. However, the maximum arsenic detection in subsurface geologic materials at OU 11 was 9.8 mg/kg; in background subsurface geologic materials, the maximum was 41.8 mg/kg. The concentration of detections at the site does not support arsenic as a contaminant at OU 11, and arsenic is not on the PCOC list for subsurface soils.

Arsenic was detected at concentrations exceeding the UTL in 4 of 78 ground water samples (5 percent) at OU 11. The UTL is 2 µg/L and the four detections were at 2.1, 3.9, 4.0 and 5.9 µg/L. The locations of the four detections are shown in Figure D-8B. Arsenic failed the UTL exceedance test. However, the frequency histogram (Figure D-8) does not indicate significant differences between the site and the background data sets.

The arsenic detections show no temporal or spatial pattern. The four exceedances occurred in three different wells (4986, 46492, and B410689) at three different dates. There is no recurrence in wells and no association between detections and spray activities. The exceedances were in one well on the southern edge of OU 11 and in one well more than 1,000 feet down gradient of the OU. The other two exceedances were in well 4986, located in spray area 2. The time series plots (Figure D-9) visually support the lack of temporal consistency. All subsequent samples in well 4986 have been reported as nondetections. However, samples collected since February of 1993 are not directly comparable, as they are "dissolved" rather than "total" values. The dissolved values have been referred to because total values were not taken at this well since January 1993. Throughout OU 11, comparisons of total to dissolved metals values have shown a close correlation. Therefore, in the absence of total values, as recommended in Risk Assessment Guidance for Superfund (RAGS) (EPA, 1989), it appears reasonable to extrapolate total concentrations from the dissolved values.

Similar arsenic concentrations (2.7 to 5.4 µg/L) detected in well 5286, upgradient of OU 11, indicate a lack of correlation between spray activities and arsenic detections in ground water. Arsenic has not been included on the list of PCOCs because the random nature of the few detections does not indicate contamination.

Barium

Barium did not fail statistical tests for soils or geologic materials. Barium was detected in 77 of 81 ground water samples at the site. Two of these detections exceeded the background UTL value of 331 µg/L. The two detections were at well 5086 (1040 µg/L) and at well 46292 (378 µg/L). Figure D-10 shows the locations of these detections. Barium did not fail the inferential statistical tests but the exceedances did require additional consideration. The highest exceedance, in well 5086, is of questionable validity due to the elevated TSS levels of that particular 1992 sample. The time series plots (Figure D-11) graphically illustrate the spurious nature of the values. All subsequent detections in the well have been below the UTL value. The exceedance in well 46292 is also well illustrated in the time series plot. The first sample taken from the well, shortly after well installation in 1992, had the highest barium concentration. All subsequent detections have been below the UTL value.

There have been two isolated detections of barium above the UTL in ground water at OU 11 (2.7 percent). One detection was of questionable validity and the other has not recurred since an initial sample was collected in 1992. There is no evidence of site contamination and barium is not included on the PCOC list.

Beryllium

Beryllium did not fail statistical tests for soils or geologic materials. Beryllium was detected in only 5 of 79 ground water samples (6 percent) in OU 11, with 2 detections exceeding the UTL value. The mean concentration is 1 µg/L with a minimum concentration of 0.8 µg/L and a maximum detection of 16.4 µg/L. Statistical comparisons reveal that the distribution of total beryllium in OU 11 ground water is not significantly different than in background ground water. Beryllium failed the background UTL test (Table C-3). A review of histograms for beryllium in

ground water show that the distributions of beryllium in the background and OU 11 data sets are very similar (Figure D-12) excepting the presence of one anomalously high value in the OU 11 data set.

Elevated detections of beryllium in ground water occur sporadically in OU 11 (Figure D-13). Concentrations of beryllium are generally well below the background UTL with the exception of two detections at wells 5086 and 46492. Review of beryllium data from well 5086 indicates that the concentrations measured from the February 1992 sample are anomalous. No other detections of beryllium have been measured in samples from well 5086 as shown in the time series plot for beryllium in well 5086 (Figure D-14). The one sample from 5086 in which beryllium was detected above the background UTL had an extremely high TSS content (1,900 mg/L) (see discussion of total aluminum). Because of the high TSS content, this sample is not representative of ground water from the UHSU, and results from the sample should not be used. Subsequent results for the well support this conclusion.

The only other ground water sample exceeding the background UTL for beryllium was collected from well 46492 located downgradient of OU 11. The concentration in this sample (2.1 µg/L) exceeds the background UTL (2.0 µg/L) by a small amount, and there are no other elevated concentrations of beryllium near well 46492 (Figure D-13). In addition, well 46492 is not in an area formerly used for spray application of wastes. Thus, the spatial and temporal distribution of beryllium exceedances does not suggest that spray activities at OU 11 have elevated the beryllium concentrations in ground water.

Beryllium in ground water is not included in the PCOC list because distributions of beryllium concentrations in the background and OU 11 data sets are similar as evidenced by statistical comparisons; there are no spatial or temporal patterns to the detection of elevated beryllium concentrations; one of the two UTL exceedances occurs in a nonrepresentative sample; and other media in OU 11 do not have elevated concentrations of beryllium.

Cesium

Cesium was not associated with site history and was not detected in surficial soils. Cesium was detected in OU 11 boreholes in 6 of 67 samples (9 percent). The range of concentrations detected at OU 11 was 0.77 to 6.6 mg/kg. The locations of these detections are shown in Figure D-15. Only two of the detections are within spray areas; the other four detections are downgradient several hundred feet. Furthermore, the detections were not contiguous within each borehole.

The inferential statistical tests were inapplicable for cesium in subsurface soils because no detections of cesium were reported in the background data set. The background data set reported detection limits ranging from 200 to 484 mg/kg, whereas the maximum OU 11 detection was 6.6 mg/kg. The histogram (Figure D-16) illustrates discrepancies in detection limits, as well as the range of concentrations.

Due to the erratic nature of the detections and the extremely low concentrations present at the site, cesium was not deemed indicative of contamination and was not included on the PCOC list.

Cesium was detected in 4 of 71 ground water samples (<6 percent) at OU 11. The locations of the detections are as shown in Figure D-17.

The inferential statistical tests were not appropriate for cesium in ground water because the background data set did not detect cesium. The range of detection limits for the background set was 500 to 1,000 µg/L, while the maximum detection at OU 11 was 80 µg/L. There is no statistical indication that the OU 11 data set varies from the background data set. The frequency histogram (Figure D-18) depicts no significant differences.

Spatially the individual detections of cesium in ground water show no correlation with historic spray activities. Two of the detections are outside the OU to the north and south and the other two detections are downgradient. Cesium was detected once in well 5286, upgradient of the OU, as well. Temporally, detections of cesium have been isolated and never recurrent in one well. In addition, the cesium detections in OU 11 ground water are not correlated with the isolated detections in subsurface soils. No elevated detections for cesium in ground water have been reported since 1991.

The low concentrations and erratic nature of the cesium detections in ground water at OU 11 are not indicative of contamination and cesium has not been included on the PCOC list.

Chromium

Cobalt did not fail statistical tests for soils or geologic materials. Chromium was detected in 33 of 80 ground water samples at the site. One of the 80 samples (1.25 percent) contained a chromium concentration of 208 µg/L, slightly exceeding the background UTL value of 185 µg/L. The maximum concentration detected in the background ground water was 729 µg/L. The UTL exceedance was in well 5086, shown in Figure D-19. Chromium failed none of the statistical tests but the one UTL exceedance required further consideration. As illustrated in the time series plots (Figure D-20), chromium is detected consistently below 25 µg/L at the site, with the exception of the February 1992 value of 208 µg/L. This value is of questionable validity because it has not recurred in the well and the particular sample contained TSS values which were orders of magnitude greater than normal. The high TSS content indicates the sample is not representative of site ground water and should not be used to identify contamination. Chromium has not been detected at the site in consistent or elevated levels, and chromium has not been included on the PCOC list for any media.

Cobalt

Cobalt did not fail statistical tests for surficial soils. One detection of 73 analyses (1.4 percent) exceeded the background UTL for cobalt in subsurface geologic materials. The exceedance is shown on Figure D-21, borehole 50194. The background UTL value is 27 mg/kg, and the one OU 11 exceedance is 91.6 mg/kg.

The isolated detection exceeding the UTL was the only statistical difference in the data set. The histogram (Figure D-22) and the box-and-whisker plot (Figure D-23) do not display differences between the site and background data sets. Cobalt occurs at OU 11 in concentration distributions

that reflect the background data. The one UTL exceedance occurs on the northern edge of spray area 1.

Cobalt is not evident in the surficial soils, and its random distribution in the subsurface parallels the randomness of the background data set. The one UTL exceedance does not indicate contamination at the site but rather a spurious data point, and cobalt is not included on the PCOC list for subsurface soils.

Cobalt has been detected in ground water at OU 11 in 20 of 81 samples. Only one of these detections exceeded the background UTL of 13 µg/L. Figure D-24 shows the detection of cobalt in well 5086, just south of OU 11 spray area 1.

The histogram (Figure D-25) for cobalt does not illustrate any differences in the background and OU 11 data sets. Review of the time series plots (Figure D-26) for cobalt reveal a maximum, anomalous concentration of cobalt in one sample at one well. All cobalt detections through time have occurred at values less than 10 µg/L, except the February 1992 detection, exceeding 60 µg/L. This one value is associated with high TSS content in the water sample, rendering that particular sample of questionable value. The high TSS value is also associated with several other anomalously high single detections of metals, further compromising the validity of the sample. Subsequent sampling of the well has not detected either the high TSS or the high metal values. Removal of this invalid sample from the data set would result in no UTL exceedances for cobalt and cobalt has not been included on the PCOC list for ground water.

Copper

Copper was detected in all 53 of the surficial soils samples collected at OU 11 with only one value that exceeded the background UTL value of 30 mg/kg. A value of 88.1 mg/kg was detected in a sample just outside the southeast corner of OU 11. Figure D-27 shows the location of the elevated detection of copper at the site.

Copper did not fail any of the inferential statistical tests but was investigated because of the one value exceeding the UTL. The frequency histogram (Figure D-28) and box-and-whisker plot (Figure D-29) support the statistics results with the conclusion that the data sets are not significantly different but that there was one anomalous detection. If the detection was associated with spray history, it would be reasonable to expect to see an increasing concentration of copper in spray areas, or along the wind dispersion path. The distribution of copper concentrations instead reflects low-level, random values indicative of the background. The isolated occurrence of copper in surficial soils is not considered site contamination, but rather natural metal content. Copper has not been included on the PCOC list for surficial soils.

Copper was detected in ground water in 33 of 81 samples at OU 11. Only one of these detections, 191 µg/L in well 5086, exceeded the background UTL value of 37 µg/L. The locations of copper detections are shown on Figure D-30. Aside from the one exceedance, the copper detections in ground water at the site have ranged in concentration from 1 µg/L to 31 µg/L. Copper failed the Gehan test due to the one isolated exceedance. The exceedance in well 5086 occurred in 1992 and as the time series plots (Figure D-31) illustrate, has not recurred in the

well or in the OU since 1992. The elevated exceedance is of questionable validity because the TSS content of the sample was elevated by more than two orders of magnitude, and many other metals have elevated values in this one sample. The sample is not representative of ground water quality and should not be relied upon to identify contamination. The time series plots (Figure D-31) for the remainder of the copper detections reveal minor fluctuations below the UTL, which are similar to those for the background data set.

The only UTL exceedance of copper is in a sample of questionable validity. The one exceedance does not reflect site contamination, and copper has not been included on the PCOC list for any media.

Iron

Iron was detected in 79 of 81 samples in OU 11 UHSU ground water, but only one sample exceeded the UTL value. The mean concentration of the samples is 7979 µg/L, with a minimum result of 30.1 µg/L and maximum detection of 198,000 µg/L. Statistical comparisons reveal that the distribution of iron in OU 11 ground water is statistically different than in background ground water. Iron failed the Quantile, Gehan, and T-tests (Table C-3). However, review of histograms and box-and-whisker plots for total iron in ground water shows that the distributions of total iron in the background and OU 11 data sets are relatively similar (Figures D-32 and D-33).

Concentrations of total iron are generally well below the background UTL of 31,743 µg/L with the exception of one detection at well 5086 (Figure D-34). Review of iron data from well 5086 indicates that the concentrations measured from the February 1992 sample are anomalous. No other concentrations approaching the same level (198,000 µg/L) have been measured in samples from well 5086 as shown in the time series plot for iron in well 5086 (Figure D-35). The one sample from 5086 in which iron was detected had an extremely high TSS content (1,900 mg/L) (see discussion of total aluminum). Because of the high TSS content, this sample is not representative of ground water from the UHSU. Removal of results for this nonrepresentative sample from the database would result in no UTL exceedances for iron in OU 11 UHSU ground water. Subsequent samples from the same well have not exceeded the UTL value.

Iron in ground water is not included in the PCOC list because there are no spatial or temporal patterns to the elevated iron concentrations; one UTL exceedance occurs in a nonrepresentative sample; and no other media in OU 11 have elevated concentrations of iron.

Lead

Lead was detected in all 53 of the surficial soil samples at OU 11 but only four of the detections (7.6 percent) occurred at concentrations greater than the background UTL. The UTL value of 62 mg/kg was exceeded in four detections ranging from 62.8 to 82.9 mg/kg. One of the four exceedances occurred in an area east and south of all known spray activities (Figure D-36).

Lead failed the Gehan and T-tests due to the four UTL exceedances. The frequency of detections (100 percent) and the range of detections do not differ significantly from the background data set. The range in background is 26.6 mg/kg to 51 mg/kg and the range at OU 11 is 15.4 mg/kg to

82.9 mg/kg. The range of occurrences is also of interest in comparison to the residential screening level. The residential screening level is cited because there is no verified toxicity value for lead. The residential screening level of 400 mg/kg is more than an order of magnitude above the maximum concentration of lead found in OU 11 soils (82.9 mg/kg).

Finally, the pattern of distribution of lead is random and not associated with spray activities. The pattern shown is indicative of naturally occurring lead in soils. Lead has not been included on the PCOC list for soils because the detections at the OU reflect background conditions, not widespread site contamination.

Lead has been detected in ground water at OU 11 in 62 of 80 samples. The background UTL value of 19 µg/L was exceeded only twice (<3 percent), in well 46292 at a value of 27.4 µg/L and in well 5086 at a value of 60 µg/L. These detections occurred in 1992. All other detections have been below the UTL since 1990. The UTL exceedances are plotted on Figure D-37.

Lead failed the statistical tests (Gehan and Quantile) due to these two exceedances. Review of the frequency histogram (Figure D-38) does not reveal a data set that is significantly different from the background data set. The time series plots for lead (Figure D-39) illustrate the nature of the detections. The exceedance in well 46292 may be associated with well development. As the time series plot shows, the high concentration has not been repeated in the well since the first sampling round in September of 1992. In fact, lead values in the well have shown a steady decrease since the elevated value was detected.

The elevated detection in well 5086 is, as with other metals, associated with one sampling round that is of questionable quality. The February, 1992 sample from this well had an erratically high TSS value. As the time series plot illustrates, the detection is not representative of ground water quality, and the concentration has not been repeated since 1992. The subsequent detections in the well have been consistently close to 0 µg/L.

The two detections of lead that exceeded the UTL are not recurrent but rather associated with unique well problems in 1992. These two detections are not spatially associated with each other or with spray activities. Therefore, the lead detections are not considered to be indicative of site contamination, and lead has not been included on the PCOC list for ground water.

Magnesium

Magnesium was detected in 79 of 81 samples in OU 11 ground water, but only one detection (1.2 percent) exceeded the UTL value. The mean result at OU 11 is 6063 µg/L, with a minimum concentration of 2110 µg/L and maximum concentration of 37,000 µg/L. Statistical comparisons reveal that the distribution of magnesium in OU 11 ground water is not significantly different than the distribution in background ground water. Magnesium passed all of the inferential statistical tests (Table C-3), but one sample exceeded the UTL. Review of histograms for magnesium in ground water show that the distributions of total magnesium in the background and OU 11 data sets are very similar (Figures D-40 and D-41) aside from the one anomalously high value in the OU 11 data set.

Concentrations of magnesium are well below the background UTL (33,514 µg/L) with the exception of one detection at well 5086 (Figure D-42). Review of magnesium data from well 5086 indicates that the concentration measured from the February 1992 sample is anomalous. No other detections of magnesium have been measured in samples from well 5086. This is shown in the time series plot for magnesium in well 5086 (Figure D-43). The one sample from 5086 in which magnesium was detected had an extremely high TSS content (1,900 mg/L) (see discussion of total aluminum). Because of the high TSS content, this sample is not representative of ground water from the UHSU. Subsequent samples from this well have been below the UTL value. Removal of results for this nonrepresentative sample from the database would result in no UTL exceedances for total magnesium in OU 11 UHSU ground water.

Magnesium in ground water is not included in the PCOC list because distributions of magnesium concentrations in the background and OU 11 data sets are not statistically different as evidenced by the comparative statistical tests; there are no spatial or temporal patterns to the detection of elevated magnesium concentrations; the one UTL exceedance occurs in a nonrepresentative sample; and no other media in OU 11 have elevated concentrations of magnesium.

Manganese

Total manganese was detected in 78 of 81 samples in OU 11 ground water. Nine of these samples (11 percent) exceeded the background UTL value of 635 µg/L. The mean result is 257 µg/L with a minimum concentration of 2 µg/L and maximum detection of 2,710 µg/L. Statistical comparisons reveal that the distribution of total manganese in OU 11 ground water is significantly different than in background ground water. Total manganese failed the Quantile, Gehan, and T-tests (Table C-3), and nine samples exceeded the UTL value. Review of histograms for total manganese in ground water show that total manganese concentrations differ in OU 11 ground water (Figures D-44 and D-45). The detection of manganese at concentrations above background is problematic because manganese is not associated with past production, waste-generation, or waste-disposal activities at the Rocky Flats Plant.

The spatial distribution of manganese in ground water indicates that UTL exceedances of manganese are confined to three wells within IHSS 168 (Figure D-46) and confined to sampling events in 1993 or earlier. Samples from well B411289 contained higher-than-background concentrations of total and dissolved manganese since 1990, but no values have been reported exceeding the UTL since mid-1992. One sample from well 46292 exceeded the background UTL (635 µg/L) in 1992, but nine subsequent sampling events have been below the UTL. Concentrations of total manganese also exceeded the background UTL in a sample from well 5086. However, this sample had an extremely high TSS content and is not representative of ground water from the UHSU (see discussion of total aluminum). Samples from other wells within and downgradient of IHSS 168 have total manganese concentrations within the range for background ground water.

Other sitewide and OU-specific studies of ground-water chemistry provide (1) several possible mechanisms for manganese enrichment of ground water and (2) explanations for exceedances of background concentrations of manganese in ground water.

The recent Sitewide Groundwater Geochemistry Report (EG&G, 1995) includes a map of average manganese concentrations in UHSU ground water across the Rocky Flats site. The map shows areas of high and low concentration which are not consistently associated with areas of industrial or waste-disposal activities. The report describes the UHSU ground water as undersaturated with respect to manganese oxides and manganese hydroxides. Because UHSU ground water is undersaturated with respect to manganese-bearing mineral phases, ground water tends to dissolve those phases and receive manganese from the surrounding geologic materials (manganese enrichment) rather than precipitate them and lose manganese (depletion). Therefore, in the presence of manganese-bearing mineral phases, geochemical models predict that ground water will show an increase in manganese concentration through time due to the natural dissolution process.

Studies of the detection of manganese in ground water from OU 1 (DOE, 1994) indicate that natural variations in the manganese concentration of ground water may not have been detected by the background monitoring-well network. Small-scale "plumes" of manganese have been identified and attributed to natural variability. No such "plumes" were identified by the background characterization of UHSU ground water. Therefore, the background database may not fully represent the range of naturally occurring manganese concentrations in ground water from Rocky Flats.

Several lines of reasoning were presented at OU 2 to identify manganese as naturally occurring (EG&G, 1994b). First, manganese showed no distribution pattern related to sources of contamination at OU 2. Second, dissolution of manganese by ground water in the subsurface was proposed as a possible mechanism for natural manganese variation in ground water at OU 2.

Manganese concentrations are elevated with respect to background only in ground water. If elevated manganese concentrations in ground water were related to OU 11 spray operations, concentrations of total manganese would also be elevated in the pathways, surficial soils and subsurface geologic materials. However, the distributions of total manganese in surficial soils and subsurface geologic materials do not fail any statistical tests when compared to their respective background data sets (Tables C-1 and C-2). Thus, the detection of manganese in OU 11 ground water does not appear to be related to the historic spray activities at OU 11.

Total manganese in ground water is not included in the PCOC list because manganese is not associated with past production or waste-disposal at Rocky Flats; there is no consistent spatial pattern to the detection of elevated manganese concentrations; there is strong evidence that the elevated manganese concentrations are the result of natural processes; natural variations in the manganese concentration in ground water may not have been detected by the background monitoring-well network; and no other media in OU 11 have elevated concentrations of manganese.

Mercury

Mercury exceeded the background UTL in one of 73 borehole samples (1.3 percent) at OU 11. The single exceedance of 25 mg/kg is shown in Figure D-47. Mercury failed none of the inferential statistical tests but the one exceedance directed further consideration. The frequency

histogram (Figure D-48) does not indicate significant differences from the background data set and the single isolated detection does not indicate site contamination. The closest borings are within 10 feet of boring 51494 and did not contain elevated mercury nor did other samples within boring 51494. The exceedance appears to be a spurious data point not associated with spray activities and mercury is not included in the PCOC list for subsurface soils.

Mercury was detected in 6 of 81 ground water samples (7 percent) at the site. These detections exceeded the background UTL of 0.20 µg/L. The locations of the detections are shown in Figure D-49. Three of the detections are in known spray areas, and three of the detections are outside spray areas. The exceedances ranged in value from 0.21 µg/L to 0.37 µg/L. Mercury failed the Gehan test due to these UTL exceedances. The exceedances are only slightly greater than the UTL and the frequency histogram does not indicate a data set significantly different from background (Figure D-50). The highest mercury value was at well 4986. The time series plots (Figure D-51) illustrate levels of mercury consistently at the detection limits with the exception of the 0.37 µg/L (slightly above the detection limit) in well 4986 in January of 1993. The maximum detection in background was 0.27 µg/L, which also exceeds the UTL and is larger than five of the six OU 11 exceedances. The elevated detection in well 4986 was not detected in wells within 10 feet of this well, in borehole samples from the well or in surficial soil samples. It appears to be an anomalous exceedance. Total mercury has not been reported in this well since January 1993. However, dissolved mercury values have been reported through October 1994 and are all reported at the detection limit.

The isolated detections of mercury do not indicate ground water contamination at the site and mercury is not included in the PCOC list for ground water.

Total Nickel

Total nickel was detected in 36 of 81 samples in OU 11 ground water with one exceedance of the background UTL. The mean concentration is 11 µg/L with a minimum concentration of 2 µg/L and maximum detection of 155 µg/L. Statistical comparisons reveal that the distribution of total nickel in OU 11 ground water is significantly different than in background ground water. Total nickel failed the Gehan test (Table C-3) due to the one value exceeding the background UTL for total nickel. Review of histograms and box-and-whisker plots of total nickel in ground water reveal that the distributions of total nickel in the background and OU 11 data sets are similar and outliers are present in both data sets (Figure D-52).

Concentrations of total nickel are generally well below the background UTL (90 µg/L) with the exception of one detection at well 5086 (Figure D-53). Review of total nickel data from well 5086 indicates that the concentrations measured from the February 1992 sample are anomalous. No other concentrations approaching the same level (155 µg/L) have been measured in samples from well 5086 (Figure D-54). This sample also had an extremely high TSS content (1,900 mg/L) (see discussion of total aluminum). Because of the high TSS content, this sample is not representative of ground water from the UHSU, and results from the sample should not be used. Removal of results for this nonrepresentative sample from the database would result in no UTL exceedances for total nickel in OU 11 UHSU ground water.

Total nickel in ground water is not included in the PCOC list because there are no spatial or temporal patterns to the detection of elevated nickel concentrations; the one UTL exceedance occurs in a nonrepresentative sample; and no other media in OU 11 have elevated concentrations of nickel.

Potassium

Total potassium was detected in 65 of 81 samples in OU 11 ground water, with 4 exceedances of the background UTL (4.9 percent). The mean concentration is 739 µg/L with a minimum concentration of 518 µg/L and maximum detection of 25,200 µg/L. Statistical comparisons reveal that the distribution of total potassium in OU 11 ground water is not significantly different than in background ground water. Total potassium passed the Gehan test (Table C-3), but four samples exceeded the UTL of 4,783 µg/L. Review of histograms and box-and-whisker plots of total potassium in ground water reveal that the distributions of total potassium in the background and OU 11 data sets are similar (Figures D-55 and D-56).

The elevated concentrations of total potassium occur in samples from wells upgradient of, downgradient of, and within IHSS 168 (Figure D-57). Concentrations are not uniquely confined to concentrations of total potassium in OU 11 are generally well below the background UTL with the exception of one sample from well 5086, and three samples from well 46492. The sample from well 5086 is associated with high TSS and is not representative of UHSU ground water (see discussion of total aluminum). Elevated concentrations of total potassium also occur upgradient of OU 11 in wells 5286 and 46192. The spatial distribution of the elevated concentrations is not consistent with the areas of spray application (well 46492 is located more than 1000 feet downgradient of the nearest spray area). Therefore, the elevated levels of potassium in ground water do not appear to be related to historic waste disposal practices at OU 11.

Potassium concentrations are elevated with respect to background only in ground water. If elevated potassium concentrations in ground water were related to OU 11 spray operations, concentrations of total potassium would be elevated in surficial soils and subsurface geologic materials as well. However, the distributions of total potassium in surficial soils and subsurface geologic materials do not fail any statistical tests when compared to their respective background data sets (Tables C-1 and C-2). Thus, the detection of potassium in OU 11 ground water does not appear to be related to the historic spray activities at OU 11.

Total potassium in ground water is not included in the PCOC list because distributions of total potassium concentrations in the background and OU 11 data sets are similar as evidenced by comparative statistical tests; there is no spatial pattern to the detection of elevated potassium concentrations that is consistent with spray operations at OU 11; and no other media in OU 11 have elevated concentrations of potassium.

Silver

Silver was detected in one of 53 surficial soil samples (1.8 percent) at OU 11. The location of the detection is shown in Figure D-58. Silver was not detected in background soils samples, rendering the statistical tests invalid (using 100 percent nondetection results). However, the

single silver detection at OU 11 does not render the data sets statistically different. The frequency histogram (Figure D-59) illustrates the similarity of the data sets.

The detection at OU 11 was of 0.60 mg/kg. The detection limits of the background set ranged from 2 to 10 mg/kg. The silver detection does not correlate with areas of spray activity and is not indicative of soils contamination. Silver was not included on the PCOC list for soils.

Silver was detected in five of 81 ground water samples (6 percent) from OU 11. Only one of these detections exceeded the background UTL value of 4 µg/L. The location of the exceedance is shown in Figure D-60. The silver value reported in this detection was 9.4 µg/L.

The inferential statistical tests did not indicate any significant difference between background and the OU 11 site detections of silver. The frequency histogram (Figure D-61) supports a conclusion of no statistical differences. The one detection of silver which exceeds the UTL is located upgradient and removed from spray activities. Additionally, the detection has not been repeated in subsequent sampling events in well B111189 and has not been detected in neighboring wells or in soils media. The detection of silver appears to be an erratic detection not indicative of contamination and silver has not been included on the PCOC list for ground water.

Tin

Total tin was detected in only 8 of 80 samples in OU 11 ground water (10 percent), with three values (3.7 percent) exceeding the UTL value. The mean result is 12 µg/L with a minimum concentration of 10 µg/L and maximum detection of 48.2 µg/L. Statistical comparisons reveal that the distribution of total tin in OU 11 ground water is significantly different than in background ground water. Total tin failed the Gehan test (Table C-3). Review of histograms and box-and-whisker plots of total tin in ground water reveals that the median of the OU 11 data for total tin in ground water is lower than that of background (Figures D-62 and D-63).

The concentrations of total tin exceeded the background UTL of 36 µg/L in three samples from OU 11. The UTL exceedances occurred once in three separate wells (4886, B111189, and B411389) (Figure D-64). The magnitudes of the exceedances ranged from 1.1 to 1.3 times the background UTL value. Time series plots of tin concentrations at these wells (Figure D-65) show that total tin does not recur consistently at concentrations above the background UTL value or at detectable concentrations. No exceedance of the UTL has been reported in these wells since 1992. In addition, tin exceeds the background UTL in a total of three samples from wells 5186 and 5286 located upgradient of OU 11.

Total tin in UHSU ground water is not included in the PCOC list because it is not consistently detected at concentrations above the detection limit or the background UTL and no other media in OU 11 have elevated concentrations of tin.

Vanadium

Total vanadium was detected in 44 of 81 samples in OU 11 ground water with two exceedances of the UTL (2.4 percent). The mean result was 15 µg/L with a minimum concentration of 2 µg/L

and maximum concentration of 349 µg/L. Statistical comparisons reveal that the distribution of total vanadium in OU 11 ground water is significantly different than in background ground water. Total vanadium failed the Gehan test due to the two exceedances (Table C-3). Review of histograms and box-and-whisker plots of total vanadium in ground water reveals that the distribution of vanadium in site and background ground water are similar (Figures D-66 and D-67).

The concentrations of total vanadium exceeded the background UTL of 63 µg/L in two samples from two separate wells in OU 11 (5086 and 46292) (Figure D-68). The sample from well 5086 had anomalously high TSS content and is not representative of UHSU ground water (see discussion of total aluminum). The value is not recurring. Well 46292 is not in an historic spray application area suggesting this anomalously high value is not related to previous waste disposal activities. The high value does appear related to well development, however, as only the initial sample in 1992 contained elevated metals. The high value has not recurred in the well since 1992. Vanadium has been detected at concentrations exceeding the background UTL in one well upgradient of OU 11, in an area unimpacted by OU 11 (unless water flows up).

Total vanadium in UHSU ground water is not included in the PCOC list because it is not consistently detected at elevated concentrations within OU 11; there is no spatial or temporal pattern to the detection of elevated vanadium concentrations; and other media in OU 11 do not have elevated concentrations of vanadium.

Zinc

Total zinc was detected in 46 of 81 samples in OU 11 ground water with one exceedance of the UTL value (1.2 percent). The mean concentration was 26 µg/L with a minimum concentration of 1.3 µg/L and maximum detection of 405 µg/L. Statistical comparisons reveal that the distribution of total zinc in OU 11 ground water is not significantly different than in background ground water (Table C-3). Review of histograms and box-and-whisker plots for total zinc in ground water show that the distributions of total zinc in the background and OU 11 data sets are very similar excepting the presence of one anomalously high value in the OU 11 data set (Figures D-69 and D-70).

Review of total zinc data from well 5086 indicates that the concentrations measured from the February 1992 sample are anomalous. No other detections of zinc have been measured in samples from well 5086 as shown in the time series plot for zinc in well 5086 (Figure D-71). The one sample from 5086 in which zinc was detected had an extremely high TSS content (1,900 mg/L) (see discussion of total aluminum). Because of the high TSS content, this sample is not representative of ground water from the UHSU. Removal of results for this nonrepresentative sample from the database would result in no UTL exceedances for total zinc in OU 11 UHSU ground water.

Total zinc in ground water is not included in the PCOC list because distributions of total zinc concentrations in the background and OU 11 data sets are similar as evidenced by comparative statistical tests; there are no spatial or temporal patterns to the detection of elevated zinc

concentrations; the one UTL exceedance occurs in a nonrepresentative sample; and no other media in OU 11 have elevated concentrations of zinc.

D.2 Radionuclides

Plutonium-239/240, Americium-241

Plutonium and americium are presented together since americium is a decay product of plutonium. Plutonium and americium surficial soil concentrations were identified as greater than background by the Slippage, Quantile, Gehan, and T tests (Table C-1). Plutonium exceeded the UTL in 24 samples (45 percent), and americium exceeded the UTL in 5 samples (9 percent). Subsurface soil concentrations for plutonium were identified as greater than background by the Gehan test and six exceedances (8 percent) of the UTL. Subsurface soil concentrations for americium were identified as greater than background by the Slippage Quantile, and Gehan tests and five exceedances (7 percent) of the UTL (Table C-2). However, the histogram and box-and-whisker plot presented in Figures D-72 and D-73 show no significant difference in the distributions of activities between OU 11 and background geologic materials. Americium and plutonium are not identified as greater than background by the inferential statistical tests for ground water, but are present in samples at activities exceeding the background UTL values (Table C-3). Americium-241 exceeded the background UTL in four samples (2 percent) and plutonium exceeded the UTL in one sample (0.5 percent). In the case of americium-241, the exceedances ranged in magnitude from two to five times the background UTL value.

As presented in Figures D-74 and D-75, the concentrations of plutonium and americium in surficial soil are generally of the same order of magnitude, slightly elevated above background, and may roughly coincide with the areas used for spray application. The areas downgradient and outside of the spray areas also exhibit similar concentrations, indicating that windblown material from the east (e.g., plant fires and the 903 pad) may also be the source.

The maximum surficial soil concentrations of plutonium and americium shown on Figures D-74 and D-75 are 2.2 and 0.43 pCi/g, respectively. Both of these maximums occurred at the same location, SS102094, and are several times higher than the next highest reported values. The next highest reported values are not collocated, the concentration of Pu-239,240 is 0.21 pCi/g located in the spray area at SS103294 and the concentration of Am-241 is 0.096 pCi/g located at SS140394 located outside of the spray area. This indicates that the maximums for plutonium and americium are isolated events and are not representative of the data sets at OU 11.

An additional source of background data is the Background Soils Characterization Project (BSCP) (DOE, 1995). The reported range of Pu-239,240 is 0.026 to 0.1 pCi/g, and the range for Am-241 is 0.0095 to 0.036 pCi/g. Most of the OU 11 sample data lie near the upper end of these ranges, indicating a small difference between the sample data and background.

Plutonium and americium activities in subsurface geological materials occasionally exceed the background UTL (Figure D-76) value. The variation of activity with depth was examined for a pattern consistent with spray application and infiltration. Plutonium and americium tend to have low mobility and maximum activities are expected to occur at shallow depths near the

contaminant source, in this case the spray application areas. As shown in Figures D-76, D-76B, and D-77, plutonium activities vary randomly with depth and the maximum activities of the two radionuclides are not collocated, as expected if they originate from the same source material. The subsurface data for plutonium and americium are composites over 2-foot intervals. The resolution possible with these depth composites is insufficient to show detailed weathering with depth over the scale of several inches commonly observed. The UTL exceedances for plutonium and americium in the upper subsurface samples may be due to the surface component, due to contamination in the shallow subsurface soils, or due to a combination of both. Based on possible contamination at shallow depths, americium-241 and plutonium-239,240 were identified as subsurface PCOCs.

The sample results for Pu-239,240 in UHSU ground water are shown in Figure D-78. The values show no pattern of contamination. Similar results are shown for Am-241 in Figure D-79.

The maximum activity of plutonium-239,240 and one americium-241 UTL exceedance occurred in the same sample. The sample was collected from well 5086 and had a very high total suspended solids (TSS) content (1,900 mg/L). The TSS content is more than two orders of magnitude higher than typical TSS contents in samples from well 5086. Because of the high TSS content, this sample is not representative of ground water from the UHSU; the results from this sample should not be used to determine maximum concentrations in the UHSU. Plutonium-239,240 was not identified as a ground water PCOC because this questionable sample represented the only UTL exceedance from OU 11.

The maximum activity of americium-241 occurred in ground water from B410689. Two samples collected from B410689 in 1990 had total americium-241 activities that exceeded the background UTL value. This well is located along the south-eastern boundary of IHSS 168, more than 1,000 feet downgradient of the nearest spray area (Figure D-79). Americium-241 activities at this location have not been consistently elevated with respect to background since 1990 (Figure D-80). The average activity at B410689 is 0.022 pCi/L, approximately one half the background UTL (0.04 pCi/L). Given erratic low activities of americium-241 since 1990 at this location, low activities through time at other locations, and the absence of elevated plutonium (parent radionuclide to americium) activities in ground water, americium-241 was not identified as a ground water PCOC.

In summary, Pu-239,240 and Am-241 are found in low concentrations near the upper range of background in surficial soils. Pu-239,240 and Am-241 sample results for subsurface soil and ground water indicate possible contamination at shallow depths, but no contamination in subsurface or in ground water. Therefore, Pu-239,240 and Am-241 were identified as PCOCs in shallow soil, but were not identified as PCOCs for ground water.

Tritium

Based on the results of the Slippage, Quantile, Gehan, and T tests, tritium activities in the geologic materials from OU 11 are statistically different than in geologic materials from background locations (Table C-2). Eight of the 124 tritium measurements (6 percent) from geologic materials exceed the background UTL value of 560.2 pCi/g. Tritium activity appears to

be correlated with depth (Figure D-81); the highest activities occur in samples collected within 10 feet of the ground surface. Even though tritium has not been associated with liquid wastes pumped to the West Spray Field, the apparent correlation of tritium with depth supported including it as a subsurface soil PCOC.

Three of the 193 tritium measurements (1.5 percent) from OU 11 ground water exceed the background UTL value of 600 pCi/L (Table C-3). The three exceedances occur in ground water from three different monitor wells, B110889, B111189, and B410589 (Figure D-82), and their magnitudes range from 1.3 to 2.6 times the background UTL value. Given the poor precision (average difference for duplicate samples is 25 relative percent difference; EG&G, 1995) of tritium measurements at low activities, these exceedances may not be significant. Repeat sampling at these three locations demonstrates that the exceedances are also not recurrent through time.

High-precision analyses of tritium in ground water have been performed as part of a stable-isotopic study presented in the Groundwater Geochemistry Report (EG&G, 1995). The study included samples from UHSU monitoring wells located within OU 11. The average tritium content in ground water from monitoring wells in OU 11 ranged from less than 2.6 pCi/L to 137.8 pCi/L. The reproducibility (precision) of individual tritium measurements included in the study was ± 6.5 pCi/L. Based on these results and the lack of temporal patterns of tritium activity in ground water at OU 11, as shown in Figure D-83 tritium was not identified as a PCOC in ground water.

Based on the results of statistical tests and the decreasing concentrations with depth, tritium is identified as a subsurface soil PCOC. Tritium was not identified as a PCOC in ground water because the sample results are similar to background and there is no observable temporal pattern.

Uranium-233,234; Uranium-235; Uranium-238

Uranium surficial soil concentrations were identified as greater than background by the Slippage, Quantile, Gehan, and T tests, with results varying by isotope (Table C-1). Uranium exceeded the background UTL in 33 samples for U-233,234; 4 samples for U-235; and 20 samples for U-238. Subsurface soil concentrations for uranium were identified as greater than background by the Slippage, Quantile, Gehan, and T tests, and 13 to 52 exceedances of the UTL (Table C-2). Uranium in ground water is not identified as greater than background by the inferential statistical tests or any exceedances of the background UTL values.

As presented in Figures D-84, D-85, and D-86, the concentrations of the uranium isotopes in surficial soil are generally of the same order of magnitude, in the upper range of background, and appear to roughly coincide with the areas used for spray application. However, the areas down gradient of the spray areas also exhibit similar concentrations, indicating that the uranium may also be natural.

Recent background data from the BSCP (DOE, 1995) are compared to OU 11 data for the uranium isotopes in the table below. As presented in Figures D-84, D-85, and D-86, most of the OU 11 sample data are within the upper end of the BSCP sample data.

Uranium Detection Ranges

Uranium Isotope	BSCP Background Range (pCi/g)	OU 11 Sample Range (pCi/G)
U-233,234	0.6 - 3.1	1.3 - 4.3
U-235	0.11 - 0.34	0.013 - 0.3
U-238	0.74 - 2.6	1.4 - 4.5

Uranium isotopes are present at activities exceeding the UTL in samples of geologic materials from background areas. However, patterns of spatial distribution are not consistent with origination of the uranium from a spray source at the ground surface, indicating that the source may be natural.

Naturally occurring uranium-rich rocks are known to be present in the Rocky Flats Alluvium. The uranium used at the Rocky Flats Plant to make nuclear weapons parts was enriched or depleted in U-235. Through analysis of the isotopic ratios of environmental samples, uranium used at Rocky Flats may be distinguished from naturally occurring uranium.

Naturally occurring uranium is composed of three principal isotopes, U-238, U-235, and U-234, which are found in the proportions listed below. Of these, U-235 is the fissile material (capable of spontaneous chain reaction) used in nuclear reactors and nuclear weapons. However, U-235 occurs in such low proportions that it often requires enrichment in this isotope to be used in commercial reactors or nuclear weapons. The isotopic separation process used in the United States over the past few decades, gaseous diffusion, results in uranium enriched in both U-235 and U-234. The byproduct of the enrichment process is natural uranium that is depleted of the U-235 and U-234 isotopes. The percentages of each isotope by weight for natural, commercial, weapons, and depleted uranium are presented below for comparison.

Typical Isotopic Abundances by Weight

Isotope	Natural[1]	Commercial[1]	Weapons[2]	Depleted[1]
U-238	0.992739	0.9701	0.0532	0.9975
U-235	0.007204	0.0296	0.9324	0.0025
U-234	0.000057	0.0003	0.0101	0.000005

1 DOE, 1988

2 DOE, EIS 1990

Uranium has been used since the initial operation of the RFP to make weapons parts. Enriched and depleted uranium metal were used to make weapons parts, and depleted uranium was processed to make armor plates for M1A1 tanks (CDH, 1992). In addition, U-233, a man-made fissile isotope, was also used from the late 1950s to the early 1970s (CDH, 1992). The presence of uranium has been identified in the Solar Evaporation Ponds, and consequently may have been sprayed in OU 11. By comparing isotopic ratios of natural uranium and environmental samples, the presence of enriched uranium can be identified.

To compare isotopic ratios, the ratio of the number of atoms of each isotope is used. The ratio of U-234 to U-238 changes more dramatically with enrichment than the ratio of U-235 to U-238, therefore, the ratio of U-234 to U-238 is generally used in isotopic ratio analysis. If laboratory results are reported in percent weight, as in the table above, the isotopic ratio is calculated as follows.

$$\frac{N_1}{N_2} = \frac{\dfrac{(weight\ N_1)\,(Avagodro's\ Number)}{N_1\ atomic\ weight}}{\dfrac{(weight\ N_2)\,(Avagodro's\ Number)}{N_2\ atomic\ weight}}$$

Where

N_1	=	Number of atoms of first isotope (e.g., U-234)
N_2	=	Number of atoms of second isotope (e.g., U-238)
N_1 atomic weight	=	Atomic weight of first isotope (g/mole)
N_2 atomic weight	=	Atomic weight of second isotope g/mole)
Avagadro's Number	=	6.02E+23 atoms/mole

For the percentages presented above, the isotopic ratios of U-234 to U-238 are:

- natural (5.84E-05)
- commercial enriched approx. 3 percent (3.14E-04)
- weapons enriched approx. 93 percent (1.9E-01)
- depleted (5.09E-06).

The isotopic ratio spans approximately four orders of magnitude, depending on the degree of enrichment. Thus, the U-234:U-238 ratio is a sensitive indicator of enrichment.

If laboratory results are reported in activity units such as picocuries per gram (pCi/g), the isotopic ratio is calculated as follows.

$$\frac{N_1}{N_2} = \frac{(A_1)(A_1\ half\text{-}life)}{(A_2)(A_2\ half\text{-}life)}$$

Where

A_1 = Activity of first isotope (pCi/g)

A_1 half-life = Radioactive half-life of first isotope (years)

A_2 = Activity of second isotope (pCi/g)

A_2 half-life = Radioactive half-life of second isotope (years)

The half-lives for U-234 and U-238 are 2.45E+05 years and 4.47E+09 years respectively (DOE, 1988).

Due to the analysis technique, laboratory results report U-233 and U-234 together, as U-233,234. Therefore, a distinction between U-233 and U-234 cannot be made from this data. However, an increase in the isotopic ratio of U-233,234 to U-238 still indicates the presence of technologically enhanced uranium. It should be noted that enriched and depleted uranium could be present in amounts such that the isotopic ratio is similar to natural uranium, however, the probability is very low, since the isotopic ratio spans approximately four orders of magnitude.

Isotopic ratios for surficial soil and borehole data are presented in Figures D-87 and D-88, respectively. For comparison, isotopic ratios for natural, commercial, and depleted uranium are also presented. Weapons grade uranium was not presented as its isotopic ratio, 0.19, is off the scale. The error associated with each OU 11 environmental sample is shown as error bars for each result. As illustrated, only naturally occurring uranium is identified in OU 11 environmental samples. Therefore, uranium-233,234; uranium-235; and uranium-238 were not identified as surficial soil or subsurface soil PCOCs.

D.3 Semivolatiles

Bis(2-ethylhexyl) phthalate

Bis(2-ethylhexyl) phthalate, a common laboratory contaminant (EPA, 1989), was reported above the detection limit in a number of subsurface geologic material samples in the 0- to 12-foot depth interval (27 out of 67; 40 percent detection). The magnitude of concentrations above the detection limit range from 36 µg/kg (Well 50194 and 50794) to 140 µg/kg (Well 50894) with a mean concentration of 119 µg/kg. Bis(2-ethylhexyl) phthalate has been found above the detection limit at 10 of the 11 sampling locations and at many of the sampled depth intervals. Figure D-89 shows the detected concentrations of Bis(2-ethylhexyl) phthalate in subsurface geologic materials in the 0 to 12 foot depth interval. Well 51194 was the only location where Bis(2-ethylhexyl) phthalate was not detected in the subsurface geologic material. Bis(2-

ethylhexyl) phthalate was also detected in 51294, which is downgradient of IHSS 168 and outside the spraying area. The concentrations in 51294 range from 37 to 75 µg/kg in the 0 to 12 foot depth interval.

Bis(2-ethylhexyl) phthalate was detected in three out of nine UHSU ground water samples taken from the IHSS 168 and the downgradient sampling locations during one round of sampling. Only a subset of the ground water wells were sampled for semi-volatile chemicals (46292, 46392, and 46492 in September 1992; 50194, 50794, 50994, 51094, 51294, and 51494 in August 1994). No detections were reported in the three wells sampled in 1992 (42692, 46392, 46492) while detections were reported in three of the six wells sampled in 1994 (see Figure D-90). The highest detected concentration, 26 µg/L, was found away from spray areas in a downgradient well, 51294. The other two detections, both 9 µg/L and both estimated values below the detection limit (qualified with a J), were found in IHSS 168 (50994 and 51094) over 1300 feet from 51294 and 1100 feet from each other. Bis(2-ethylhexyl) phthalate was not detected in Well 51494 ground water which is located between 50994 and 51094 (Figure D-90).

Bis(2-ethylhexyl) phthalate is considered by EPA to be a common laboratory contaminant along with toluene, acetone, methylene chloride, 2-butanone, and other phthalate esters (EPA, 1989; EPA, 1992; EPA, 1988a; EPA, 1988b). Bis(2-ethylhexyl) phthalate is a plasticizer and can be introduced into analytical samples from bottles or other plastic equipment. Bis(2-ethylhexyl) phthalate can be found in analytical ground water samples at concentrations around 10 µg/L at varying degrees of detection. Concentrations of 50 µg/L or greater typically represent non-laboratory contamination (Gala, 1995). Analytical samples for soil media can typically contain Bis(2-ethylhexyl) phthalate levels up to 100 µg/kg, possibly 200 µg/kg, at varying degrees of detection due to laboratory or field contamination. The levels found in the subsurface geologic materials samples and ground water samples are within these typical ranges (see Table D-2 and D-3).

The levels of Bis(2-ethylhexyl) phthalate due to laboratory contamination can vary according to the size of the laboratory (Gala, 1995). Assessment of blank contamination is hindered by the few field blanks collected for ground water. Additionally, the laboratory reported few B-qualified data. Larger laboratories tend to prepare the method blank samples more carefully and since less levels of Bis(2-ethylhexyl) phthalate are found in method blanks the analytical samples are not qualified with a B (indicating blank contamination).

The assessment of the OU 11 analytical data, including the QA/QC information, showed that many common laboratory contaminants were detected in a great proportion of samples (see discussion below). This shows a trend of possible contaminant introduction into analytical samples in the laboratory or during the field investigation activities. Possible field-related sources include plastic sleeves and other plastic equipment used in the sampling of the well. The equipment rinsate samples for background ground water and OU 11 borehole samples showed low levels of Bis(2-ethylhexyl) phthalate. Bis(2-ethylhexyl) phthalate was detected in 7 out of 30 equipment rinsate samples that were collected during the sampling of the subsurface geologic materials boreholes. Detected concentration levels ranged from 2 to 36 µg/L with a mean of 6 µg/L. Bis(2-ethylhexyl) phthalate was detected in 11 percent of the RFETS-sitewide equipment

rinsates associated with the background samples (concentration = 2 µg/L). The presence in the equipment rinsate samples suggest Bis(2-ethylhexyl) phthalate may have been introduced into the samples during the field activities and the concentration levels are not representative of site conditions.

In the OU 11 subsurface geologic materials and ground water data sets only the common laboratory contaminants are detected frequently. On average the chemicals classified as common laboratory contaminants were detected in 14 percent of the samples, across both media. However, besides the common laboratory contaminants, very few organic chemicals were detected and only at a rate of 1.7 percent, nearly ten times lower than the common laboratory contaminants. Table D-2 presents a summary of the frequency of detection and the magnitude of concentrations for the common laboratory contaminants and the other organic chemicals that have been positively detected. Only chloroform (5 detections out of 116 samples) and trichloroethene (1/115) were detected in subsurface geologic materials samples. Benzene (4/203), carbon disulfide (1/142), carbon tetrachloride (1/204), chloroform (10/203), ethylbenzene (1/204), hexachlorobutadiene (1/60), tetrachloroethene (6/204), total xylenes (1/145), and trichloroethene (2/204) were positively detected in ground water samples. Table D-2 also shows that the common laboratory contaminants are found at low concentrations near the detection limit. Their frequent appearance in the environmental medium of OU 11 and in background and other OUs (for an example see Table D-3), indicates these chemicals have likely been introduced in field sampling or laboratory analysis activities.

Information from other data sets were reviewed to assess the detection and magnitude of Bis(2-ethylhexyl) phthalate in soil and ground water media. Table D-3 summarizes several RFETS-related Bis(2-ethylhexyl) phthalate data sets, including OU 11, RFETS-sitewide summaries, and OU 2. Bis(2-ethylhexyl) phthalate was detected in 9 out of 40 OU 2 surficial soil samples (23 percent detections) at a range of 49J to 110J µg/kg. Bis(2-ethylhexyl) phthalate was found in background surficial soil samples at levels similar to OU 11 levels (4 out of 18 samples, 22 percent detections, 35J to 140 µg/kg; DL = 330 µg/kg). The sitewide detection frequency of Bis(2-ethylhexyl) phthalate in ground water is 23 percent, similar to OU 11 and the range of concentrations (1 to 130 µg/L) bounds the OU 11 ground water concentrations of 9J to 26 µg/L. Similarity in the detection frequency and range of concentrations between OU 11, OU 2, overall sitewide, and background levels indicates the detection of Bis(2-ethylhexyl) phthalate in OU 11 is not likely due to environmental contamination unique to OU 11 (i.e., similar levels are found due to introduced contamination).

Based on the evidence presented in the previous paragraphs, Bis(2-ethylhexyl) phthalate is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

Di-n-butyl phthalate

Di-n-butyl phthalate, a common laboratory contaminant (EPA, 1989), was detected in 40 percent (27 of 67) of the subsurface geologic materials samples from 0 to 12 feet (see Figure D-91) at concentrations ranging from 39 to 520 µg/kg with a mean concentration of 216 µg/kg. Detection limits range from 10 to 330 µg/kg. If the levels in the subsurface geologic materials were

attributable to non-laboratory contamination, one would likely expect vertical migration to ground water and, therefore, expect to see some detections in ground water. Di-n-butyl phthalate (DBP) has been detected in samples from greater than 65 feet below ground surface; however, there are no detections of DBP in ground water.

EPA considers acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters to be common laboratory contaminants (EPA, 1989; EPA, 1992). In the OU 11 subsurface geologic materials and ground water data sets only the common laboratory contaminants are detected frequently. On average the chemicals classified as common laboratory contaminants were detected in 14 percent of the samples, across both media. However, besides the common laboratory contaminants, very few organic chemicals (11) were detected and only at a rate of 1.7 percent, nearly ten times lower than the common laboratory contaminants. Table D-2 presents a summary of the frequency of detection and the magnitude of concentrations for the common laboratory contaminants and the other organic chemicals that have been positively detected. Benzene (4/203), carbon disulfide (1/142), carbon tetrachloride (1/204), chloroform (10/203), ethylbenzene (1/204), hexachlorobutadiene (1/60), tetrachloroethene (6/204), total xylenes (1/145), and trichloroethene (2/204) were positively detected in ground water samples. Table D-2 also shows that the common laboratory contaminants are found at low concentrations near the detection limit. Their frequent appearance in the environmental medium of OU 11 and in background and other OUs (for an example see Table D-2), indicates these chemicals have likely been introduced in field sampling or laboratory analysis activities.

Based on the evidence presented in the previous paragraphs, di-n-butylphthalate is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

Diethyl phthalate

Diethyl phthalate, a common laboratory contaminant (EPA, 1989), was detected 2 times in 67 samples (3 percent detections) of geologic materials (Table D-2). Diethyl phthalate was detected twice in the 0 to 12 foot depth interval (in wells 50394 and 50994). More frequent detections would be expected in this interval, due to vertical migration processes, if surface application of sprayed wastes were the source. Chemicals that are infrequently detected (less than 1 in 20) may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal activities (EPA, 1989). The detected concentrations range from 190 to 240 µg/kg with a mean concentration of 166 µg/kg. Diethylphthalate was detected only once in ground water (26 µg/L) in Well 46292, however, samples were collected from the wells during only one sampling round (September 1992). A subset of the ground water wells were sampled for semi-volatile chemicals (46292, 46293, and 46492 in September 1992; 50194, 50794, 50994, 51094, 51294, and 51494 in August 1994). Overall, diethyl phthalate was detected in ground water in 1 of 9 samples (11 percent detections) in IHSS 168 and downgradient of IHSS 168. The low detection frequencies indicate that the reported detections of diethyl phthalate are not due to environmental contamination.

EPA considers acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters to be common laboratory contaminants (EPA, 1989; EPA, 1992). In the OU 11 subsurface geologic materials and ground water data sets only the common laboratory contaminants are detected

frequently. On average the chemicals classified as common laboratory contaminants were detected in 14 percent of the samples, across both media. However, besides the common laboratory contaminants, very few organic chemicals (11) were detected and only at a rate of 1.7 percent, nearly ten times lower than the common laboratory contaminants. Table D-2 presents a summary of the frequency of detection and the magnitude of concentrations for the common laboratory contaminants and the other organic chemicals that have been positively detected. Only chloroform (5 detections out of 116 samples) and trichloroethene (1/115) were detected in subsurface geologic materials samples. Benzene (4/203), carbon disulfide (1/142), carbon tetrachloride (1/204), chloroform (10/203), ethylbenzene (1/204), hexachlorobutadiene (1/60), tetrachloroethene (6/204), total xylenes (1/145), and trichloroethene (2/204) were positively detected in ground water samples. Table D-2 also shows that the common laboratory contaminants are found at low concentrations near the detection limit. Their frequent appearance in the environmental medium of OU 11 and in background and other OUs (for an example see Table D-3), indicates these chemicals have likely been introduced in field sampling or laboratory analysis activities.

Based on the above evidence comparing frequency of detections, diethyl phthalate is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

D.4 Volatiles

2-Butanone

2-Butanone was detected once out of 45 samples (2 percent detections) of subsurface geologic materials from 0 to 12 feet (4 µg/kg in Well 51494). If the analyte was present due to vertical migration of surface applied contamination, more frequent detections would be expected than were reported. 2-Butanone is also reported in the trip and field blanks sitewide (see page 2-5). 2-Butanone was detected in two ground water samples from 96 OU 11 samples (2 percent detections). The two samples were collected in 1990 from 2 different wells (18 µg/L in B411389 and 19 µg/L in B410689) (See Figure D-92). Repeated sampling and analysis of ground water from the same wells and adjacent wells during the 1991 to 1994 sampling activities has not confirmed the presence of 2-butanone in ground water (Figure D-93). The low detection frequency indicates the presence of 2-butanone is not likely due to environmental contamination but represents an artifact of the sampling and analysis methods.

EPA considers acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters to be common laboratory contaminants (EPA, 1989; EPA, 1992). In the OU 11 subsurface geologic materials and ground water data sets only the common laboratory contaminants are detected frequently. On average the chemicals classified as common laboratory contaminants were detected in 14 percent of the samples, across both media. However, besides the common laboratory contaminants, very few organic chemicals (11) were detected and only at a rate of 1.7 percent, nearly ten times lower than the common laboratory contaminants. Table D-2 presents a summary of the frequency of detection and the magnitude of concentrations for the common laboratory contaminants and the other organic chemicals that have been positively detected. Benzene (4/203), carbon disulfide (1/142), carbon tetrachloride (1/204), chloroform (10/203), ethylbenzene (1/204), hexachlorobutadiene (1/60), tetrachloroethene (6/204), total xylenes

(1/145), and trichloroethene (2/204) were positively detected in ground water samples. Table D-2 also shows that the common laboratory contaminants are found at low concentrations near the detection limit. Their frequent appearance in the environmental medium of OU 11 and in background and other OUs (for an example see page 2-5 and Table D-3), indicates these chemicals have likely been introduced in field sampling or laboratory analysis activities.

Based on the evidence presented in the previous paragraphs, 2-butanone is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

Acetone

Acetone, a common laboratory contaminant, was frequently detected in the geologic materials sampled (10 of 44 samples; 23 percent detections) (Figure D-94). The concentration levels ranged from 1 to 15 µg/kg with a mean concentration of 5 µg/kg (acetone has a reported detection limit of 10 µg/kg). All but one of the detectable results were reported as estimated concentrations below the detection limit (J-qualified results).

Acetone was detected in 10 of 135 samples (7 percent detections) of ground water from OU 11 (see Figure D-95). Chemicals that are infrequently detected (less than 1 in 20) may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal activities (EPA, 1989). Six of the results were accompanied by qualifiers indicating that acetone had also been detected in the lab blanks (B qualified, considered estimated concentrations); the other four detected results were reported at concentrations below the detection limit (J-qualified). Acetone has been detected in 1990 and 1991 and has not routinely occurred in any well, as shown in Figure D-96. It does not occur in consecutive quarters at wells that have been sampled repeatedly. When acetone has been detected, the time-series plots show no consistent pattern of detection through time. Additionally, acetone is detected in trip and field blanks of ground water samples sitewide (see page 2-5).

EPA considers acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters to be common laboratory contaminants (EPA, 1989; EPA, 1992). In the OU 11 subsurface geologic materials and ground water data sets only the common laboratory contaminants are detected frequently. On average the chemicals classified as common laboratory contaminants were detected in 14 percent of the samples, across both media. However, besides the common laboratory contaminants, very few organic chemicals (11) were detected and only at a rate of 1.7 percent, nearly ten times lower than the common laboratory contaminants. Table D-2 presents a summary of the frequency of detection and the magnitude of concentrations for the common laboratory contaminants and the other organic chemicals that have been positively detected. Benzene (4/203), carbon disulfide (1/142), carbon tetrachloride (1/204), chloroform (10/203), ethylbenzene (1/204), hexachlorobutadiene (1/60), tetrachloroethene (6/204), total xylenes (1/145), and trichloroethene (2/204) were positively detected in ground water samples. Table D-2 also shows that the common laboratory contaminants are found at low concentrations near the detection limit. Their frequent appearance in the environmental medium of OU 11 and in background and other OUs (for an example see Table D-3), indicates these chemicals have likely been introduced in field sampling or laboratory analysis activities.

Based on the evidence presented in the previous paragraphs, acetone is not retained as a PCOC in OU 11 subsurface geologic materials and ground water.

Benzene

Benzene was detected in 4 of a total of 203 (2 percent detection frequency) ground-water samples from the first quarter 1990 through the third quarter 1994. Two of the samples that showed detections were collected during 1990 from wells B411389 and B110989, shown on Figure D-97. These samples had reported benzene concentrations of 7 and 1 µg/L. These two wells are separated by a distance of 1500 feet. Benzene was not detected in well 4986, located between these two wells, indicating that there is no correlation between the two detections. Furthermore, benzene has not been detected in any of the samples from these two wells since 1990. Figure D-98 shows a time series plot of the data from wells B411389, B110989, and 4986. Because these detections occurred only once and have not been repeated since 1990, the reported concentrations of 7 and 1 µg/L are not considered indicative of environmental contamination.

Analysis of the two samples collected during September 1994 from wells 50394 and 51294 indicate benzene concentrations of 0.2 and 0.1 µg/L, respectively. These wells are separated by a distance of 2700 feet. Well 50394 is located within IHSS 168 in an area of historical spray activity, while well 51294 is located down gradient of IHSS 168 approximately 800 feet outside of any spray areas. Benzene was not detected in wells 411389 or 410789, located between wells 50394 and 51294. Therefore, there appears to be no correlation between the measurements of the two wells, nor any relation to the spray areas.

If the source of benzene in ground water was the infiltration of applied spray liquids, benzene would be expected to have left traces in the geologic materials. However, benzene was not detected in samples of geologic materials collected from the borehole drilled at 50394 or 51294. In addition, benzene was not detected in any other borehole at OU 11. This indicates it is unlikely that the source of benzene in ground water was due to spray field activities.

When a chemical has a low frequency of detection and the few detections have values close to the detection limit, it is less certain that measured values indicate environmental contamination. In this case, the detection limits for the benzene data set range from 0.1 to 10 µg/L, compared to the detections of 0.1 and 0.2. Because these detections are in the lower range of the detection limits and the detection frequency is only 2 percent, it is questionable that these detections indicate benzene contamination in ground water.

Benzene was also reported at a concentration of 0.2 µg/L in one of the background wells, B302089, located south of Woman creek. Although the detection of benzene in background wells is not a common detection, this does illustrate that when it occurs, the concentration may be expected to be low and within the range of detection limits.

These findings indicate that the detection of benzene at OU 11 is limited to four samples that show no recurrence, pattern, or trend in time; are spatially separate; and are not related to spray field activities. Furthermore, the detected values are within the range of detection limits, and a

similar value was detected in background wells. Therefore, benzene is not identified as a ground water PCOC for OU 11.

Carbon Disulfide

Carbon disulfide was not detected above the reported detection limit in 50 subsurface geologic material samples from 0 to 12 feet but was detected once in 142 ground water samples (1 percent detections). Carbon disulfide was detected only once in 13 samples from well B411289 (within IHSS 168) (see Figure D-99). Carbon disulfide was also detected once out of 14 samples from a well located upgradient of the IHSS. These are the only samples from OU 11 containing detectable concentrations of carbon disulfide. Repeated sampling and analysis of water from well B411289 has not verified the single 1992 detection of carbon disulfide (see Figure D-100). For this well, the time-series plot shows no consistent pattern of detection through time. The low detection frequency indicates the presence of carbon disulfide is not likely due to environmental contamination but represents an individual artifact of the sampling and analysis methods.

Based on the above evidence, carbon disulfide is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

Carbon Tetrachloride

Carbon tetrachloride was not detected above the reported detection limit in 50 subsurface geologic material samples from 0 to 12 feet. Carbon tetrachloride was detected only once in 204 samples of UHSU ground water from OU 11 (detected in a 1990 sample from well 4986) (see Figure D-101). Chemicals that are infrequently detected (less than 1 in 20) may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal activities (EPA, 1989). Carbon tetrachloride was also detected once out of 17 samples from a well located upgradient of the IHSS. The detection of carbon tetrachloride has not been verified by repeated sampling of either well. For wells where carbon tetrachloride has been detected, the time-series plots show no consistent pattern of detection through time. The low detection frequency indicates the presence of carbon tetrachloride is not likely due to environmental contamination but represents an artifact of the sampling and analysis methods.

Based on this evidence, carbon tetrachloride is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

Chloroform

Chloroform was not detected in ground water in IHSS 168. However, chloroform was detected down gradient of IHSS 168 in low concentrations in 10 of 10 samples from bedrock well 46392, shown in Figure D-102. Sample data from well 46392, along with data from other wells outside of IHSS 168, was examined to identify the likely source of chloroform.

Well 46392 was installed in July 1992 and is screened across weathered bedrock from 65 to 80 feet below the ground surface. As shown in Figure D-103, the concentration of chloroform in ground water from well 46392 has decreased through time from a high of 3 µg/L for a period of approximately seven months after well installation (July 1992 through February 1993) to 0.63

µg/L in October 1994. This trend suggests that the source responsible for these concentrations is undergoing depletion through dilution, volatilization, or other mechanisms.

Well 46392 was installed adjacent to two older abandoned wells, 0881 and 0981. Due to the close proximity, sample data from these older wells was reviewed for a possible history of chloroform detections in the area. RFEDS records for these wells indicate that chloroform was not detected in ground water from those wells during the period from August 1986 through May 1992. Figure D-104 presents the time series plots of the detection limits, which was typically 5 µg/L. The lack of detection from this earlier data indicates that either (1) there was no chloroform prior to May 1992, or (2) if present, chloroform was below 5 µg/L. This information, coupled with the information on decreasing concentrations in well 46392, suggests that the source was small and localized near well 46392.

Records of the installation and development of well 46392 were examined to identify possible sources of chloroform. Drilling records show that a thread compound ("King Stuff") and drilling mud were added to the borehole during drilling in June 1992. Product information supplied by the manufacturer of "King Stuff" does not indicate chloroform as a constituent, however, the detection limit for the product test was 0.5 µg/kg, two orders of magnitude higher than the sample data from OU 11. It should be noted that this product was deemed unsatisfactory after this particular application at well 46392 and was not used at the site again.

Analyses of two samples collected from drum cuttings recovered at well 46392 confirm the presence of chloroform in those materials. The cuttings are composed of geologic materials, ground water, drilling mud, and other products such as traces of thread compound. Samples of these cuttings were analyzed for chloroform, with results of 45 and 96 µg/kg. These results can be compared to the concentration in ground water to determine if the source of chloroform is solely from the chloroform in the ground water, or if the geologic materials or the drilling products are likely sources. To compare the concentration of chloroform in cuttings to the concentration in ground water, it is necessary to convert from µg/kg to µg/L. Conservatively assuming that the cuttings are saturated and have a density similar to water alone, 1.0 kg/L, the concentrations of chloroform in drill cuttings are converted to ground water values of approximately 45 and 96 µg/L. These values are more than an order of magnitude greater than the ground water concentration of 3 µg/L, indicating that a source other than ground water is likely. Chloroform was not detected in any geologic materials at OU 11, and it is unlikely that it is the source of chloroform for this well. Eliminating the ground water and the geologic materials as likely sources, it is likely that chloroform was inadvertently introduced in the drilling mud, thread compound, or other products.

There are only two other bedrock wells in the vicinity of well 46392, well 4886 and well 5286. As shown in Figure D-102 well 4886 is located in the middle of IHSS 168, approximately 1700 feet up gradient of well 46392. Chloroform has not been detected in this well. Well 5286 is up gradient of the spray activities in IHSS 168, approximately 3800 feet from well 46392. Chloroform was detected at 0.2 µg/L in 1 of 9 samples from well 5286. Time series plots of the data for wells 4886 and 5286 are presented in Figure D-105. The results from these two up

gradient wells indicate that there is no ground water source of chloroform contamination in IHSS 168.

Spray activities at IHSS 168 were considered as a possible source of chloroform. Chloroform is volatile and has a moderate water solubility of 0.5 percent. Moderate volatilization would be expected during spraying or while on the ground surface. Chloroform that may have reached ground water after volatilization is likely to have left traces in the moisture content of subsurface soils. However, soil samples at IHSS 168 did not indicate that chloroform was present, making it unlikely that spraying is the origin of the chloroform.

These findings indicate that the presence of chloroform east of OU 11 is confined to one location, that the source was small, and that concentrations are decreasing with time. The lack of detections in soil and ground water in IHSS 168 indicate that chloroform is unlikely to have any relation to West Spray Field activities and is instead an artifact of well construction. Therefore, chloroform is not identified as a ground water PCOC for OU 11.

Ethylbenzene

Ethylbenzene was detected (2 µg/L) in one ground water sample collected from B110889 in October 1992 (1 of 204 samples; <1 percent detections) and has not been detected in any other sample from that well. Ethylbenzene has never been detected in ground water from other monitoring wells in OU 11 (see Figure D-106). In well B110889, the time-series plot shows no consistent pattern of detection through time. Ethylbenzene was not detected in any of the 50 subsurface geologic materials samples. If the ethylbenzene was associated with spray activities, more frequent detections would be expected in the subsurface, due to vertical migration of surface applied contamination. Chemicals that are infrequently detected (less than 1 in 20) may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal activities (EPA, 1989). The low detection frequency indicates the presence of ethylbenzene is not likely due to environmental contamination but represents an artifact of the sampling and analysis methods.

Based on this evidence, ethylbenzene is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

Hexachlorobutadiene

Hexachlorobutadiene was detected in ground water from Well 46392 located downgradient of IHSS 168 (1 of 60 samples; 2 percent detections) (see Figure D-107). The reported concentration was below the detection limit (J-qualified). Hexachlorobutadiene has not been detected in any other sample from that well and has never been detected in ground water from other monitoring wells in OU 11. Chemicals that are infrequently detected (less than 1 in 20) may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal activities (EPA, 1989). Hexachlorobutadiene was not detected in any of the 67 subsurface geologic materials samples for OU 11. If elevated concentrations in ground water were related to OU 11 spraying operations, concentrations of hexachlorobutadiene would be elevated in subsurface geologic materials as well. The low detection frequency indicates the

presence of hexachlorobutadiene is not likely due to environmental contamination but represents an artifact of the sampling and analysis methods.

Based on this evidence, hexachlorobutadiene is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

Methylene Chloride

Methylene chloride, a common laboratory contaminant, was frequently detected (18 out of 53 samples; 34 percent detections) in geologic materials from 0 to 12 feet with concentrations ranging from 1 to 16 µg/kg and a mean concentration of 4 µg/kg (see Figure D-108). Methylene chloride was present at concentrations above the detection limit (not J-qualified by laboratory) at depths from 15 to 70 feet below the ground surface. Methylene chloride was not detected in field QC samples (equipment rinsates).

Methylene chloride was detected more frequently in UHSU ground water from OU 11 than any of the other organic compounds. In 26 of 203 samples (13 percent detections), methylene chloride was reported above the detection limit (Figure D-109). Seven of the methylene chloride results were B-qualified, indicating the presence of laboratory contamination . In samples of UHSU ground water from background monitoring wells, methylene chloride is detected with the same frequency (11 percent) as is observed in the monitoring wells within OU 11 (13 percent). The concentrations of methylene chloride (0.3 to 13 µg/L) are typically below the reported detection limits (0.1 to 10 µg/L). However, detections of methylene chloride are not consistent through time. For wells where methylene chloride has been detected, time-series plots (Figure D-110) show no consistent pattern of detection through time. Additionally, methylene chloride is detected in field and trip blanks of ground water samples sitewide (see page 2-5). The low detection frequency indicates the presence of methylene chloride is not likely due to environmental contamination but represents an artifact of the sampling and analysis methods.

EPA considers acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters to be common laboratory contaminants (EPA, 1989; EPA, 1992). In the OU 11 subsurface geologic materials and ground water data sets only the common laboratory contaminants are detected frequently. On average the chemicals classified as common laboratory contaminants were detected in 14 percent of the samples, across both media. However, besides the common laboratory contaminants, very few organic chemicals (11) were detected and only at a rate of 1.7 percent, nearly ten times lower than the common laboratory contaminants. Table D-2 presents a summary of the frequency of detection and the magnitude of concentrations for the common laboratory contaminants and the other organic chemicals that have been positively detected. Benzene (4/203), carbon disulfide (1/142), carbon tetrachloride (1/204), chloroform (10/203), ethylbenzene (1/204), hexachlorobutadiene (1/60), tetrachloroethene (6/204), total xylenes (1/145), and trichloroethene (2/204) were positively detected in ground water samples. Table D-2 also shows that the common laboratory contaminants are found at low concentrations near the detection limit. Their frequent appearance in the environmental medium of OU 11 and in background and other OUs (for an example see Table D-3), indicates these chemicals have likely been introduced in field sampling or laboratory analysis activities.

Based on the evidence presented in the previous paragraphs, methylene chloride is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

Tetrachloroethene

Tetrachloroethene was detected in 6 of 204 samples (3 percent detections) of UHSU ground water from OU 11 (see Figure D-111). Chemicals that are infrequently detected (less than 1 in 20) may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal activities (EPA, 1989). Two of these samples (2 and 0.3 µg/L) were collected from the same well, 4986, but tetrachloroethene has not been detected in samples from that well since October 1992. Both concentrations were reported as estimated results below the detection limit (J-qualified). The other four samples are from four different wells located downgradient of IHSS 168 (46392, 46492, B110989, and B410789). At three of these locations, tetrachloroethene was not detected in any of the subsequent ground water samples. At one location, B410789, PCE was detected in February 1994 and subsequent results are currently unavailable to verify its presence. In addition, tetrachloroethene was not detected in any of the 55 subsurface geologic materials samples collected at various depths to 105 feet during the 1994 sampling activities. If the detections in ground water were attributed to non-laboratory contamination, detections in the subsurface materials would likely exist. The low detection frequency indicates the presence of tetrachloroethene is not likely due to environmental contamination but represents an artifact of the sampling and analysis methods.

Tetrachloroethene is not included as a PCOC in OU 11 subsurface geologic materials and ground water.

Toluene

Toluene, a common laboratory contaminant, was frequently detected in the geologic materials from 0 to 12 feet (22 of 55 samples; 40 percent detections) (see Figure D-112). The concentrations ranged from 1 to 25 µg/kg with a mean concentration of 3 µg/kg. However, all the concentrations are below 10 µg/kg with the exception of the maximum of 25 µg/kg at the 2-foot interval in well 51094. Most values are below the detection limit of 5 µg/kg.

Toluene has been detected in 5 of 204 samples (3 percent detections) of UHSU ground water from IHSS 168 and downgradient wells (Figure D-113). Chemicals that are infrequently detected (less than 1 in 20) may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal activities (EPA, 1989). In fact, toluene is reported in trip and field blank samples sitewide (see page 2-5). Toluene was detected once (1 µg/L, J-qualified) in a 1990 sample from well B411389 and has not been detected at this location again (Figure D-114). Time-series plots show no consistent pattern of detection through time. A water sample collected from well 50394 in September 1994 had a toluene concentration of 0.2 µg/L (J-qualified). If the concentration levels in the subsurface geologic materials are attributable to non-laboratory contamination, one would likely expect the frequent presence of the contaminant in ground water. However, there are few detections of toluene in ground water (3 percent detections). The low detection frequency indicates the

presence of toluene is not likely due to environmental contamination but represents an artifact of the sampling and analysis methods.

EPA considers acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters to be common laboratory contaminants (EPA, 1989; EPA, 1992). In the OU 11 subsurface geologic materials and ground water data sets only the common laboratory contaminants are detected frequently. On average the chemicals classified as common laboratory contaminants were detected in 14 percent of the samples, across both media. However, besides the common laboratory contaminants, very few organic chemicals (11) were detected and only at a rate of 1.7 percent, nearly 10 times lower than the common laboratory contaminants. Table D-2 presents a summary of the frequency of detection and the magnitude of concentrations for the common laboratory contaminants and the other organic chemicals that have been positively detected. Benzene (4/203), carbon disulfide (1/142), carbon tetrachloride (1/204), chloroform (10/203), ethylbenzene (1/204), hexachlorobutadiene (1/60), tetrachloroethene (6/204), total xylenes (1/145), and trichloroethene (2/204) were positively detected in ground water samples. Table D-2 also shows that the common laboratory contaminants are found at low concentrations near the detection limit. Their frequent appearance in the environmental medium of OU 11 and in background and other OUs (for an example see Table D-3), indicates these chemicals have likely been introduced in field sampling or laboratory analysis activities. Toluene is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

Total Xylenes

Total xylenes were not detected in subsurface geologic materials from 0 to 12 feet (0 detections out of 55) in samples collected during the 1994 sampling activities. Total xylenes have been detected in only 1 of 145 samples (<1 percent) in OU 11 ground water. Total xylenes were detected in a sample collected from B110889, downgradient of IHSS 168, in October 1992 (see Figure D-115) and have not been detected in any other sample from that well. Xylene has never been detected in ground water from monitoring wells within IHSS 168. The time-series plot shows no consistent pattern of detection through time. Chemicals that are infrequently detected (less than 1 in 20) may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal activities (EPA, 1989). If elevated concentrations in ground water were related to OU 11 spraying operations, concentrations of total xylenes would be elevated in subsurface geologic materials as well. The low detection frequency indicates the presence of total xylenes is not likely due to environmental contamination but represents an artifact of the sampling and analysis methods. Total xylenes is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

Trichloroethene

Trichloroethene (TCE) was not detected in subsurface geologic materials from 0 to 12 feet. TCE was detected in only two ground water samples out of 204 samples (1 percent detections) taken from 1990 to 1994 (See Figure D-116). The maximum concentration was reported in Well B110989 from a sample collected in March 1990. A concentration of 0.1 µg/L was detected in Well B410789 from a sample collected in February 1994. Previous samples from these wells (collected quarterly since 1989) do not contain detected concentrations of TCE, and TCE has

never been detected in ground-water from other monitoring wells within OU 11. The time-series plots show no consistent pattern of detection through time. The low detection frequency indicates the presence of trichloroethene is not likely due to environmental contamination but represents an artifact of the sampling and analysis methods. Trichloroethene is not included as a PCOC in OU 11 subsurface geologic materials or ground water.

D.5 Other Parameters

Cyanide

Cyanide was detected in 11 of 287 ground water samples at the site (< 4 percent). Figure D-117 shows the cyanide detections greater than the background mean plus 2 standard deviations at the site. Cyanide failed the Gehan statistical test, but there are questions regarding the validity of the statistical tests for cyanide. The background data set included three undetected records with a result and detection limit of 10,000 µg/L. It appears that the detection limits were erroneously reported because the detection limits for the remainder of the set are 10 µg/L. It is likely that the actual detection limit should be 10 µg/L; however, the error skews the data set so that no background comparison can be performed.

The maximum detection at OU 11 was 49 µg/L in well B410589, on the southern edge of OU 11. The maximum result in the background data set is 17.7 µg/L. Four of the cyanide detections are below the background maximum, and four of the detections are outside the area of spray activities. Additionally, cyanide was not detected at significant concentrations in surficial soils or subsurface soils. The site history does not relate cyanide to the spray activities and the detections of cyanide (3 percent of total samples) in ground water are not reflective of contamination nor is there supporting detections of cyanide through the soils media. Cyanide has not been included on the list of PCOCs for ground water.

Nitrate/Nitrite

Levels of nitrate/nitrite in surficial soils are not high, but they do exceed the background values by one order of magnitude. The maximum nitrate/nitrite detection at OU 11 is 37 mg/kg while the background maximum detection is 7 mg/kg. Nitrate/nitrite was detected at concentrations exceeding the background UTL value of 9.6 mg/kg in 22 of the 53 surficial soil samples collected (41 percent). Nitrate/nitrite failed the Slippage and Gehan tests in surficial soils. The results of these tests are verified graphically in the frequency histogram and the box-and-whisker plot (Figures D-118 and D-119), each of which illustrate distributions significantly different from background. The detections of nitrate/nitrite are plotted on Figure D-120. The distribution of nitrate/nitrite generally coincide with historic spray activities, historic pipeline juncture locations or locations down-wind of spray activities.

The liquids from the Solar Evaporation Ponds sprayed at OU 11 have been historically associated with nitrate/nitrite. Based on the spatial distribution of nitrate/nitrite, the statistical comparison results and the site history, nitrate/nitrite is included on the list of PCOCs for surficial soils.

Nitrate/nitrite was detected in subsurface materials throughout the site. It was detected in 61 of 67 samples from 0 to 12 feet (91 percent) at very low concentrations. However, nitrate/nitrite was not analyzed for in the background data set so inferential statistical tests and background comparisons cannot be completed. The maximum detection in subsurface soils can be compared to the surficial soils UTL as a frame of reference. The maximum concentration in subsurface is 2 mg/kg. The surficial soils UTL is 9.6 mg/kg. The nitrate/nitrite exists in the surficial soils and exists at low concentrations in borehole samples. There is no strong correlation between spray areas and subsurface nitrate/nitrite detection. Figure D-121 shows the subsurface detections. However, because nitrate/nitrite is associated with OU 11 history and is included as a PCOC in surficial soils, it will also be considered a PCOC in the subsurface. This is a conservative inclusion because the highest detection is three times less than the surficial UTL value.

Nitrate/nitrite was detected at concentrations greater than the background UTL value (6,373 µg/L) in only 5 of 209 ground water samples from OU 11 (2 percent). Four of the 5 detections are from one well (4986) in the center of spray area 2. The other detection was detected at well 50794, more than 1000 feet southwest, in spray area 1. The five detections exceeded the UTL by 27 µg/L to 3427 µg/L. Four of these exceedances were by less than 100 µg/L (<10 percent). The maximum detection of nitrate/nitrite in the OU 11 vicinity was actually upgradient of the OU at a concentration substantially higher than the site detections, but still only twice the background UTL value. Figure D-122 shows the nitrate/nitrite detections greater than the background mean plus 2 standard deviations.

Nitrate/nitrite in ground water did not fail any of the inferential statistical tests, indicating that the OU 11 concentrations are not statistically different from the background data set detections. The histogram and box-and-whisker plots (Figures D-123 and D-124) graphically support the statistical results.

The observation that the well with 4 of the 5 nitrate/nitrite detections is in the center of spray area 2 may indicate an association with the spray activities. However, time series plots (Figure D-125) illustrate erratic concentrations, randomly occurring over time. This pattern is not indicative of even low-level contamination in the ground water system. The majority of the fluctuations shown are below the background UTL. An additional observation on the nitrate/nitrite in ground water is that all of the five detections fall below the range of values detected in the background wells. The range of detections at OU 11 is 6400 to 9800 µg/L. The background detections range from 9300 µg/L to 12,000 µg/L. Finally, the ground water detections are not correlated with the maximum concentrations in the subsurface, as would be expected with contaminant migration. In conclusion, the detections of nitrate/nitrite in OU 11 ground water are not indicative of wide-spread site contamination and the analyte is not included on the PCOC list for ground water.

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Table D-1
Risk-Based Concentration Screen for the OU 11 Source Area
Residential Exposure

Potential Contaminant of Concern	Maximum Concentration or Activity (Max)	Location of Max	Residential PPRG[1]		Ratio of Max to PPRG	
			Carcinogen	Noncarcinogen	Carcinogen	Noncarcinogen
SOIL (0 to 12 feet)						
Radionuclides (pCi/g)						
AMERICIUM-241	0.43	SS102094	2.37E+00	---	0.18	---
PLUTONIUM-239/240[2]	2.2	SS102094	3.42E+00	---	0.64	---
TRITIUM	3.4	51294	1.47E+04	---	0.00023	---
Other Parameters (mg/kg)						
NITRATE/NITRITE[3]	37	SS100894	---	4.39E+05	---	0.000084
				TOTAL RATIO SUM	**0.82**	**0.000084**

[1] Programmatic Preliminary Remediation Goals (PPRGs) are from DOE (February 1995). Residential soil PPRGs were used for analytes in soil (0 to 12 feet). PPRGs are reported in the units used for each analyte group.

[2] The PPRG for plutonium-240 was used because it is more conservative than the PPRG for plutonium-239.

[3] The PPRG for nitrate was used because nitrate is the dominant species present.

Table D-2
Volatile and Semivolatile Chemical Results from OU 11

Chemical	Data Set	Number of Detects[a]	Number of Samples[a]	Detection Frequency[a]	Detection Limit	Concentration			Units
						Minimum[a,b]	Mean[a,c]	Maximum[a,d]	
Common Laboratory Contaminants									
2-Butanone	Ground Water	2	96	2%	10	10	5	19	µg/L
Acetone	Ground Water	10	135	7%	10	1	5	31	µg/L
Bis(2-ethylhexyl) Phthalate	Ground Water	3	9	33%		9J	8	26	µg/L
Di-n-butyl Phthalate	Ground Water	0	9	0%	10				µg/L
Diethyl Phthalate	Ground Water	1	9	11%	10	26	26	26	µg/L
Dimethyl Phthalate	Ground Water	0	9	0%	10				µg/L
Methylene Chloride	Ground Water	26	203	13%	10	0.1	2	13	µg/L
Toluene	Ground Water	5	204	2%	10	0.1	2	3	µg/L
2-Butanone	Subsurface Geologic Materials[e]	1	45	2%	10	4	5	4	µg/kg
Acetone	Subsurface Geologic Materials[e]	10	44	23%	10	1	5	15	µg/kg
Bis(2-ethylhexyl) Phthalate	Subsurface Geologic Materials[e]	27	67	40%	10-330	36	119	140	µg/kg
Di-n-butyl Phthalate	Subsurface Geologic Materials[e]	27	67	40%	10-330	39	216	520	µg/kg
Diethyl Phthalate	Subsurface Geologic Materials[e]	2	67	3%	10-330	190	166	240	µg/kg
Dimethyl Phthalate	Subsurface Geologic Materials[e]	0	67	0%	10-330				µg/kg
Methylene Chloride	Subsurface Geologic Materials[e]	18	53	34%	5	1	4	16	µg/kg
Toluene	Subsurface Geologic Materials[e]	22	55	40%	5	1	3	25	µg/kg

Table D-2
Volatile and Semivolatile Chemical Results from OU 11

Chemical	Data Set	Number of Detects[a]	Number of Samples[a]	Detection Frequency[a]	Detection Limit	Concentration			Units
						Minimum[a,b]	Mean[a,c]	Maximum[a,d]	
Other Chemicals									
Benzene	Ground Water	4	203	2%	.1-10	0.1	2	7	µg/L
Carbon Disulfide	Ground Water	1	142	1%	5-10	3	3	3	µg/L
Carbon Tetrachloride	Ground Water	1	204	0%	.1-10	0.1	2	2	µg/L
Chloroform	Ground Water	10	203	5%	.1-10	0.1	2	3	µg/L
Ethylbenzene	Ground Water	1	204	0%	.1-10	0.1	2	2	µg/L
Hexachlorobutadiene	Ground Water	1	60	2%	.2-.5	0.1	0.1	0.1	µg/L
Tetrachloroethene	Ground Water	6	204	3%	.1-10	0.1	2	2	µg/L
Total Xylenes	Ground Water	1	145	1%	.5-10	0.5	3	10	µg/L
Trichloroethene	Ground Water	2	204	1%	.1-10	0.1	2	1	µg/L
Chloroform	Subsurface Geologic Materials[e]	0	55	0%	5				µg/kg
Trichloroethene	Subsurface Geologic Materials[e]	0	55	0%	5				µg/kg

[a] Summary statistics were calculated using ground water and subsurface geologic materials from: IHSS 168 UHSU (sampled in 1990 through 1994) and downgradient wells (sampled in 1994).

[b] The minimum value represents the minimum concentration regardless if the sample is a detection or a nondetection.

[c] The mean value was calculated using one-half the sample quantitation limit for nondetections.

[d] The maximum value represents the maximum detected concentration in the data set.

[e] Samples from 0 to 12 feet below ground surface.

Table D-3
Summary of Bis(2-ethyl hexyl) phthalate

Data Set	Medium	Number of Detects[a]	Number of Samples[a]	Detection Frequency[a]	Concentration			Units
					Minimum[a, b]	Mean[a, c]	Maximum[a, d]	
OU 11 UHSU IHSS 168 and Downgradient Ground Water	Ground Water	3	9	33%	9J	8	26	µg/L
RFETS Sitewide Ground Water	Ground Water	68	298	23%	1	-	130	µg/L
OU 11 Subsurface Geologic Materials	Soil	37	138	27%	36	140	140	µg/kg
Background Surficial Soil	Soil	4	18	22%	35	-	140	µg/kg
OU 2 Surficial Soil Data	Soil	9	40	23%	49	-	110	µg/kg
RFETS Sitewide Ground Water Equipment Rinsate	QA/QC	1	11	9%	2	2	2	µg/L
OU 11 Subsurface Geologic Materials Equipment Rinsate	QA/QC	7	30	23%	2	6	36	µg/L

[a] Summary statistics were calculated using ground water and subsurface geologic materials from: IHSS 168 UHSU (sampled in 1990 through 1994) and downgradient wells (sampled in 1994).

[b] The minimum value represents the minimum concentration regardless if the sample is a detection or a nondetection.

[c] The mean value was calculated using one-half the sample quantitation limit for nondetections.

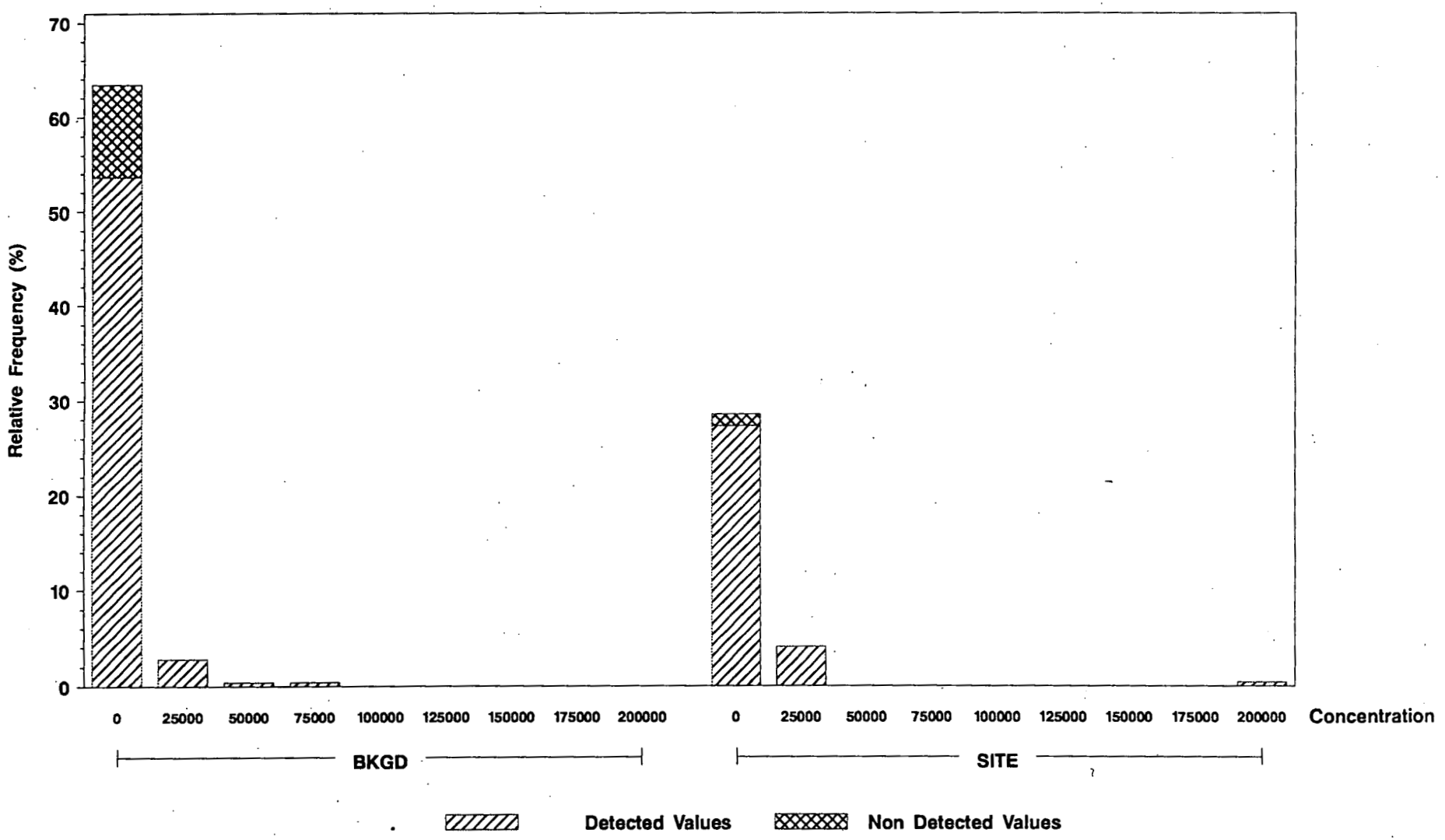
[d] The maximum value represents the maximum detected concentration in the data set.

Figure D-1

Background vs OU11 UHSU Groundwater

Frequency Histogram

ALUMINUM (ug/l) in Groundwater (Total)

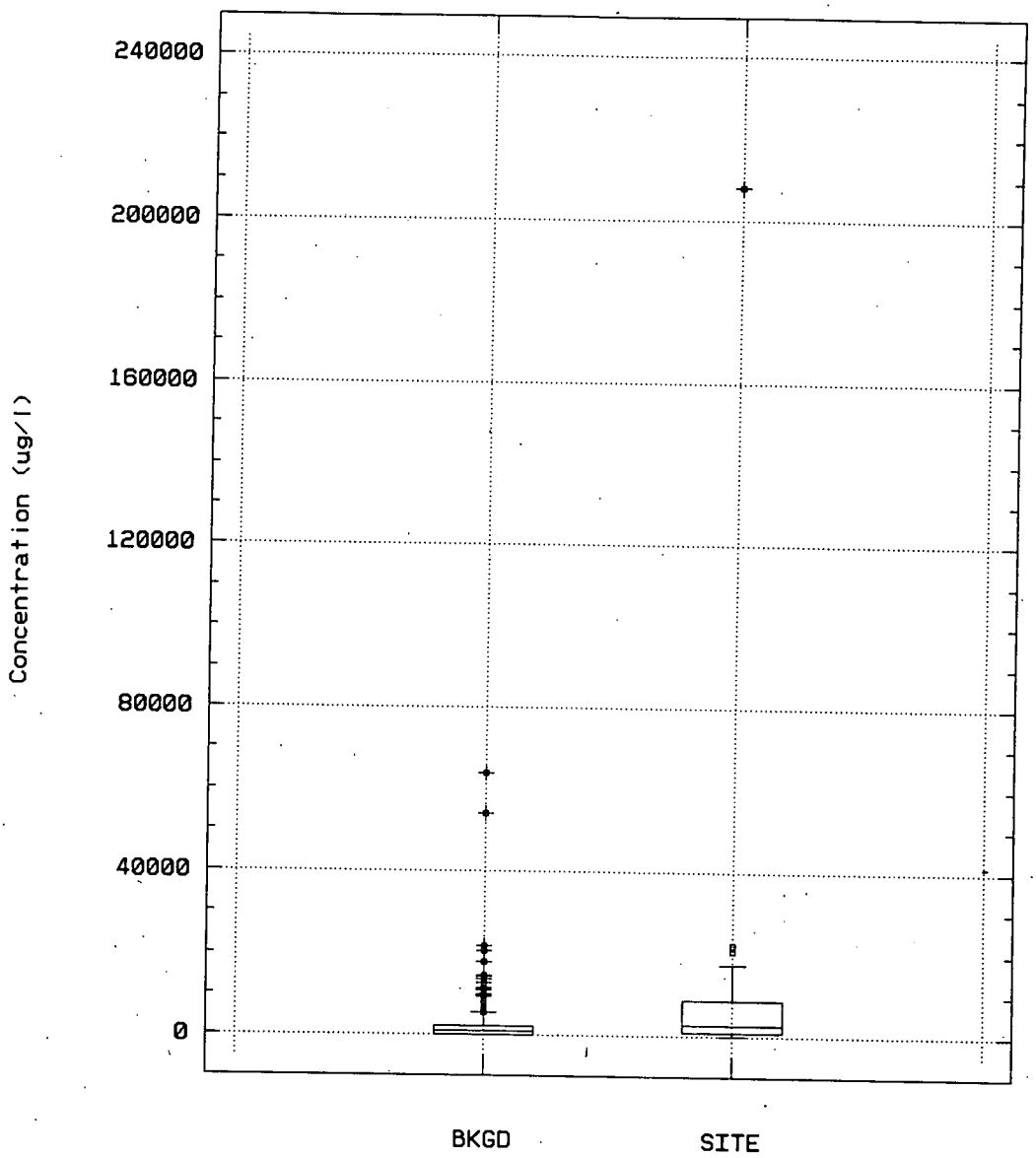


SITE = UHSU samples from saturated media within and downgradient of IHSS 168

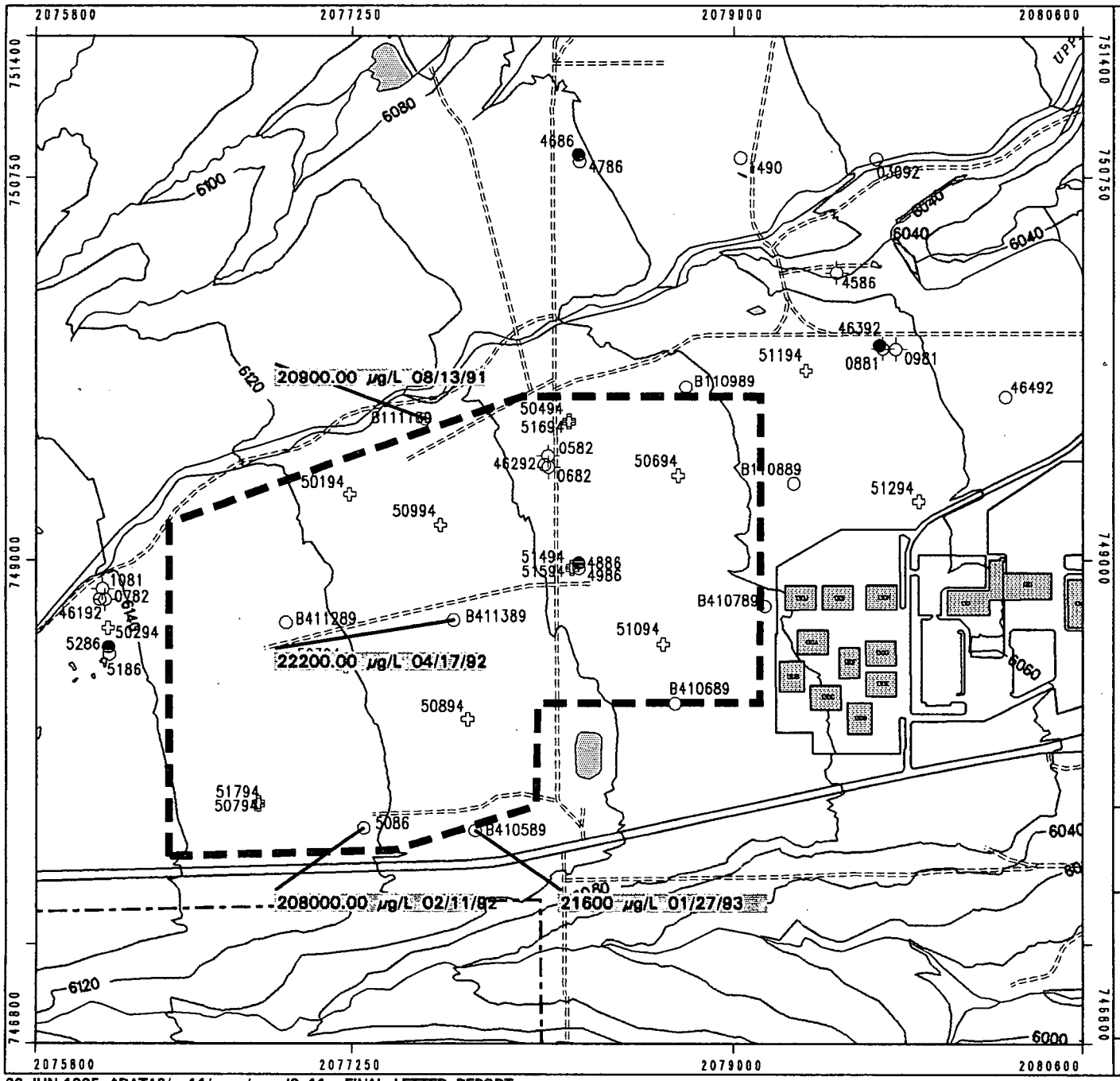
Figure D-2

Background vs OU11 UHSU Groundwater

Aluminum in Groundwater (Total)



Groundwater samples within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 18047

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

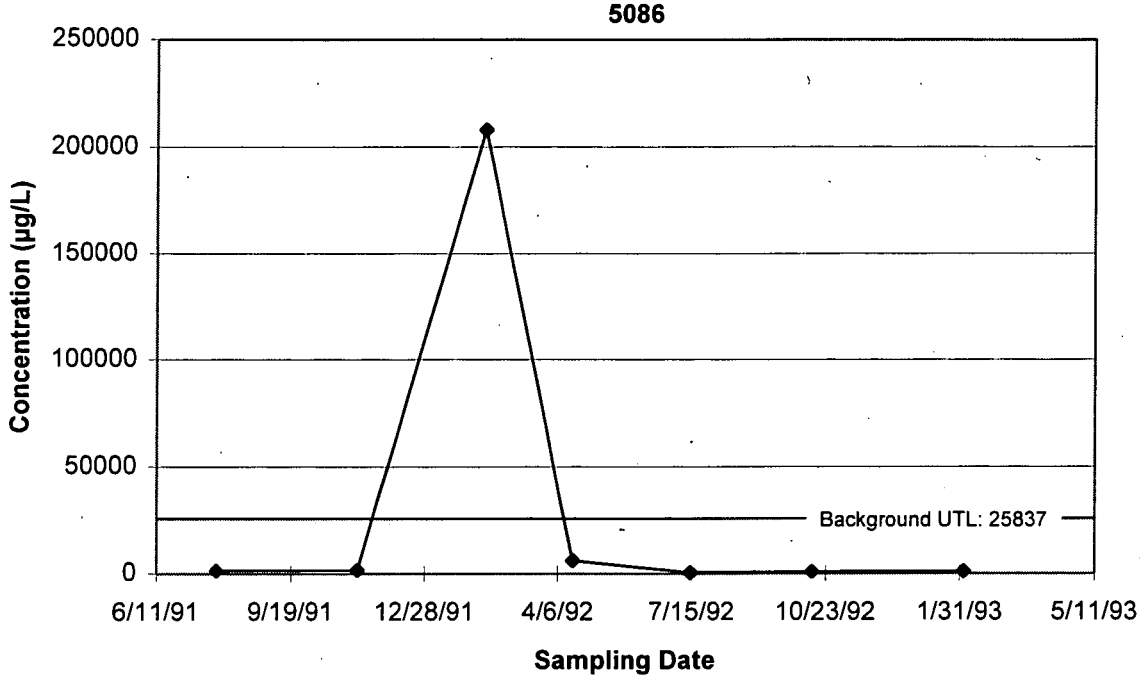
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
ALUMINUM
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-3

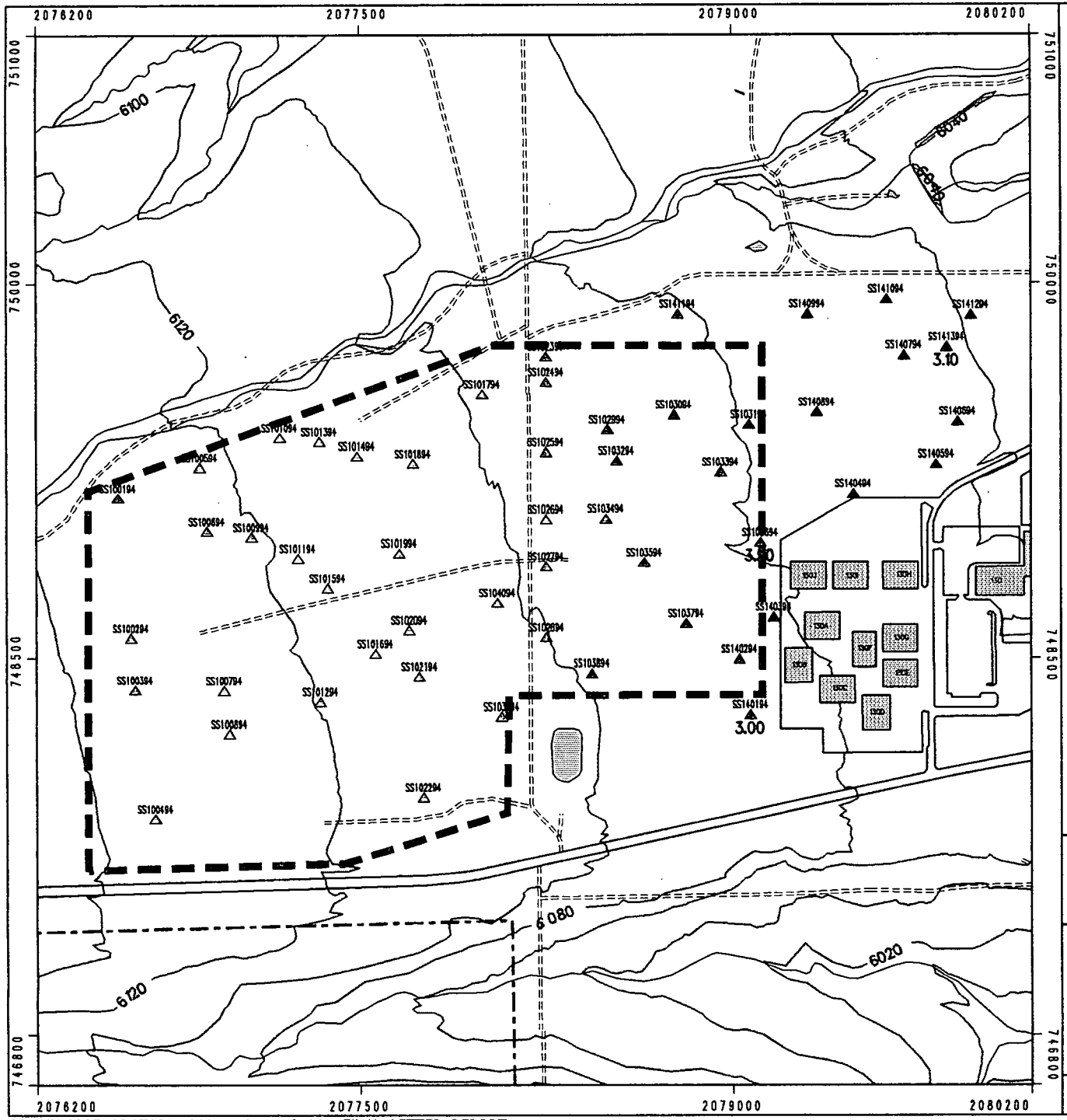
02-JUN-1995 $DATA2/ou11/maps/gw_al8x11 FINAL LETTER REPORT

Figure D-4
Time Series Plot - Total Aluminum
5086



◆ Hit - Y
o Hit - N

MEP C:\..\ALL_TS.XLS Aluminum, Beryllium, Iron 3/21/95



EXPLANATION

- Sample Location
- Values above the reporting limits
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Concentrations are in mg/kg

Scale = 1 : 7200
1 inch = 600 feet

300 0 600ft

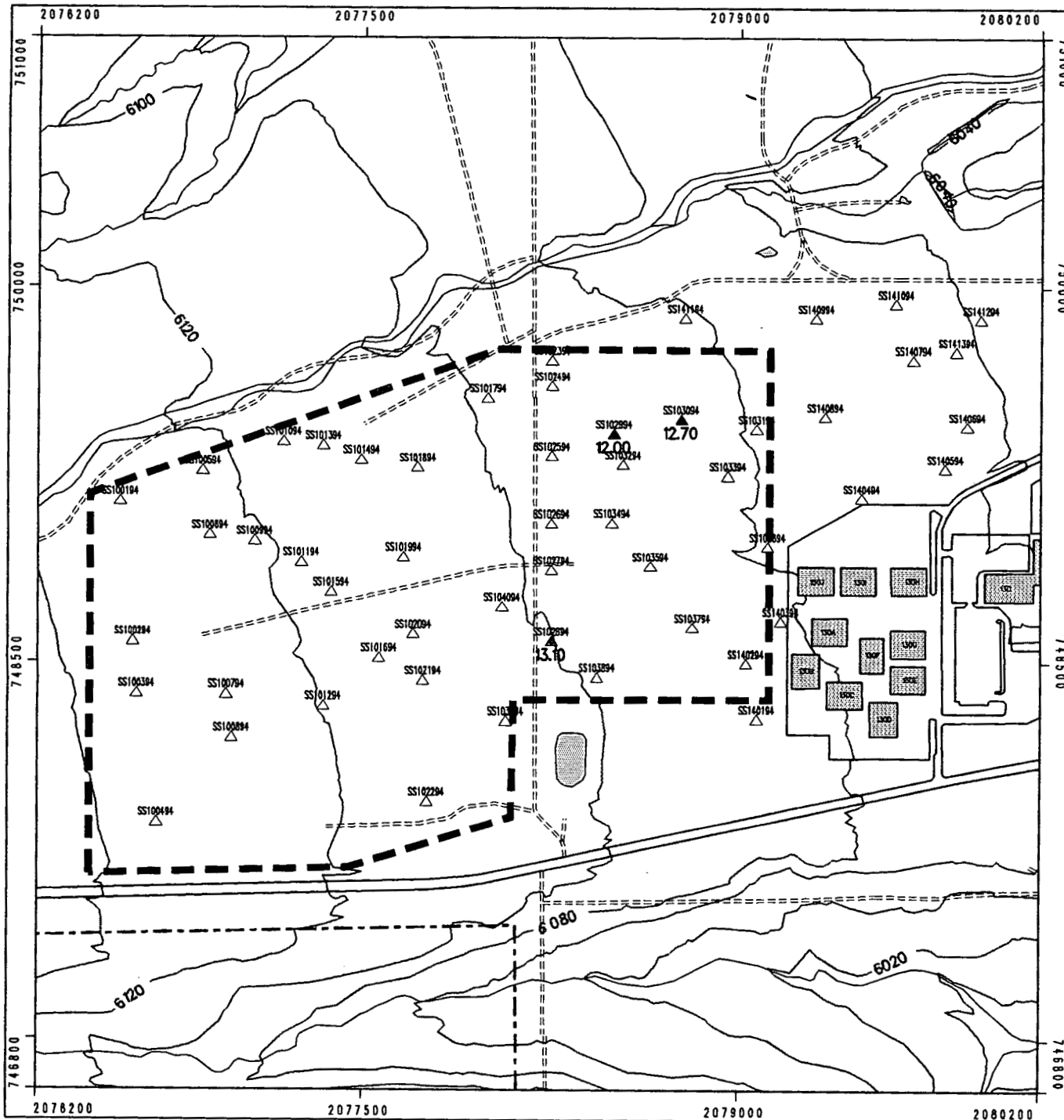
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
ANTIMONY
Concentrations*
at the
OU 11--West Spray Field

June 1995 | Figure D-5

02-JUN-1995 $DATA2/ou11/maps/ss_ant8x11 FINAL LETTER REPORT



EXPLANATION

- Sample Location
- Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Concentrations are in mg/kg
BM+2SD = 10

Scale = 1 : 7200
1 inch = 600 feet

300 0 600ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
ARSENIC
Concentrations*
at the
OU 11--West Spray Field

June 1995 | Figure D-6

Figure D-7

Background vs OU11 Surface Soil

Arsenic in Surface Soil (0 to 2 inches)

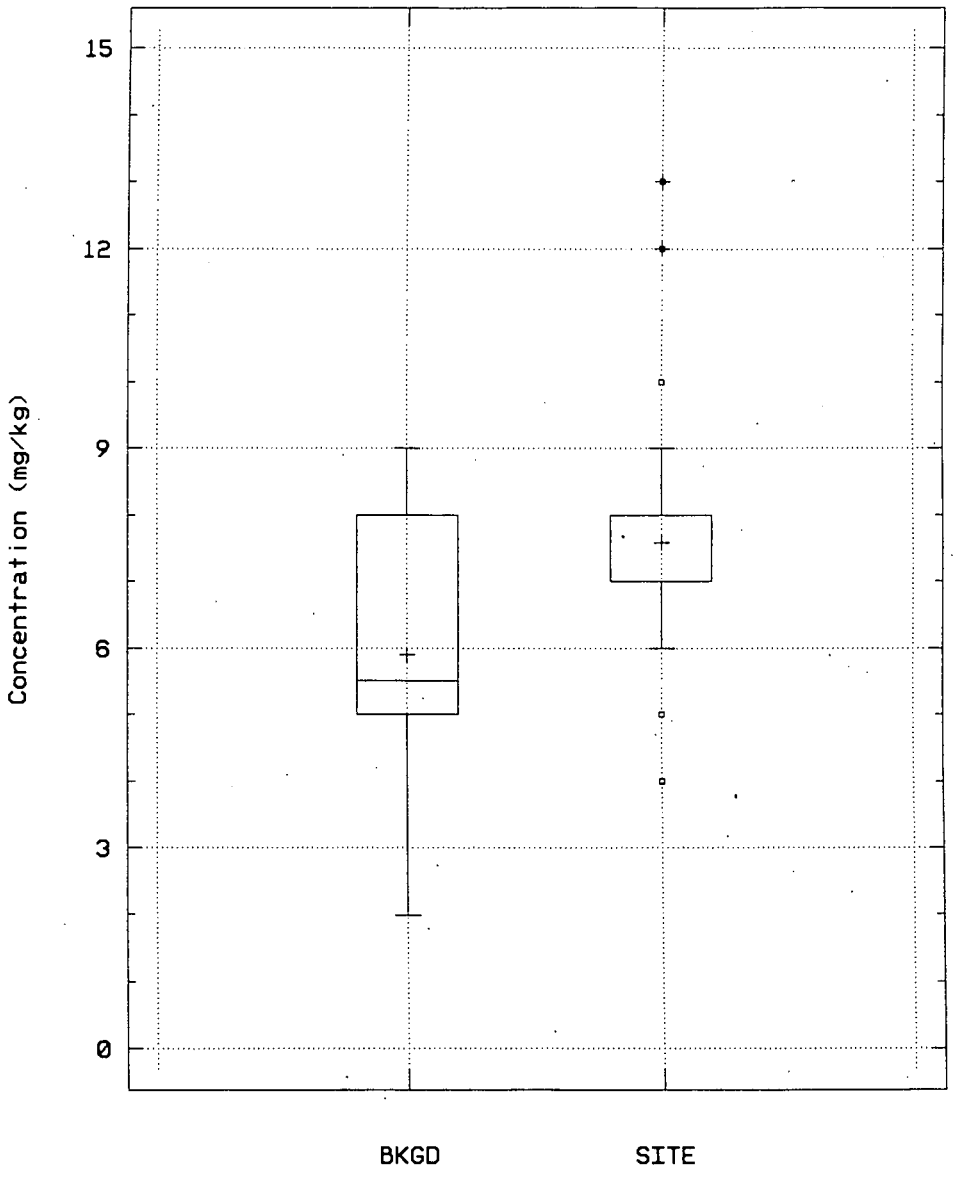
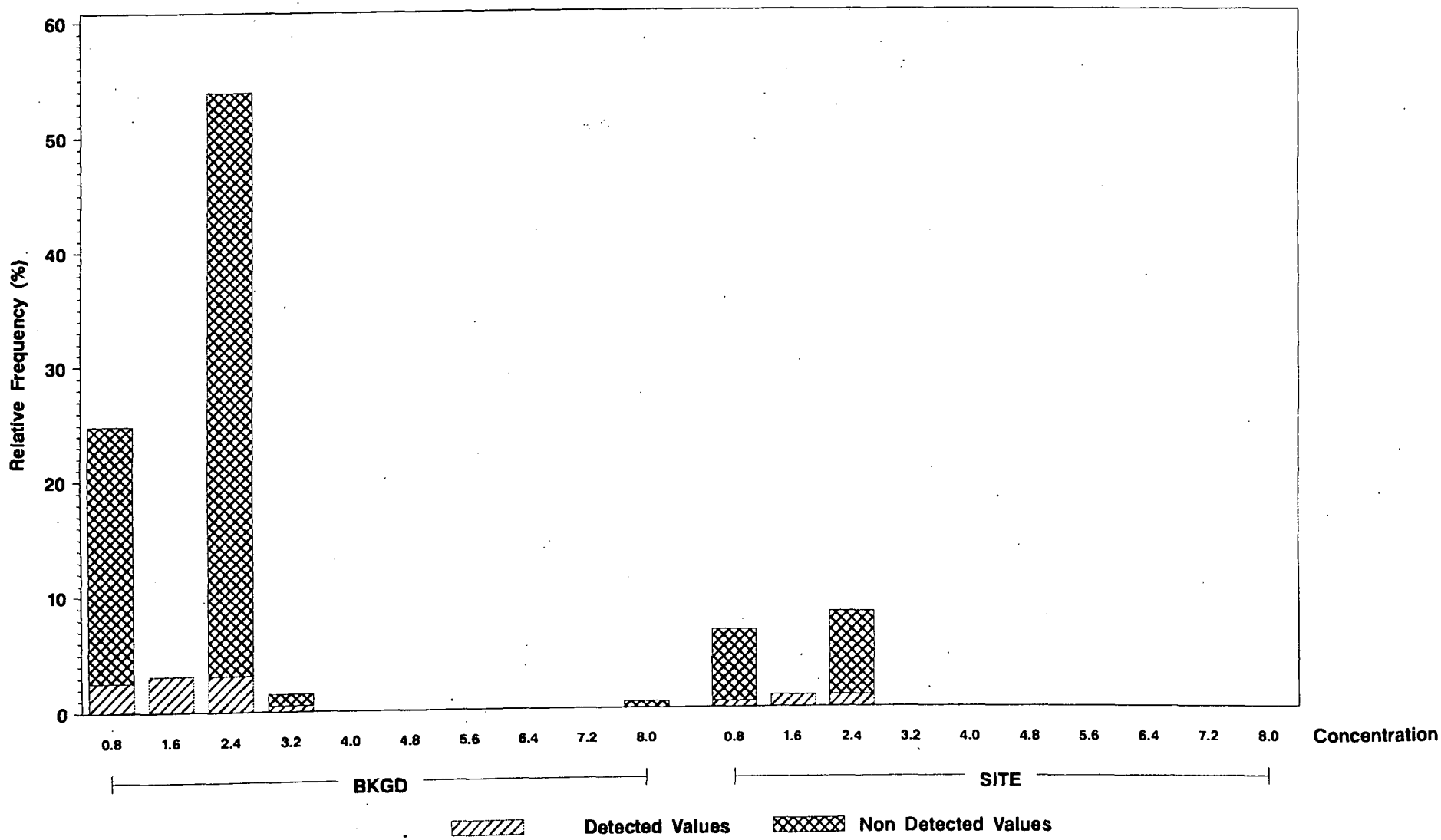


Figure D-8

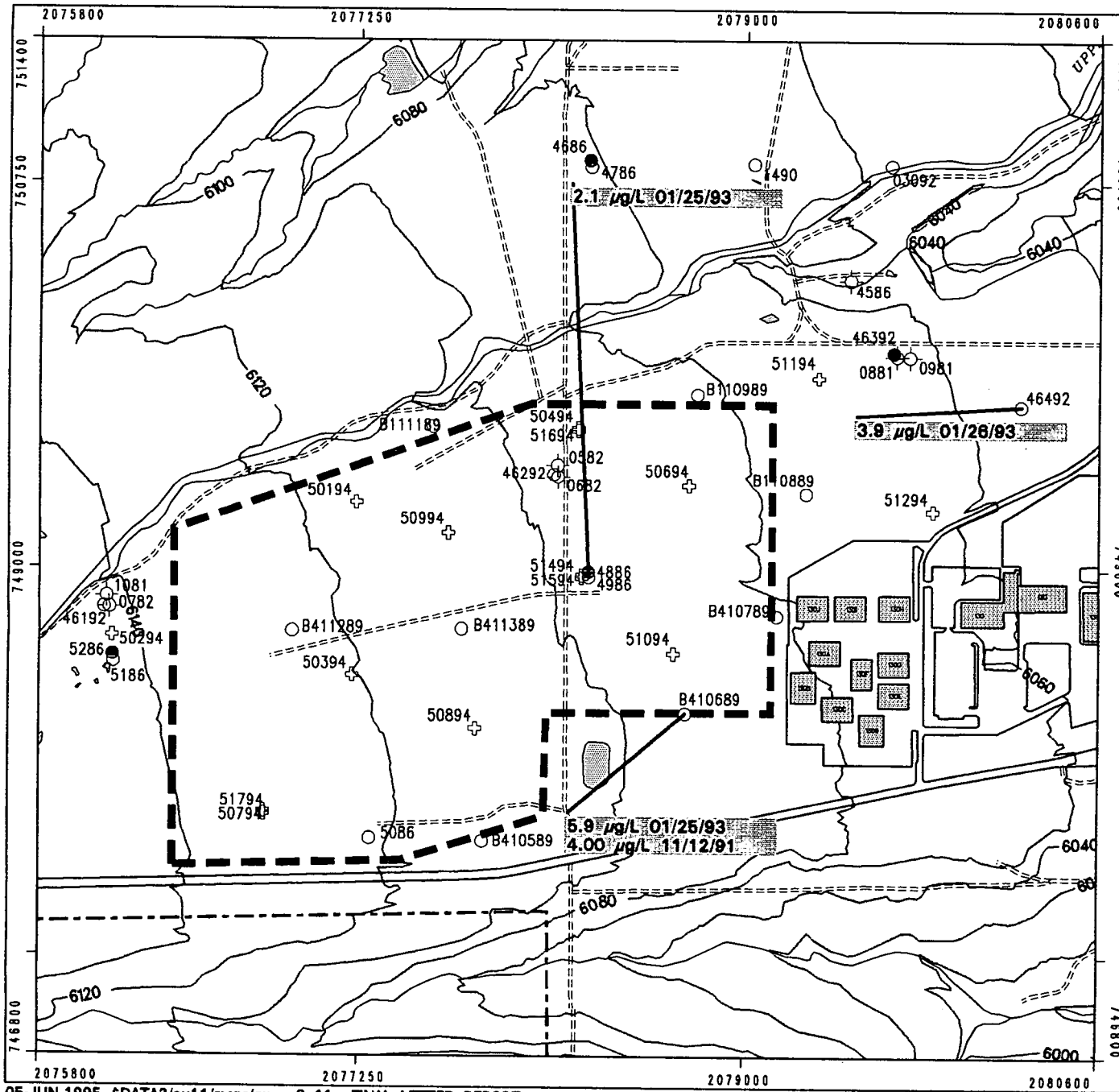
Background vs OU11 UHSU Groundwater

Frequency Histogram

ARSENIC (ug/l) in Groundwater (Total)



SITE = Wells · ''hin IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 2

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

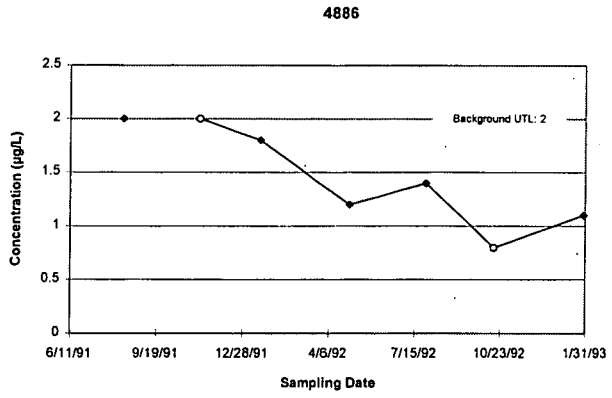
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

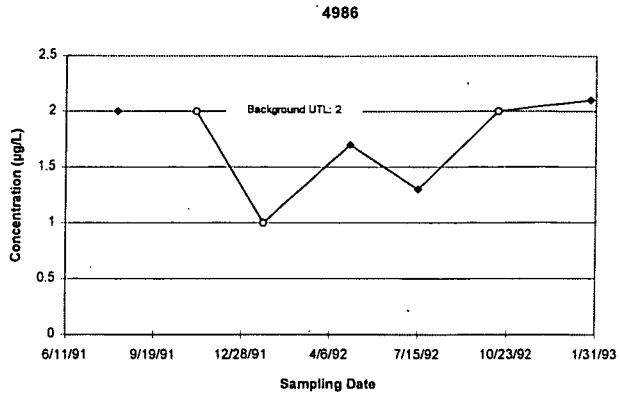
OU 11--West Spray Field
ARSENIC
Concentrations*
(and Sample Dates) in
UHSU Ground Water

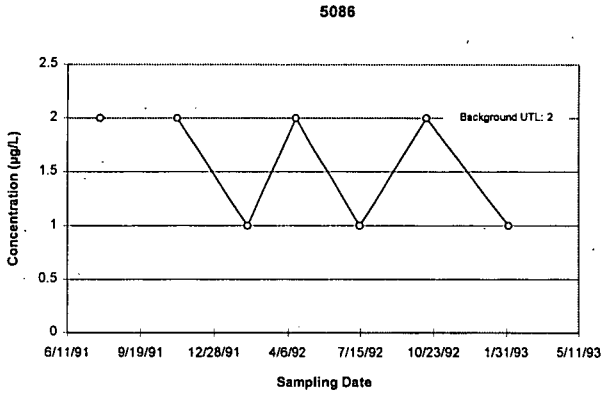
June 1995 | Figure D-8b

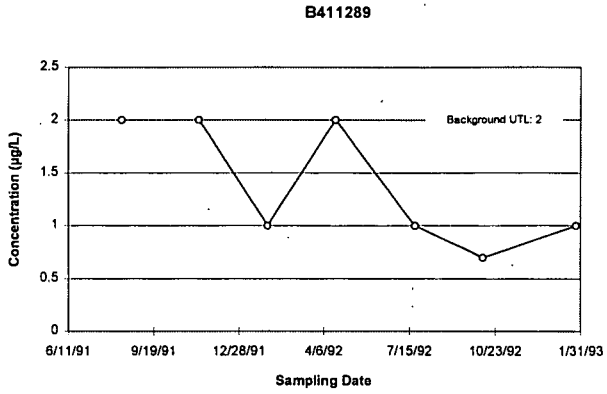
05-JUN-1995 $DATA2/ou11/maps/gw_as8x11 FINAL LETTER REPORT

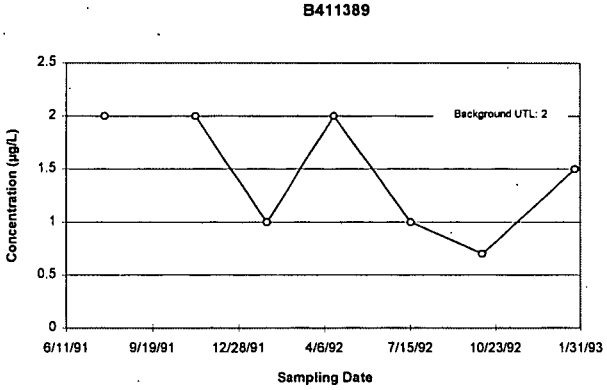
Figure D-9
Time Series Plots - Total Arsenic

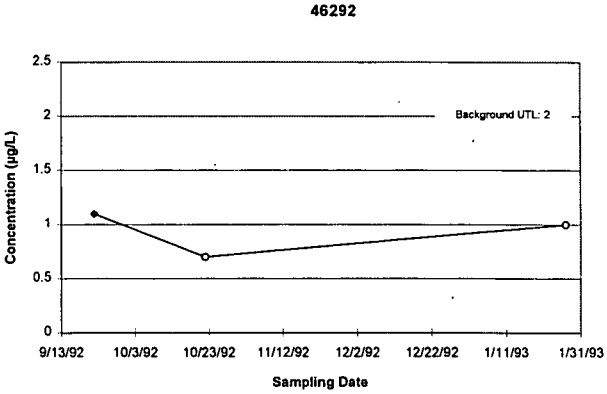






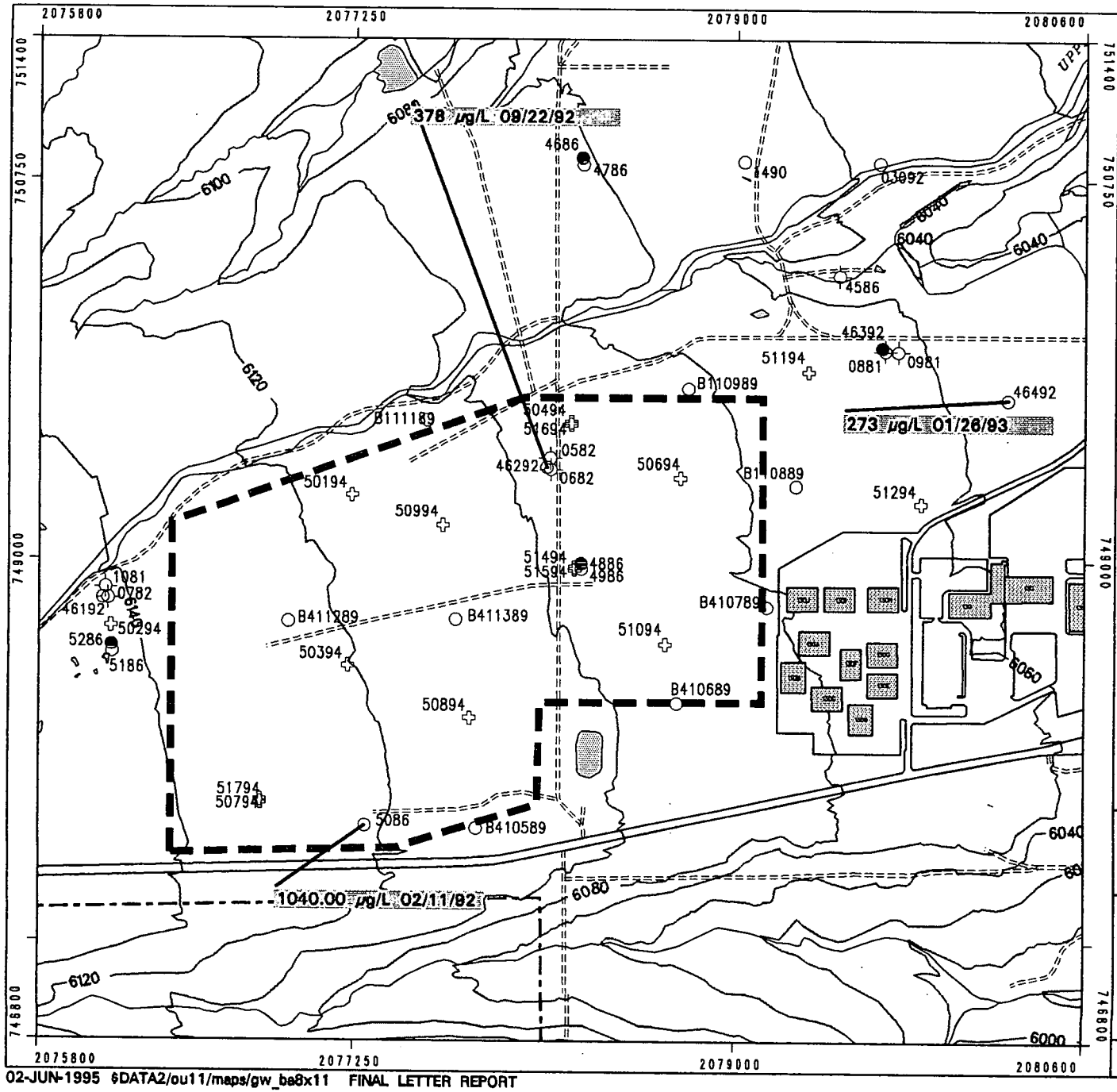






◆ Hit - Y
O Hit - N

MEP C:\.VALL_TS.XLS Arsenic 3/21/95



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 252

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

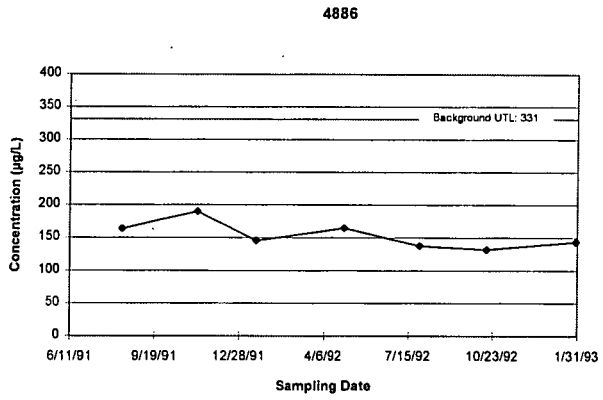
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

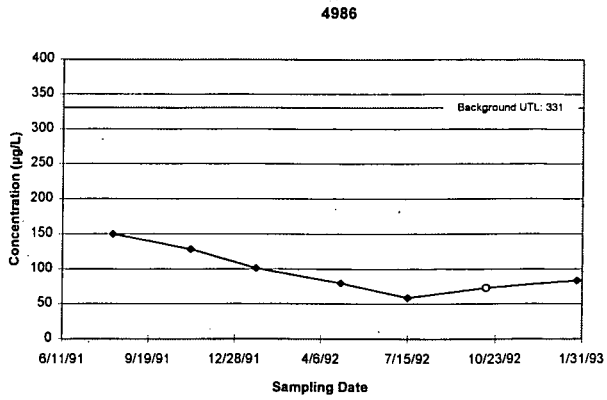
OU 11--West Spray Field
BARIUM
Concentrations*
(and Sample Dates) in
UHSU Ground Water

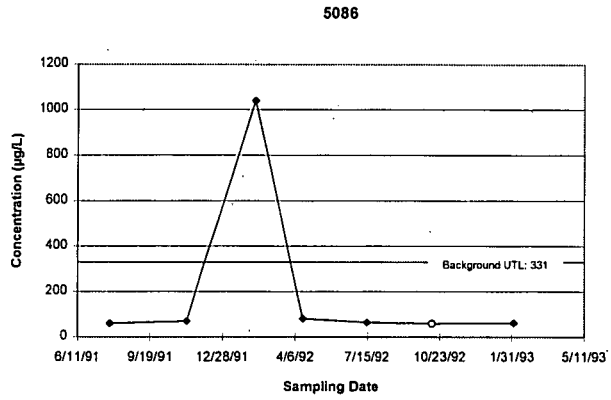
June 1995 | Figure D-10

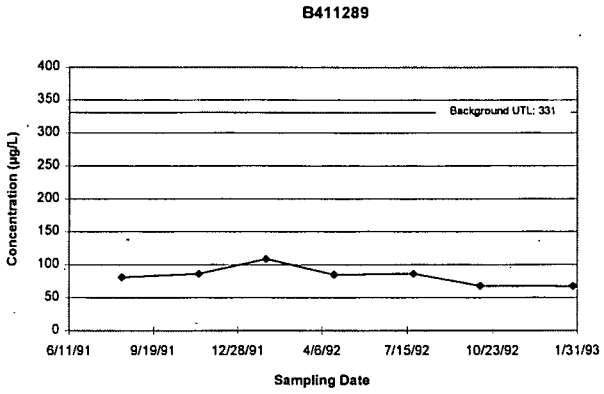
02-JUN-1995 $DATA2/ou11/maps/gw_ba8x11 FINAL LETTER REPORT

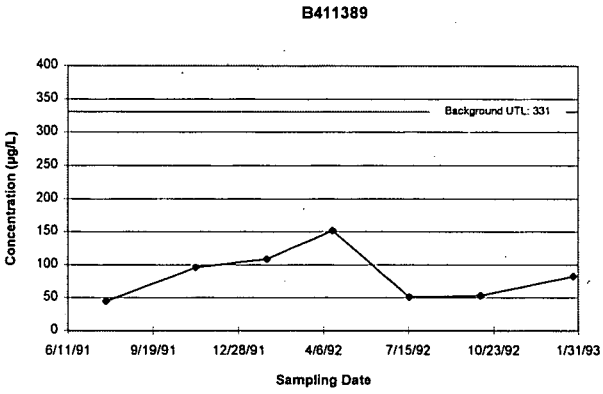
Figure D-11
Time Series Plots - Total Barium

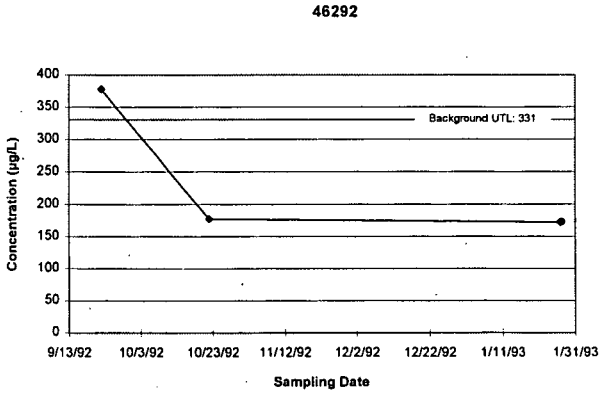












◆ Hit - Y
O Hit - N

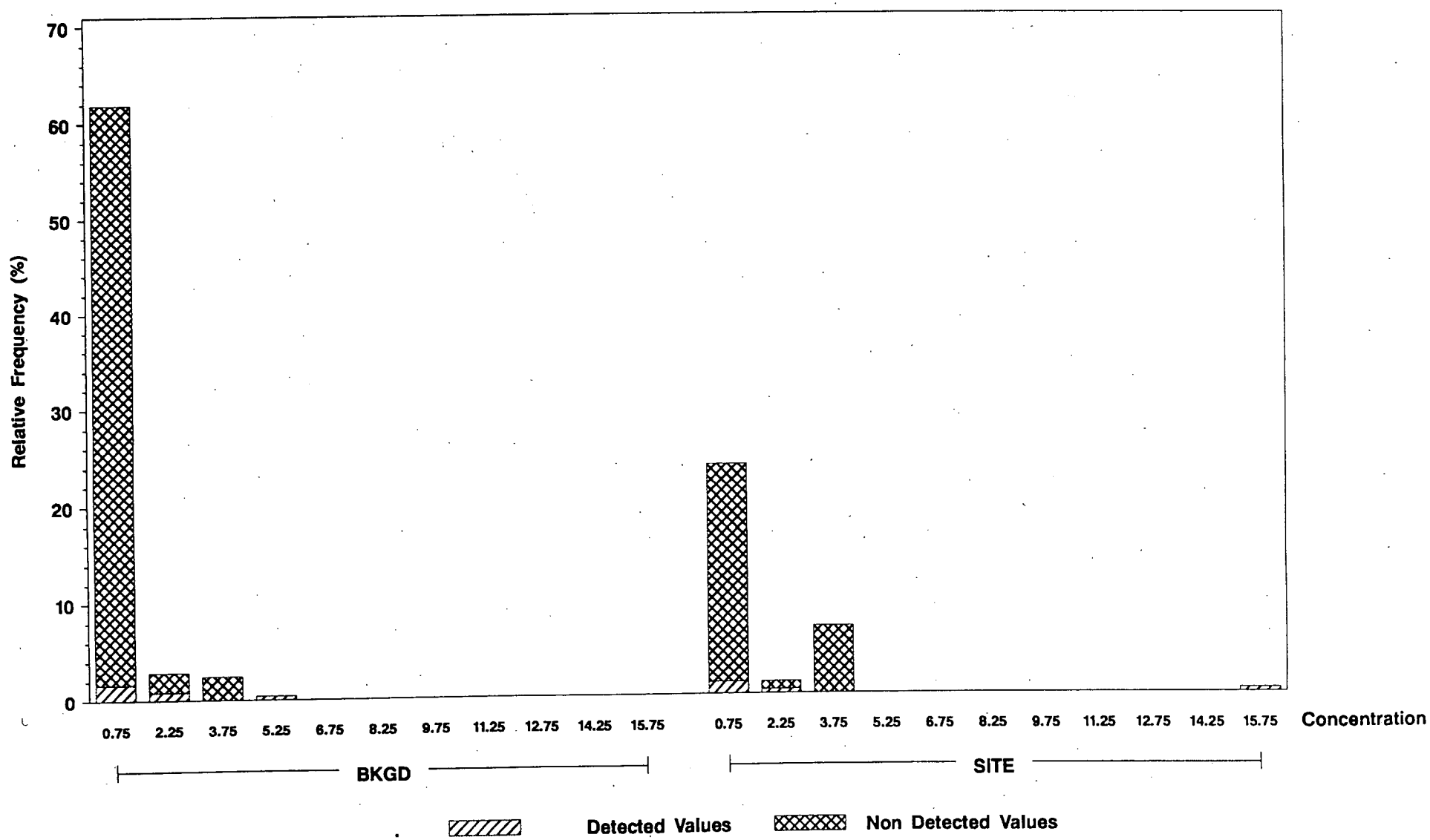
MEP C:\.VALL_TS XLS Barium 3/21/95

Figure D-12

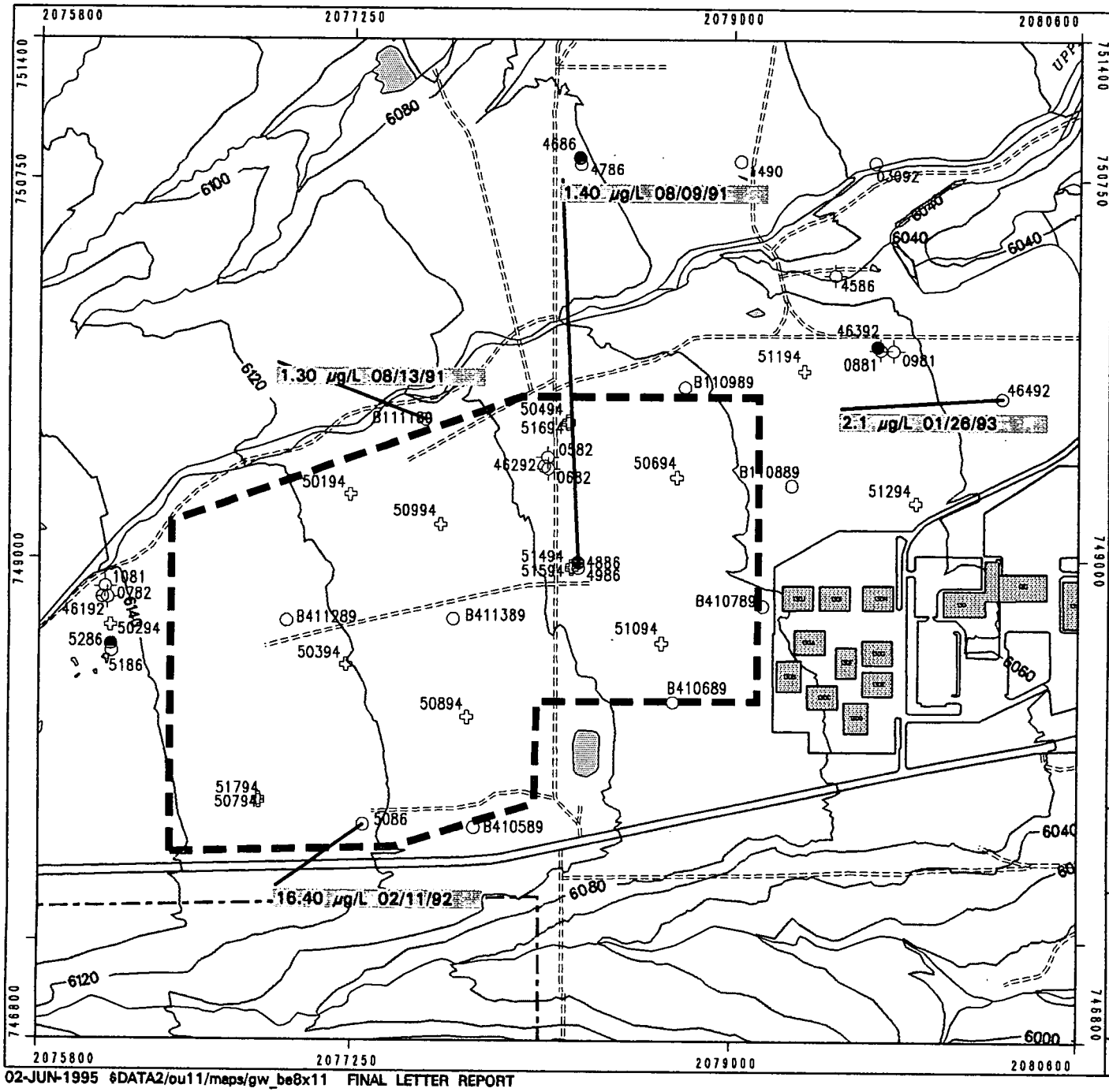
Background vs OU11 UHSU Groundwater

Frequency Histogram

BERYLLIUM (ug/l) in Groundwater (Total)



SITE = UHSU samples from saturated media within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 1

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

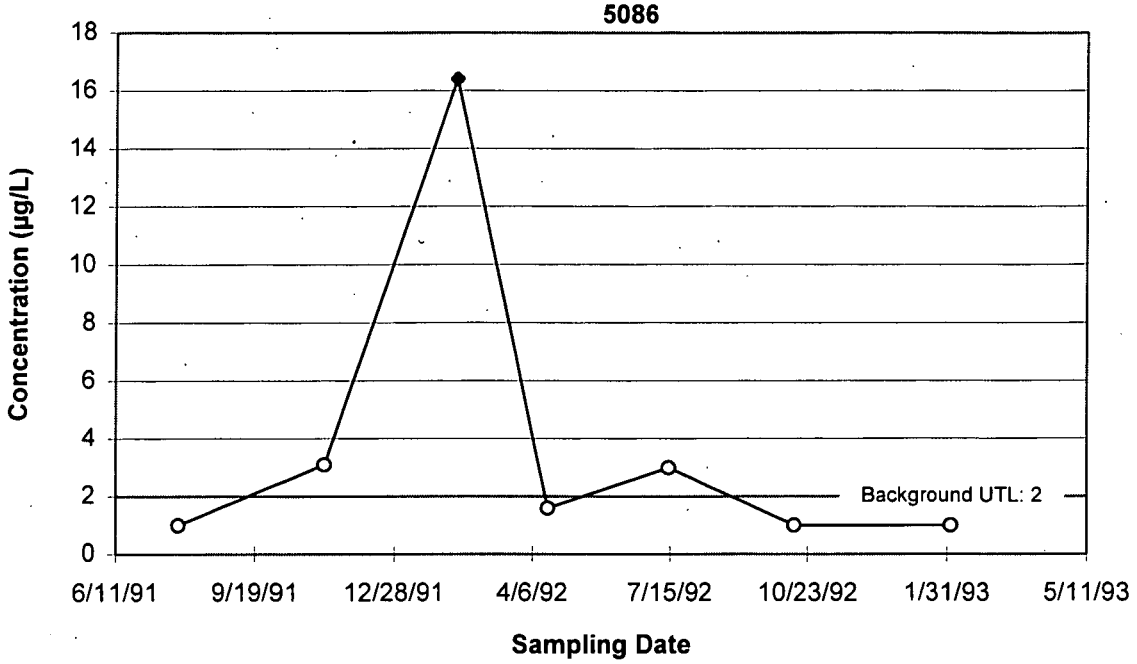
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
BERYLLIUM
Concentrations*
(and Sample Dates) in
UHSU Ground Water

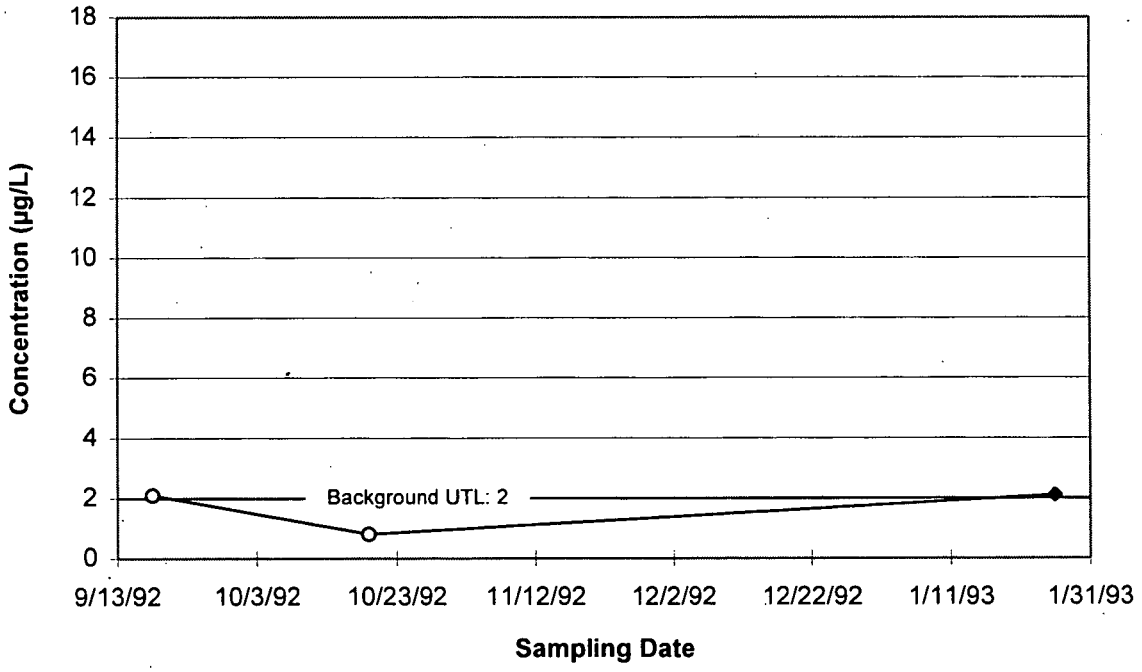
June 1995 | Figure D-13

02-JUN-1995 $DATA2/ou11/maps/gw_be8x11 FINAL LETTER REPORT

Figure D-14
Time Series Plot - Total Beryllium
5086

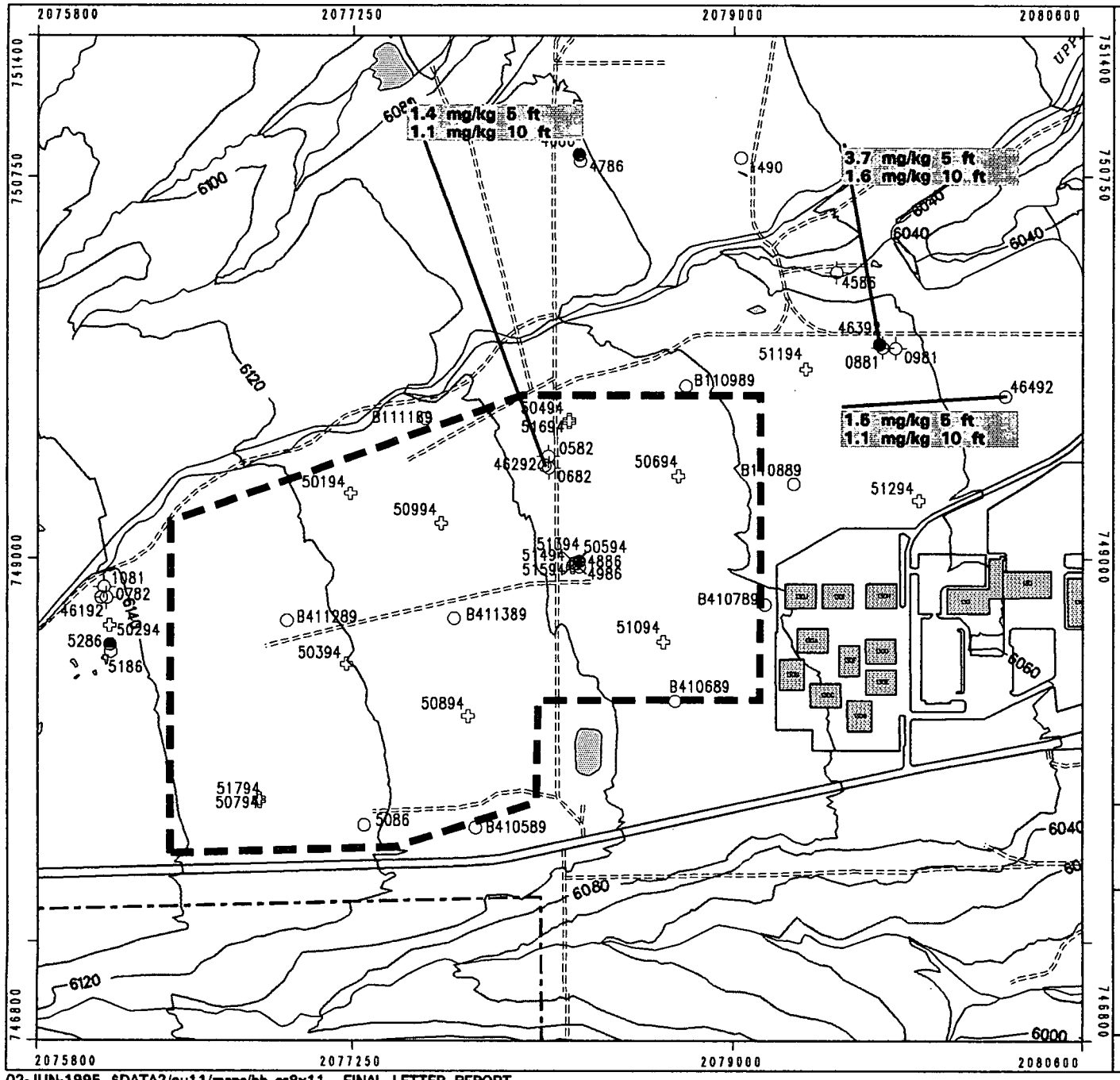


46492



◆ Hit - Y
○ Hit - N

MEP C:\..\ALL_TS.XLS Aluminum, Beryllium, Iron 4/25/95



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
CESIUM
Concentrations*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-15

02-JUN-1995 $DATA2/ou11/maps/bh_cs8x11 FINAL LETTER REPORT

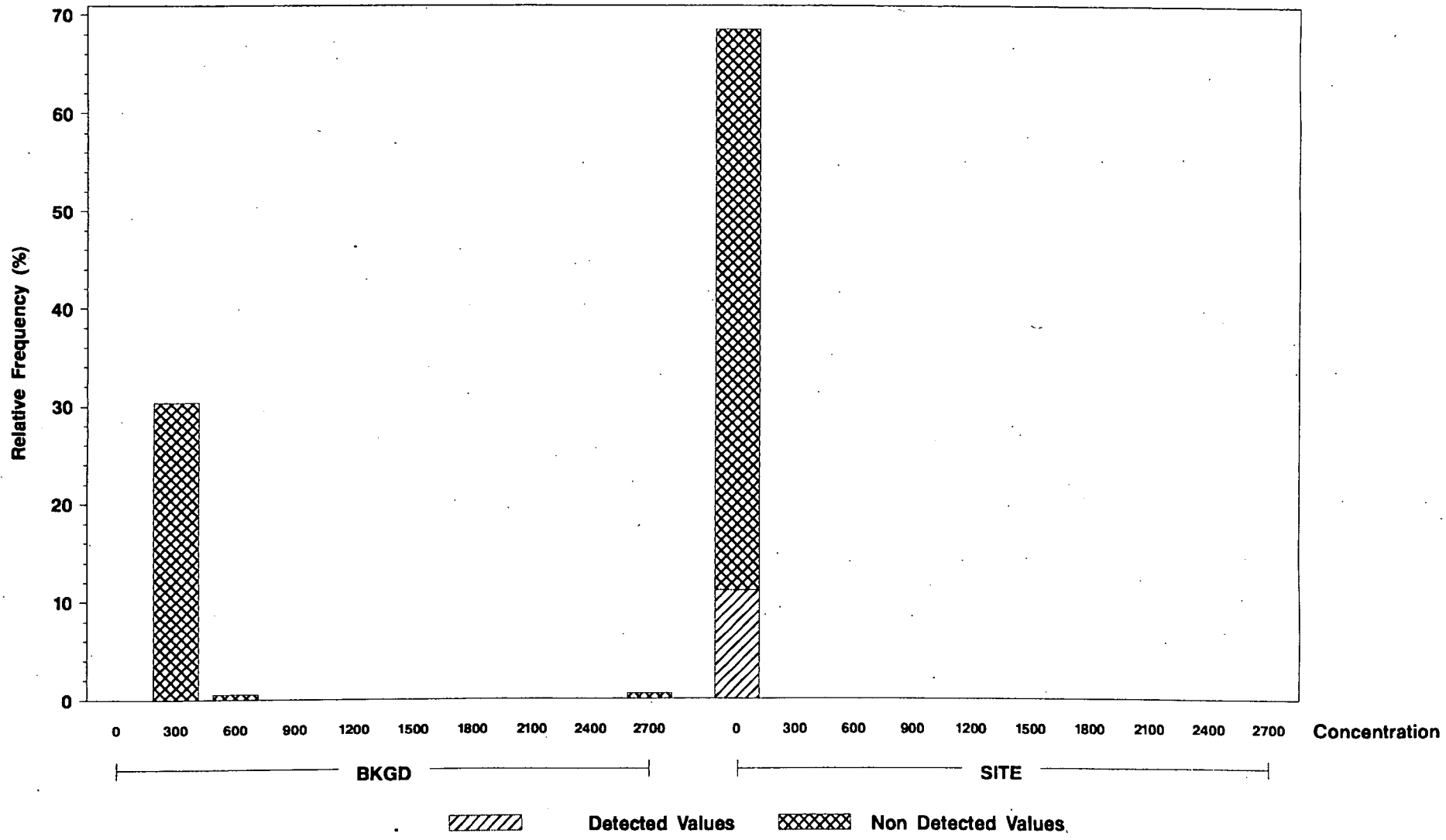
Figure D-16

Background (subsurface geologic material) Qrf vs OU11 Qrf

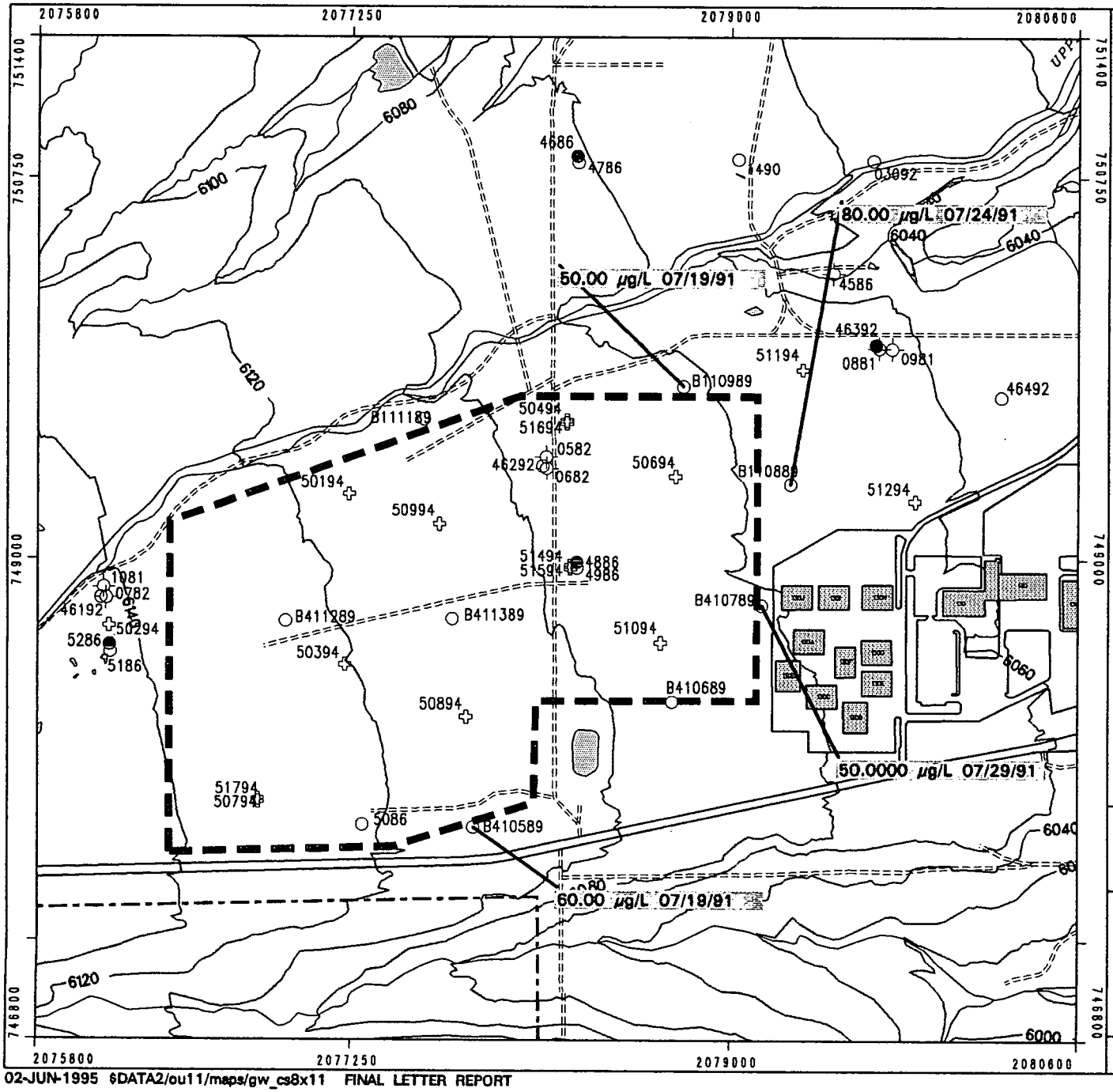
Frequency Histogram

CESIUM (mg/kg) in Qrf

(0 to 12 feet)



SITE = Boreholes within IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
CESIUM
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-17

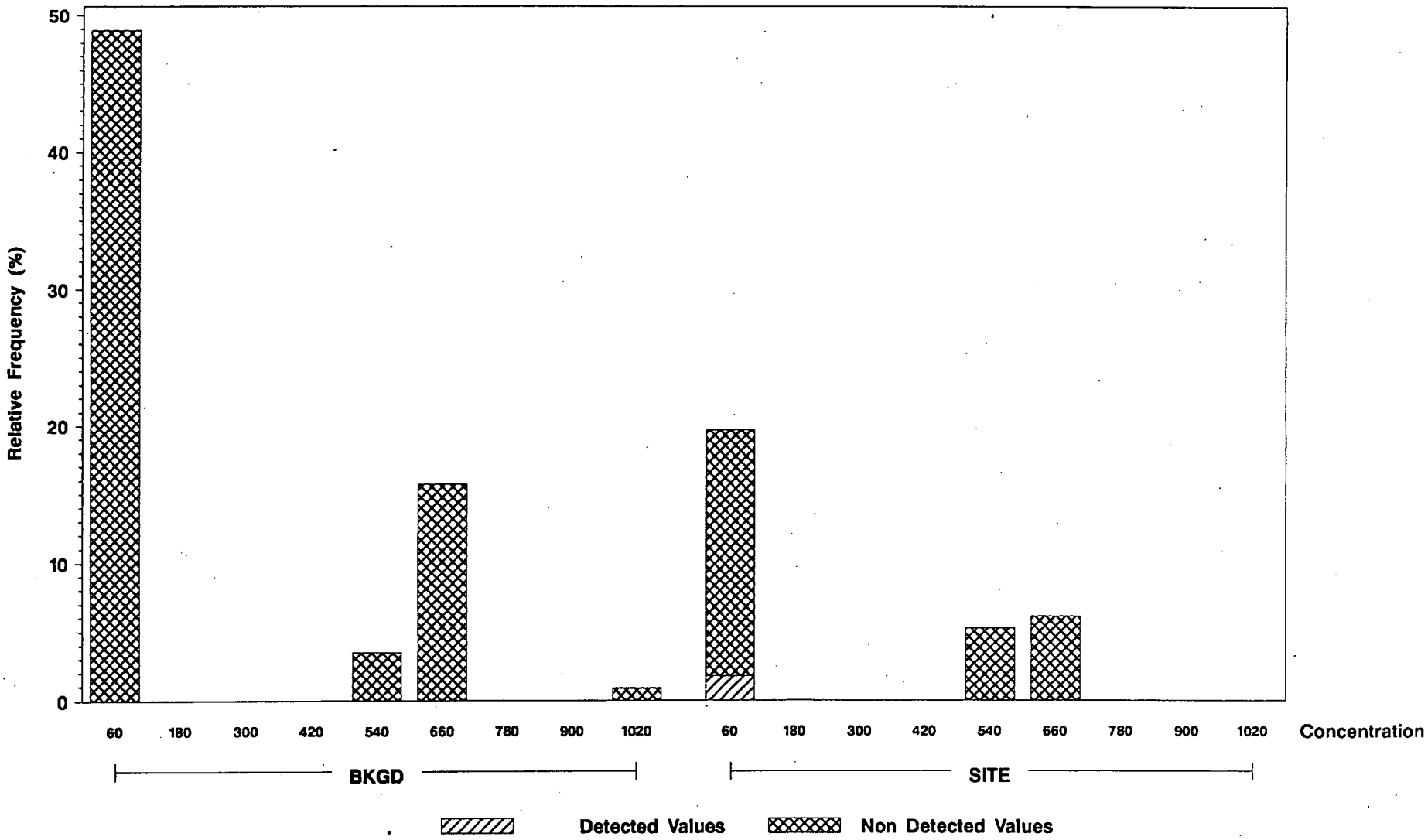
02-JUN-1995 $DATA2/ou11/maps/gw_cs8x11 FINAL LETTER REPORT

Figure D-18

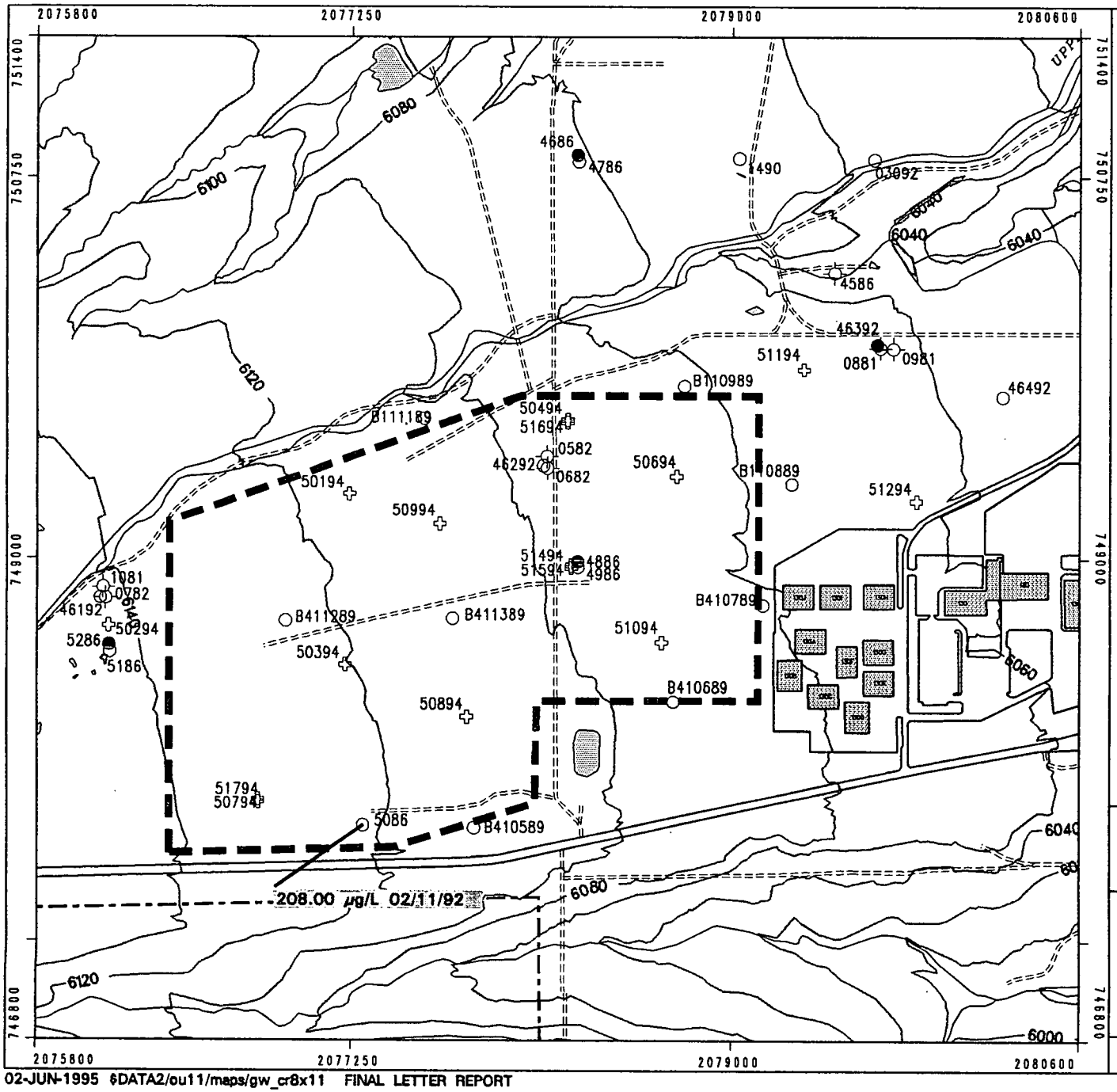
Background vs OU11 UHSU Groundwater

Frequency Histogram

CESIUM (ug/l) in Groundwater (Total)



SITE=UHSU samples from saturated media within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 125

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

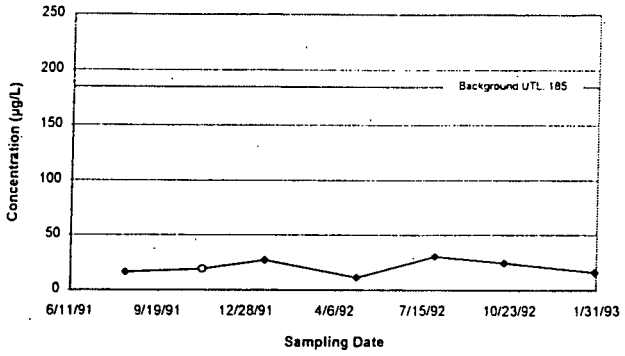
OU 11--West Spray Field
CHROMIUM
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-19

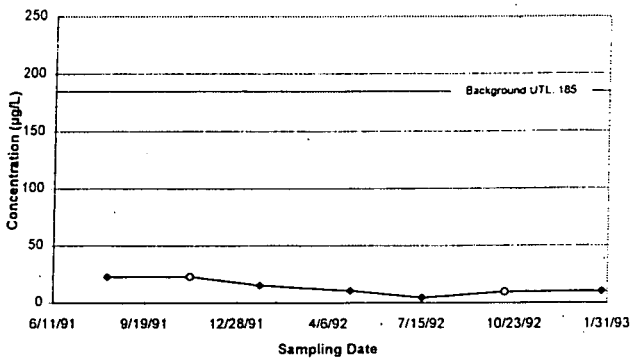
02-JUN-1995 $DATA2/ou11/maps/gw_cr8x11 FINAL LETTER REPORT

Figure D-20
Time Series Plots - Total Chromium

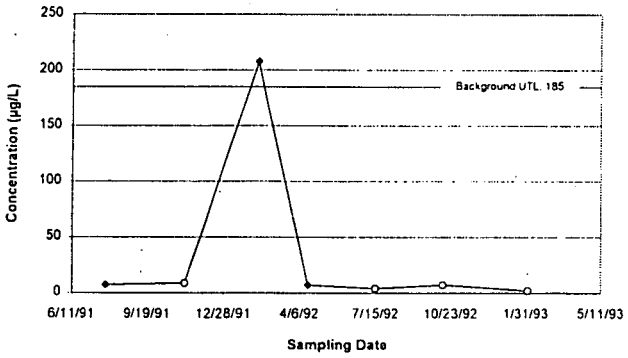
4886



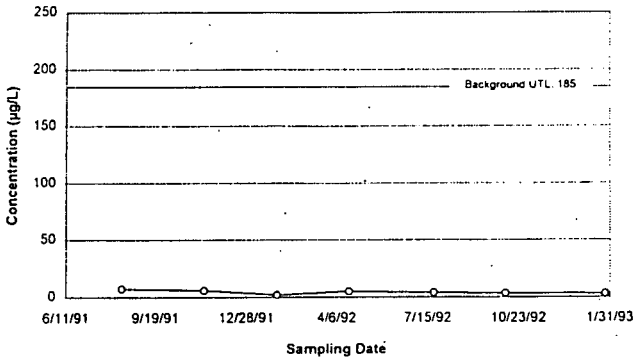
4986



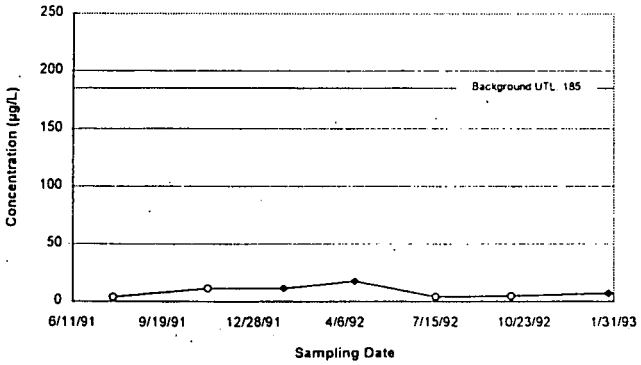
5086



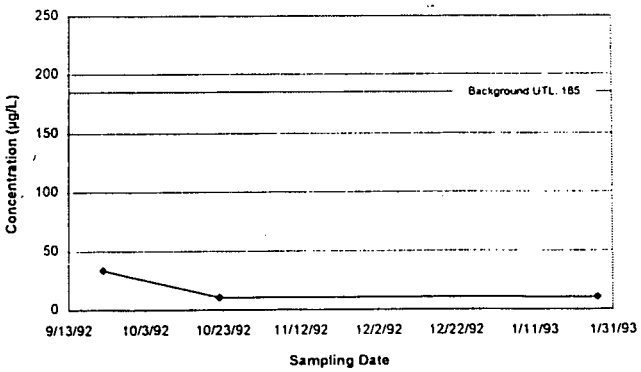
B411289



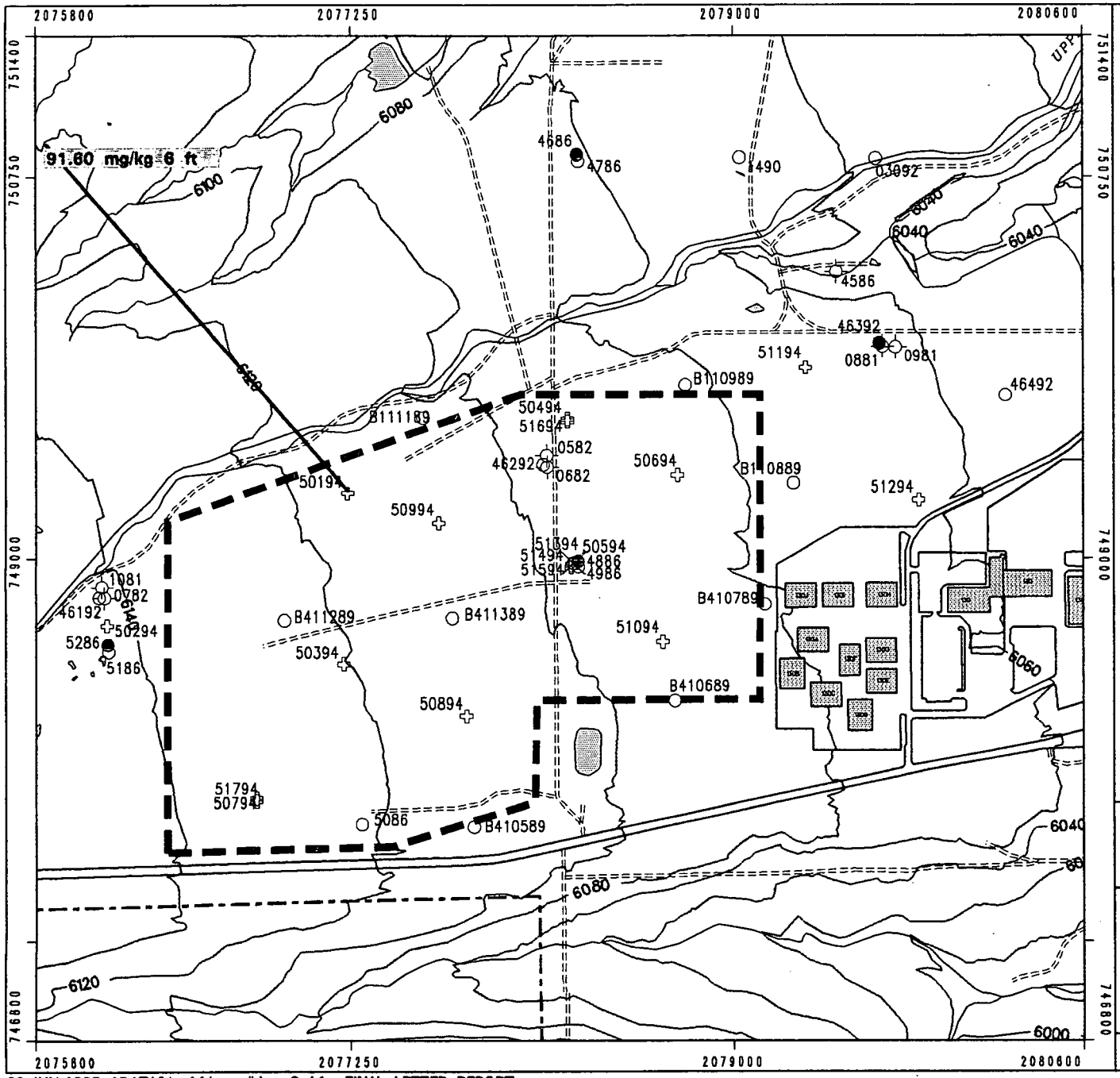
B411389



46292



◆ Hit - Y
O Hit - N



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 20

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
COBALT
Concentrations*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-21

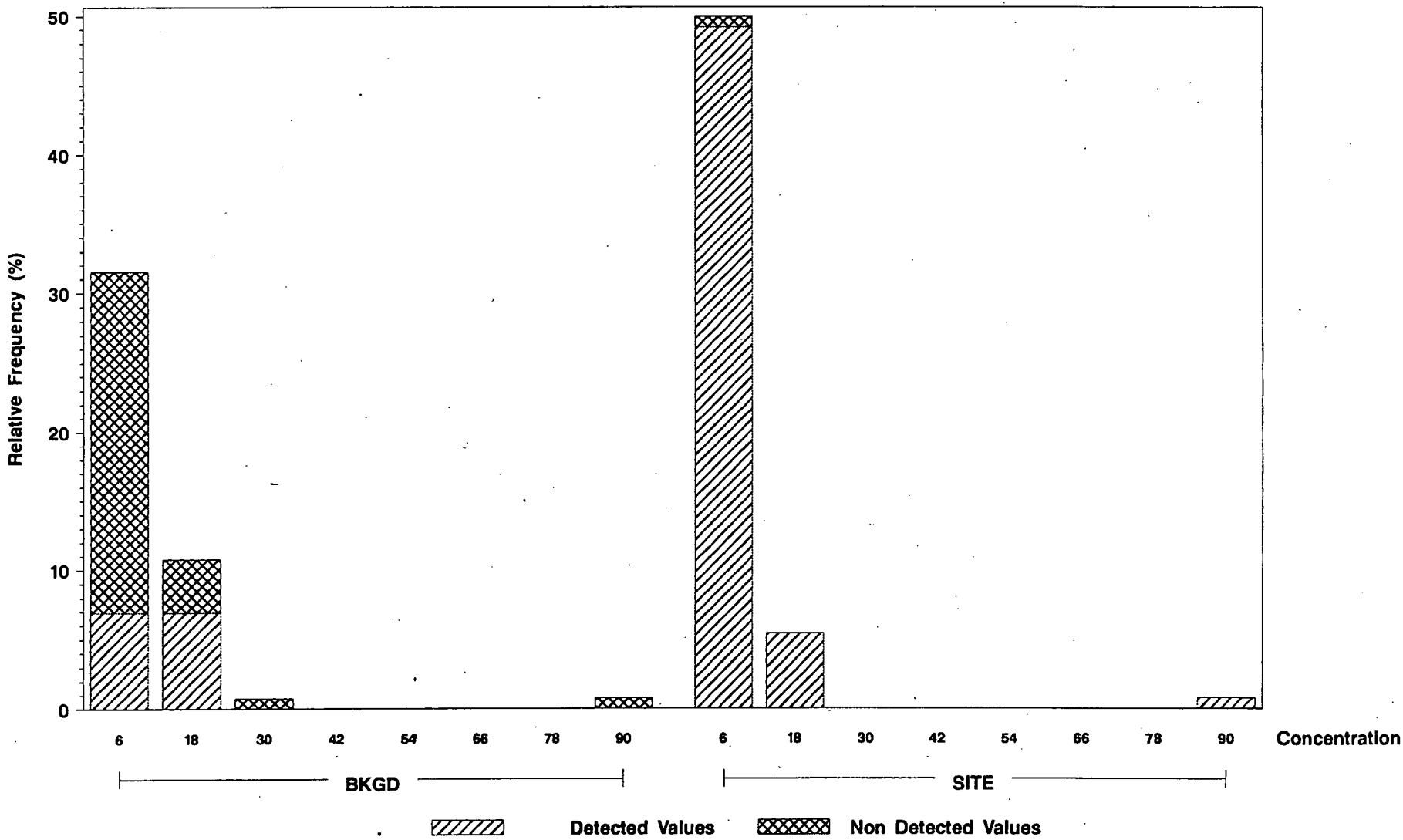
02-JUN-1995 $DATA2/ou11/maps/bh_co8x11 FINAL LETTER REPORT

Figure D-22

Background (subsurface geologic material) Qrf vs OU11 Qrf (0 – 12 feet)

Frequency Histogram

COBALT (mg/kg) in Qrf

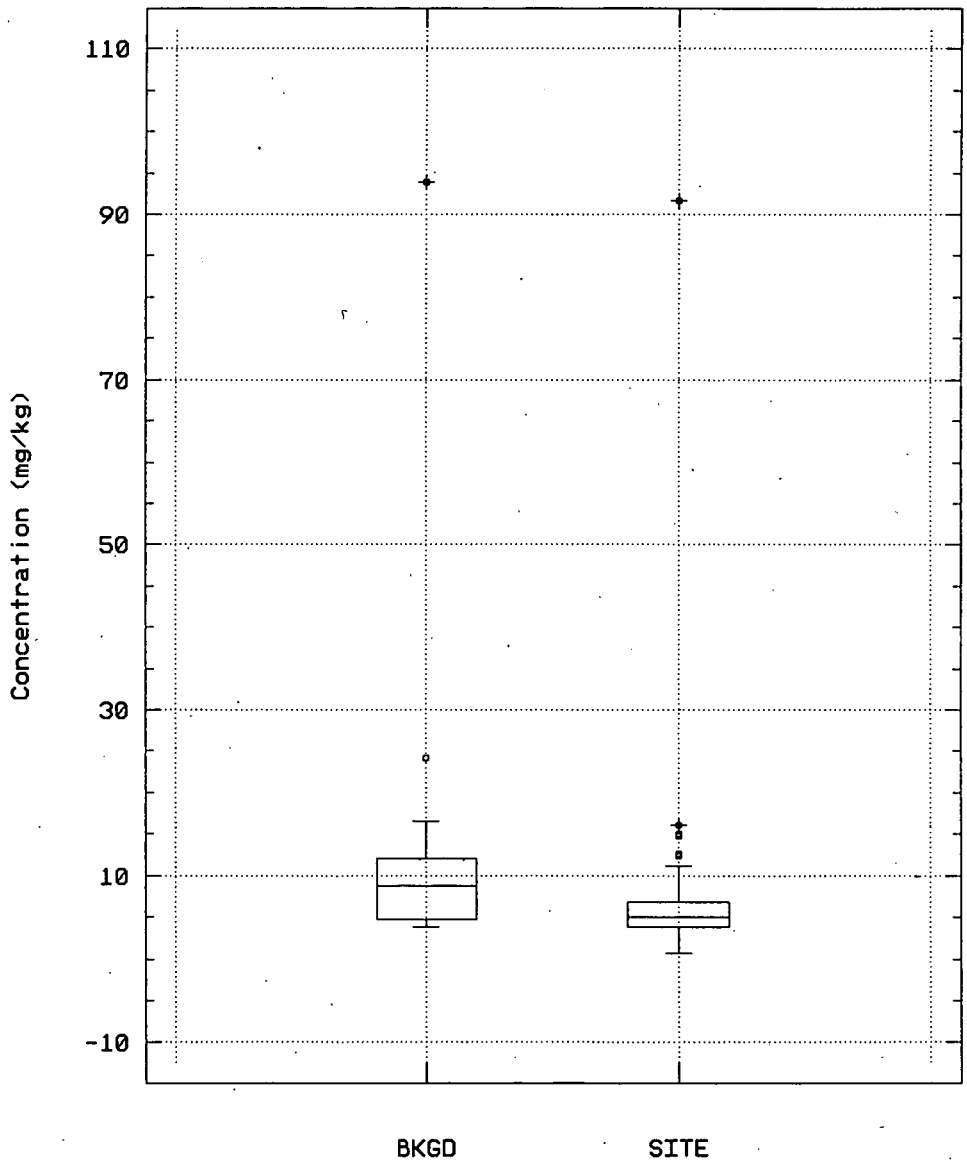


SITE = Borehole samples within and downgradient of IHSS 168

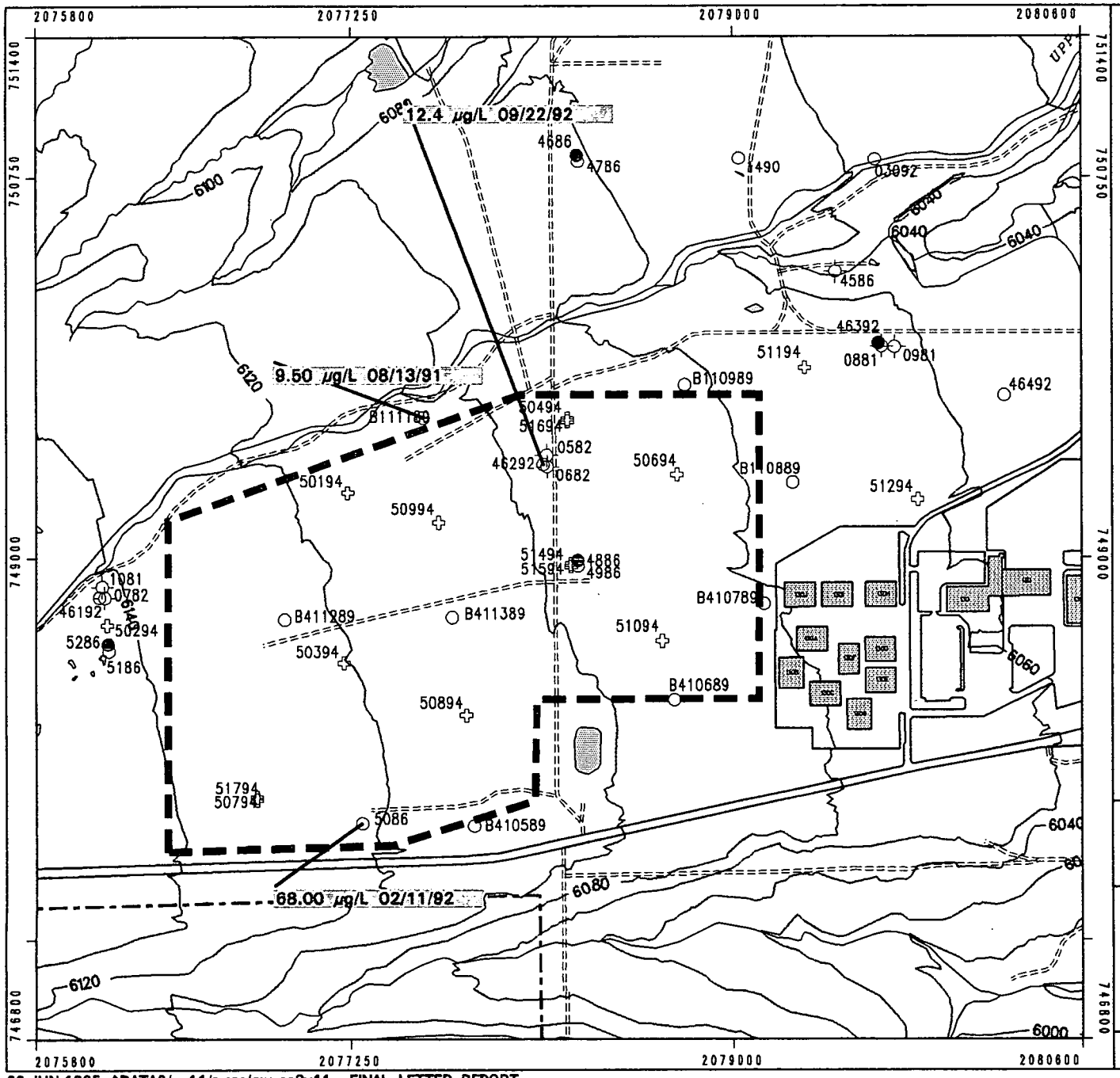
Figure D-23

Background vs OU11 Subsurface Geologic Materials (0' - 12')

Cobalt in Qrf



Borehole samples within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 9

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
COBALT
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-24

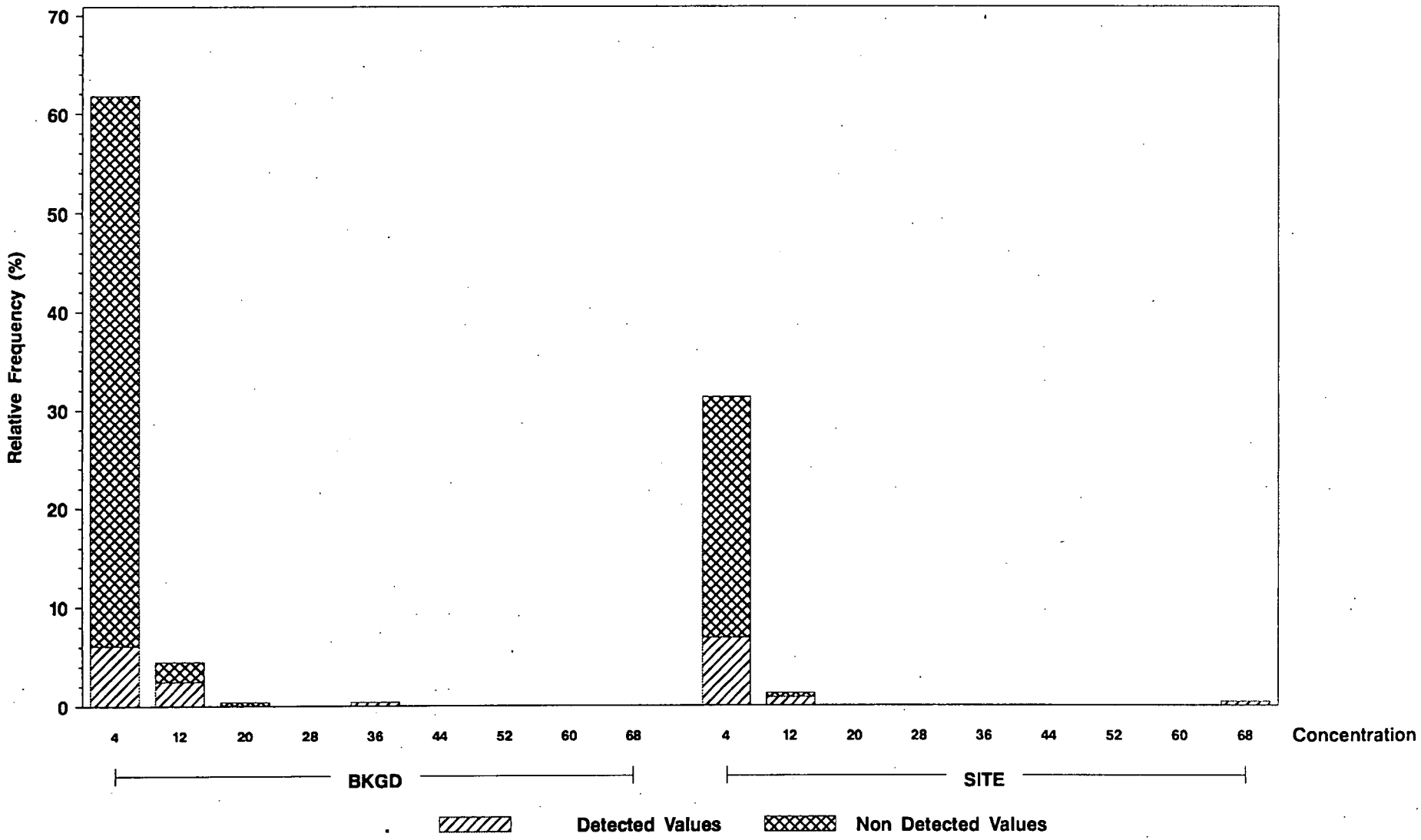
02-JUN-1995 $DATA2/ou11/maps/gw_co8x11 FINAL LETTER REPORT

Figure D-25

Background vs OU11 UHSU Groundwater

Frequency Histogram

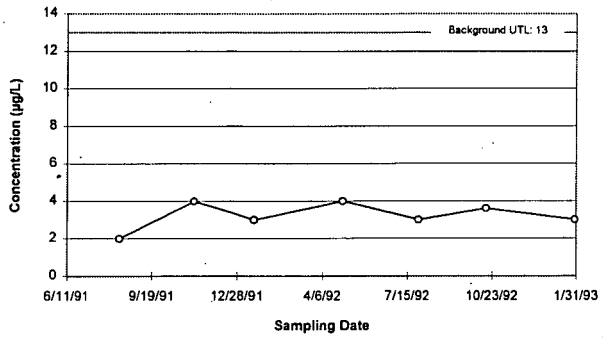
COBALT (ug/l) in Groundwater (Total)



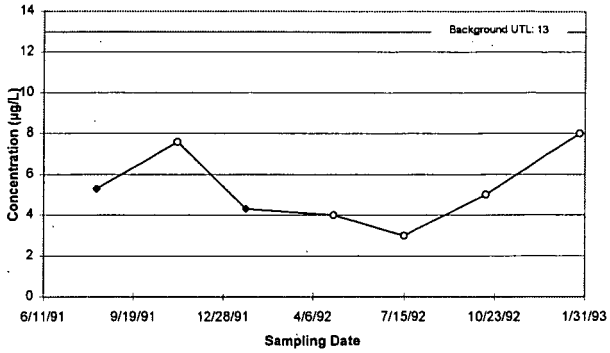
SITE = UHSU samples from saturated media within and downgradient of IHSS 168

Figure D-26
Time Series Plots - Total Cobalt

4886



4986



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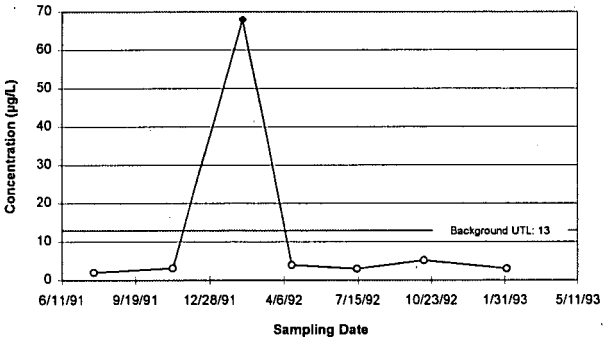
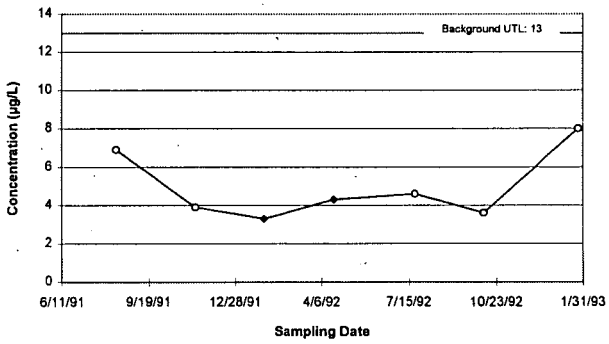
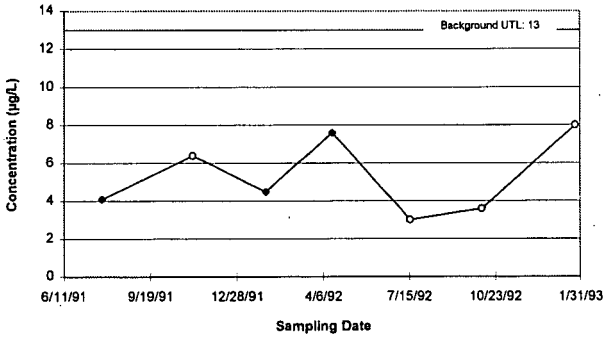


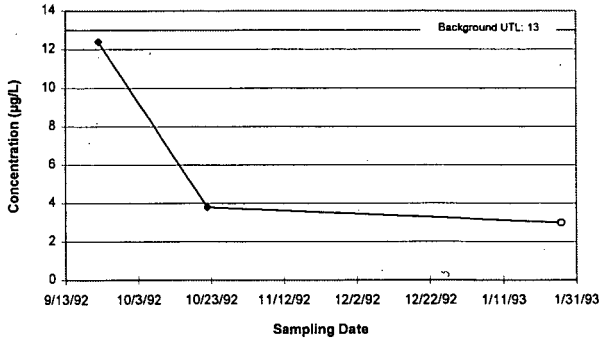
B411289



B411389



46292



◆ Hit - Y
O Hit - N

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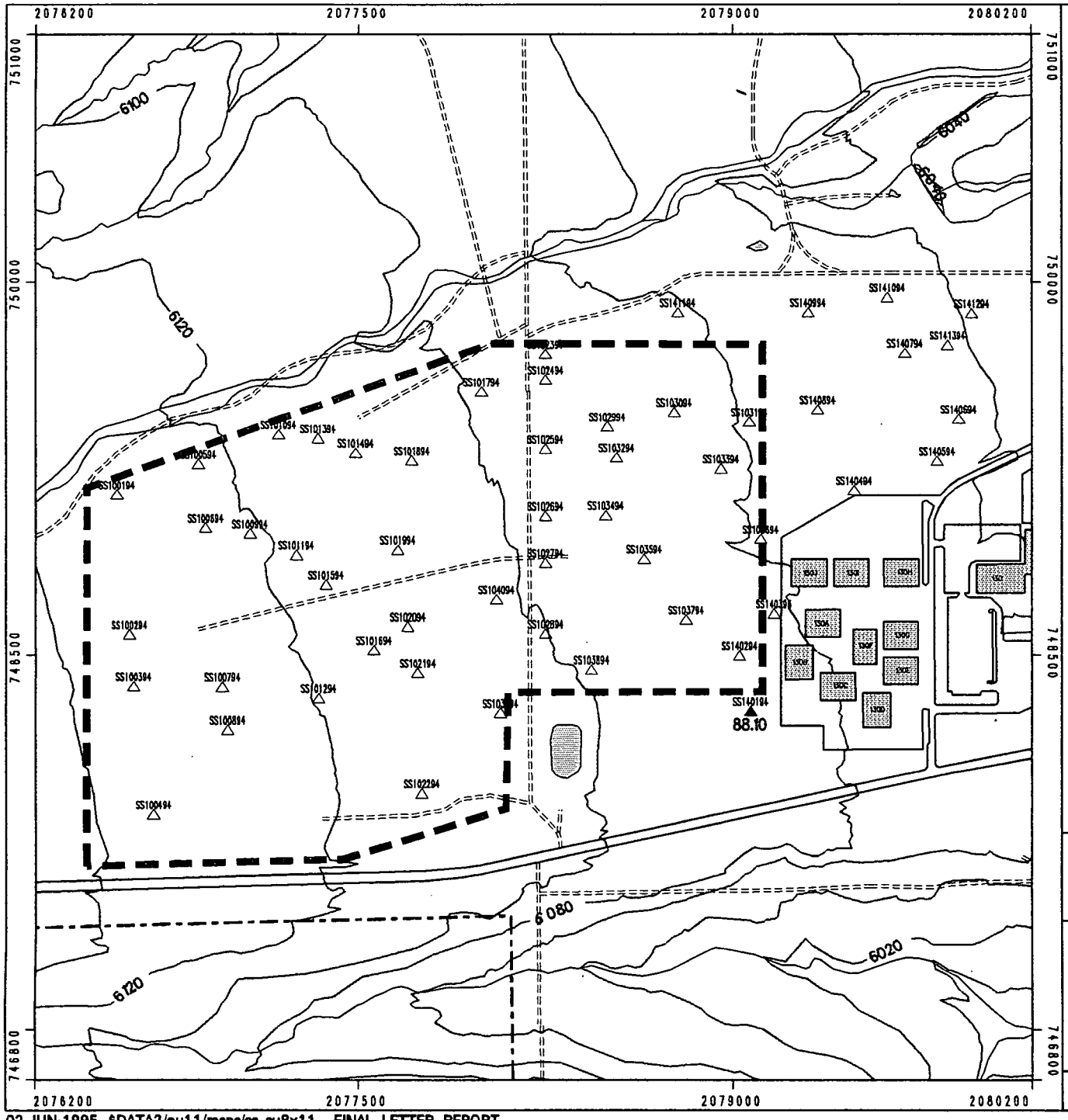


EXPLANATION

- Sample Location
- Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Concentrations are in mg/kg
BM+2SD = 22

Scale = 1 : 7200
1 inch = 600 feet

300 0 600ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
COPPER
Concentrations*
at the
OU 11--West Spray Field

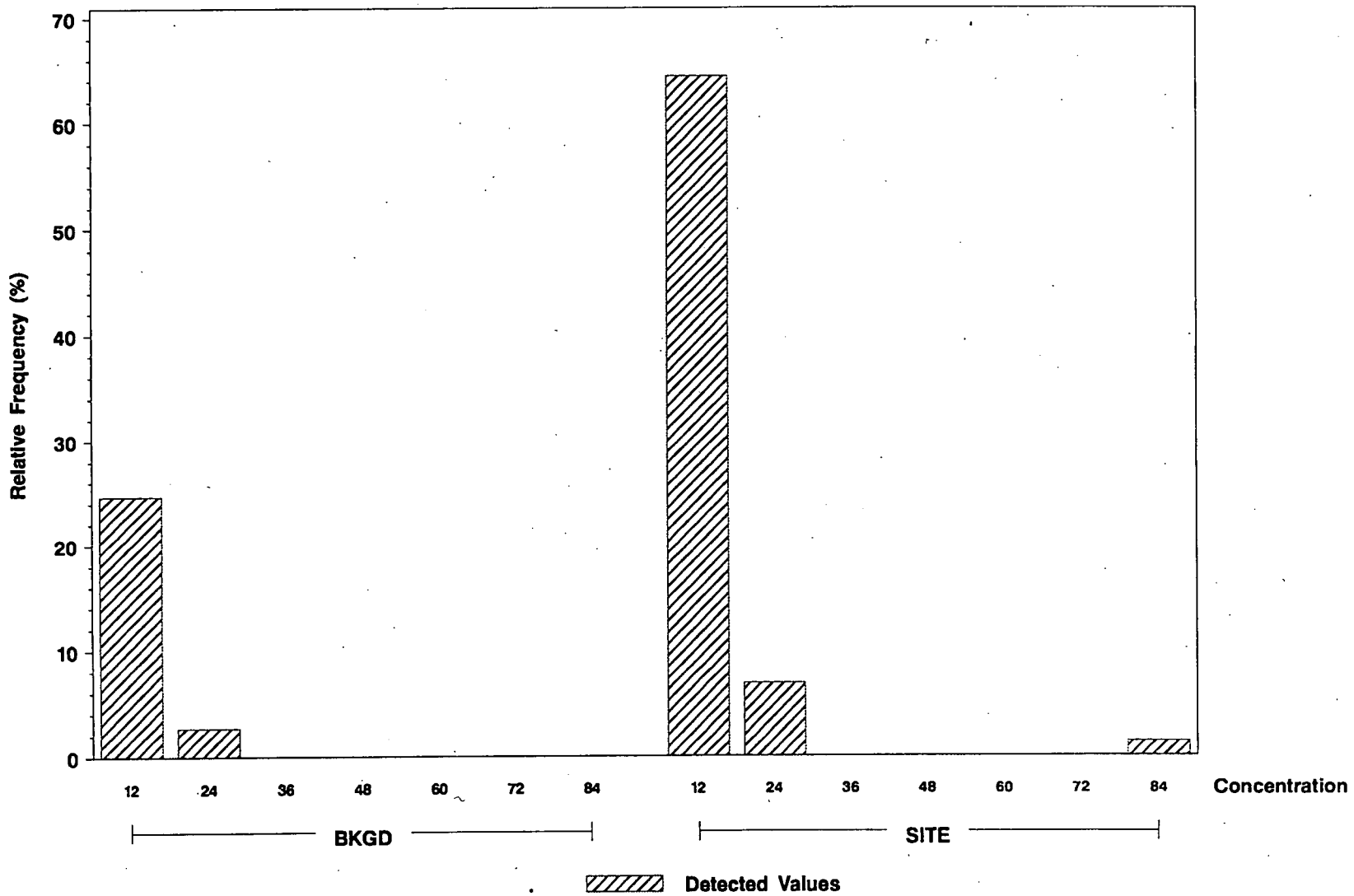
June 1995 | Figure D-27

Figure D-28

Background vs OU11 Surface Soil

Frequency Histogram

COPPER (mg/kg) in Surface Soil (0 – 2 inches)

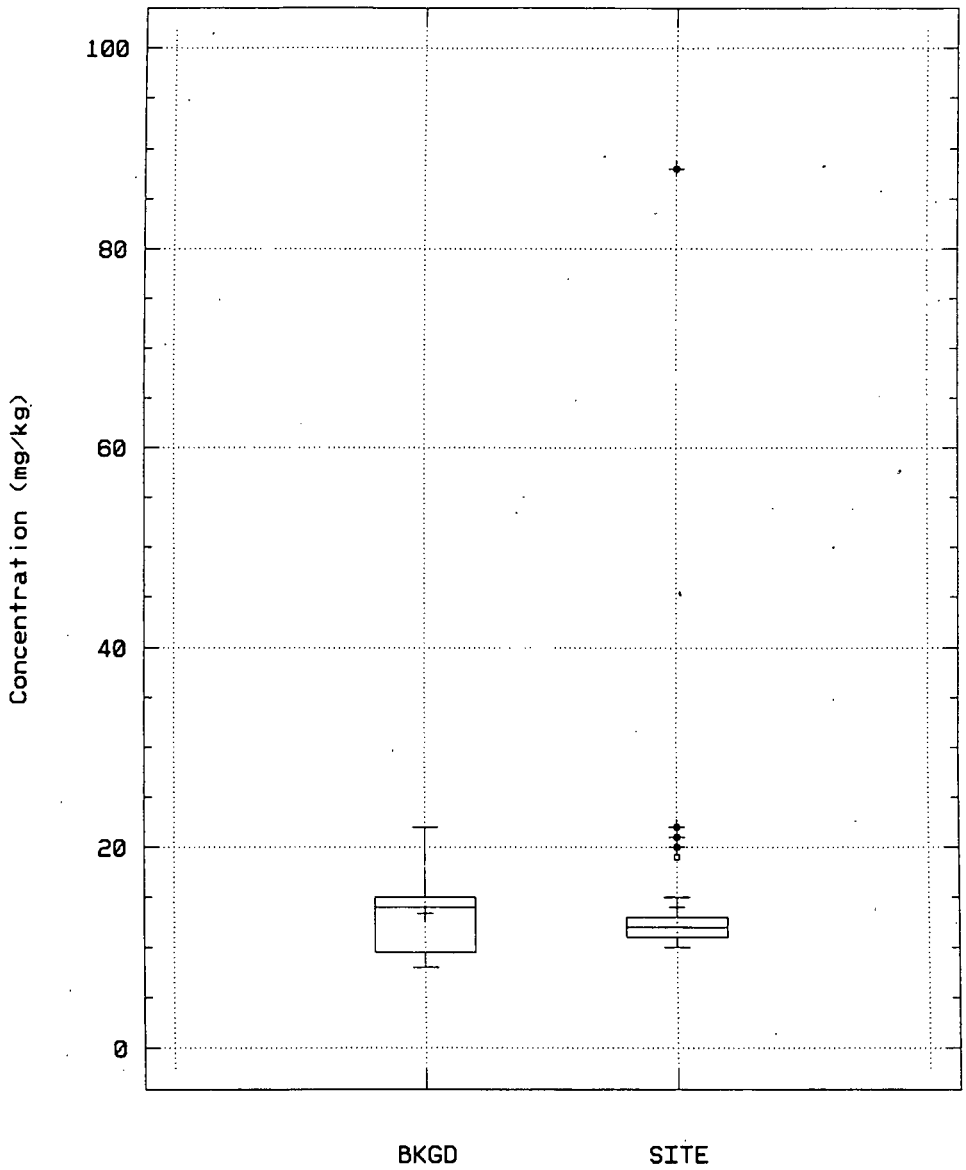


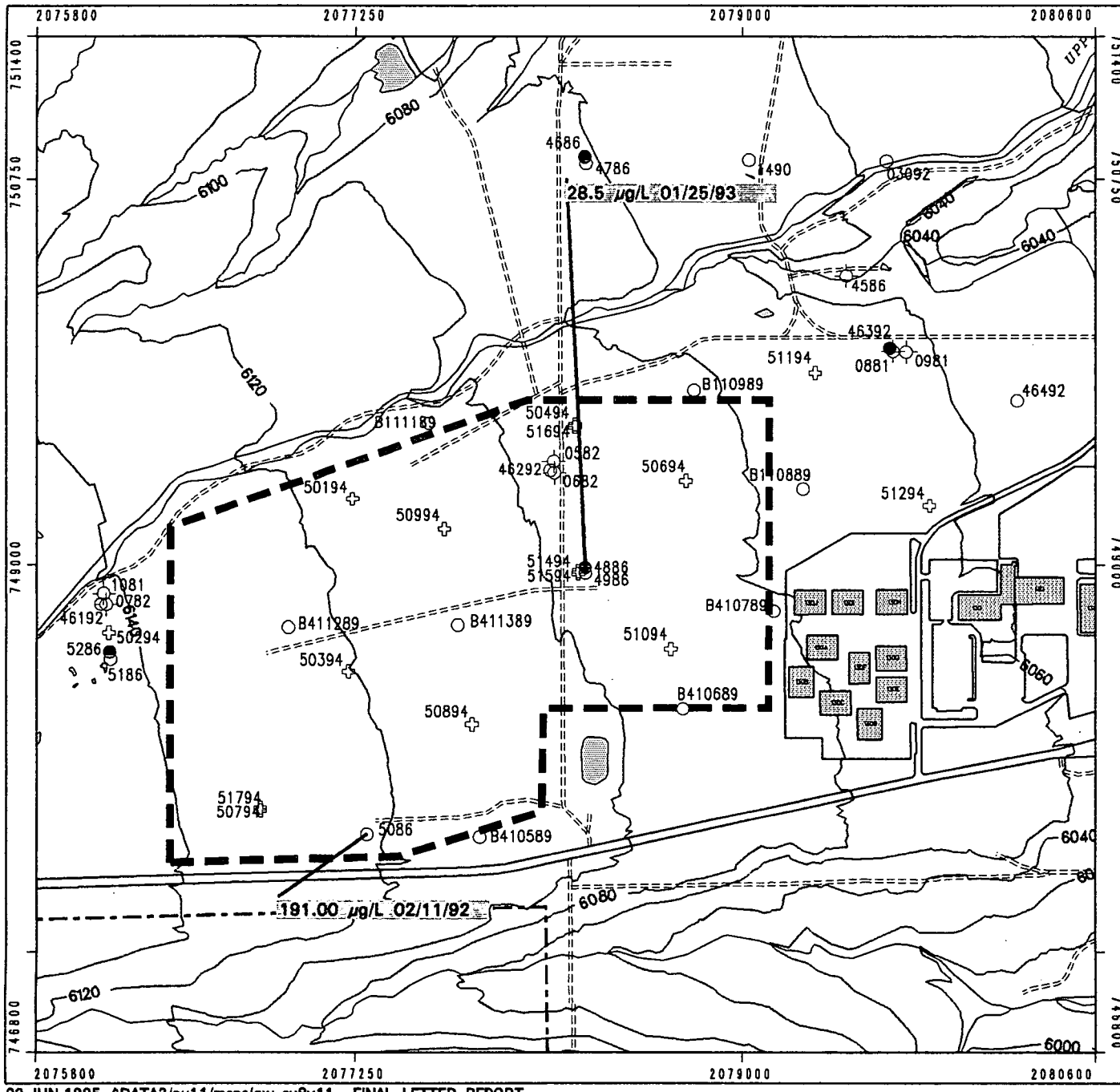
SITE = All areas sampled within OU11

Figure D-29

Background vs OU11 Surface Soil

Copper in Surface Soil (0 to 2 inches)





EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 27

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

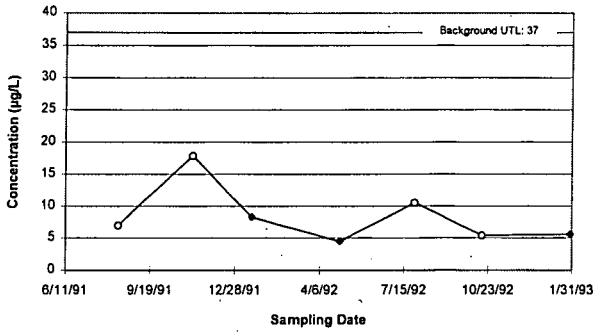
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
COPPER
Concentrations*
(and Sample Dates) in
UHSU Ground Water

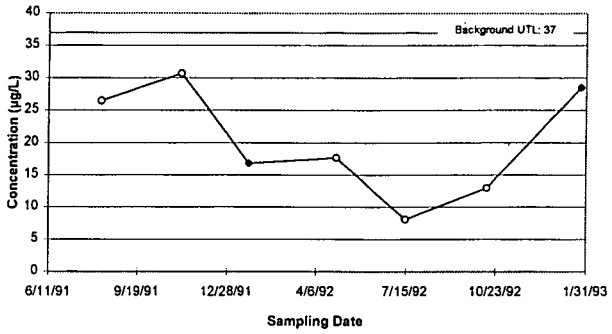
June 1995 | Figure D-30

Figure D-31
Time Series Plots - Total Copper

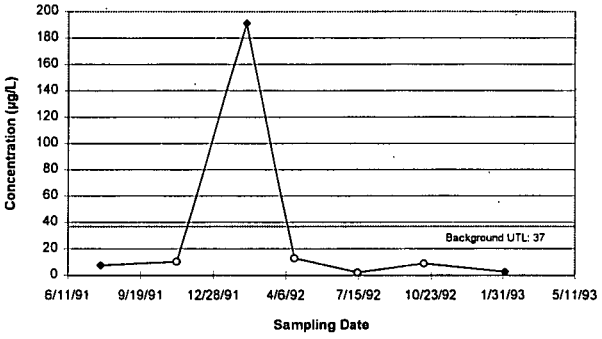
4886



4986



5086



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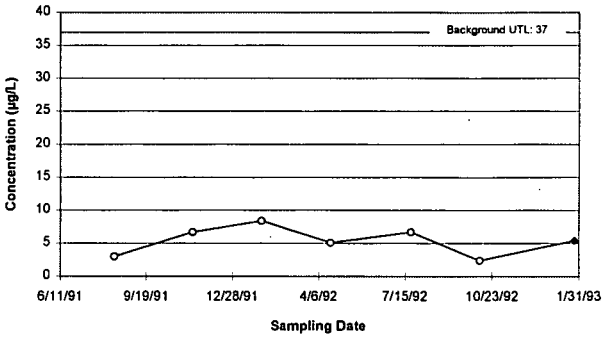

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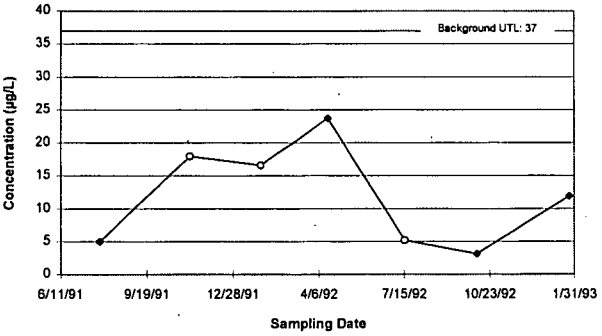

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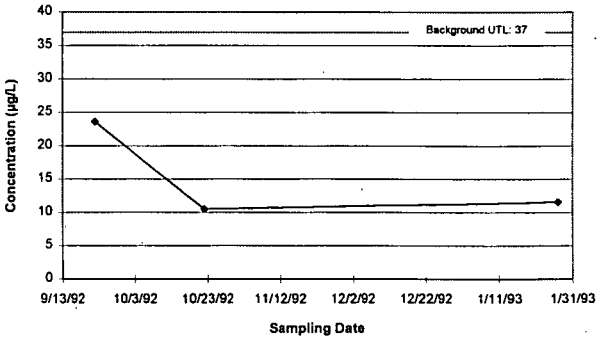

◆ Hit - Y
O Hit - N

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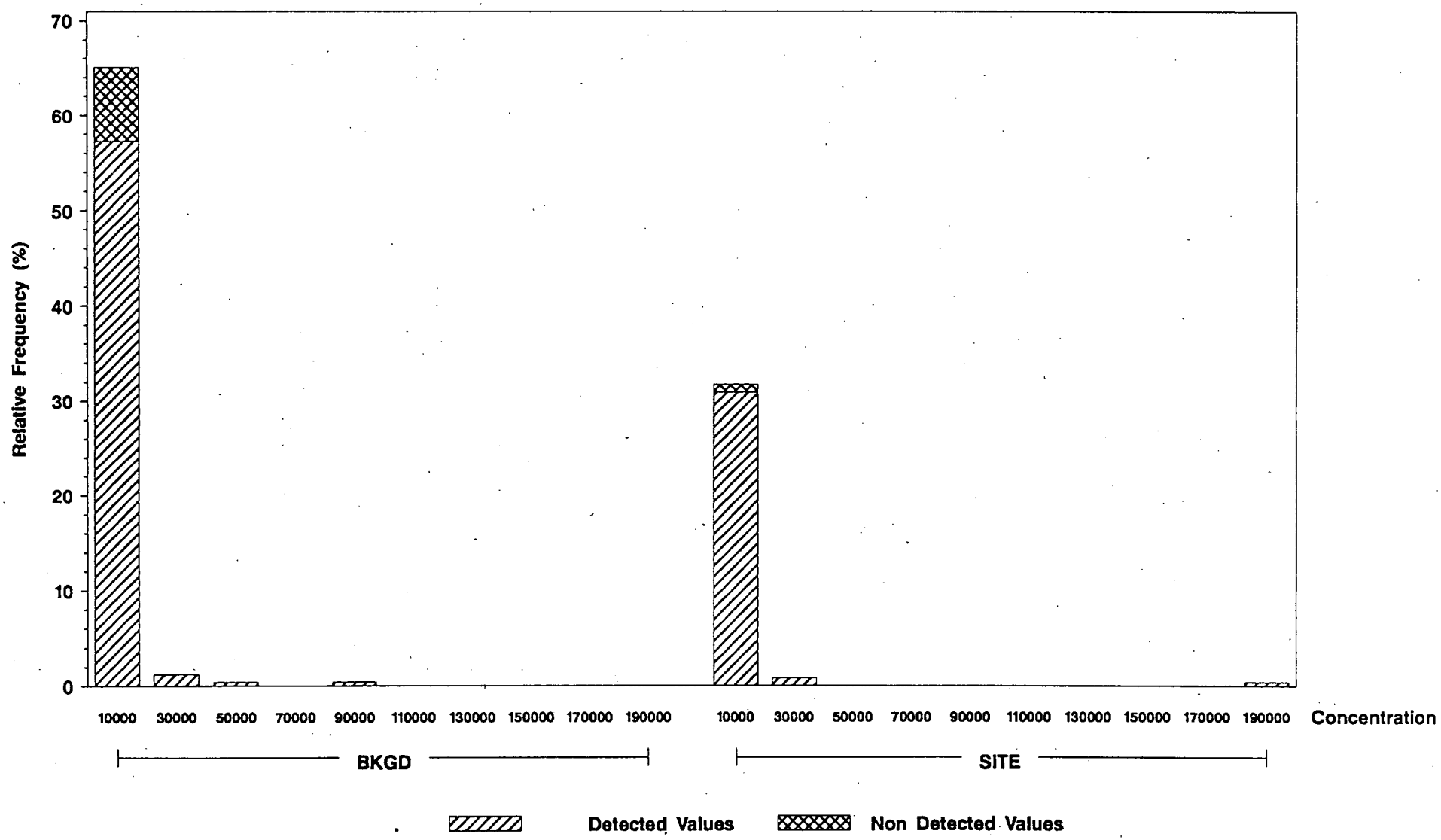
Figure D-32

Background vs OU11 UHSU Groundwater

Frequency Histogram

IRON (ug/l) in Groundwater (Total)

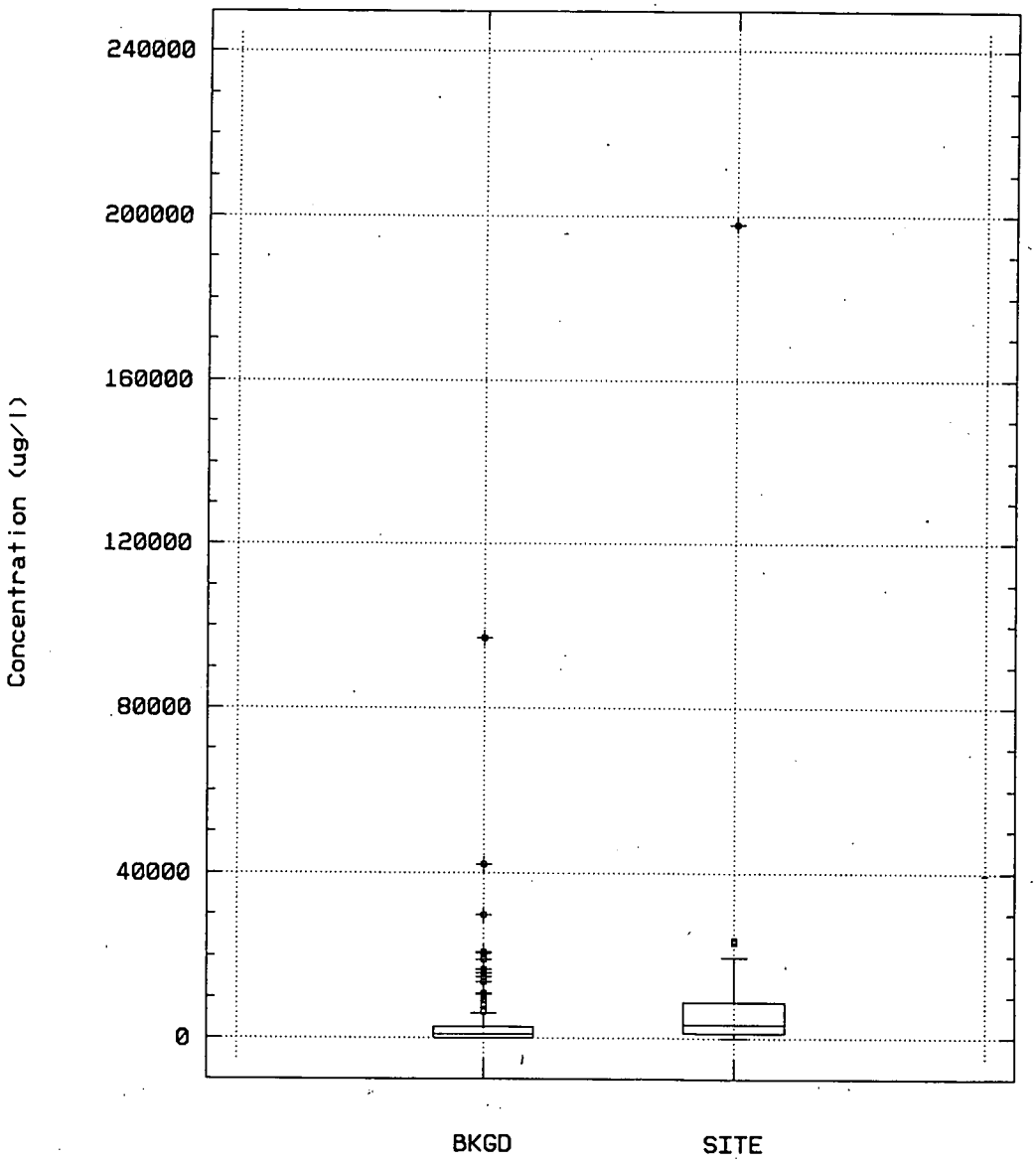


SITE=UHSU samples from saturated media within and downgradient of IHSS 168

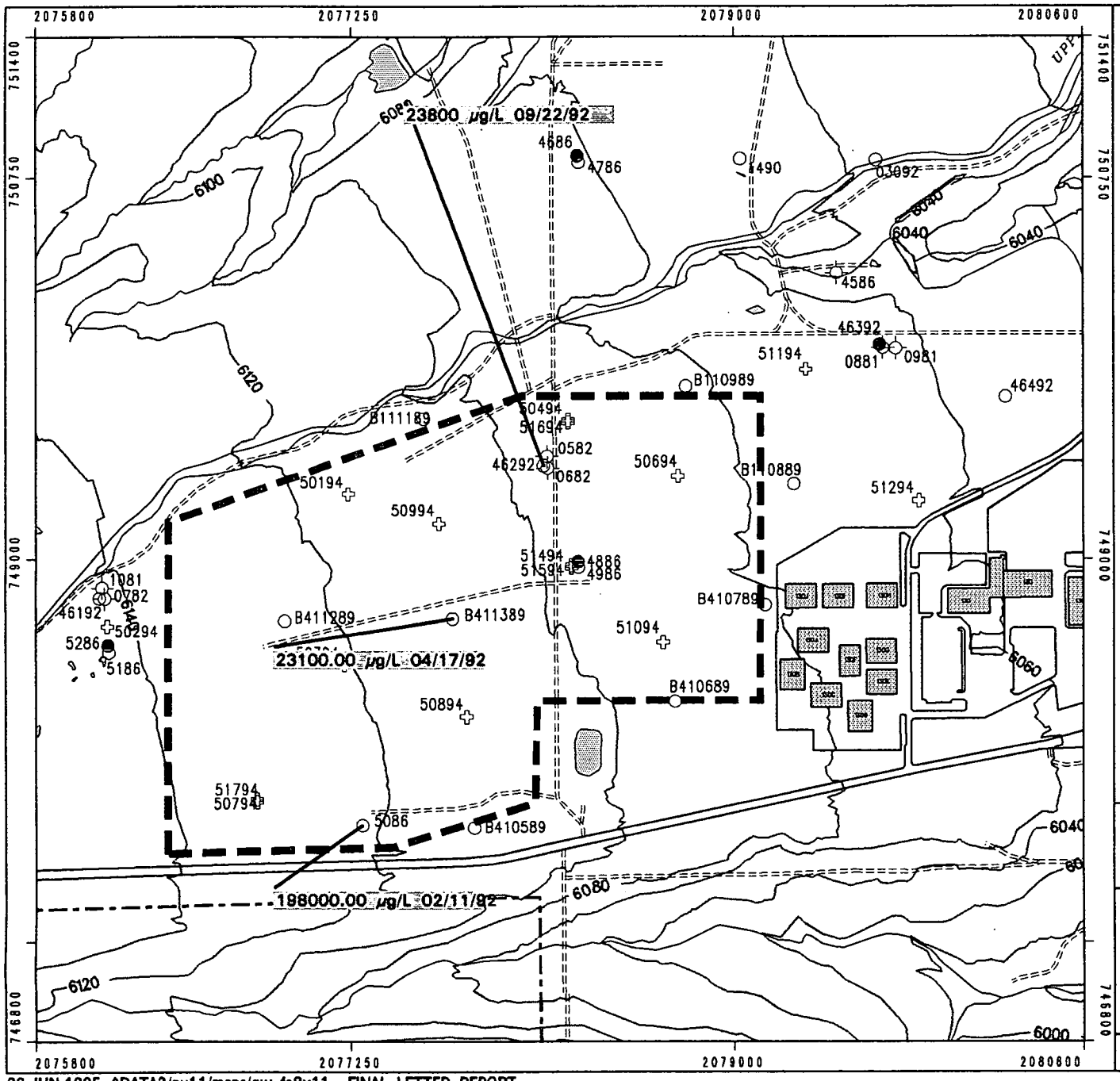
Figure D-33

Background vs OU11 UHSU Groundwater

Iron in Groundwater (Total)



Groundwater samples within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 22061

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

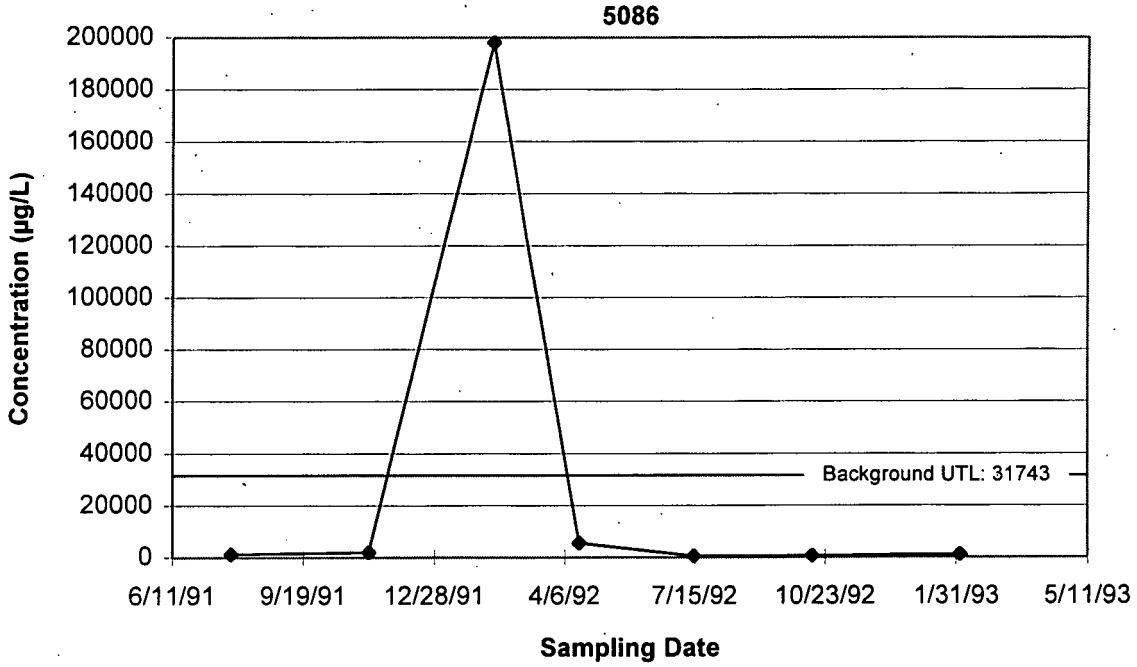
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
IRON
Concentrations*
(and Sample Dates) in
UHSU Ground Water

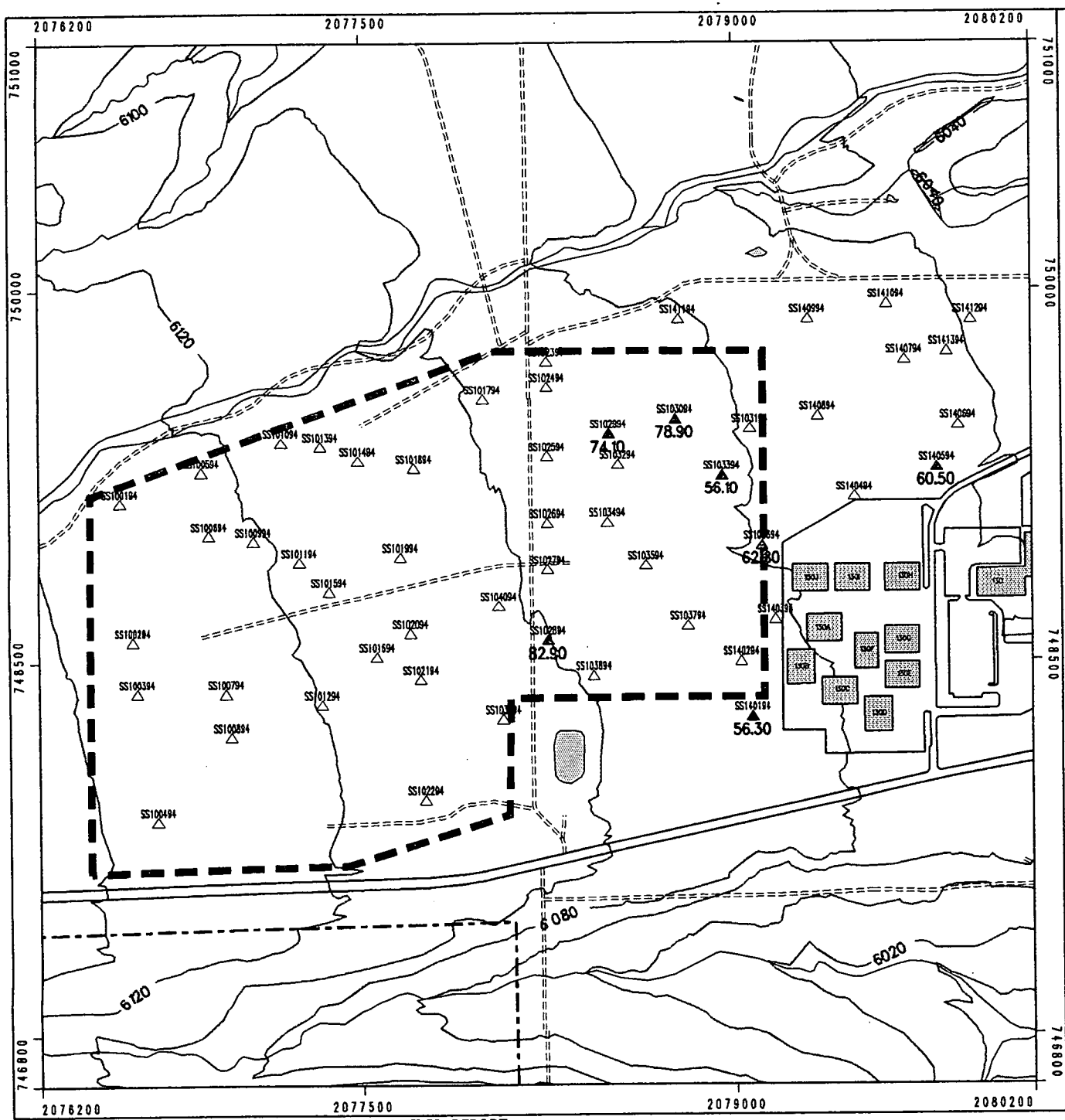
June 1995 | Figure D-34

Figure D-35
Time Series Plot - Total Iron
5086



● Hit - Y
o Hit - N

MEP C:\..\ALL_TS.XLS Aluminum, Beryllium, Iron 3/21/95



EXPLANATION

- Sample Location
- Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Concentrations are in mg/kg
BM+2SD = 50

Scale = 1 : 7200
1 inch = 600 feet

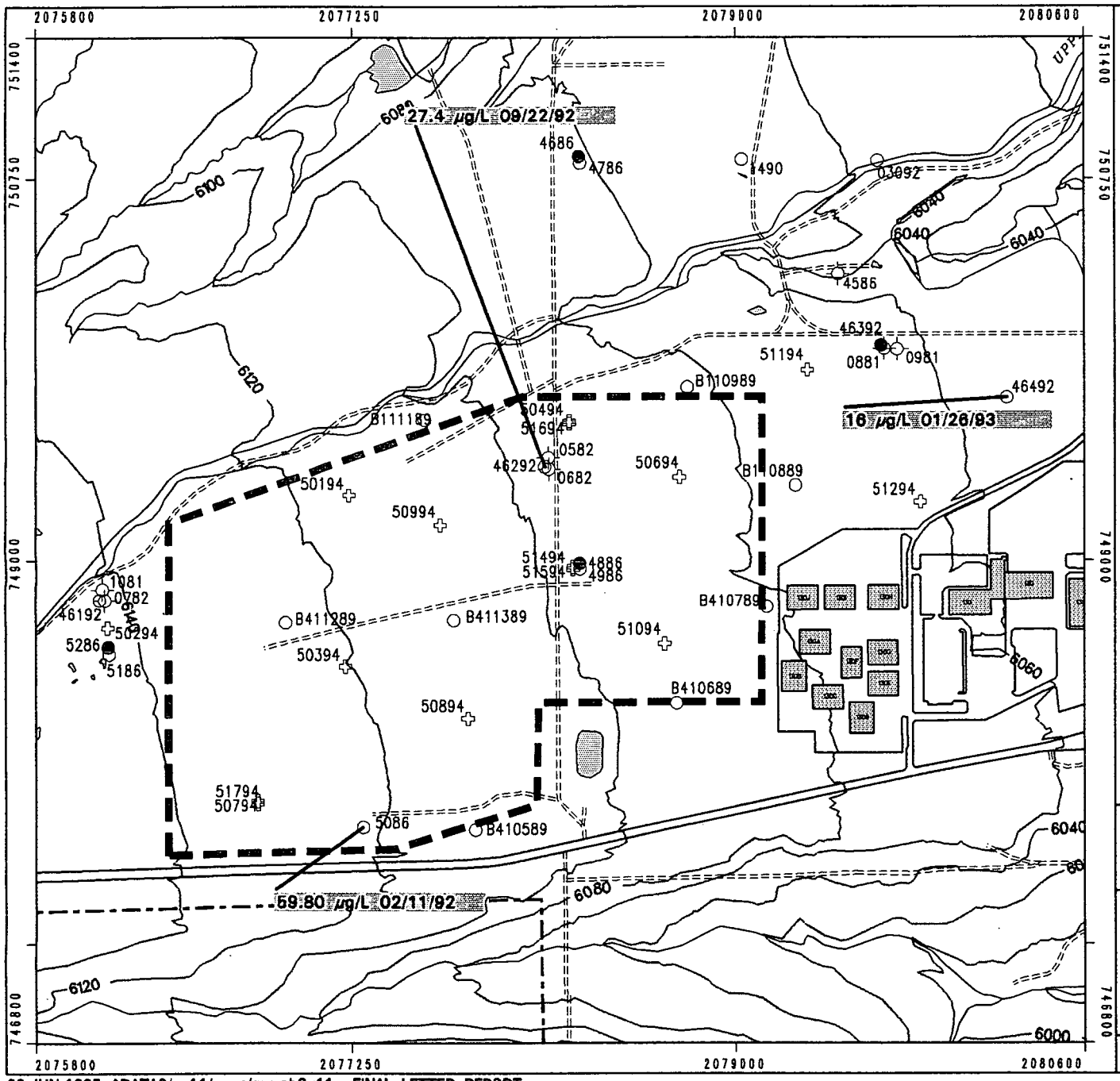
200 0 600ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
LEAD
Concentrations*
at the
OU 11--West Spray Field

June 1995 | Figure D-36



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 14

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
LEAD
Concentrations*
(and Sample Dates) in
UHSU Ground Water

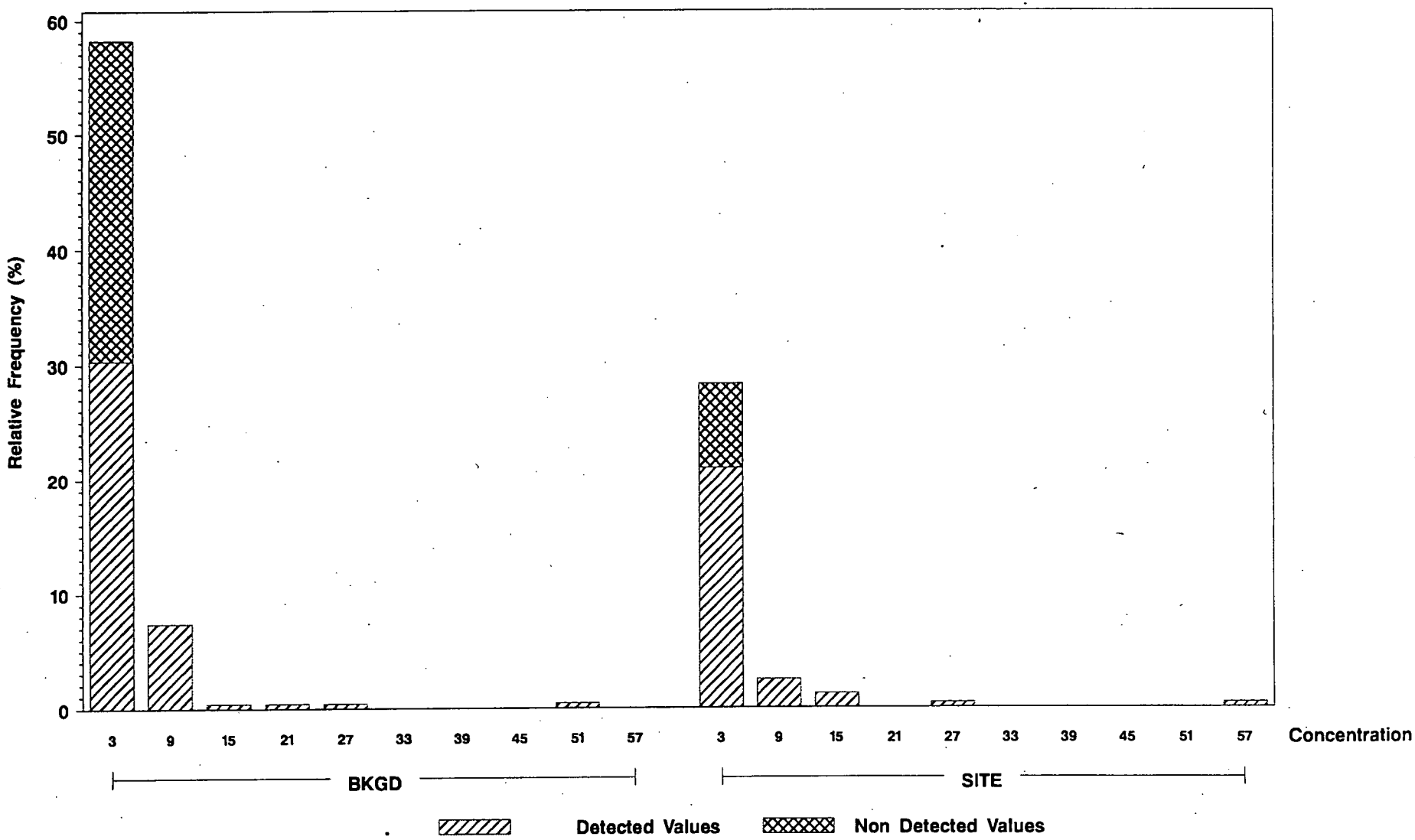
June 1995 | Figure D-37

Figure D-38

Background vs OU11 UHSU Groundwater

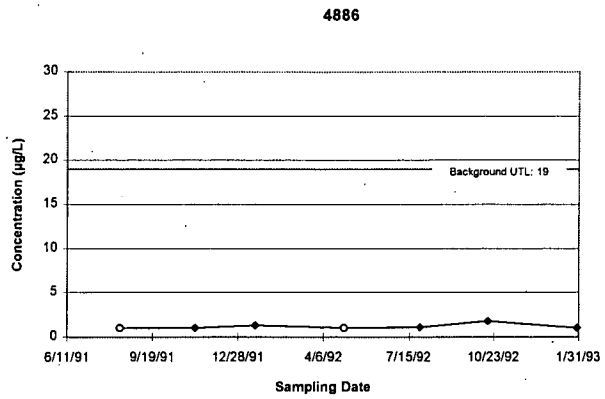
Frequency Histogram

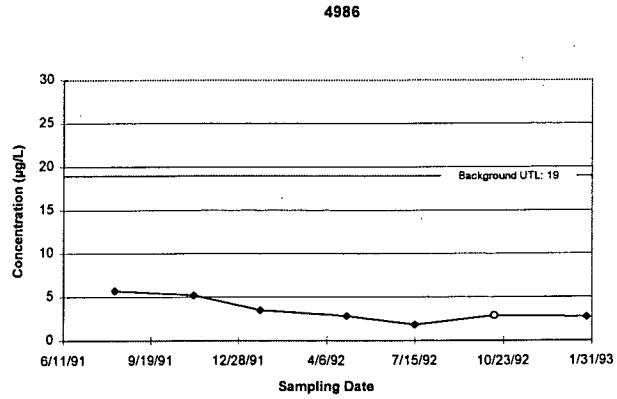
LEAD (ug/l) in Groundwater (Total)

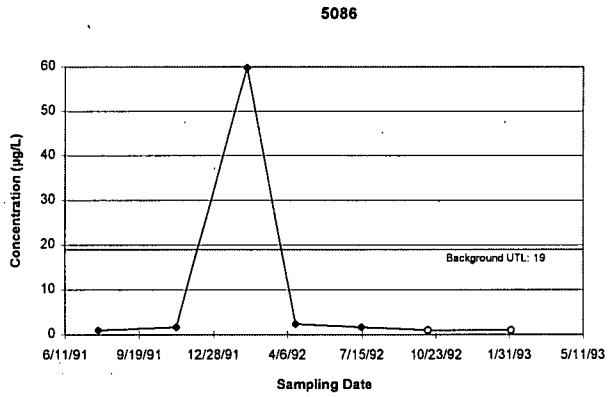


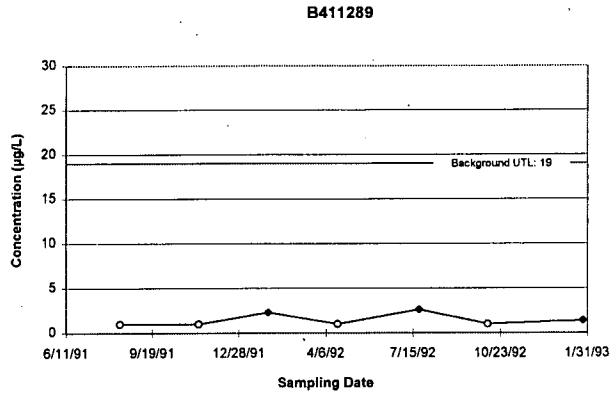
SITE = UHSU samples from saturated media within and downgradient of IHSS 168

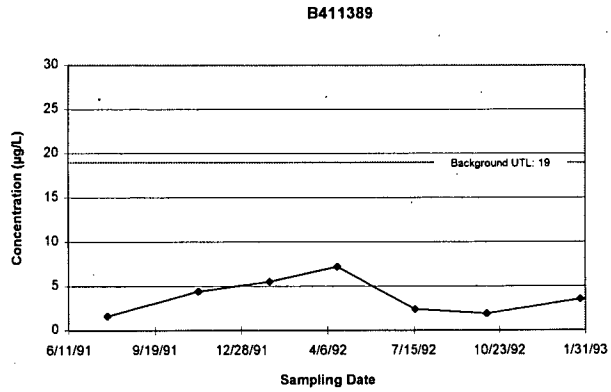
Figure D-39
Time Series Plots - Total Lead

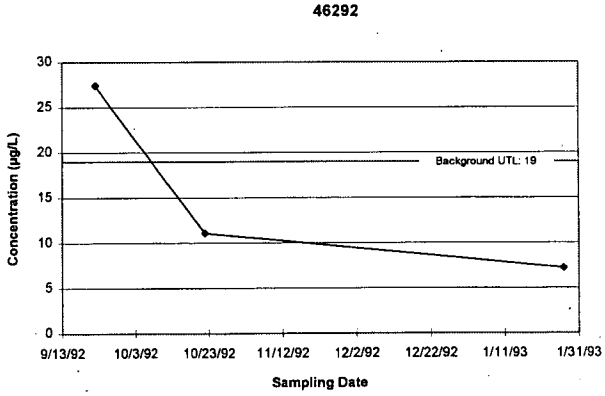












◆ Hit - Y
O Hit - N

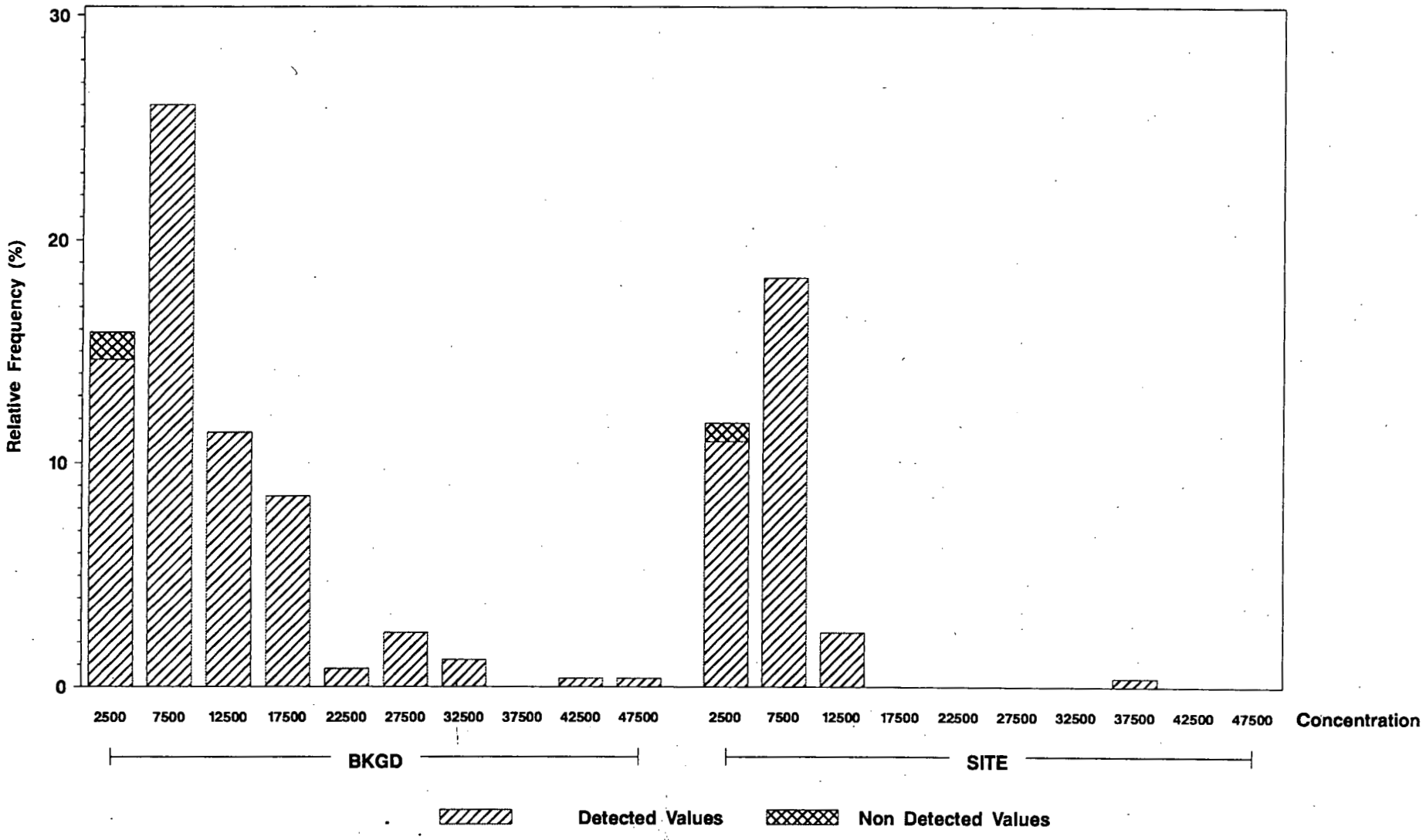
MEP C:\ALL_TS.XLS Lead 3/22/95

Figure D-40

Background vs OU11 UHSU Groundwater

Frequency Histogram

MAGNESIUM (ug/l) in Groundwater (Total)

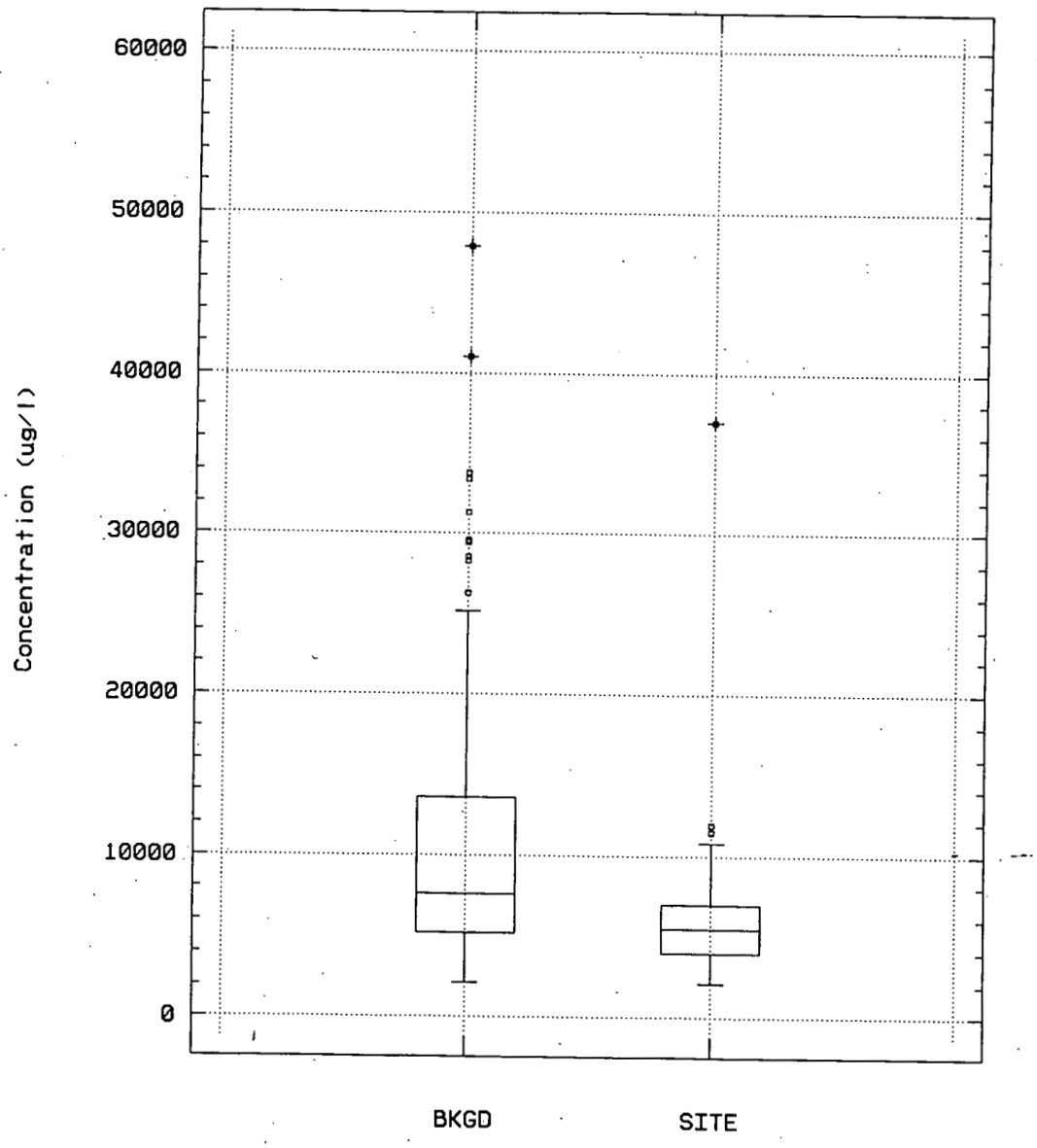


SITE=UHSU samples from saturated media within and downgradient of IHSS 168

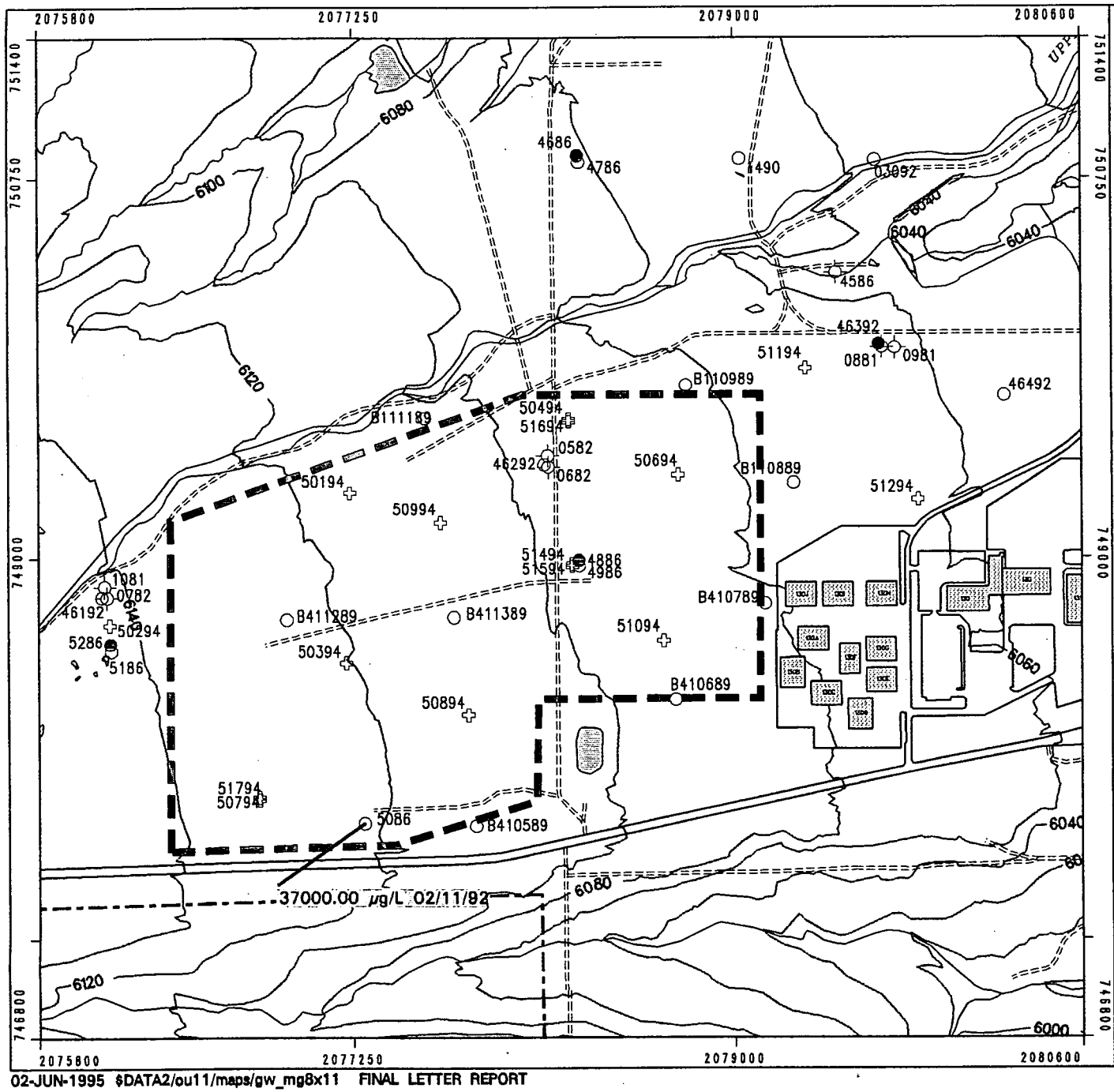
Figure D-41

Background vs OU11 UHSU Groundwater

Magnesium in Groundwater (Total)



Groundwater samples within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 25479

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

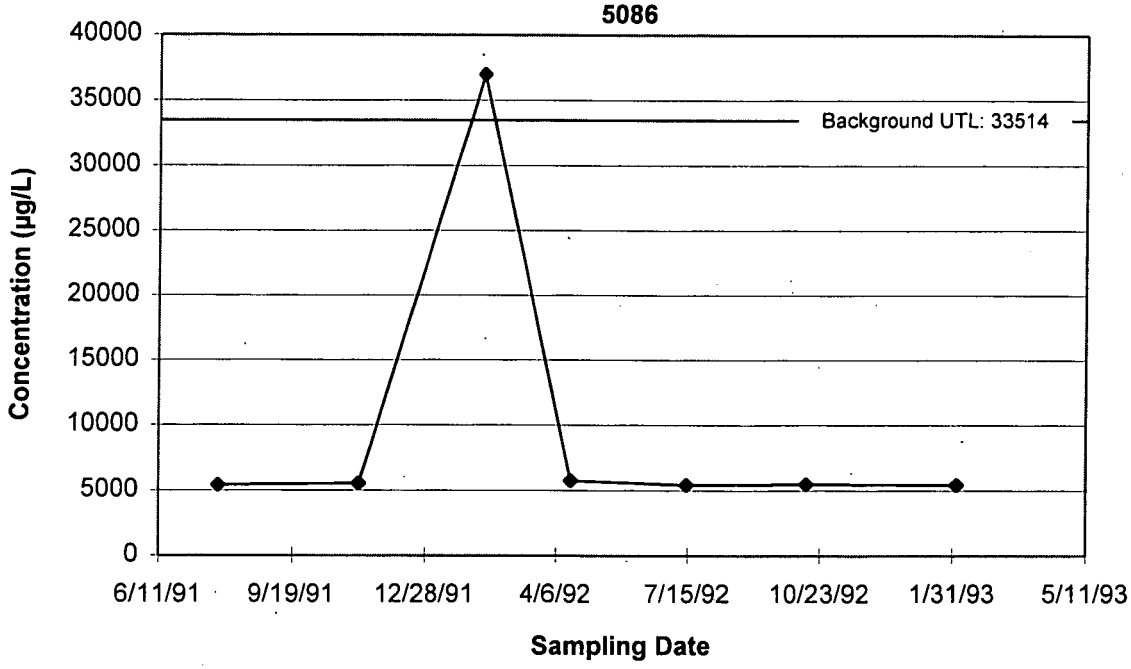
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
MAGNESIUM
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-42

02-JUN-1995 $DATA2/ou11/maps/gw_mg8x11 FINAL LETTER REPORT

Figure D-43
Time Series Plot - Total Magnesium
5086



◆ Hit - Y
o Hit - N

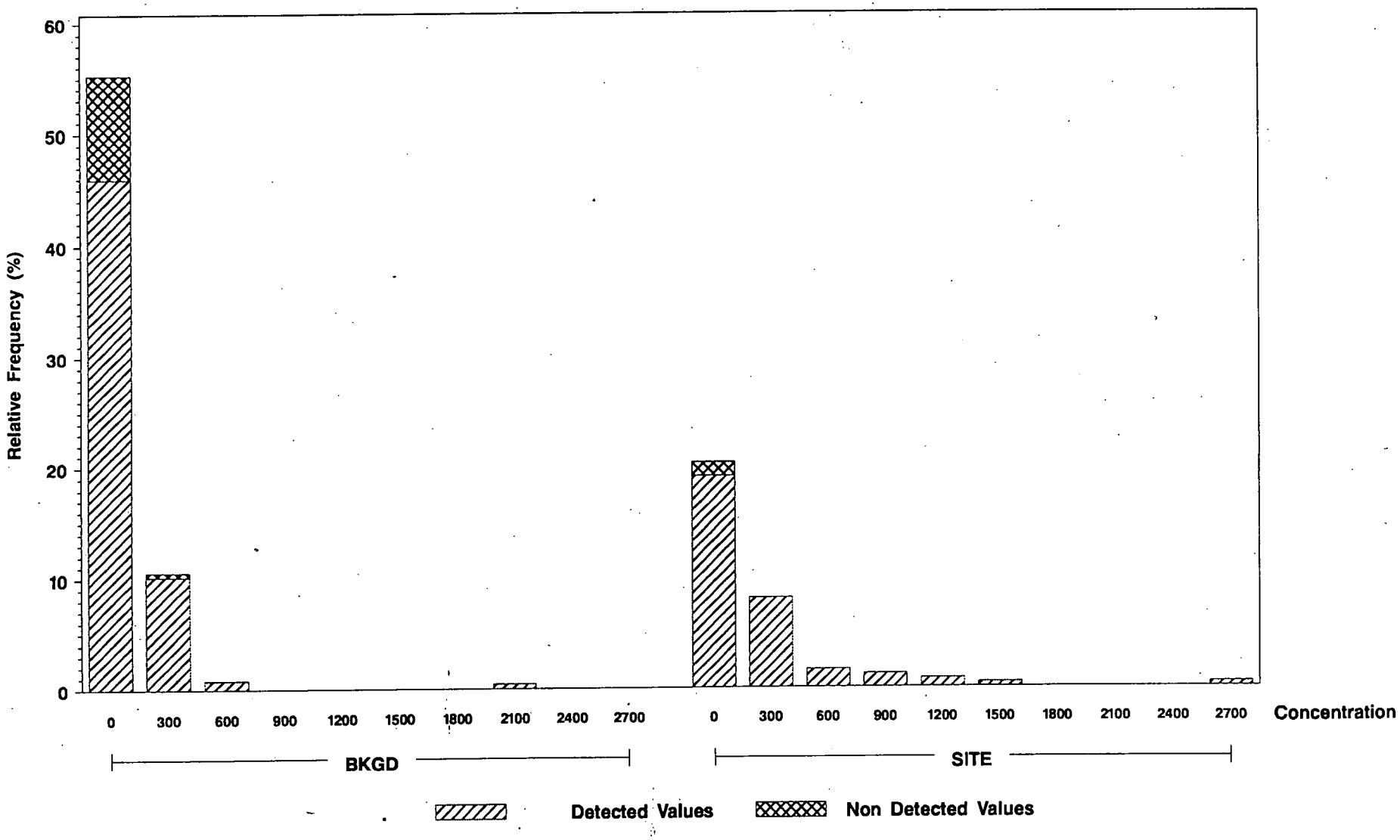
MEP C:\..\ALL_TS.XLS Magnesium, Nickel, Tin, Zinc 3/21/95

Figure D-44

Background vs OU11 UHSU Groundwater

Frequency Histogram

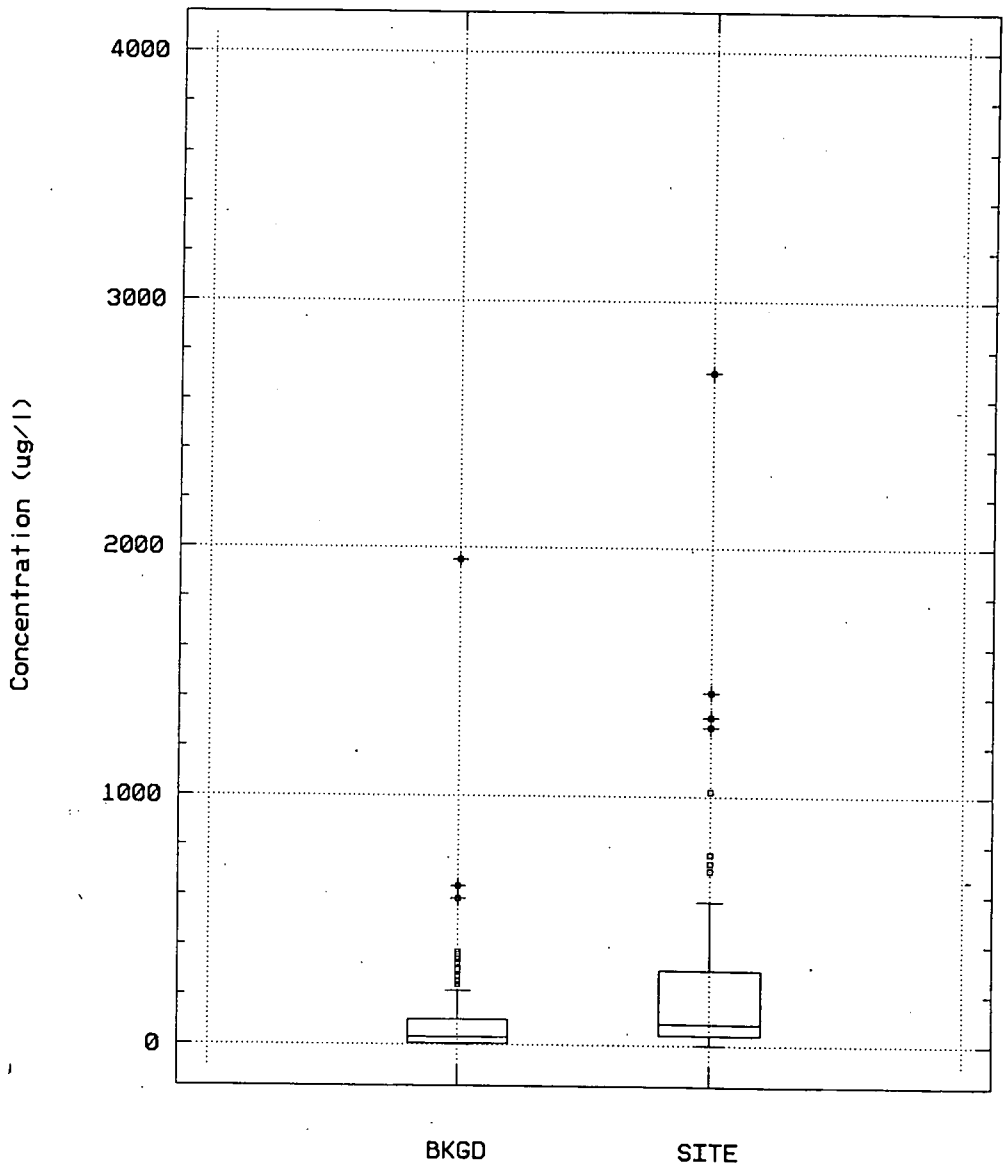
MANGANESE (ug/l) in Groundwater (Total)



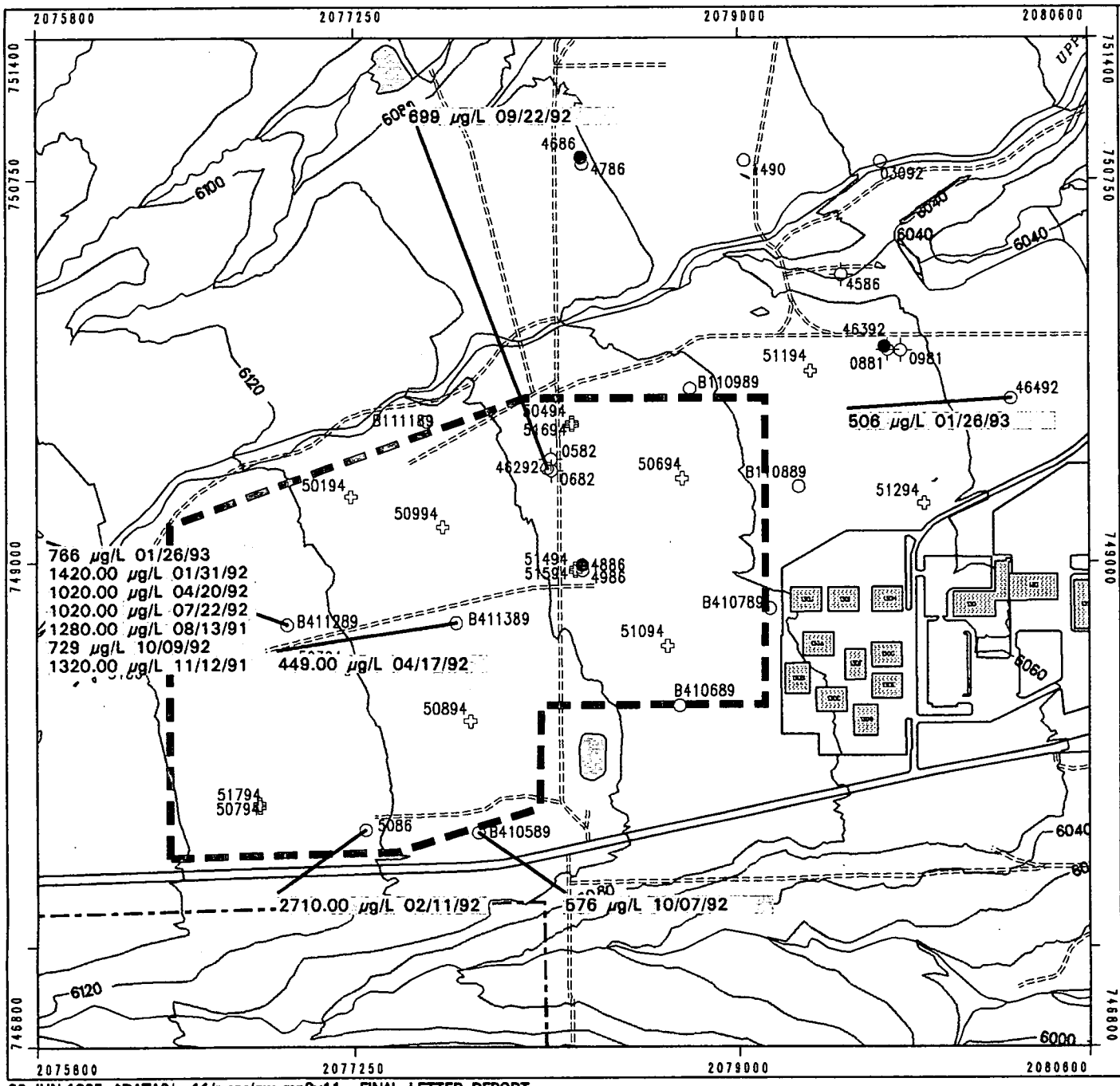
SITE=UHSU samples from saturated media within and downgradient of IHSS 168

Figure D-45
Background vs OU11 UHSU Groundwater

Manganese in Groundwater (Total)



Groundwater samples within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 446

Scale = 1 : 8400
1 inch = 700 feet

250 0 700ft

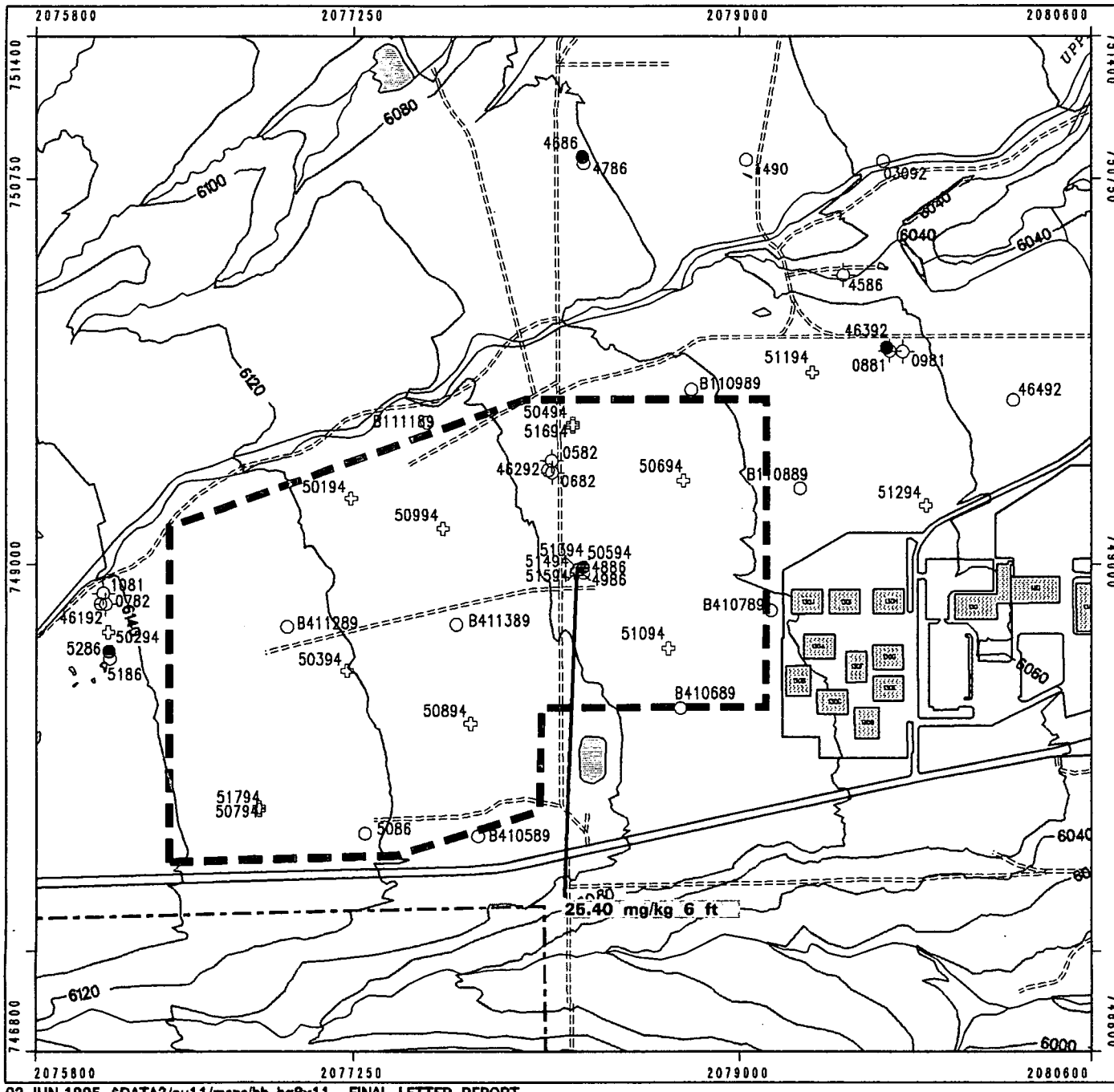
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
MANGANESE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-46

02-JUN-1995 $DATA2/ou11/maps/gw_mn8x11 FINAL LETTER REPORT



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 0.600

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
MERCURY
Concentrations*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-47

02-JUN-1995 $DATA2/ou11/maps/bh_hg8x11 FINAL LETTER REPORT

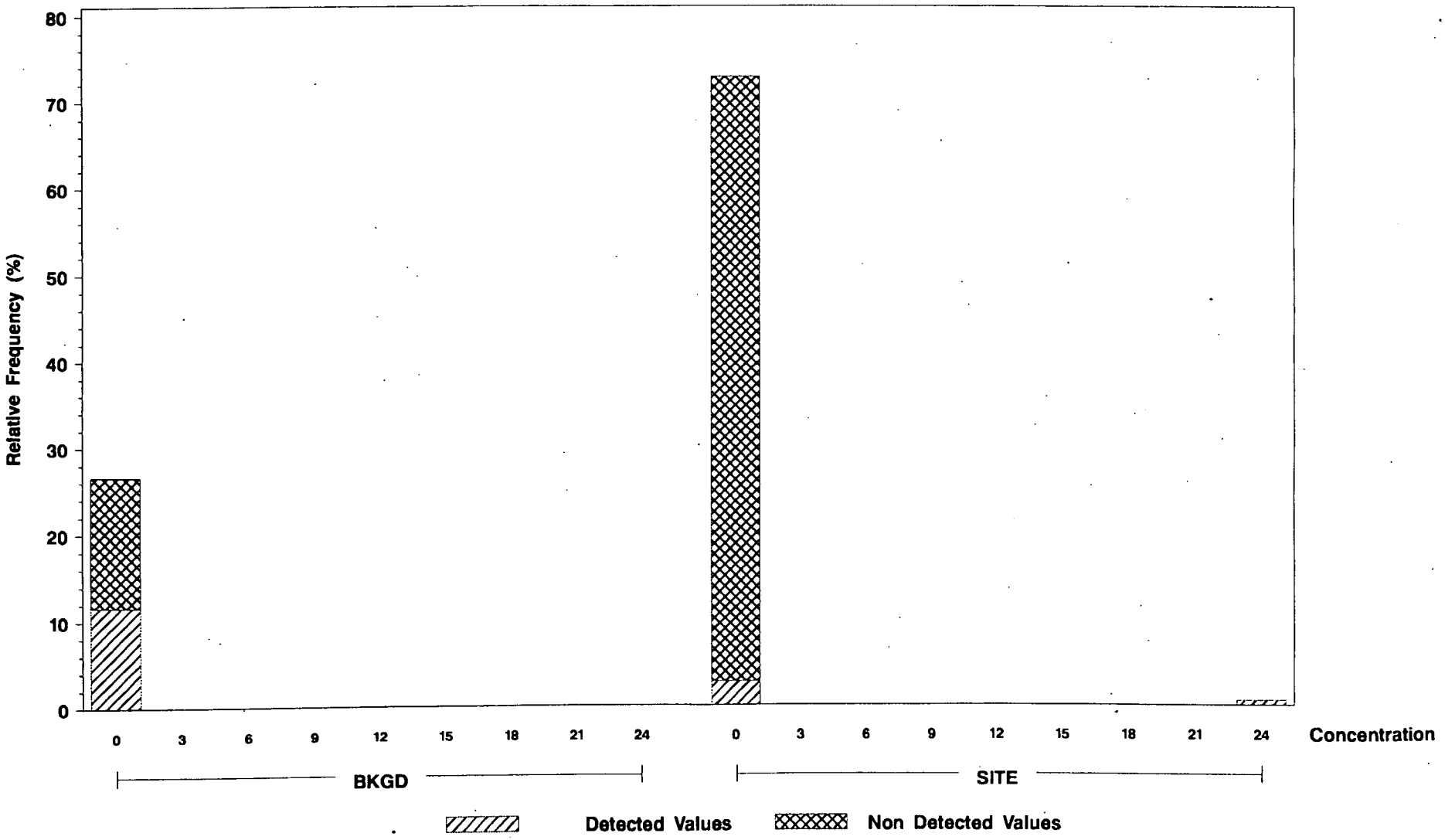
Figure D-48

Background (subsurface geologic material) Qrf vs OU11 Qrf

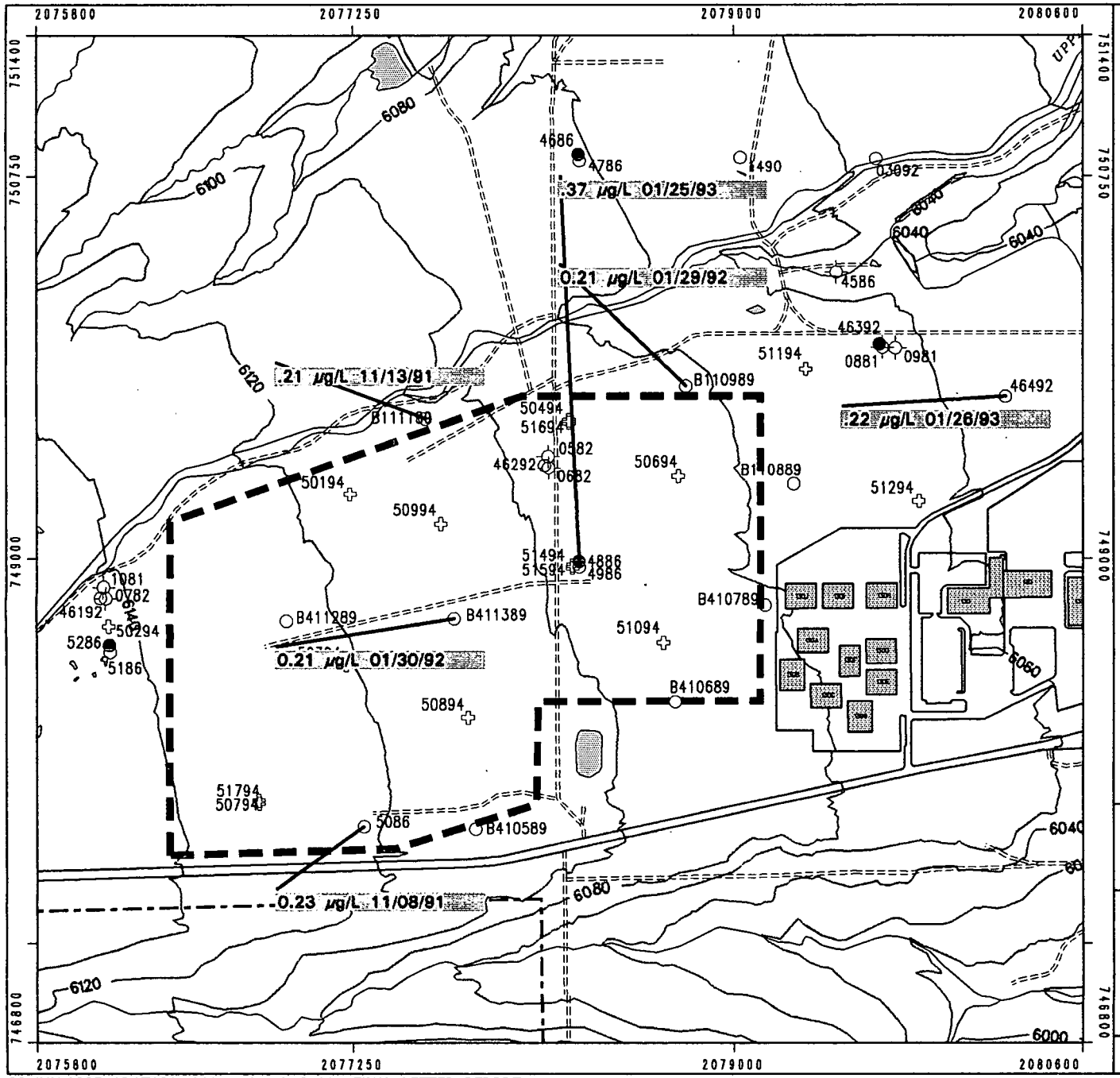
Frequency Histogram

MERCURY (mg/kg) in Qrf

(0 to 12 feet)



SITE = Boreholes within IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 0.100

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
MERCURY
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-49

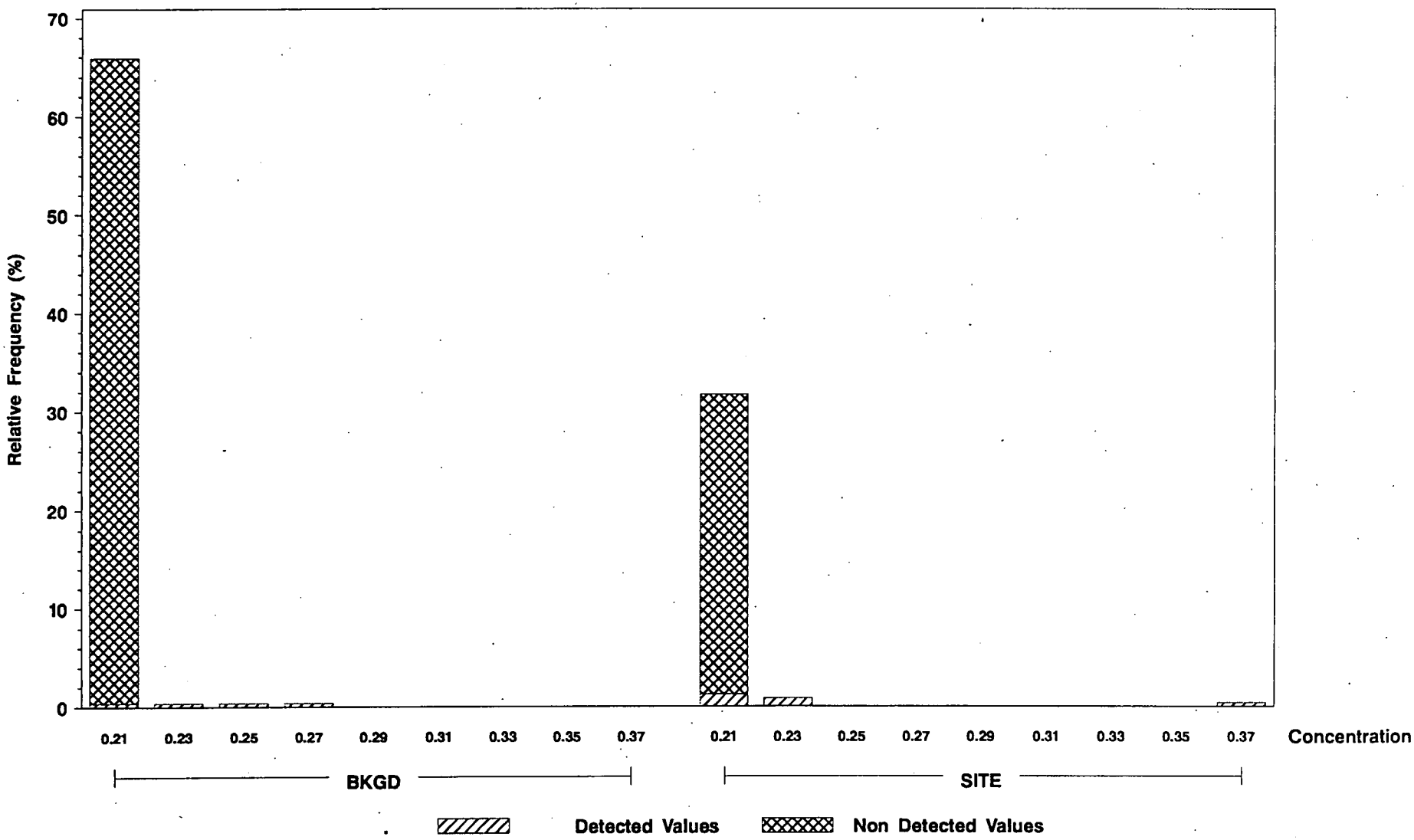
02-JUN-1995 $DATA2/ou11/maps/gw_hg8x11 FINAL LETTER REPORT

Figure D-50

Background vs OU11 UHSU Groundwater

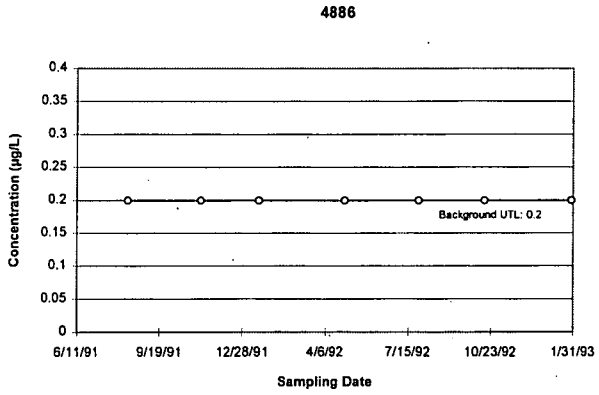
Frequency Histogram

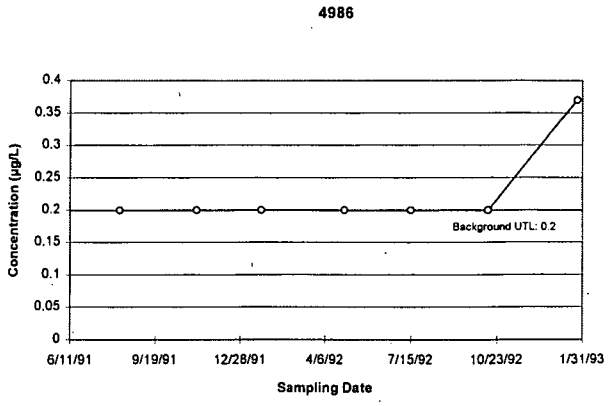
MERCURY (ug/l) in Groundwater (Total)

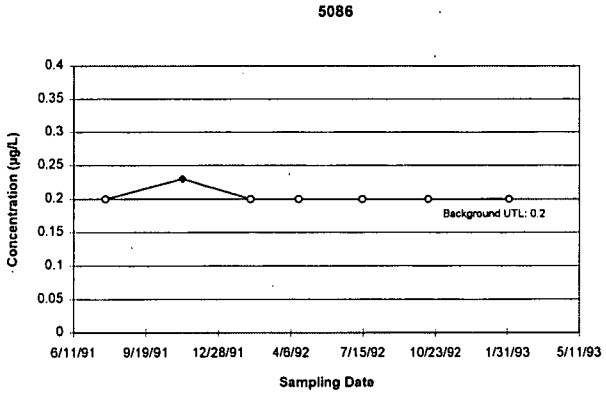


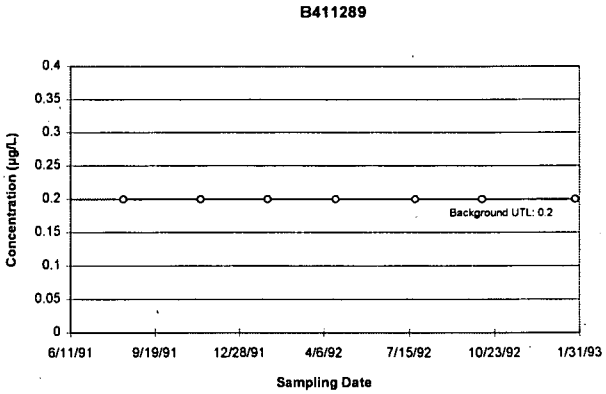
SITE = UHSU samples from saturated media within and downgradient of IHSS 168

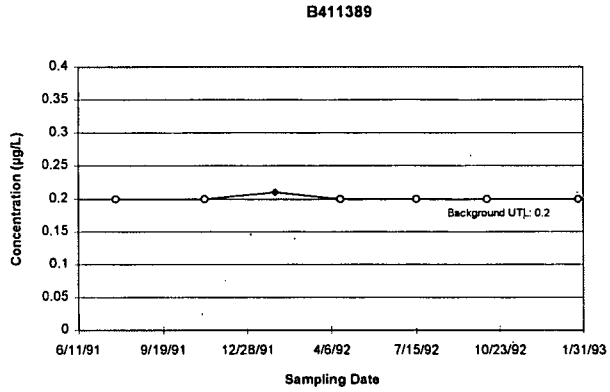
Figure D-51
Time Series Plots - Total Mercury

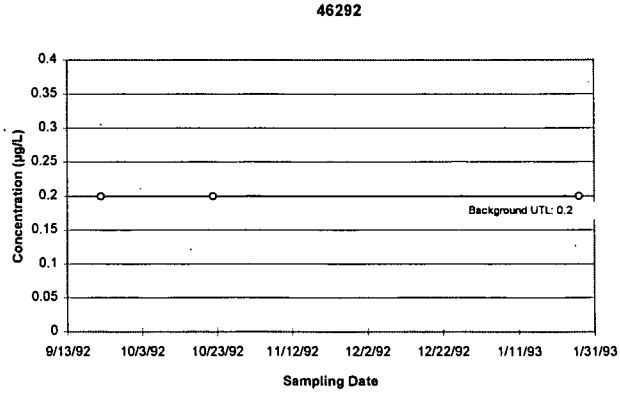












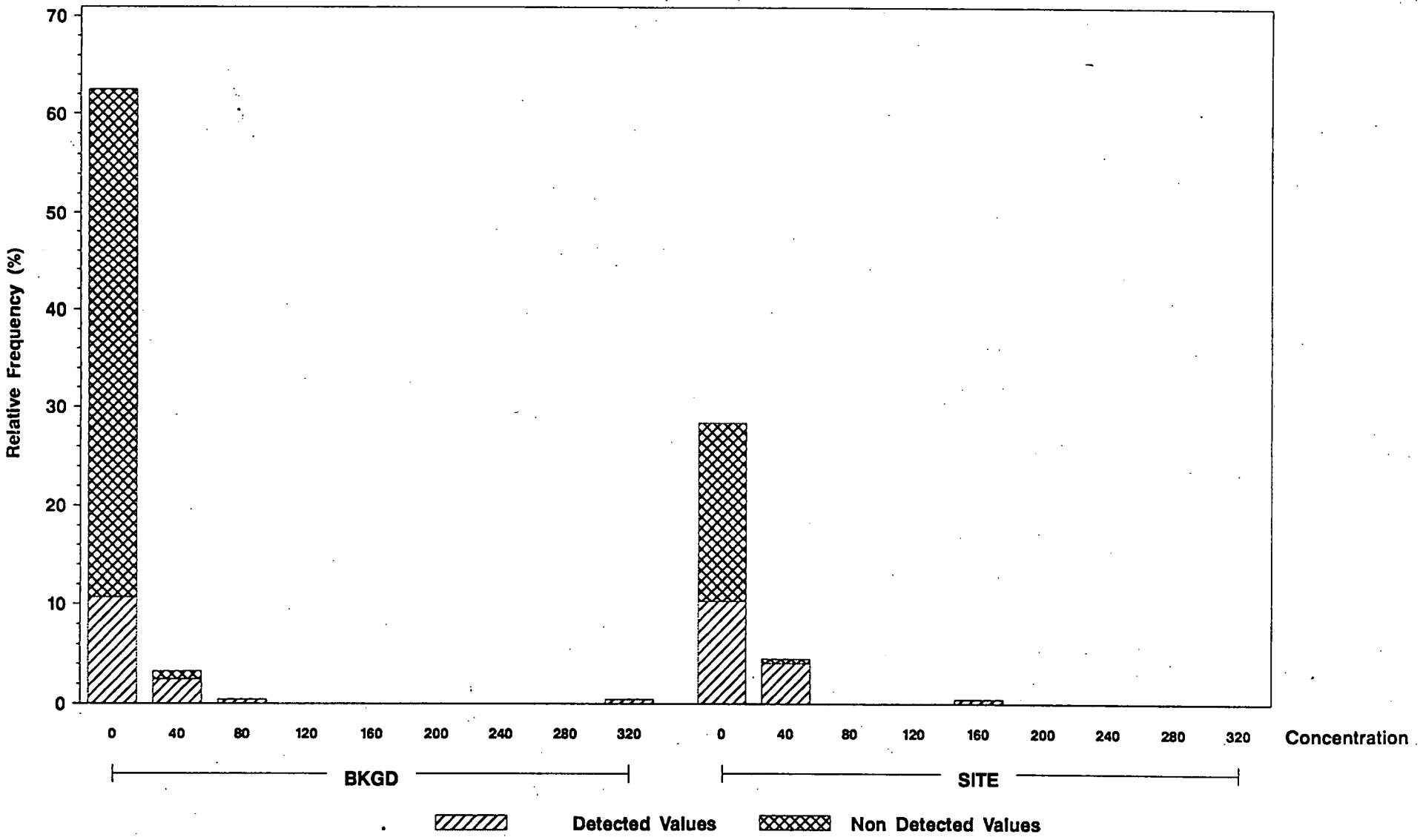
◆ Hit - Y
O Hit - N

Figure D-52

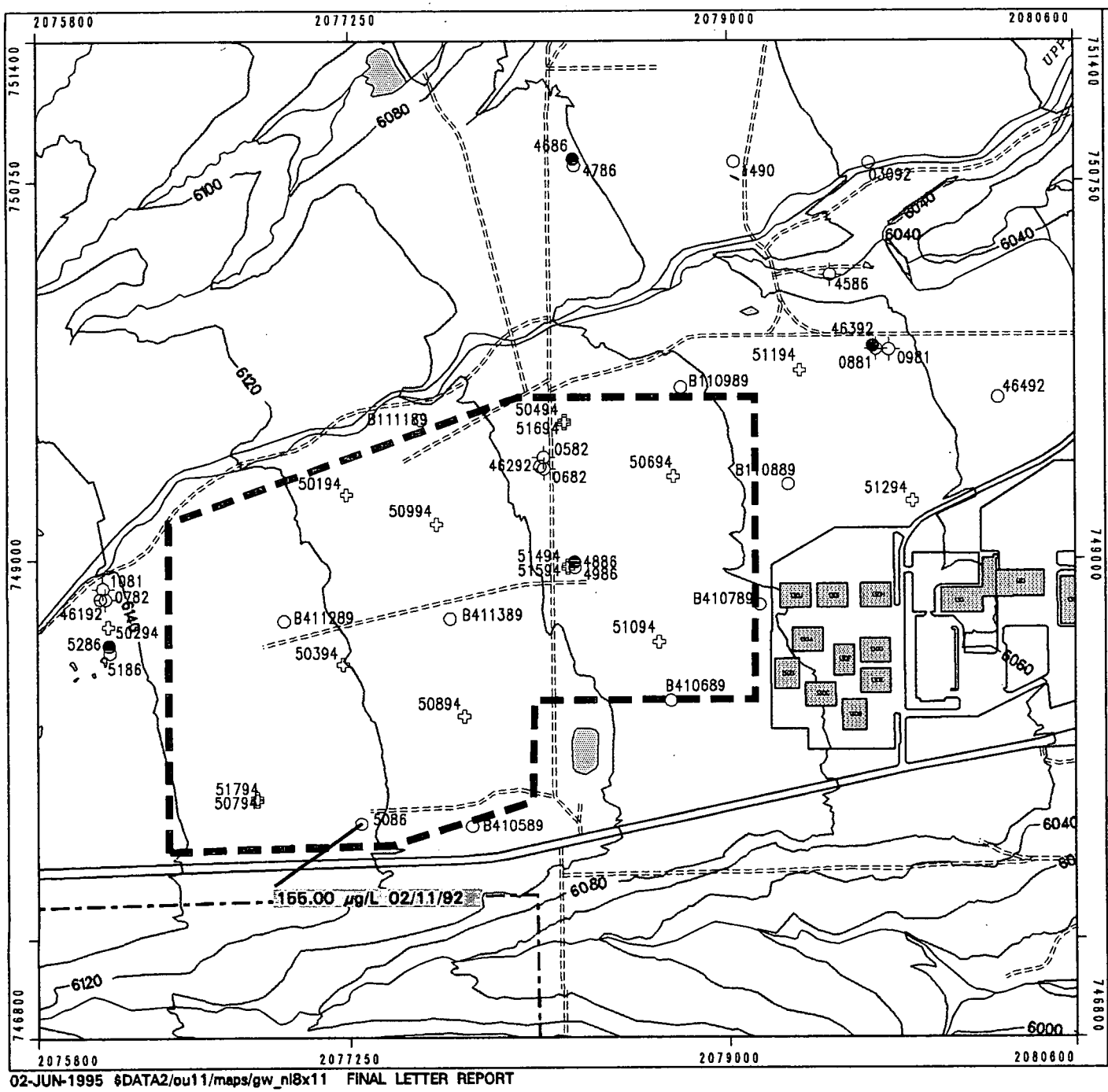
Background vs OU11 UHSU Groundwater

Frequency Histogram

NICKEL (ug/l) in Groundwater (Total)



SITE=UHSU samples from saturated media within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 62

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

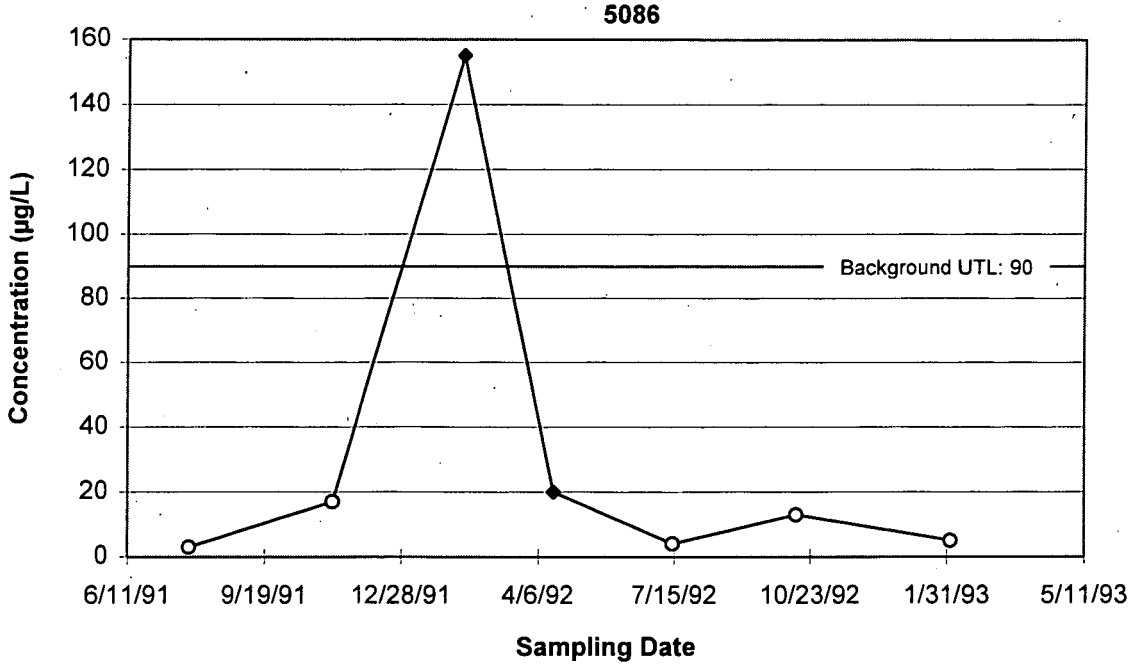
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
NICKEL
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-53

02-JUN-1995 $DATA2/ou11/maps/gw_ni8x11 FINAL LETTER REPORT

Figure D-54
Time Series Plot - Total Nickel
5086



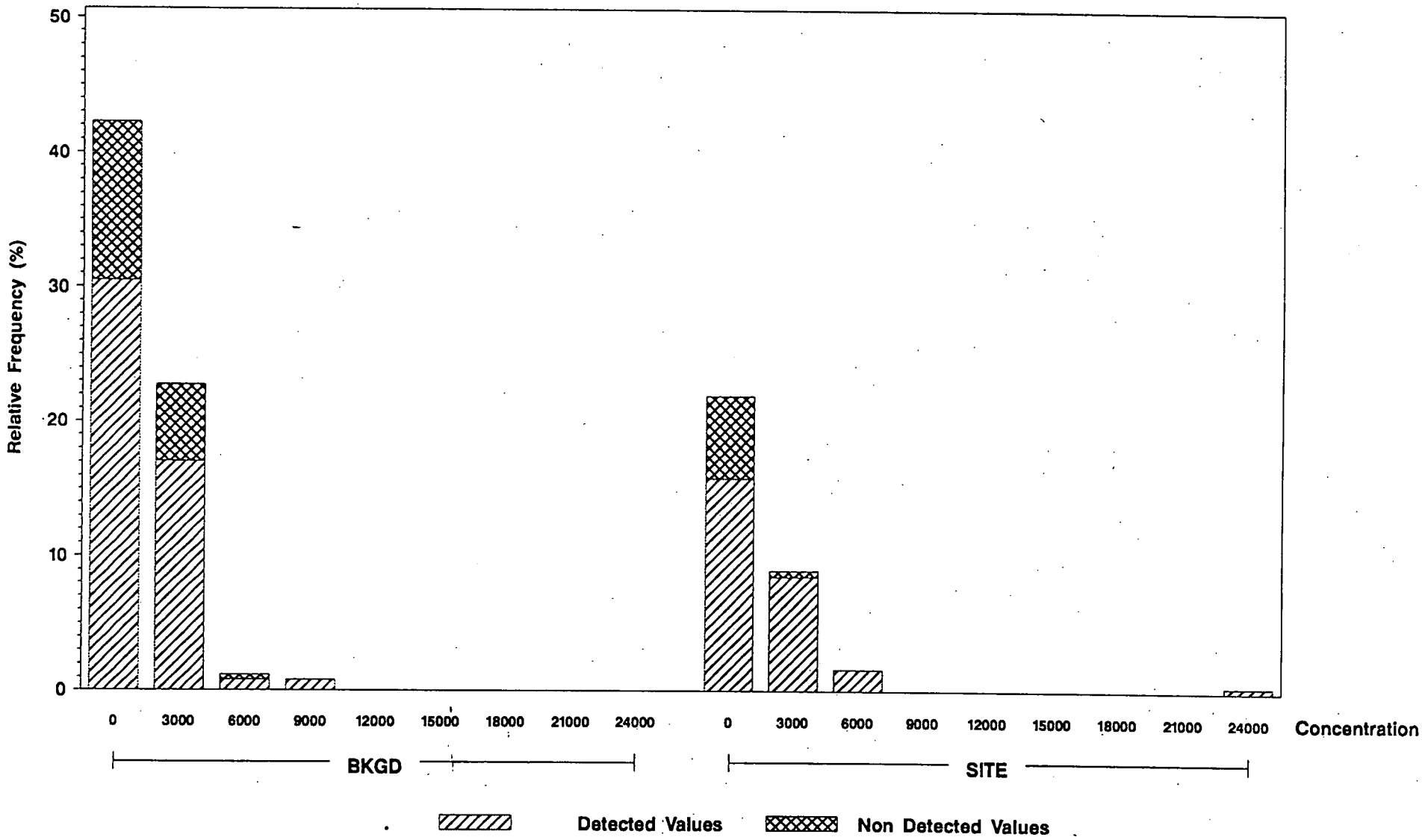
◆ Hit - Y
o Hit - N

Figure D-55

Background vs OU11 UHSU Groundwater

Frequency Histogram

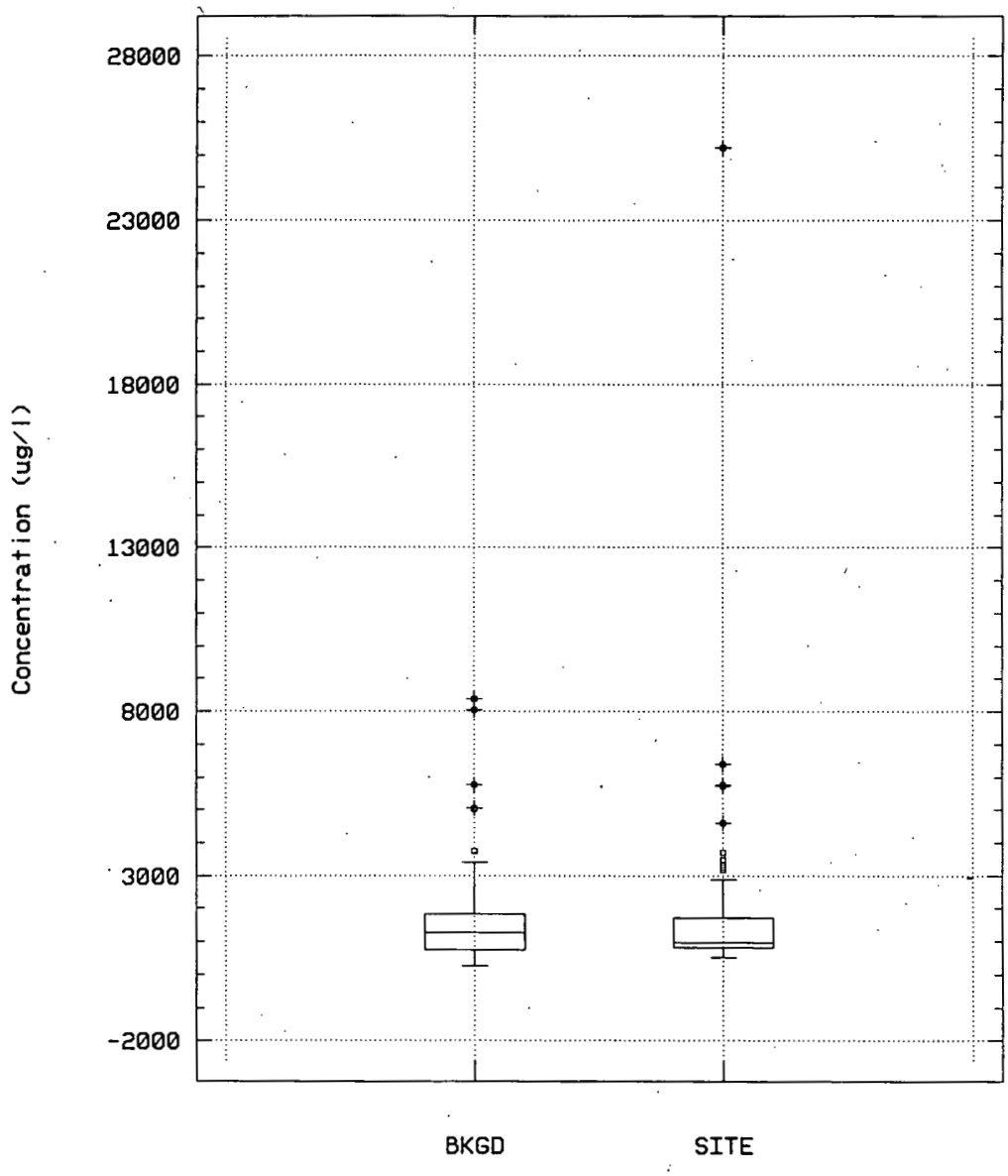
POTASSIUM (ug/l) in Groundwater (Total)



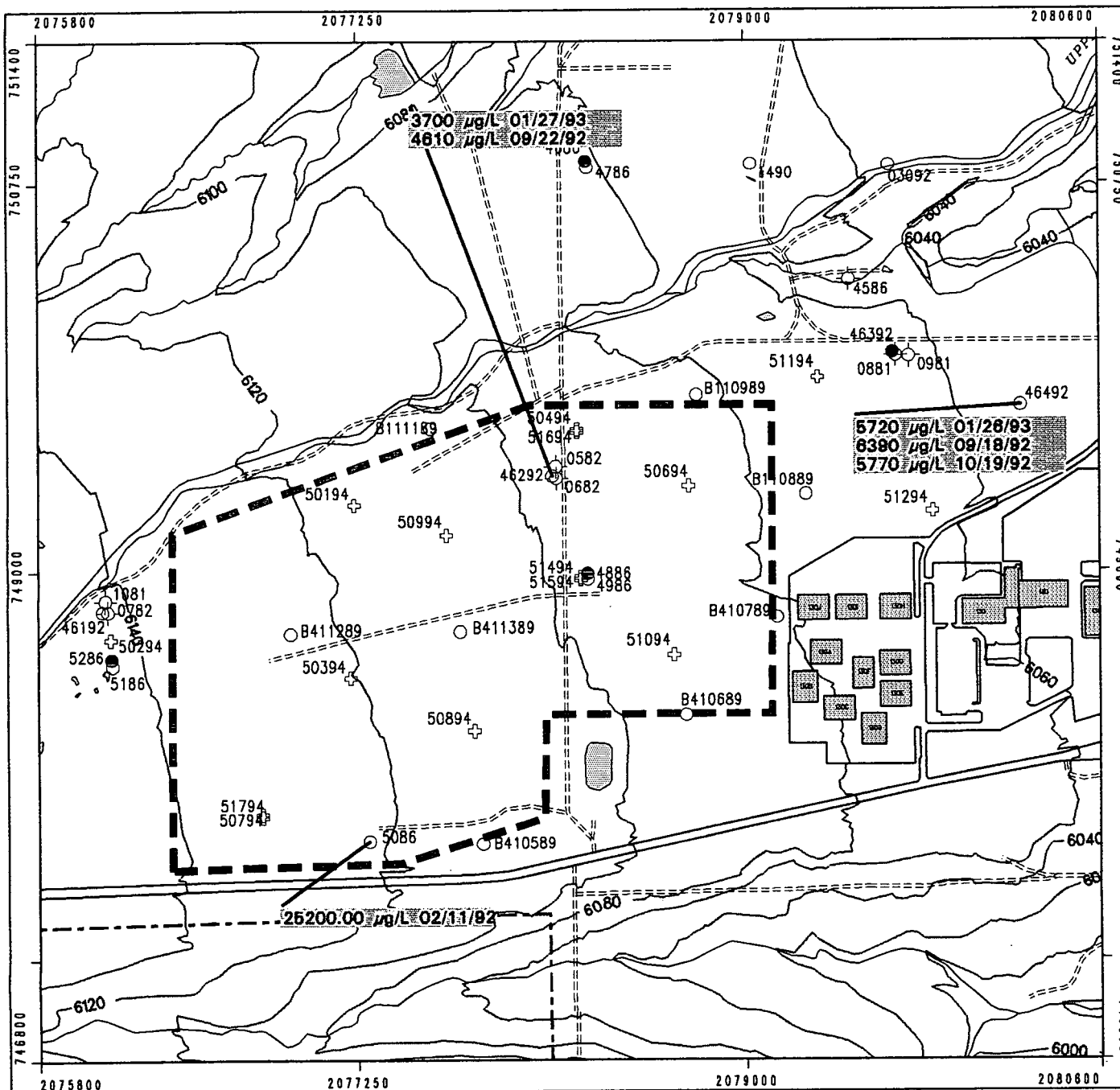
SITE=UHSU samples from saturated media within and downgradient of IHSS 168

Figure D-56
Background vs OU11 UHSU Groundwater

Potassium in Groundwater (Total)



Groundwater samples within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 3587

Scale = 1 : 8400
1 inch = 700 feet

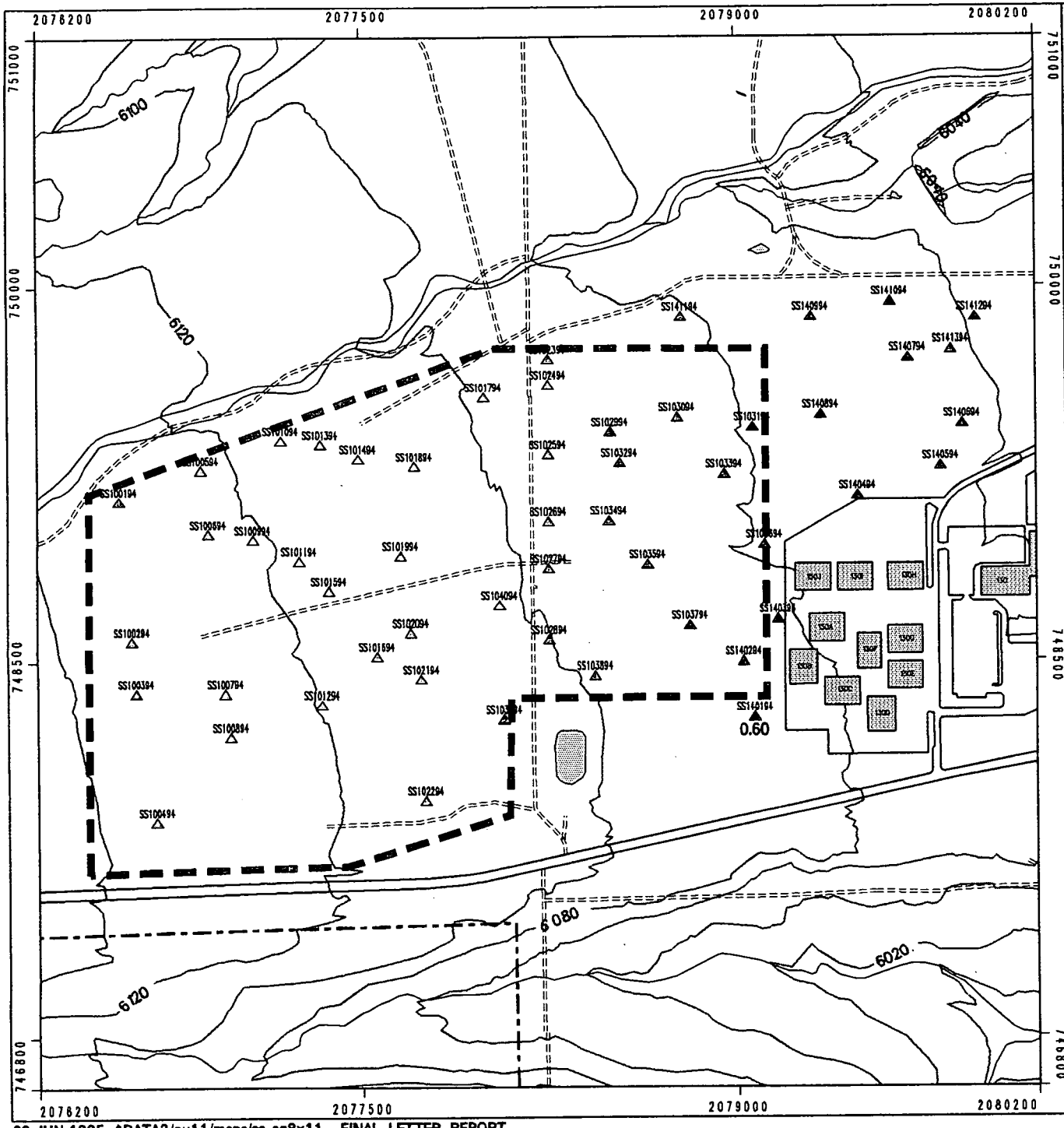
350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
POTASSIUM
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-57



EXPLANATION

- Sample Location
- Values above the reporting limits
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Concentrations are in mg/kg

Scale = 1 : 7200
1 inch = 600 feet

300 0 600ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
SILVER
Concentrations*
at the
OU 11--West Spray Field

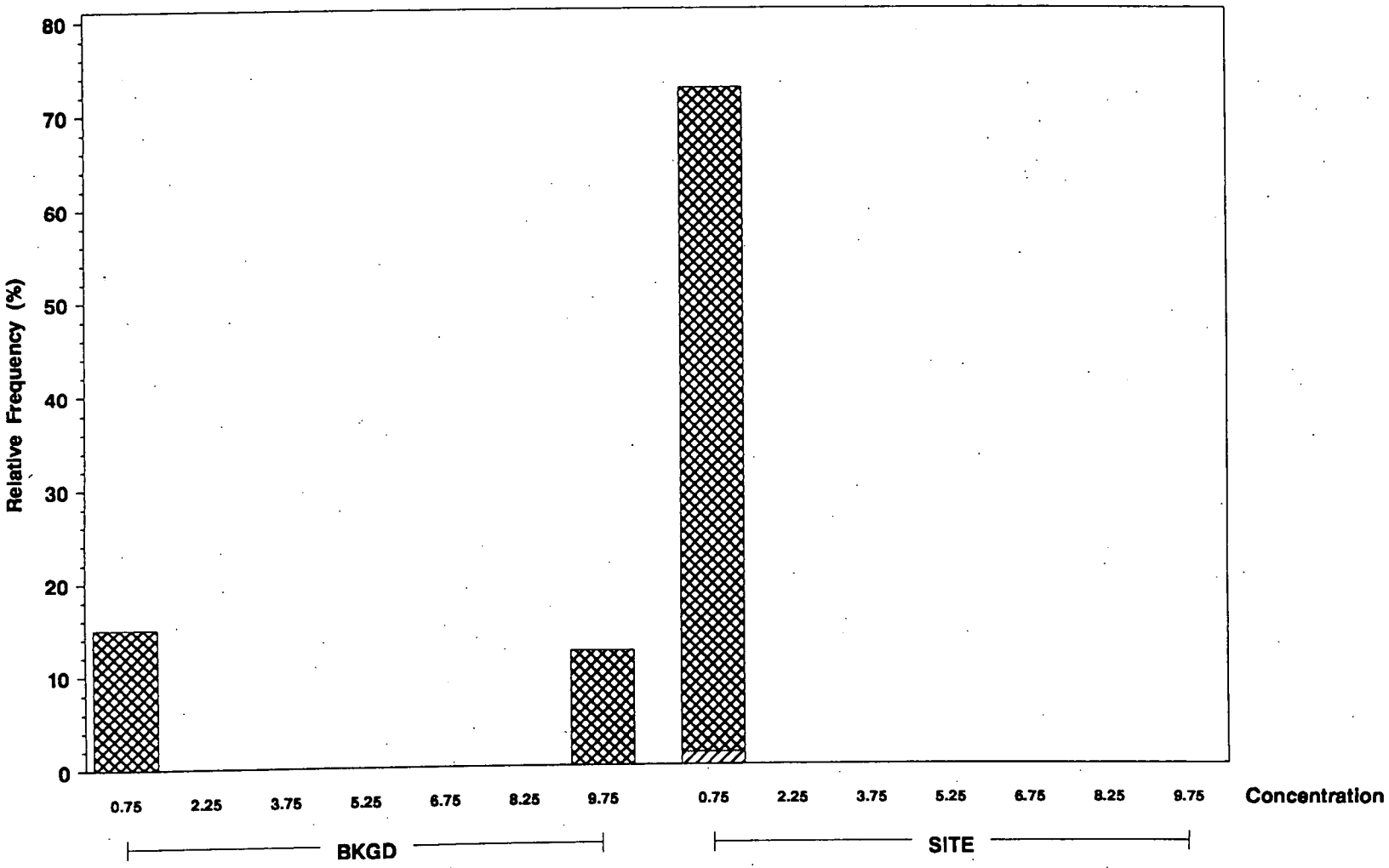
June 1995 | Figure D-58

Figure D-59

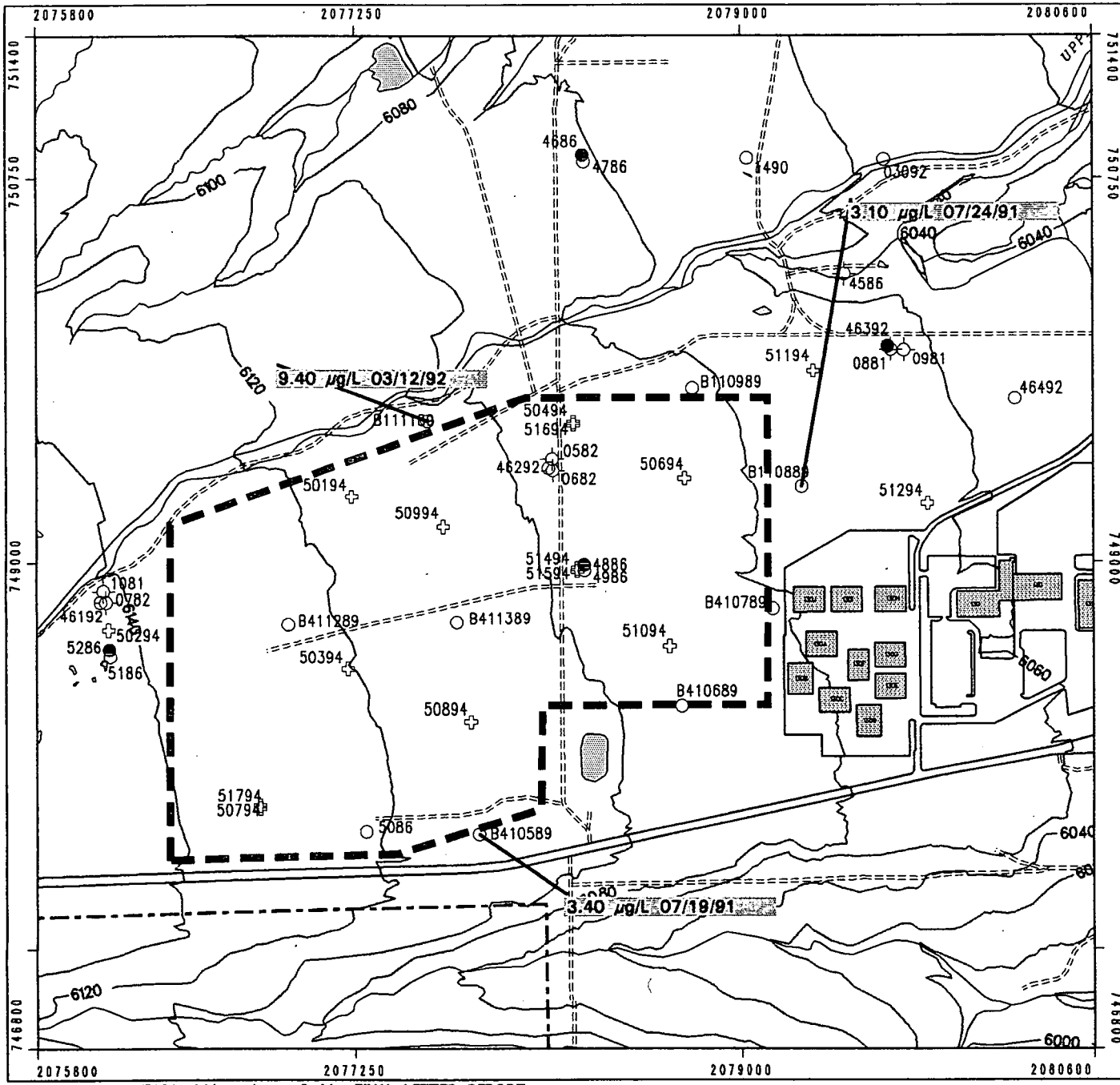
Background vs OU11 Surface Soil

Frequency Histogram

SILVER (mg/kg) in Surface Soil (0 – 2 inches)



SITE = All areas s ıled within OU11



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 3

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
SILVER
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-60

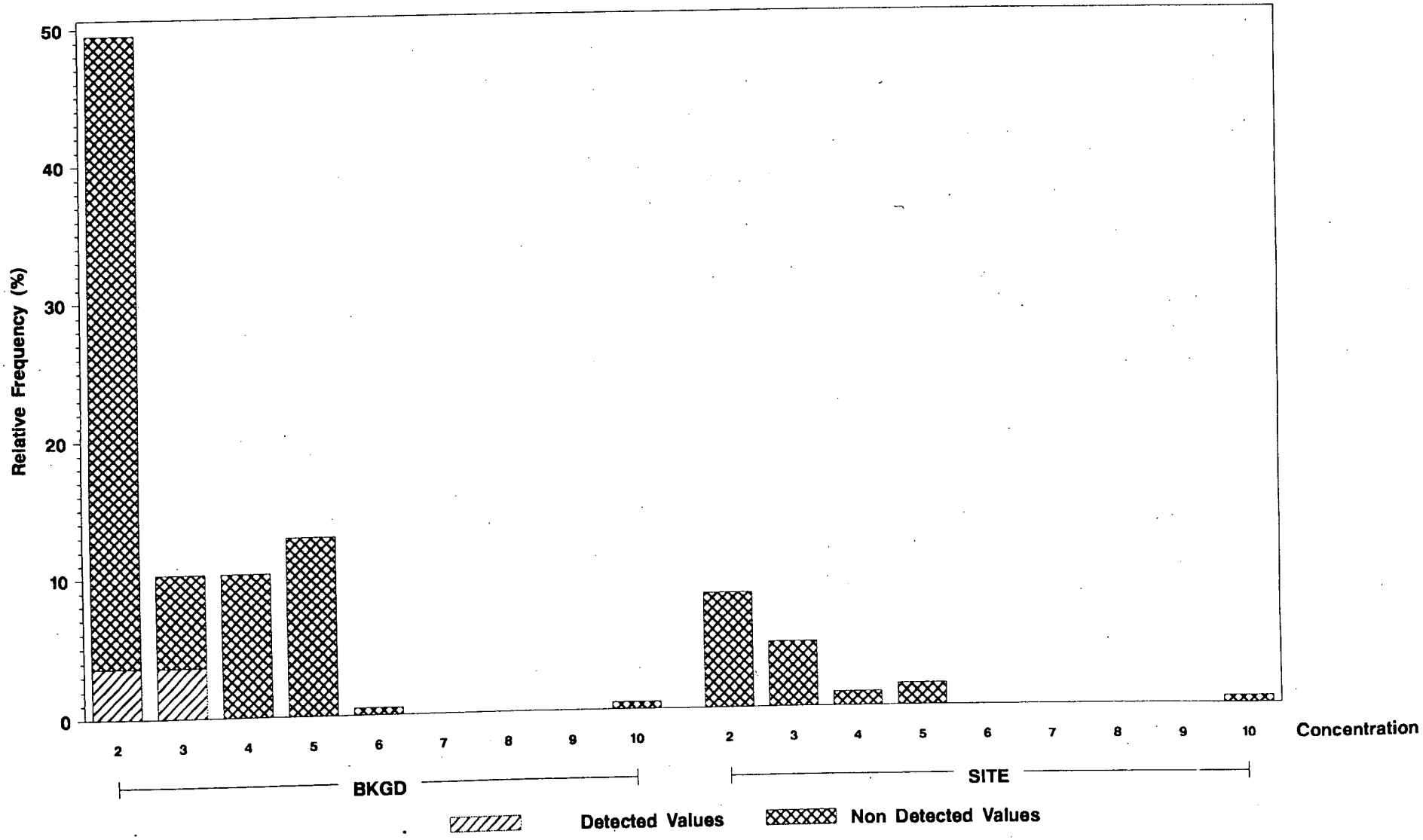
02-JUN-1995 $DATA2/ou11/maps/gw_ag8x11 FINAL LETTER REPORT

Figure D-61

Background vs OU11 UHSU Groundwater

Frequency Histogram

SILVER (ug/l) in Groundwater (Total)



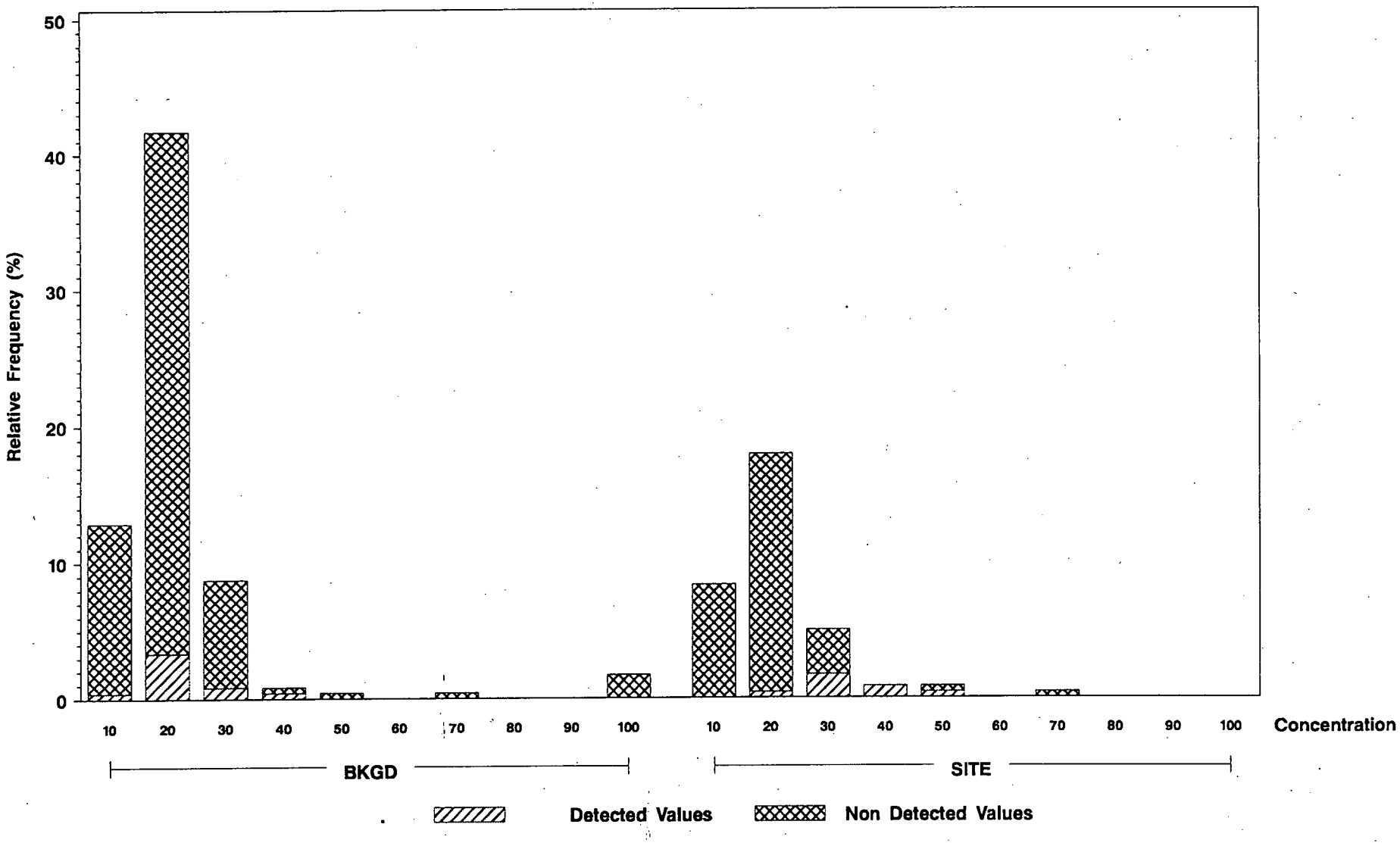
SITE = Wells hin IHSS 168

Figure D-62

Background vs OU11 UHSU Groundwater

Frequency Histogram

TIN (ug/l) in Groundwater (Total)

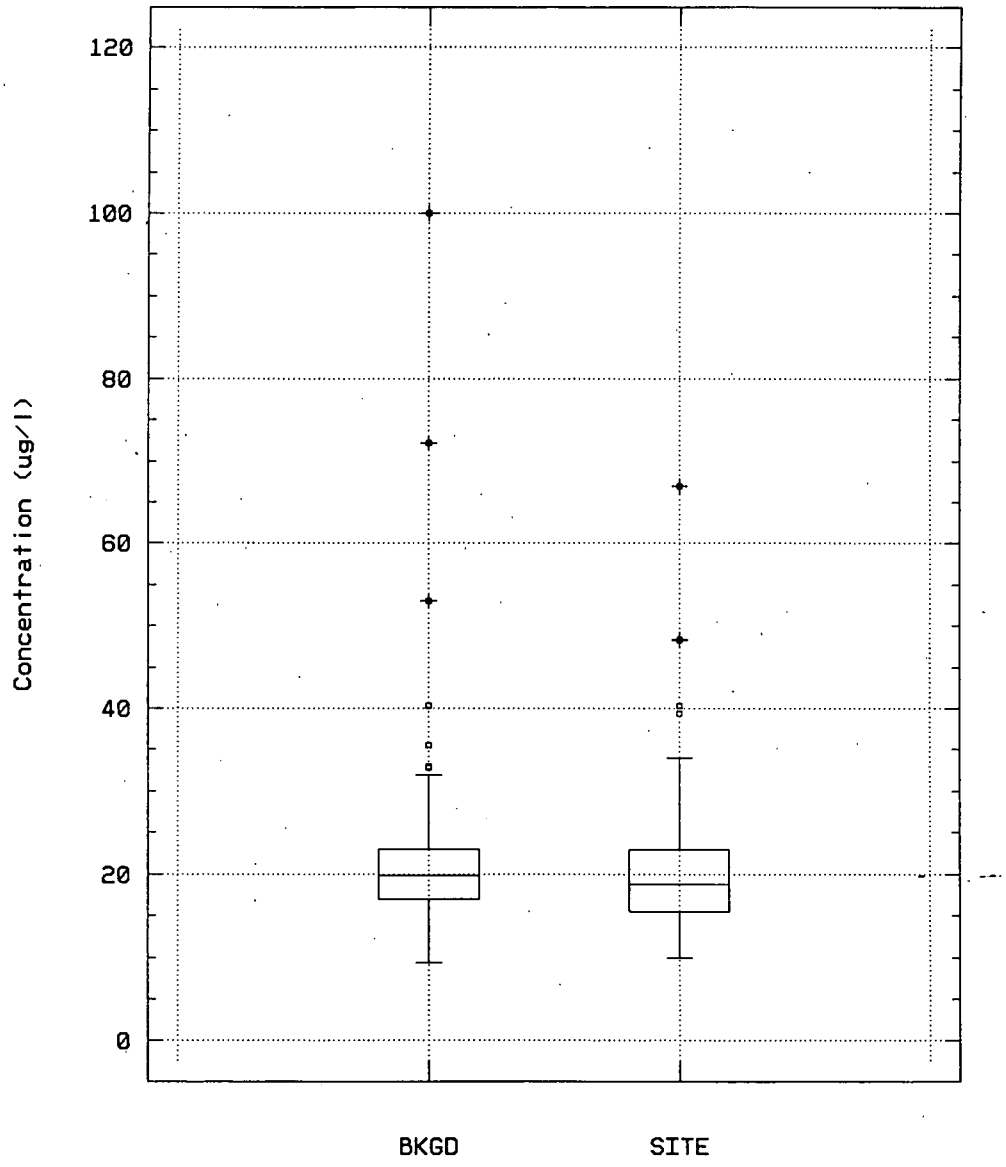


SITE=UHSU samples from saturated media within and downgradient of IHSS 168

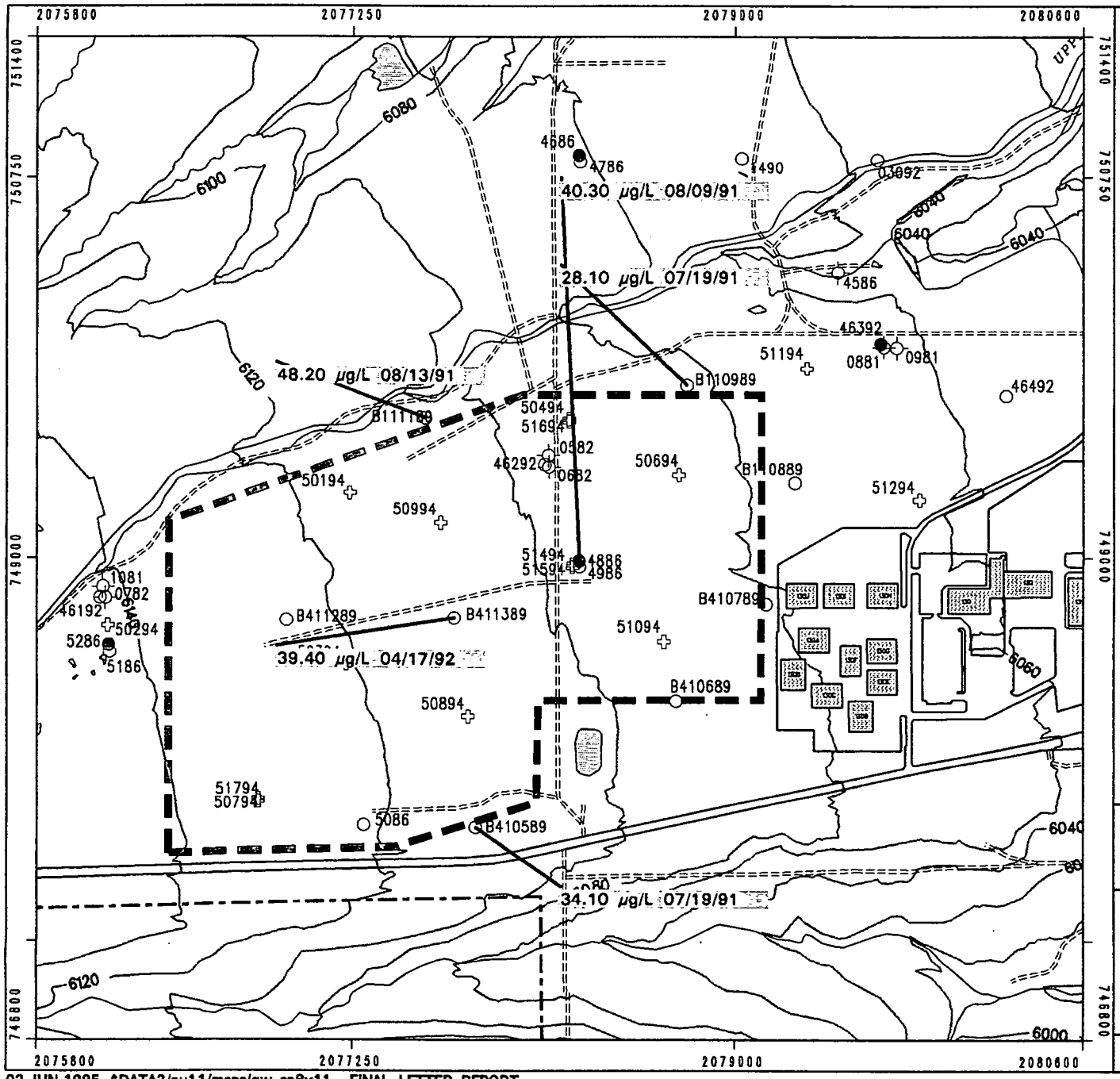
Figure D-63

Background vs OU11 UHSU Groundwater

Tin in Groundwater (Total)



Groundwater samples within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 28

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

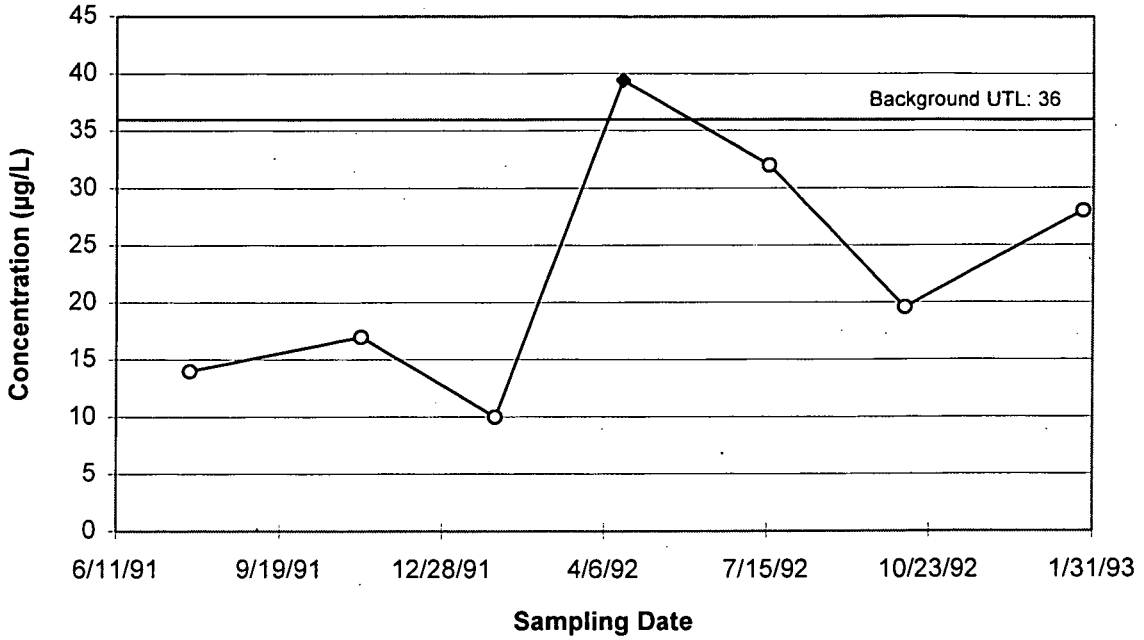
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

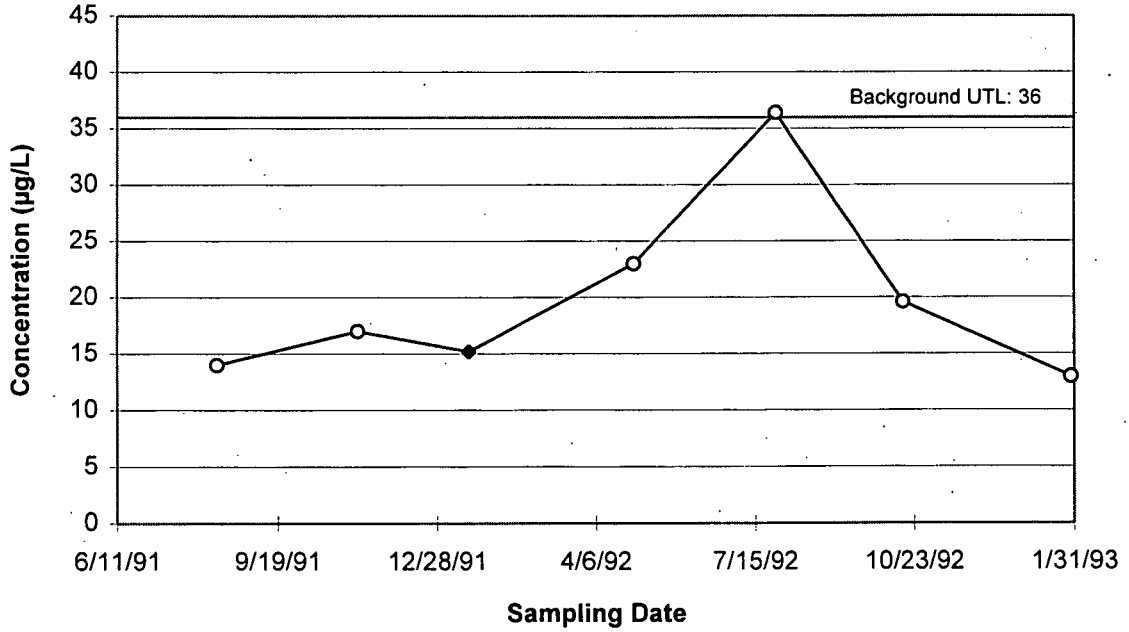
OU 11--West Spray Field
TIN
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-64

Figure D-65
Time Series Plots - Total Tin
B411389



4886



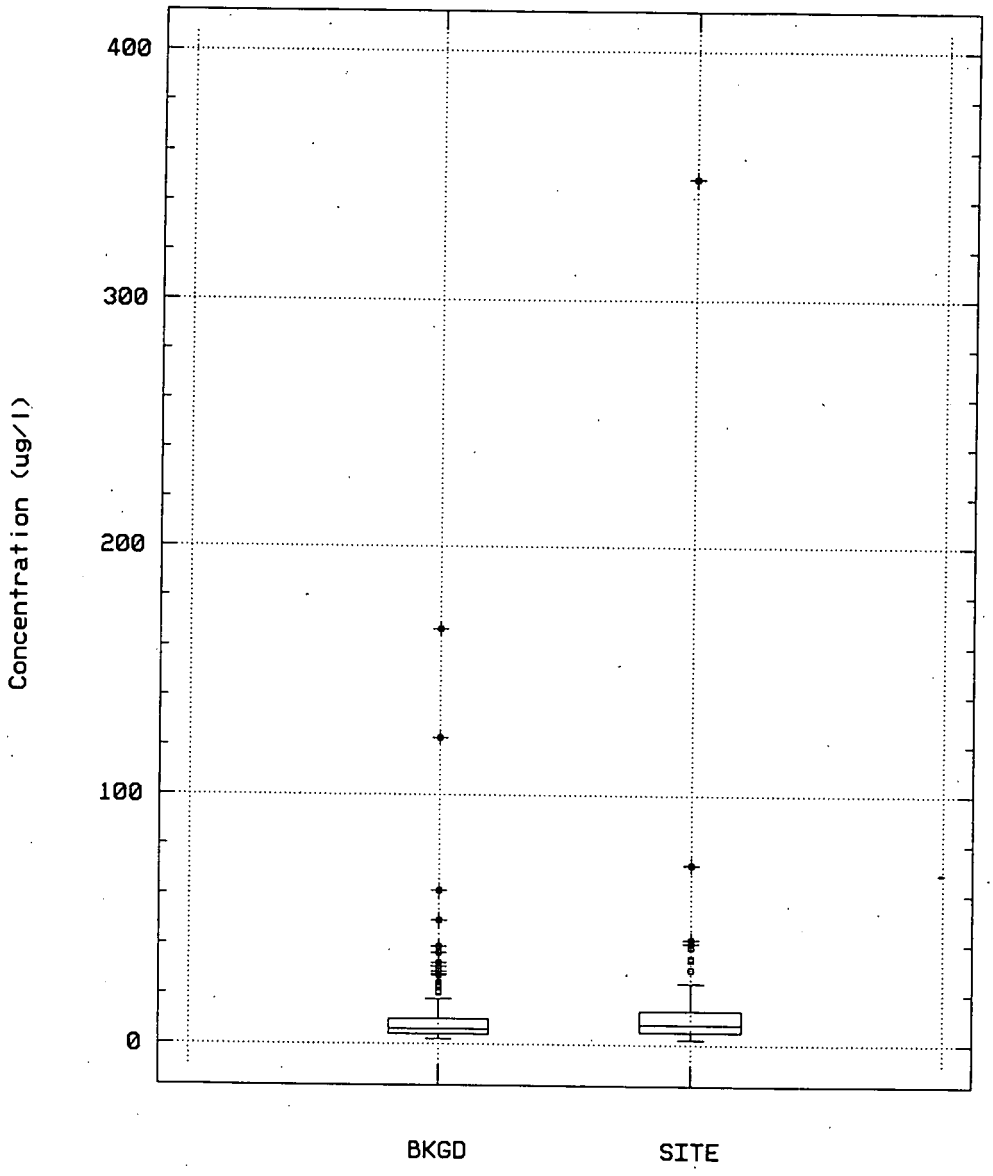
◆ Hit - Y
o Hit - N

MEP C:\..\ALL_TS.XLS Magnesium, Nickel, Tin, Zinc 3/22/95

Figure D-66

Background vs OU11 UHSU Groundwater

Vanadium in Groundwater (Total)



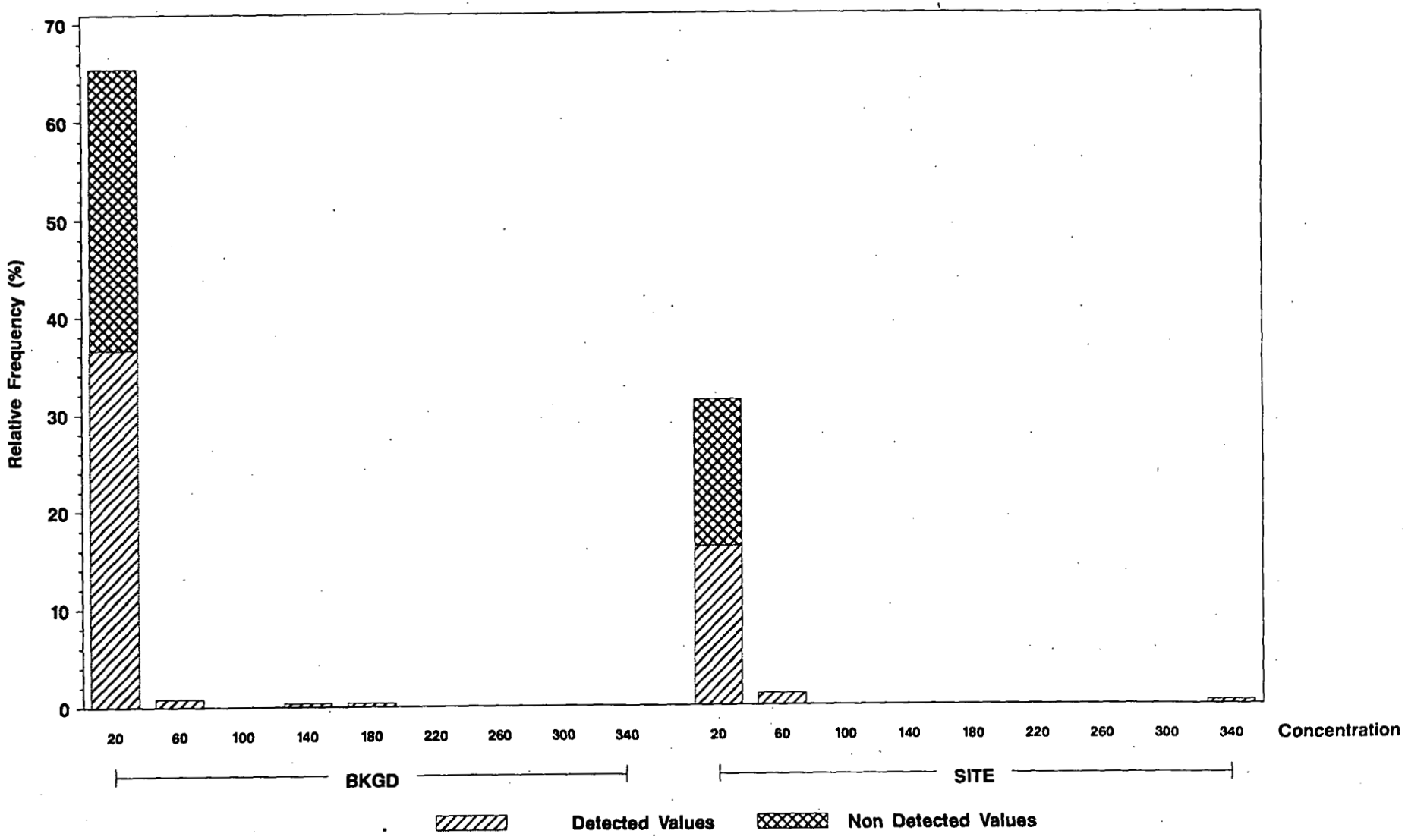
Groundwater samples within and downgradient of IHSS 168

Figure D-67

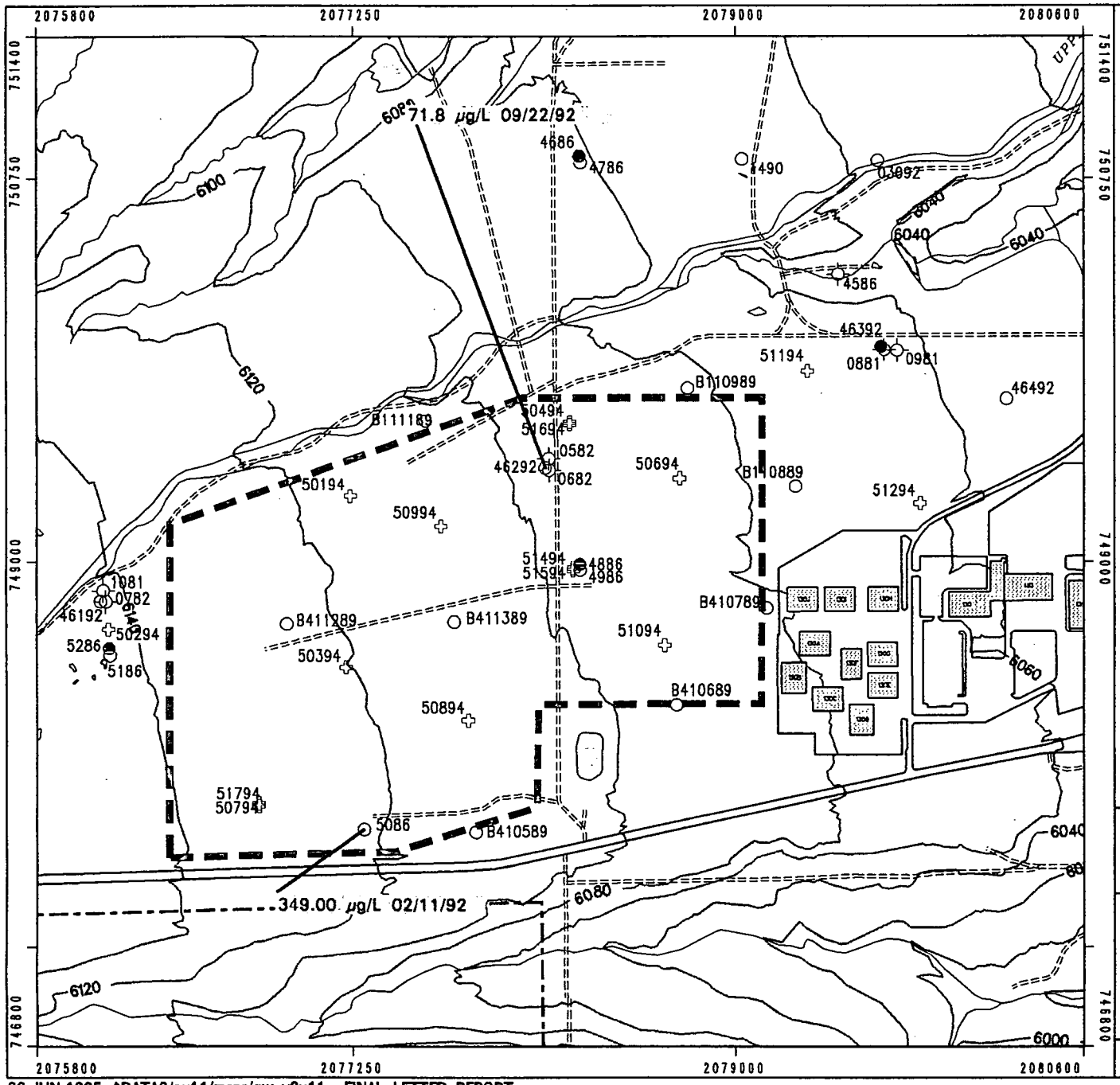
Background vs OU11 UHSU Groundwater

Frequency Histogram

VANADIUM (ug/l) in Groundwater (Total)



SITE = UHSU samples from saturated media within and downgradient of IHSS 168



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 45

N

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
VANADIUM
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-68

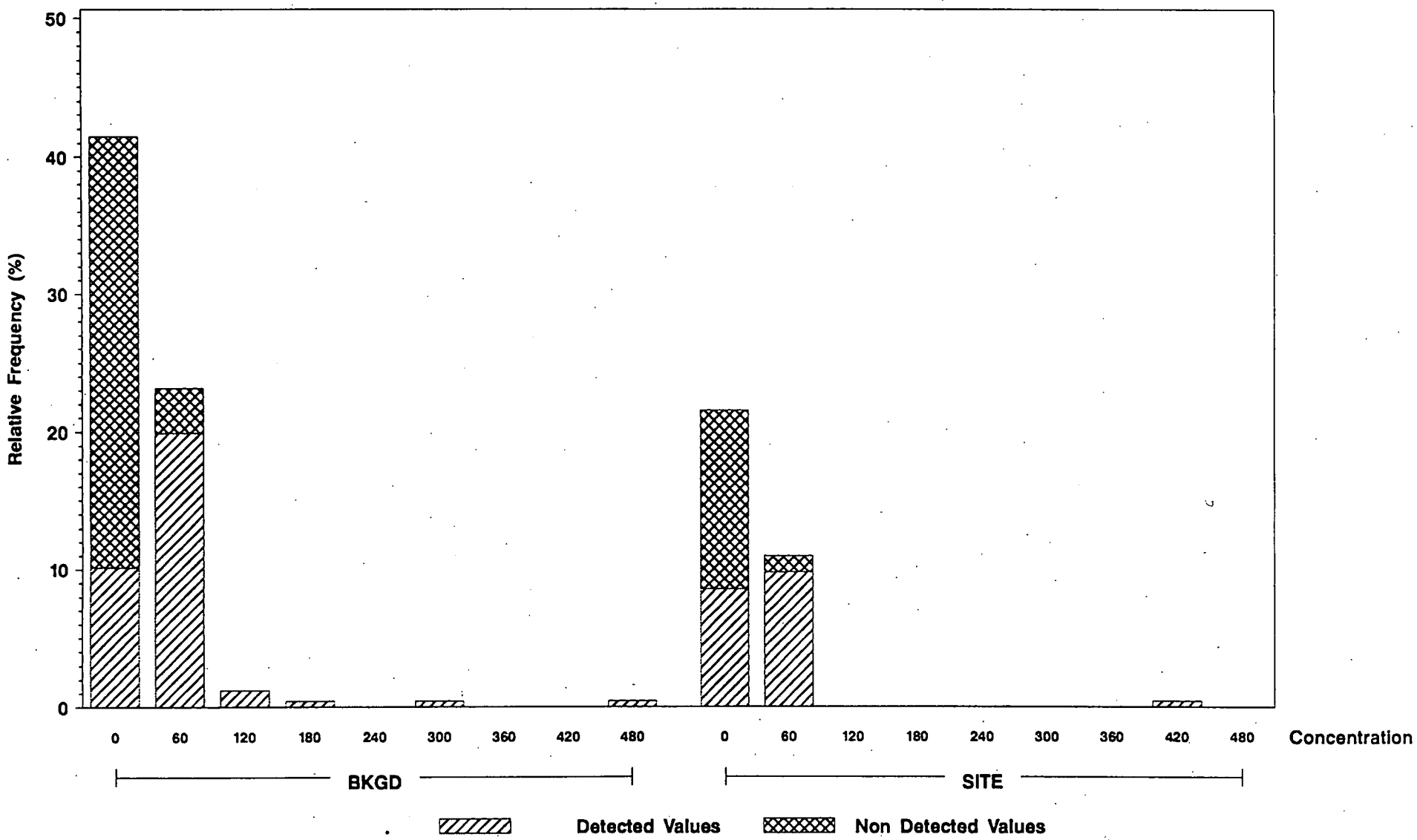
02-JUN-1995 $DATA2/ou11/maps/gw_v8x11 FINAL LETTER REPORT

Figure D-69

Background vs OU11 UHSU Groundwater

Frequency Histogram

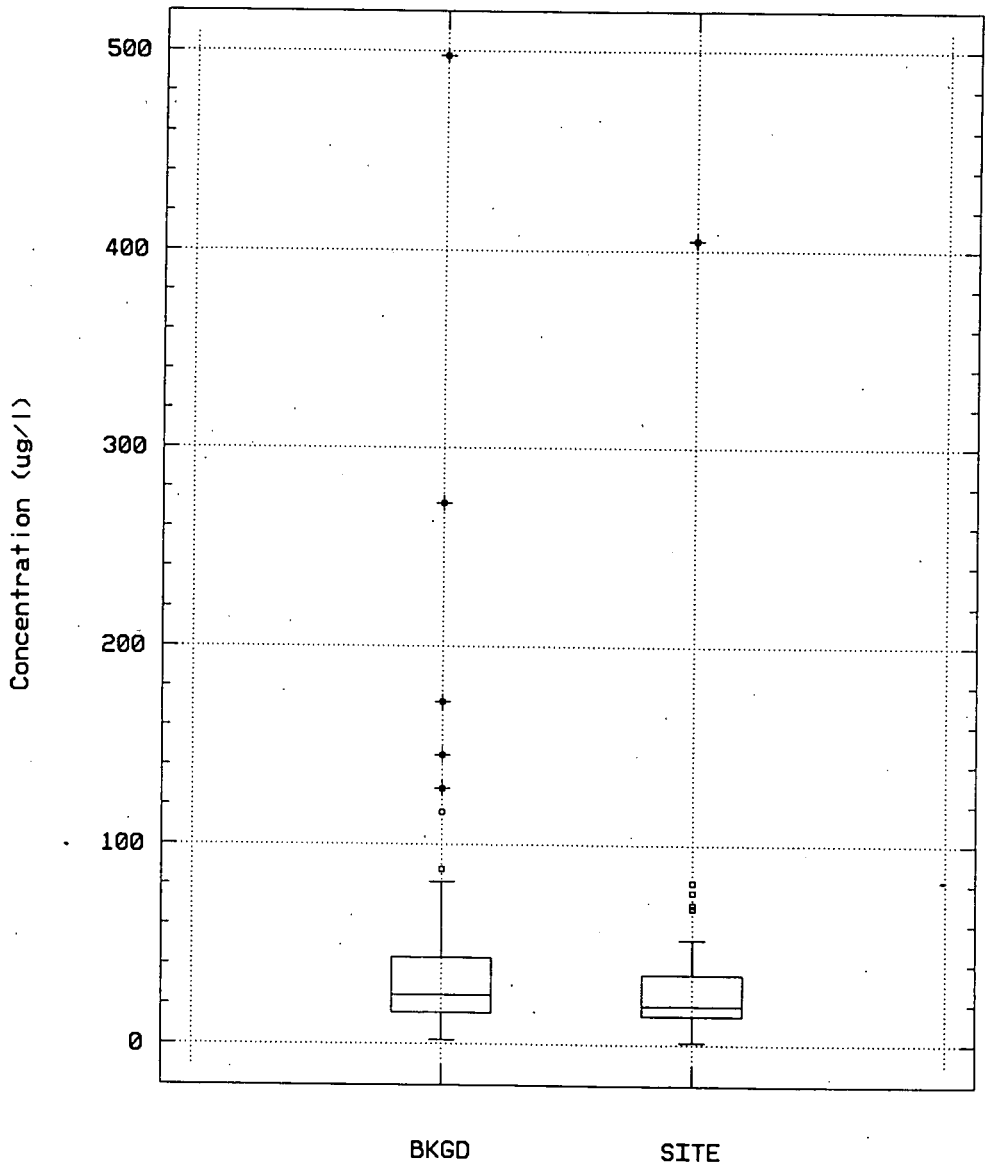
ZINC (ug/l) in Groundwater (Total)



SITE=UHSU samples from saturated media within and downgradient of IHSS 168

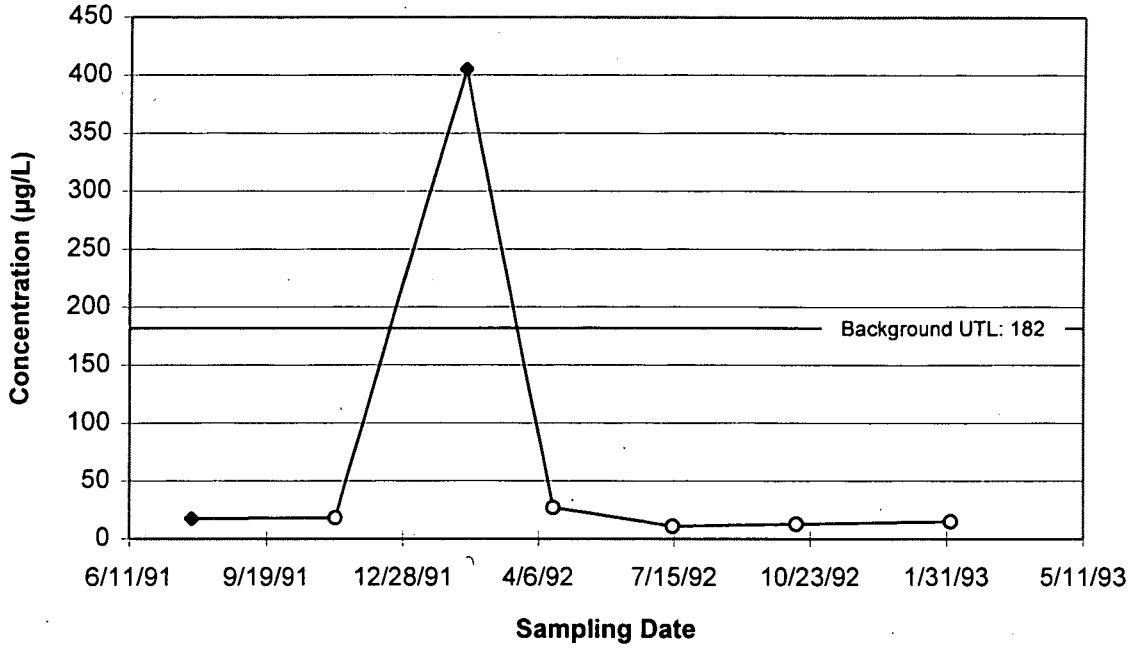
Figure D-70
Background vs OU11 UHSU Groundwater

Zinc in Groundwater (Total)



Groundwater samples within and downgradient of IHSS 168

Figure D-71
Time Series Plot - Total Zinc
5086

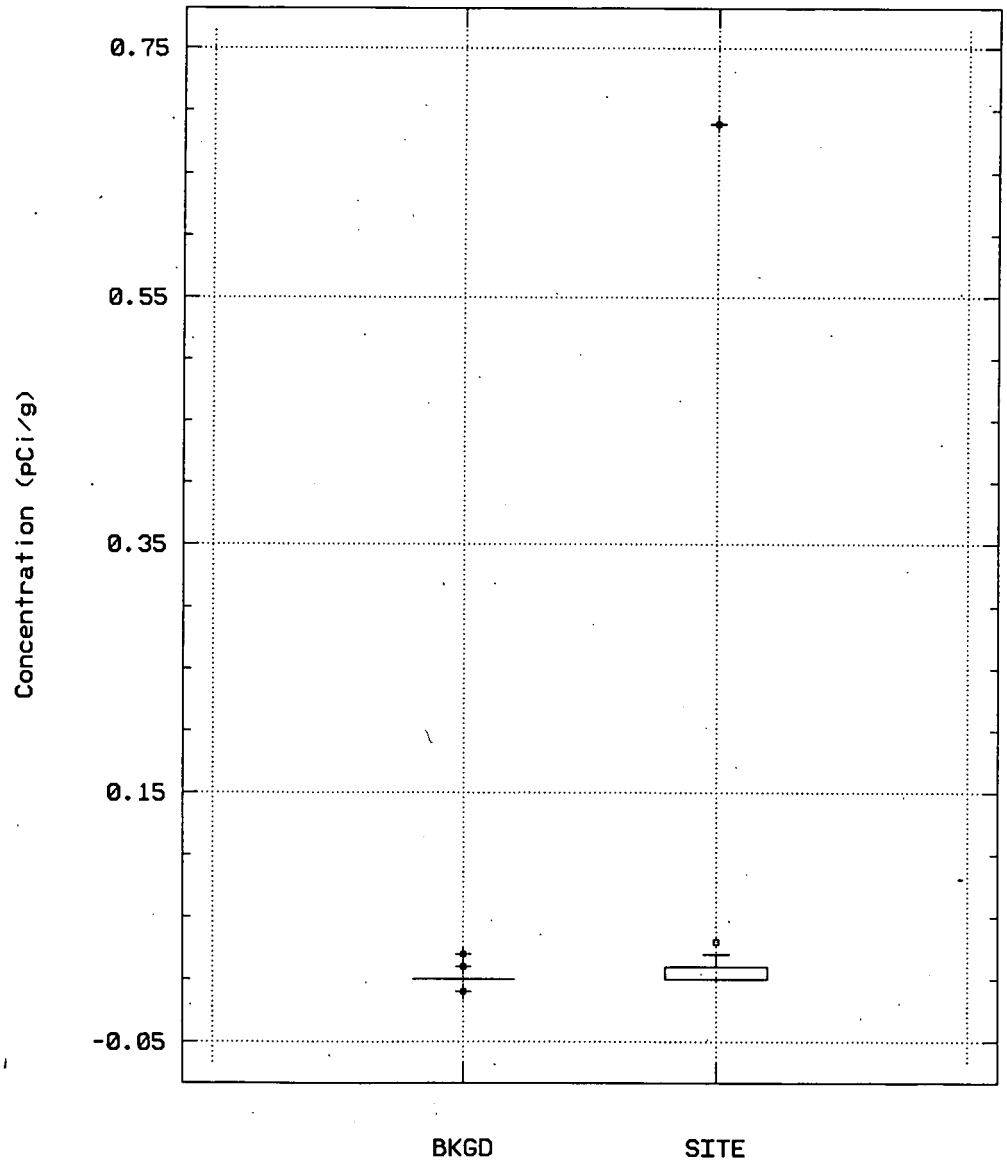


◆ Hit - Y
o Hit - N

MEP C:\..\ALL_TS.XLS Magnesium, Nickel, Tin, Zinc 3/22/95

Figure D-72
Background vs OU11 Subsurface Geologic Materials

Plutonium-239/240 in Qrf
(0 to 12 feet)



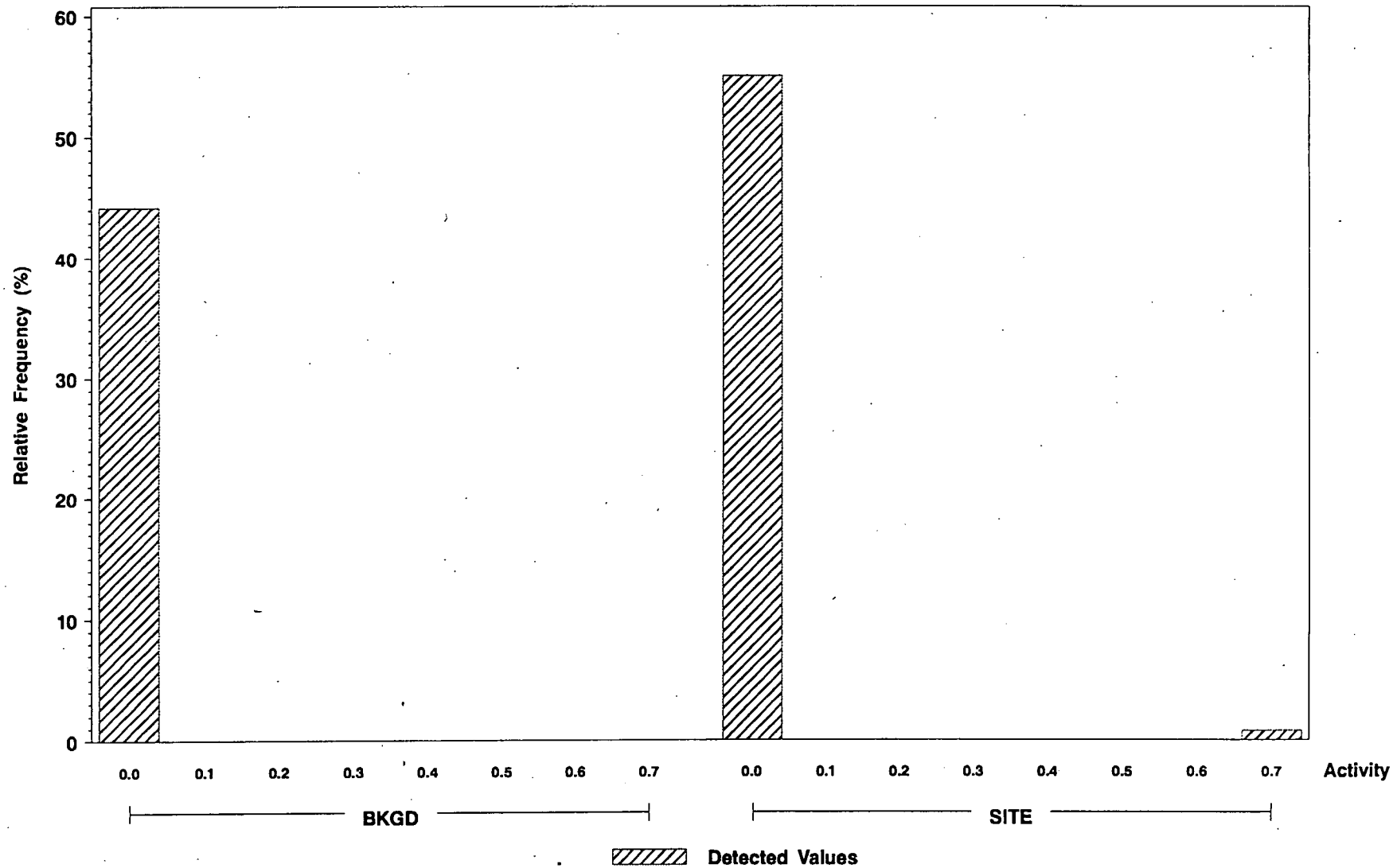
Borehole samples within and downgradient of IHSS 168

Figure D-73

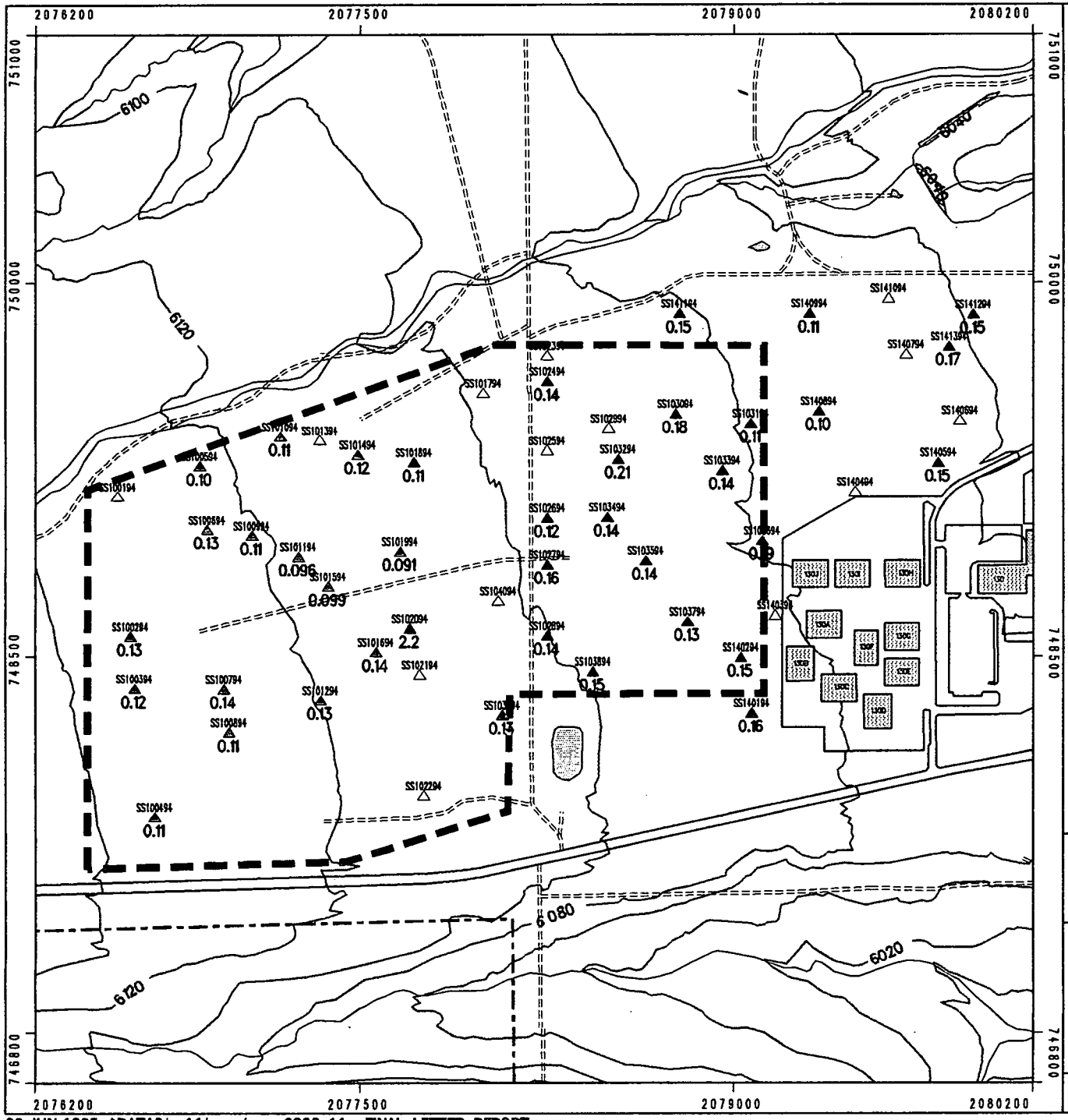
Background (subsurface geologic material) Qrf vs OU11 Qrf (0 – 12 feet)

Frequency Histogram

PLUTONIUM – 239/240 (pCi/g) in Qrf



SITE = Borehole samples within and downgradient of IHSS 168



EXPLANATION

- △ Sample Location
- ▲ Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Activities are in pCi/g
BM+2SD = 0.090

Scale = 1 : 7200
1 Inch = 600 feet

300 0 600ft

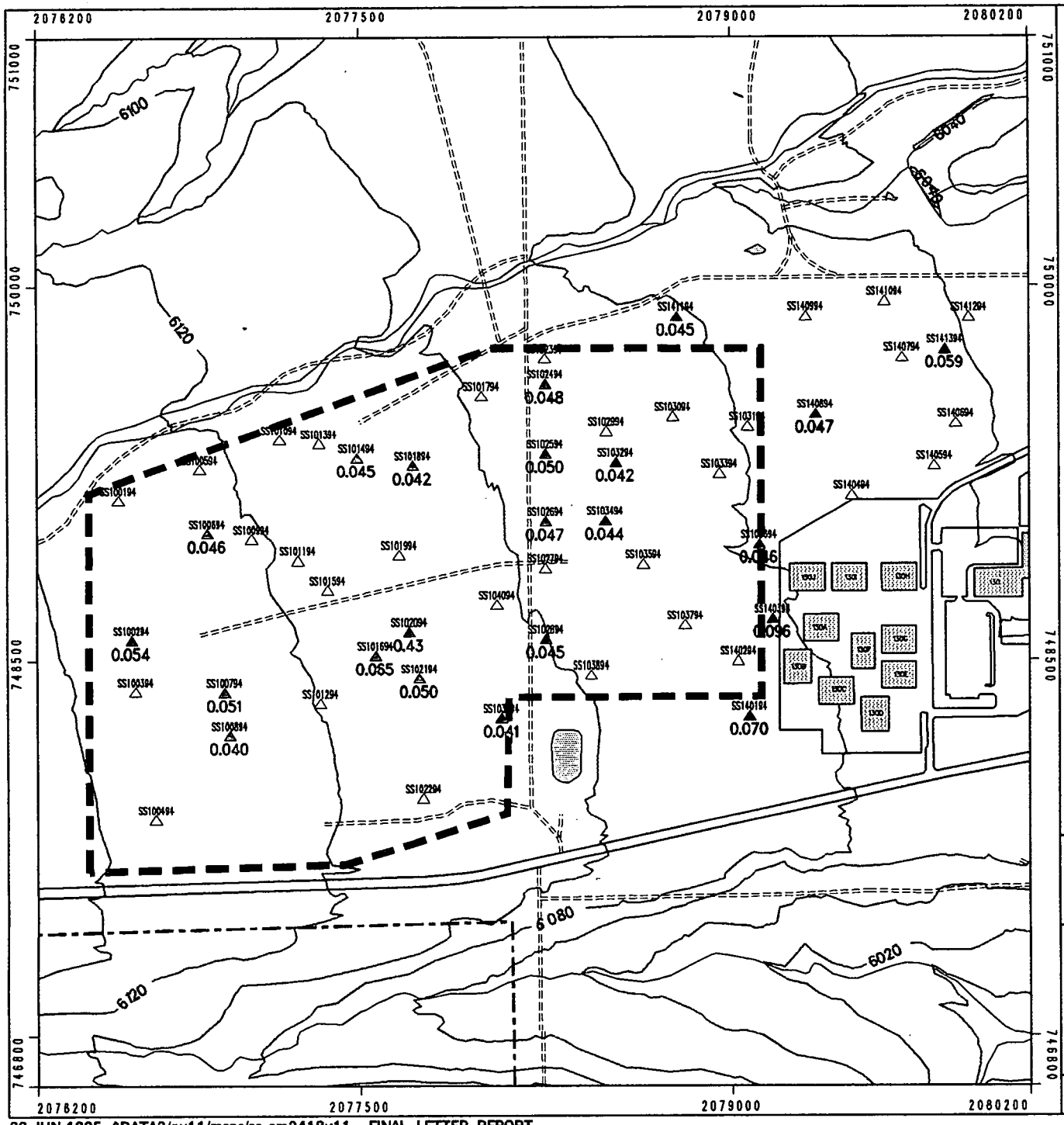
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
PLUTONIUM-239/240
Activities*
at the
OU 11--West Spray Field

June 1995 | Figure D-74

02-JUN-1995 6DATA2/ou11/maps/ss_pu2398x11 FINAL LETTER REPORT



EXPLANATION

- △ Sample Location
- ▲ Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Activities are in pCi/g
BM+2SD = 0.039

Scale = 1 : 7200
1 inch = 600 feet

300 0 600ft

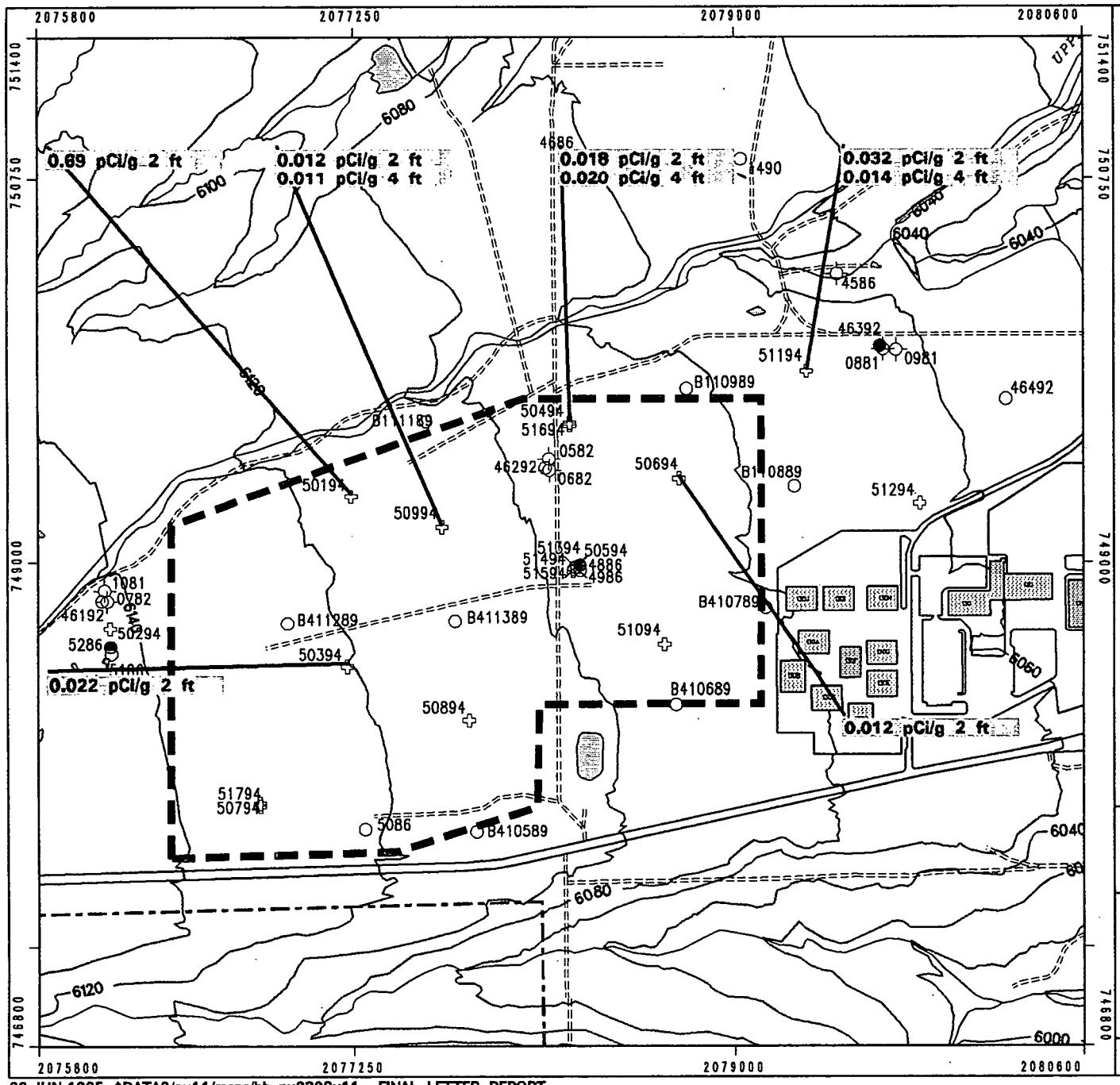
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
AMERICIUM-241
Activities*
at the
OU 11--West Spray Field

June 1995 | Figure D-75

02-JUN-1995 $DATA2/ou11/maps/ss_am2418x11 FINAL LETTER REPORT



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 0.010

Scale = 1 : 8400
1 inch = 700 feet

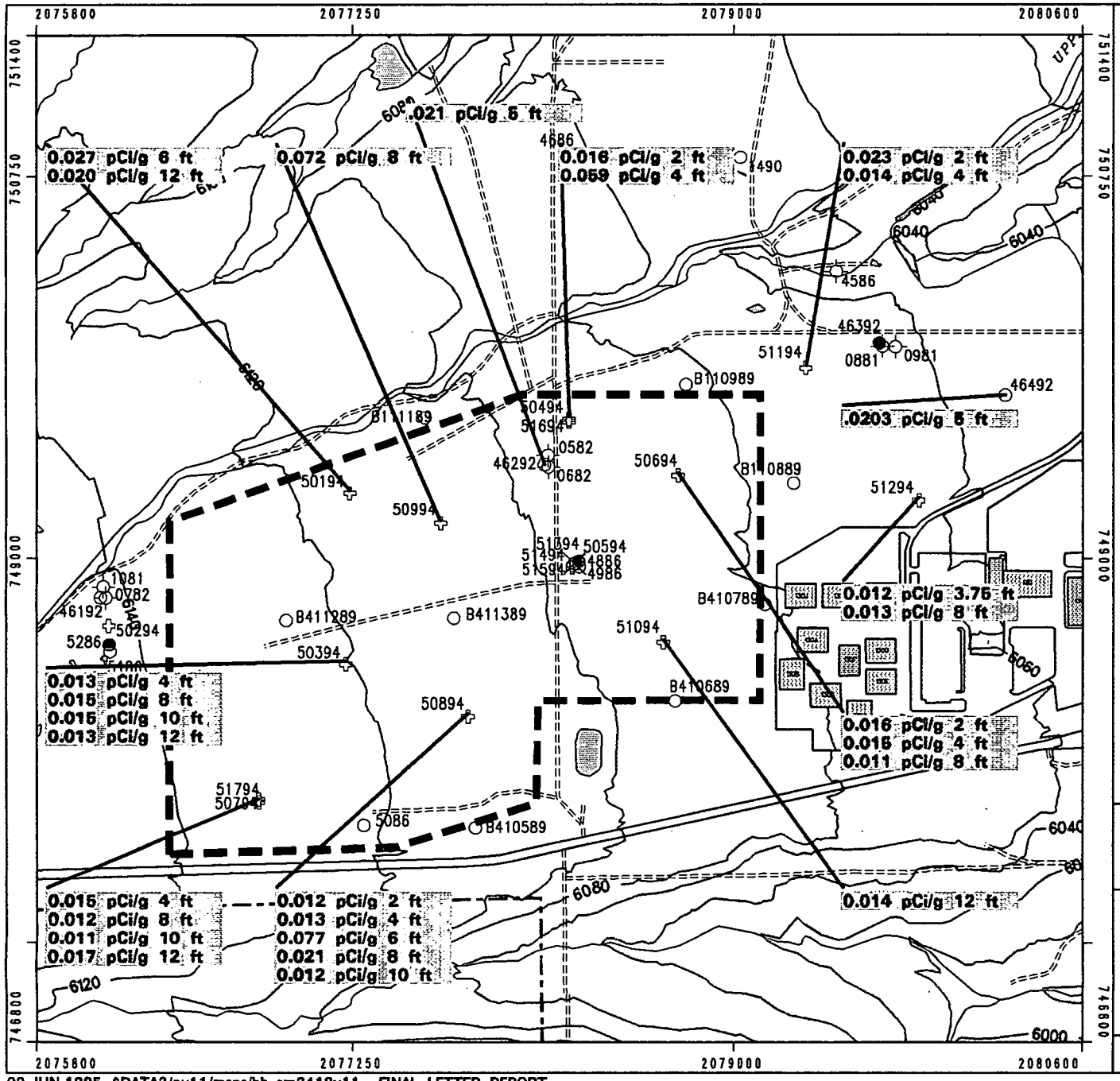
350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
PLUTONIUM-239/240
Activities*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-76



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 0.010

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

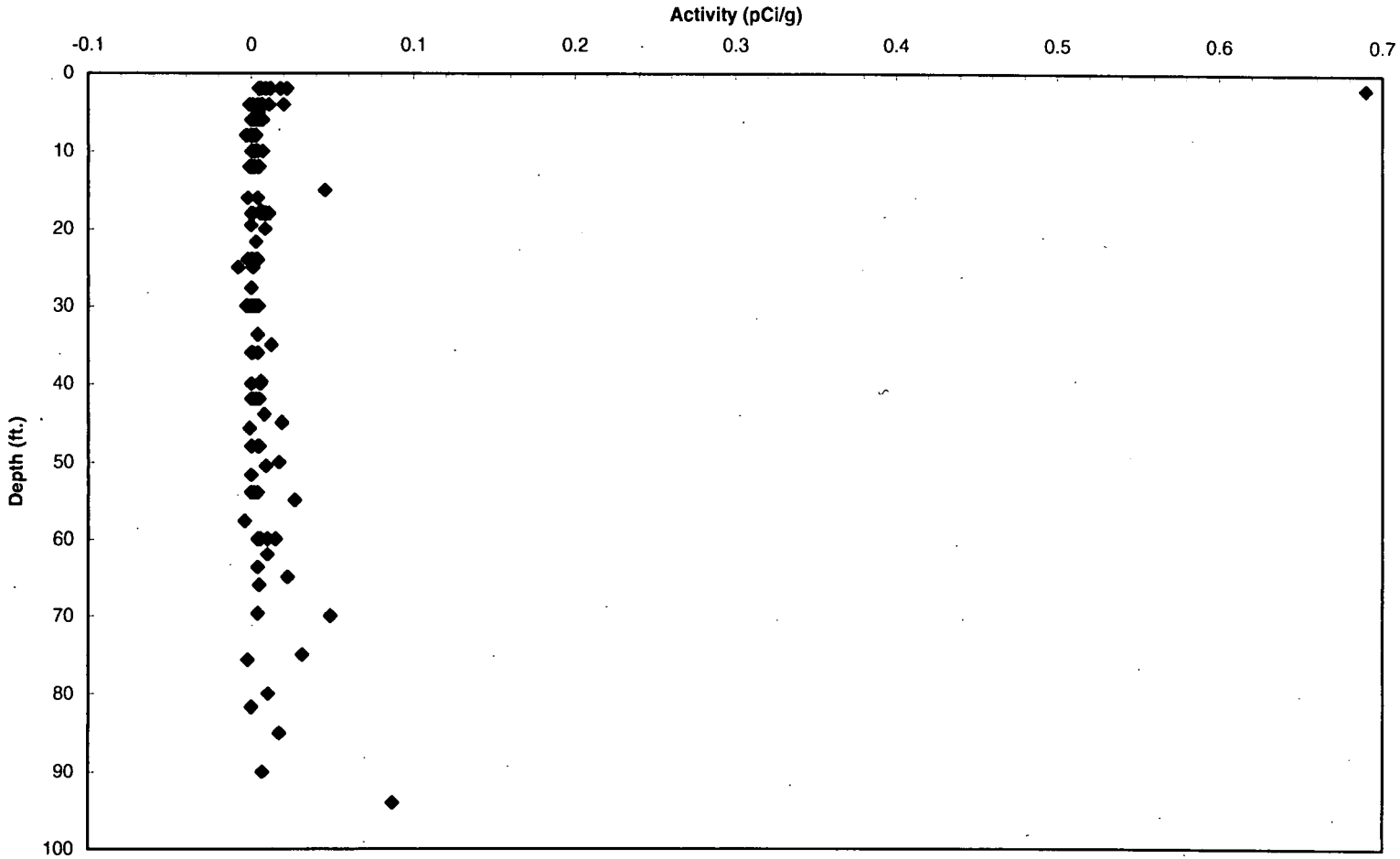
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

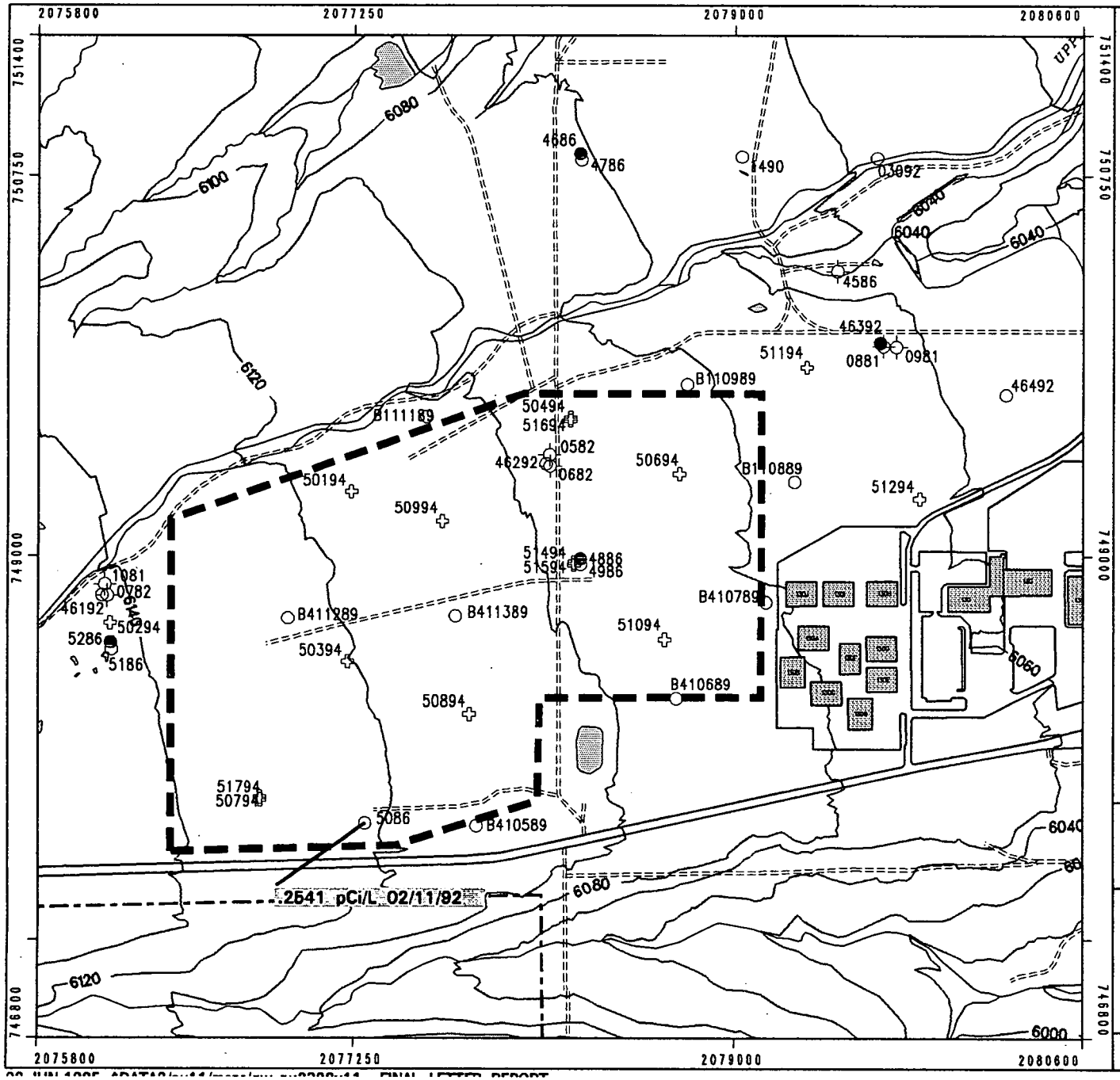
OU 11--West Spray Field
AMERICIUM-241
Activities*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-76b

02-JUN-1995 6DATA2/ou11/maps/bh_am2418x11 FINAL LETTER REPORT

Figure D-77
Activity versus Depth
Plutonium-239/240





EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 0.039

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

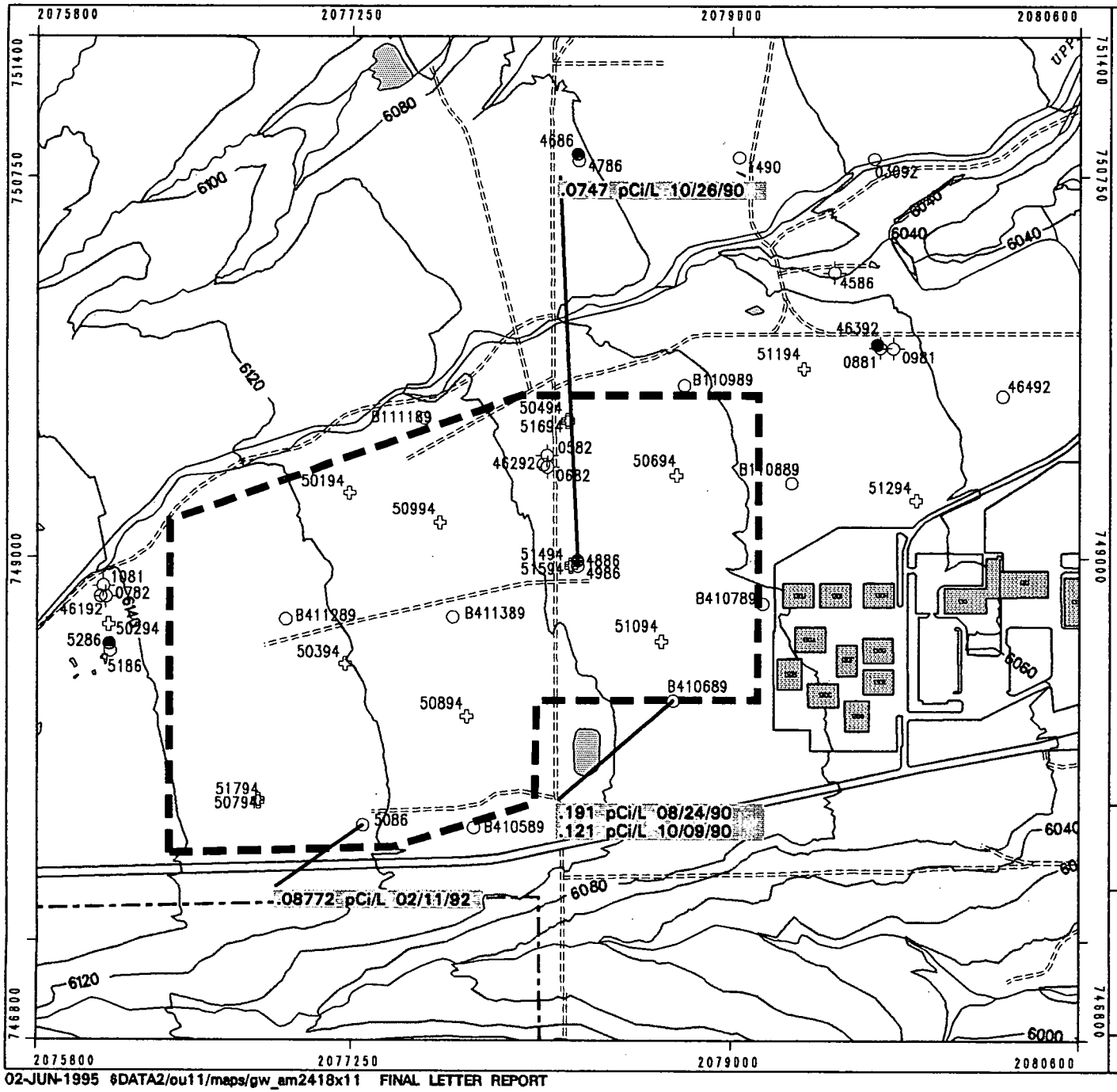
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
PLUTONIUM-239/240
Activities*
(and Sample Dates) in
UHSU Ground Water

June 1995

Figure D-78



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 0.030

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

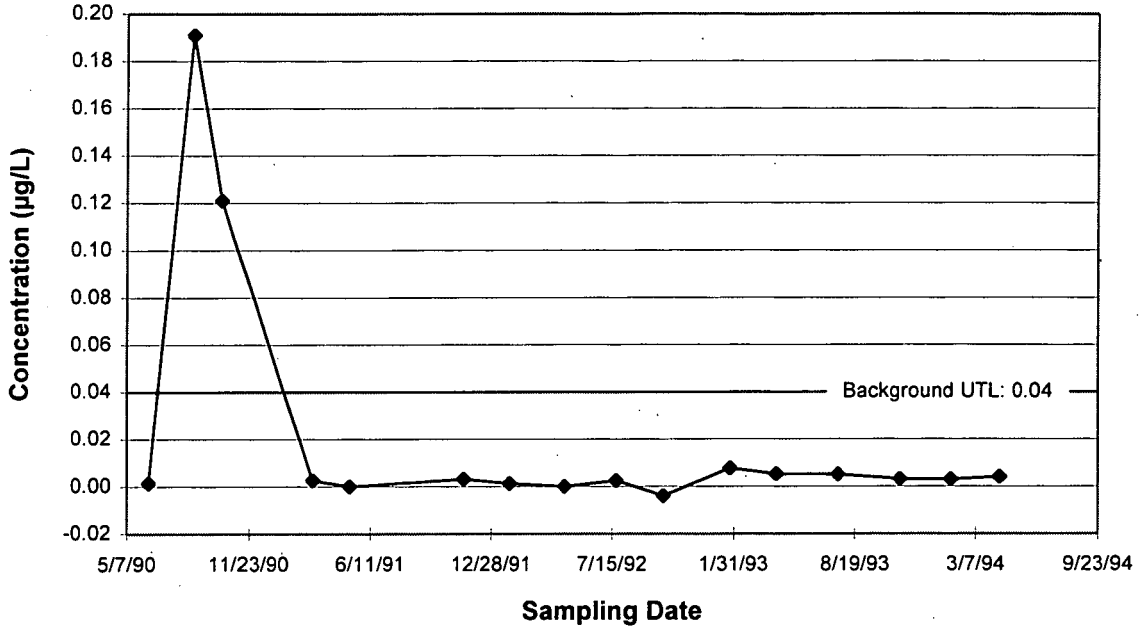
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11–West Spray Field
AMERICIUM-241
Activities*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-79

02-JUN-1995 $DATA2/ou11/maps/gw_am2418x11 FINAL LETTER REPORT

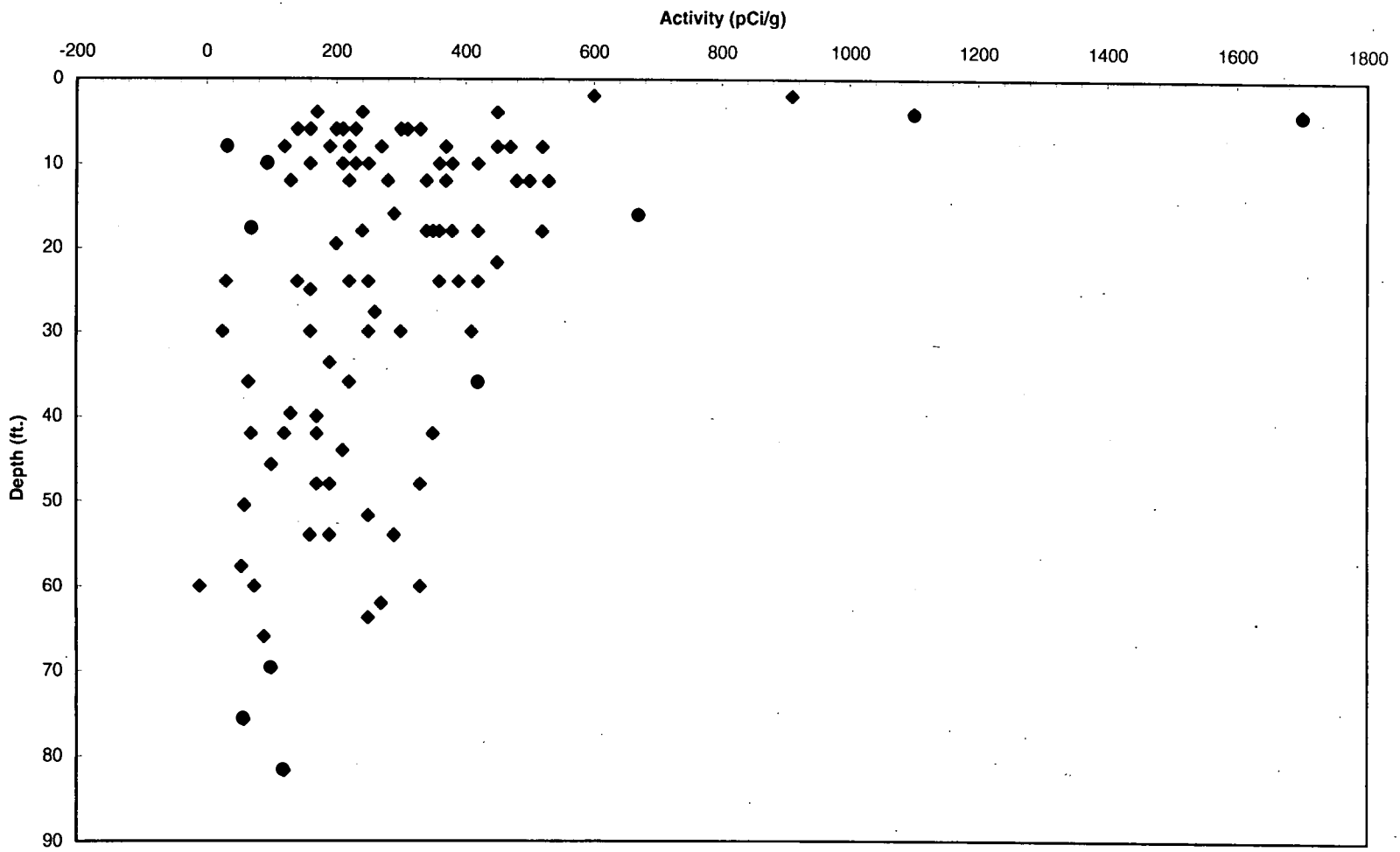
Figure D-80
Time Series Plot - Total Americium-241
B410689

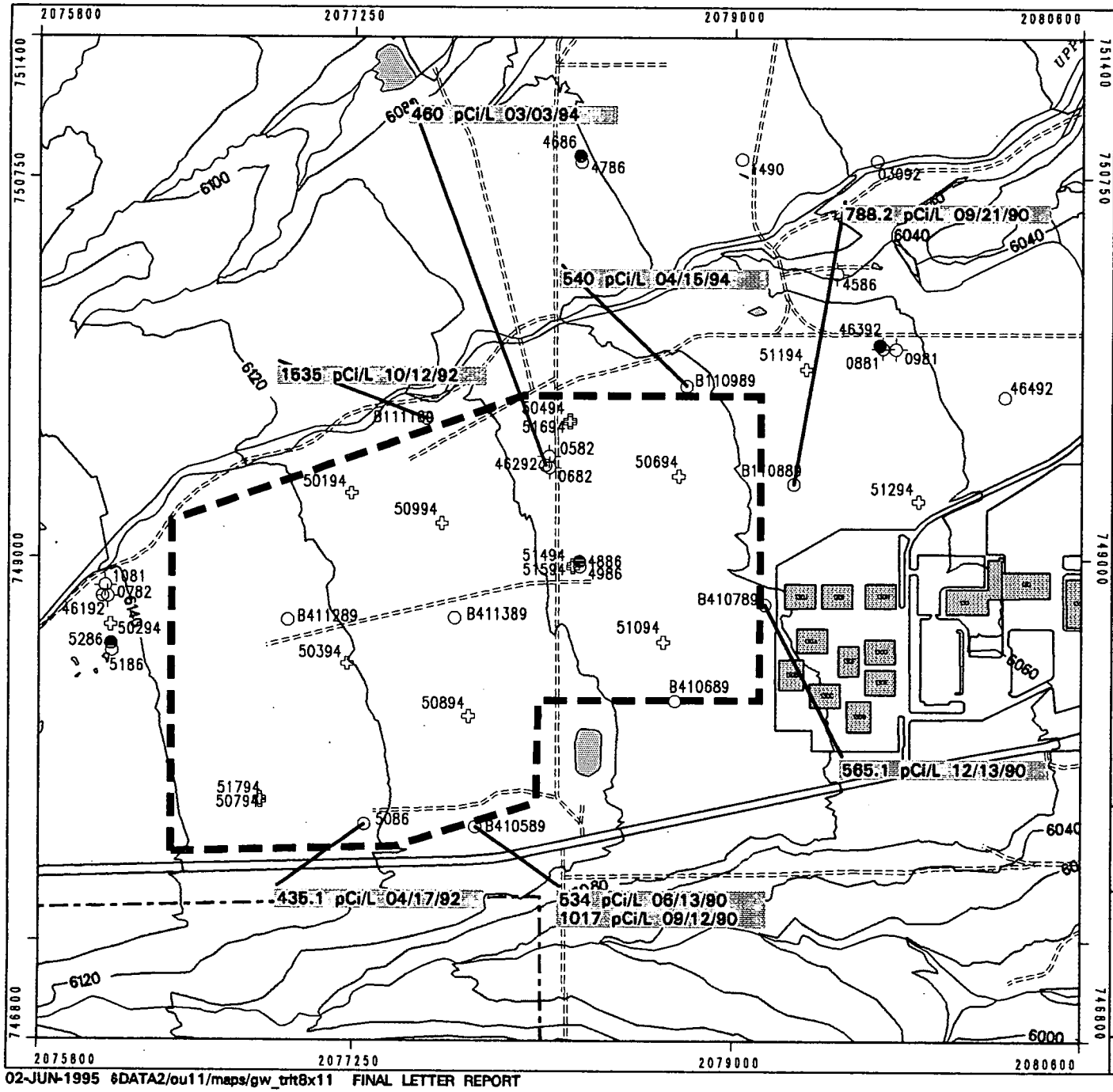


◆ Hit - Y
o Hit - N

MEP C:\..\ALL_TS.XLS Americium, Benzene, C Disulfide 3/22/95

Figure D-81
Activity versus Depth
Tritium





EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 427

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

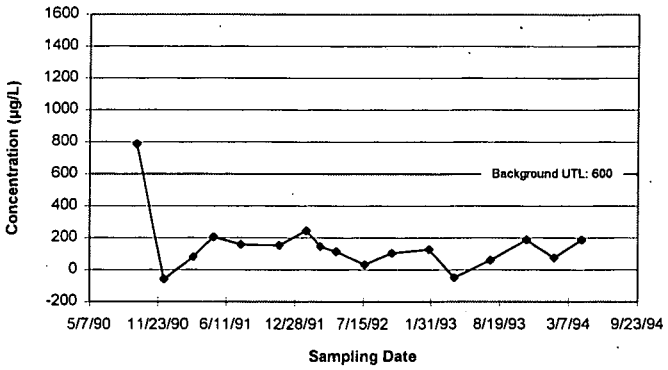
OU 11--West Spray Field
TRITIUM
Activities*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-82

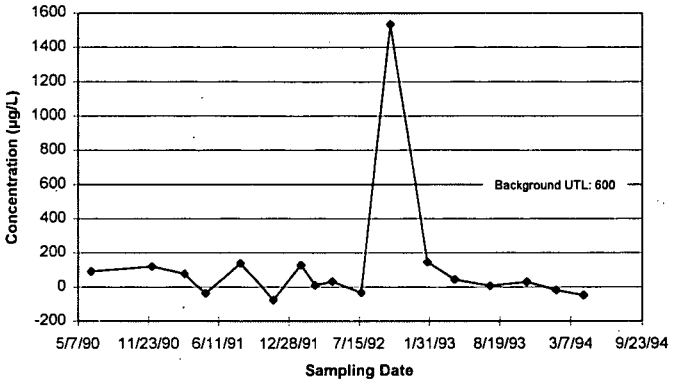
02-JUN-1995 &DATA2/ou11/maps/gw_trit8x11 FINAL LETTER REPORT

Figure D-83
Time Series Plots - Total Tritium

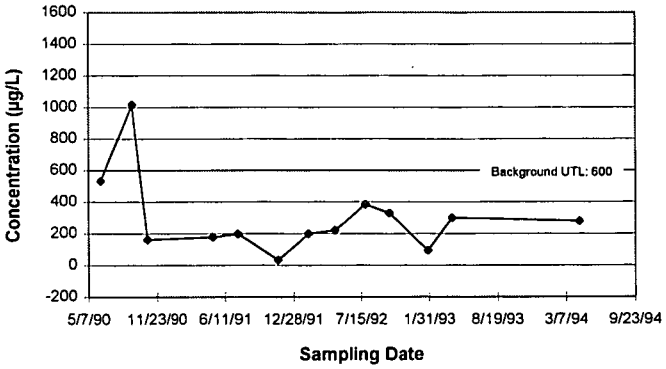
B110889



B111189

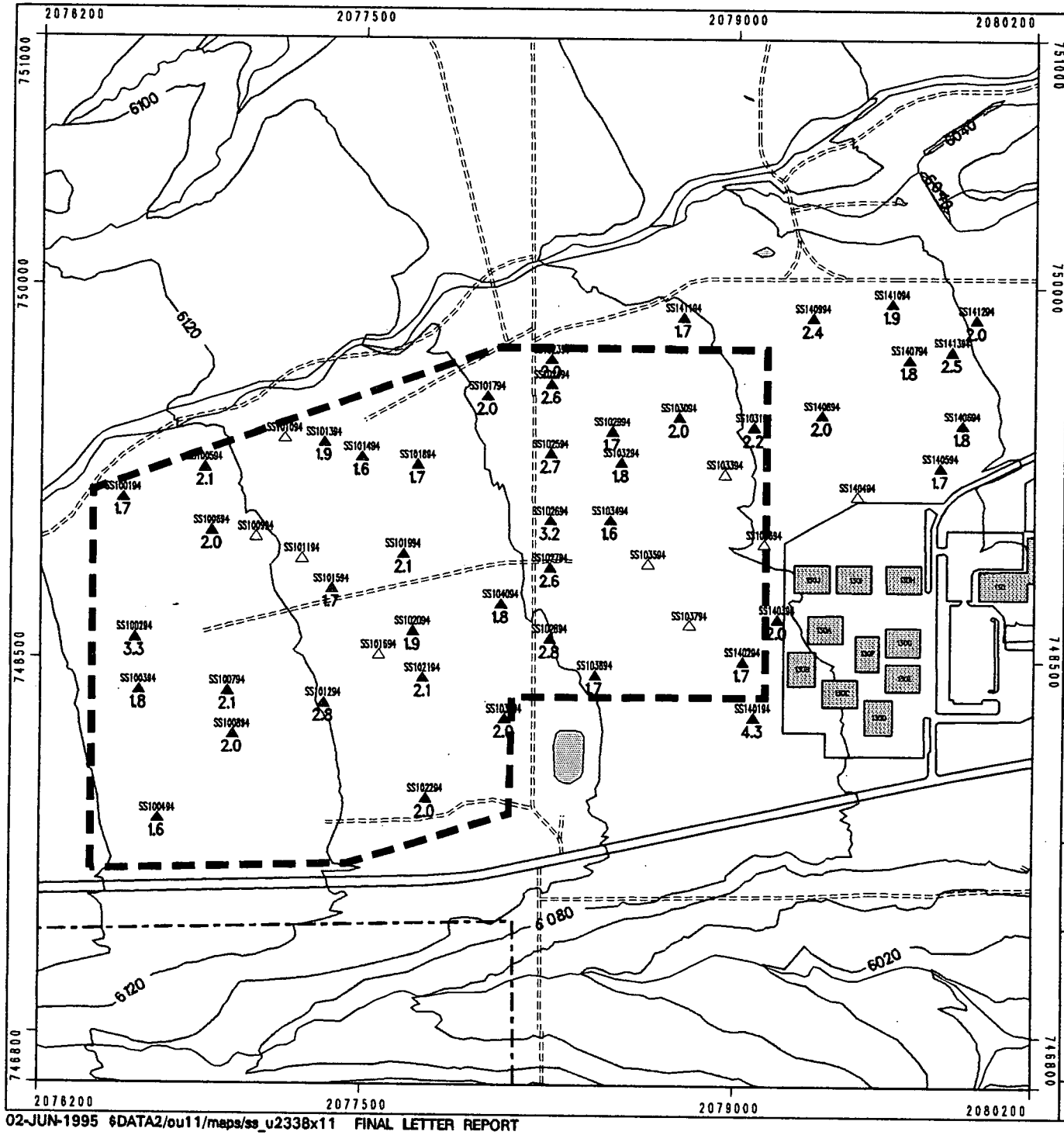


B410589



◆ Hit - Y
O Hit - N

MEP C:\..\ALL_TS.XLS Tritium 3/22/95



EXPLANATION

- △ Sample Location
- ▲ Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Activities are in pCi/g
BM+2SD = 1.500

N

Scale = 1 : 7200
1 inch = 600 feet

300 0 600ft

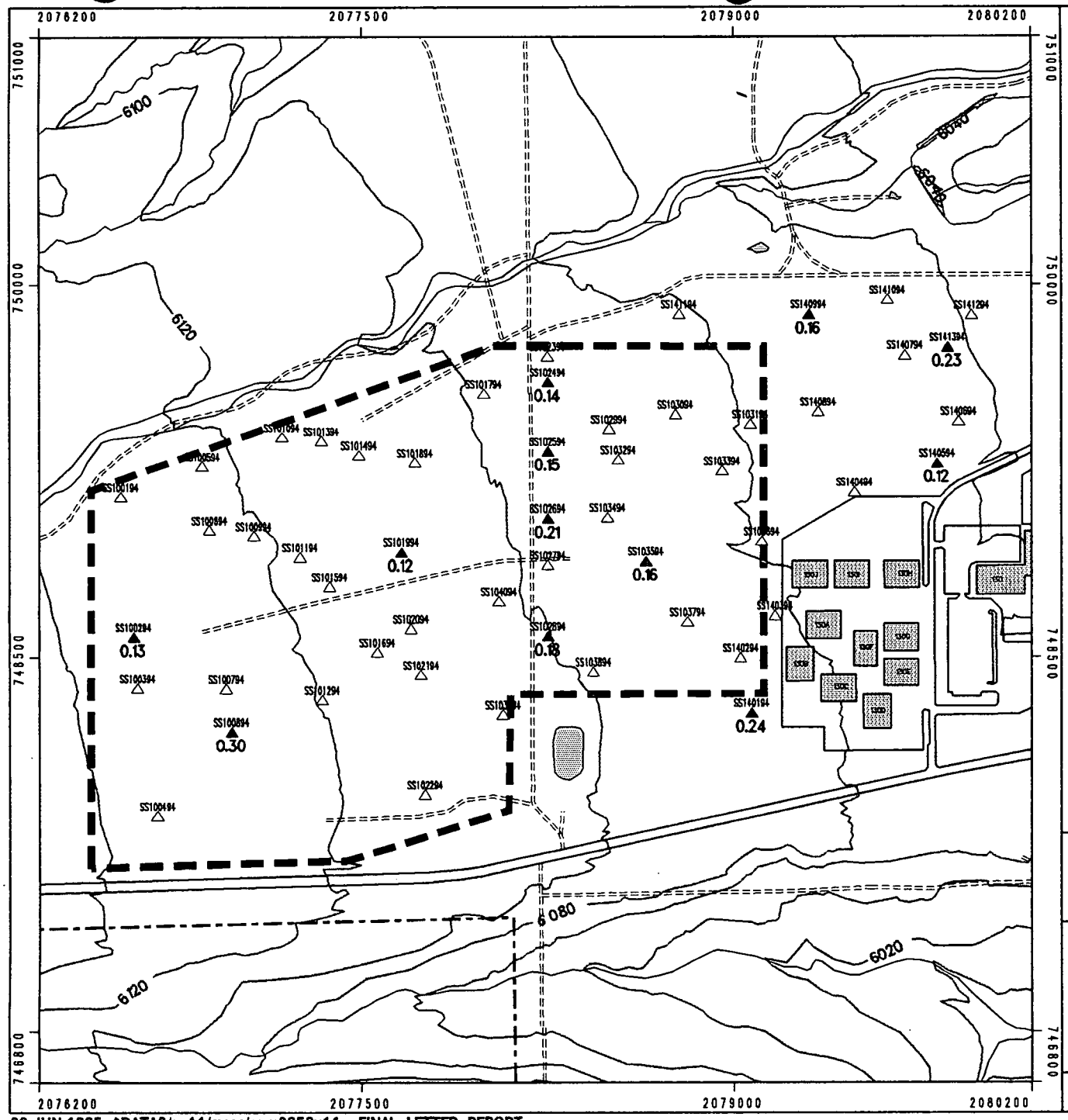
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
URANIUM-233,-234
Activities*
at the
OU 11--West Spray Field

June 1995 | Figure D-84

02-JUN-1995 $DATA2/ou11/maps/ss_u2338x11 FINAL LETTER REPORT



EXPLANATION

- △ Sample Location
- ▲ Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Activities are in pCi/g
BM+2SD = 0.115

Scale = 1 : 7200
1 inch = 600 feet

300 0 600ft

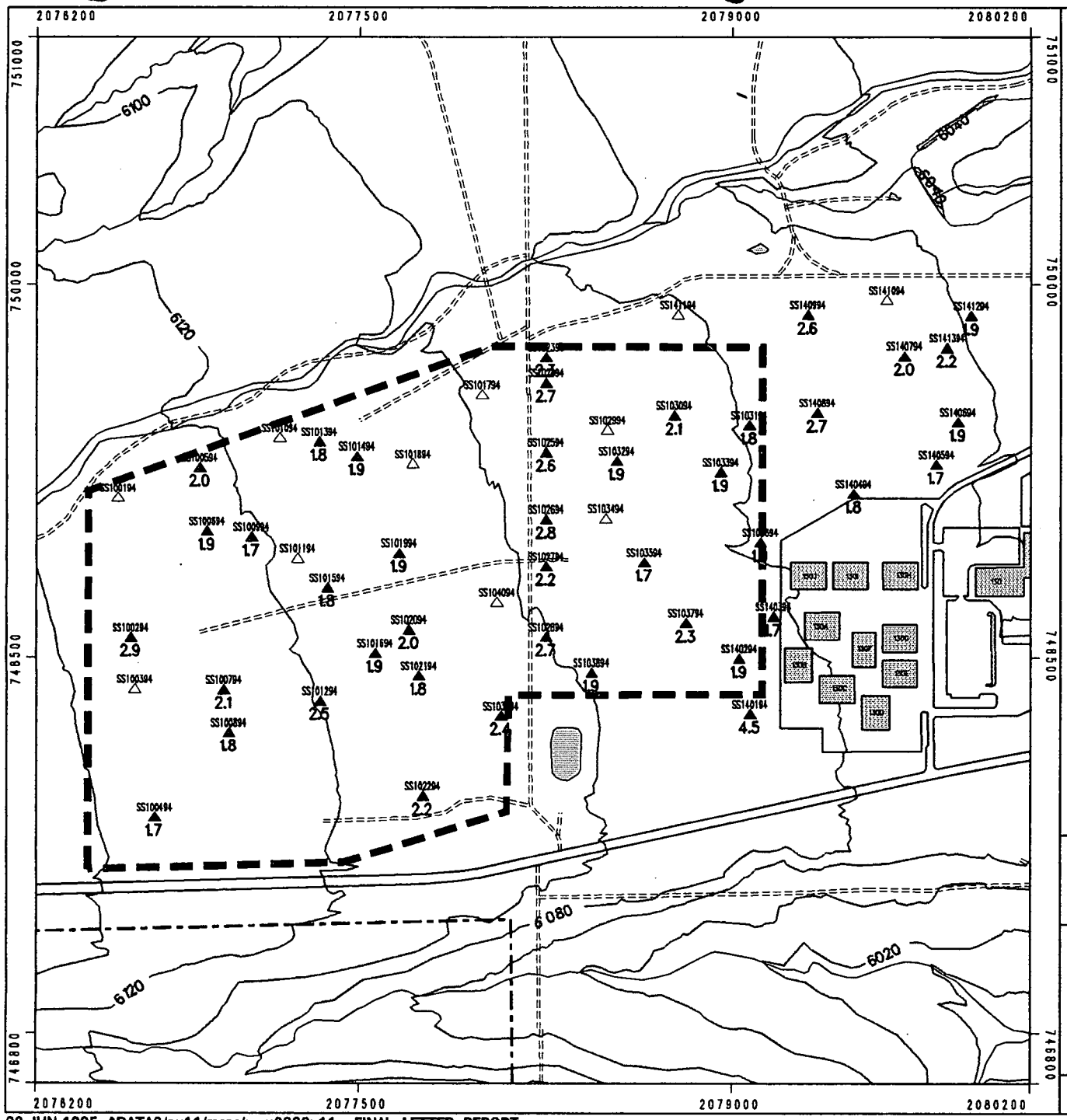
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
URANIUM-235
Activities*
at the
OU 11--West Spray Field

June 1995 | Figure D-85

02-JUN-1995 $DATA2/ou11/maps/ss_u2358x11 FINAL LETTER REPORT



EXPLANATION

- △ Sample Location
- ▲ Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Activities are in pCi/g
BM+2SD = 1.600

Scale = 1 : 7200
1 Inch = 600 feet

300 0 600ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

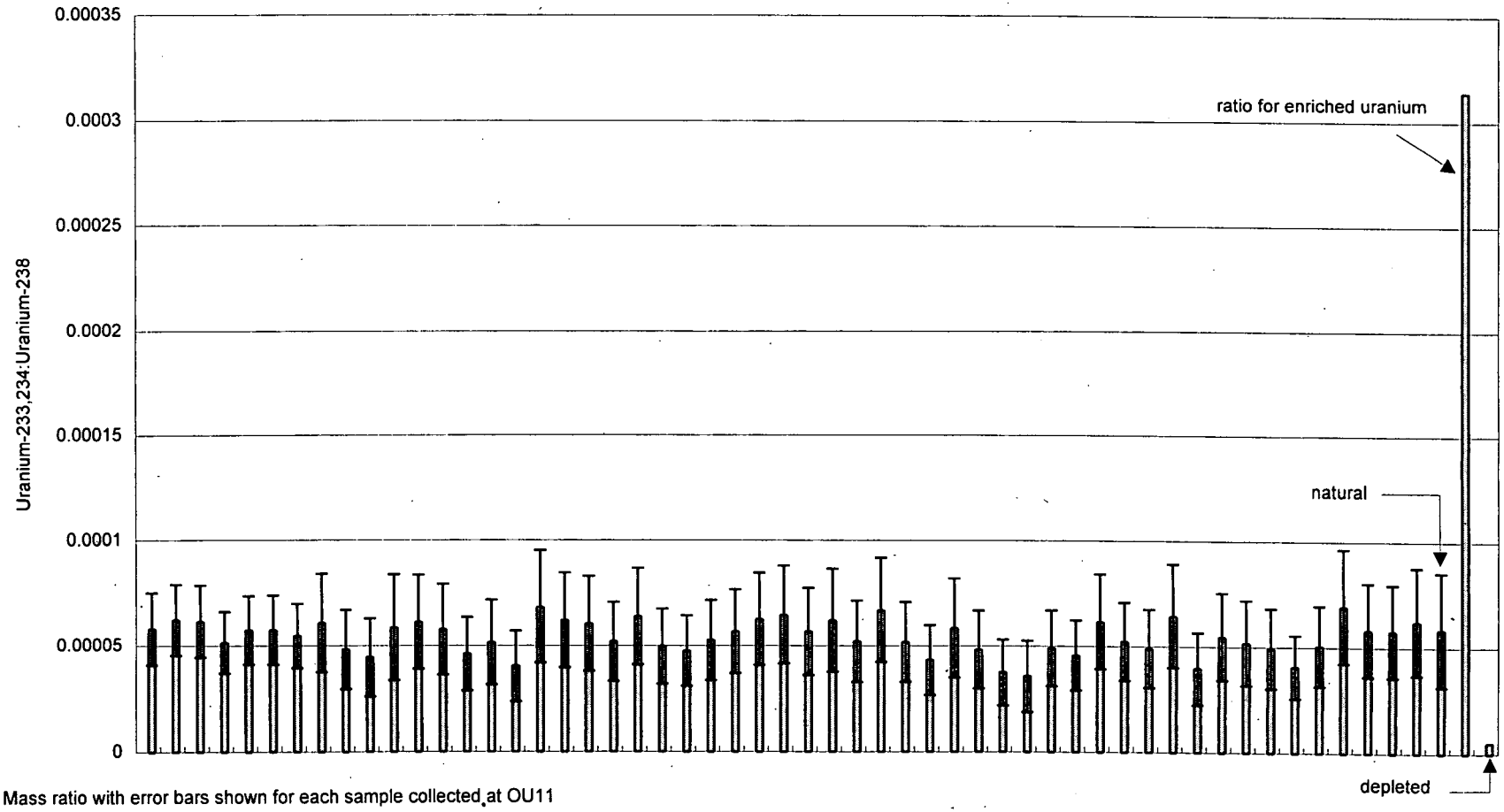
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
URANIUM-238
Activities*
at the
OU 11--West Spray Field

June 1995 | Figure D-86

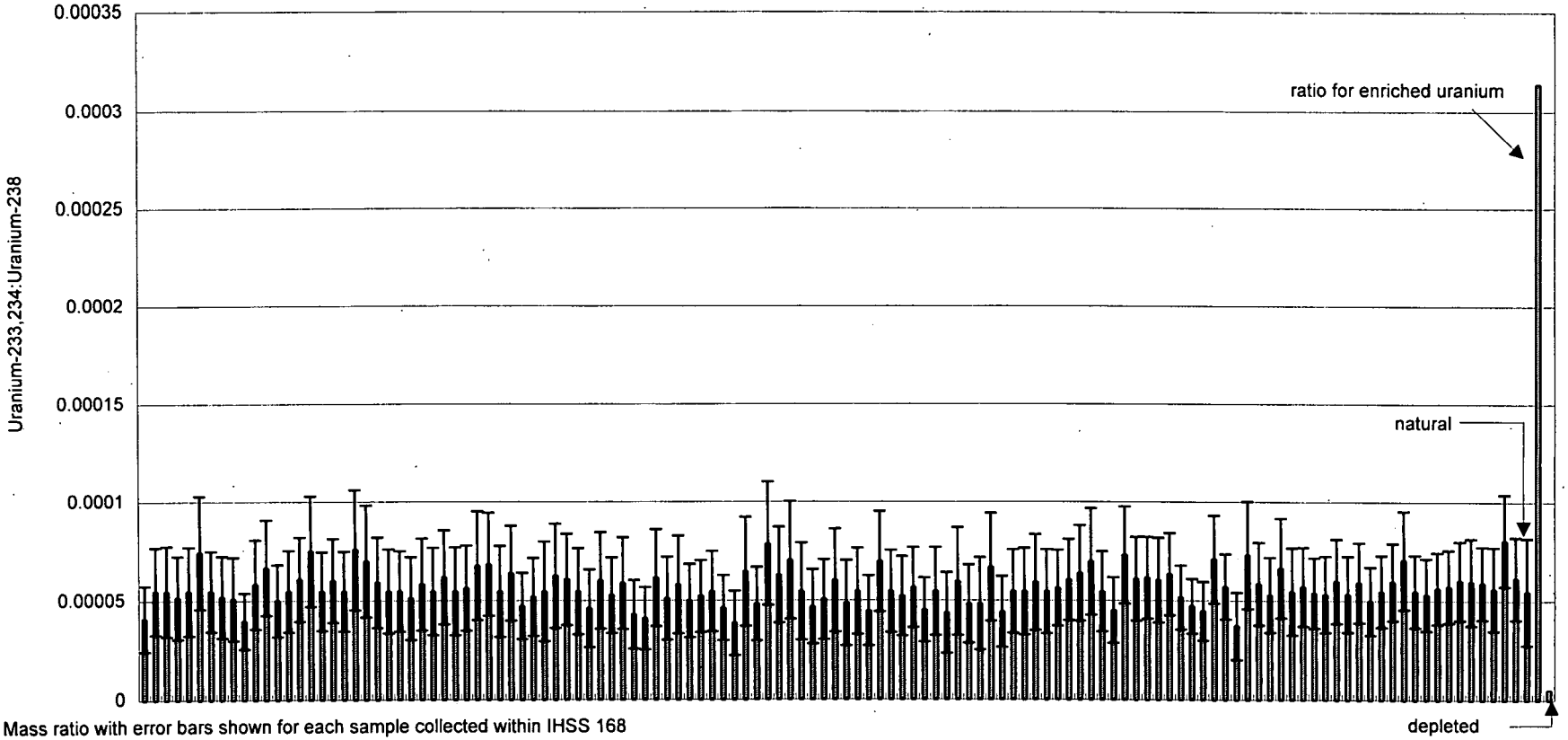
02-JUN-1995 $DATA2/ou11/maps/ss_u2388x11 FINAL LETTER REPORT

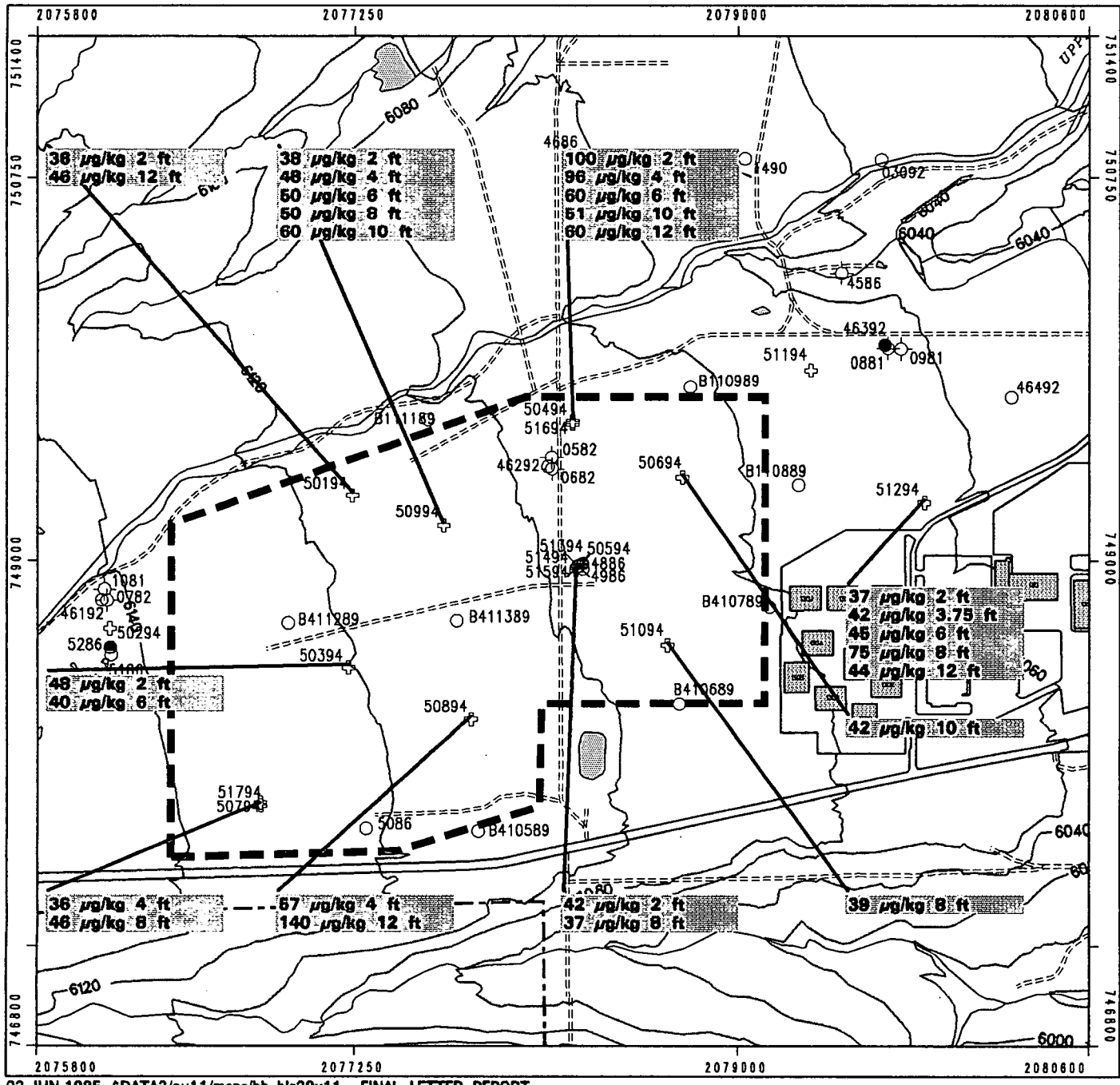
Figure D-87
Uranium-233,234/Uranium-238 Mass Ratio in Surface Soils



Mass ratio with error bars shown for each sample collected at OU11

Figure D-88
Uranium-233,234/Uranium-238 Mass Ratio in Geologic Materials





EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

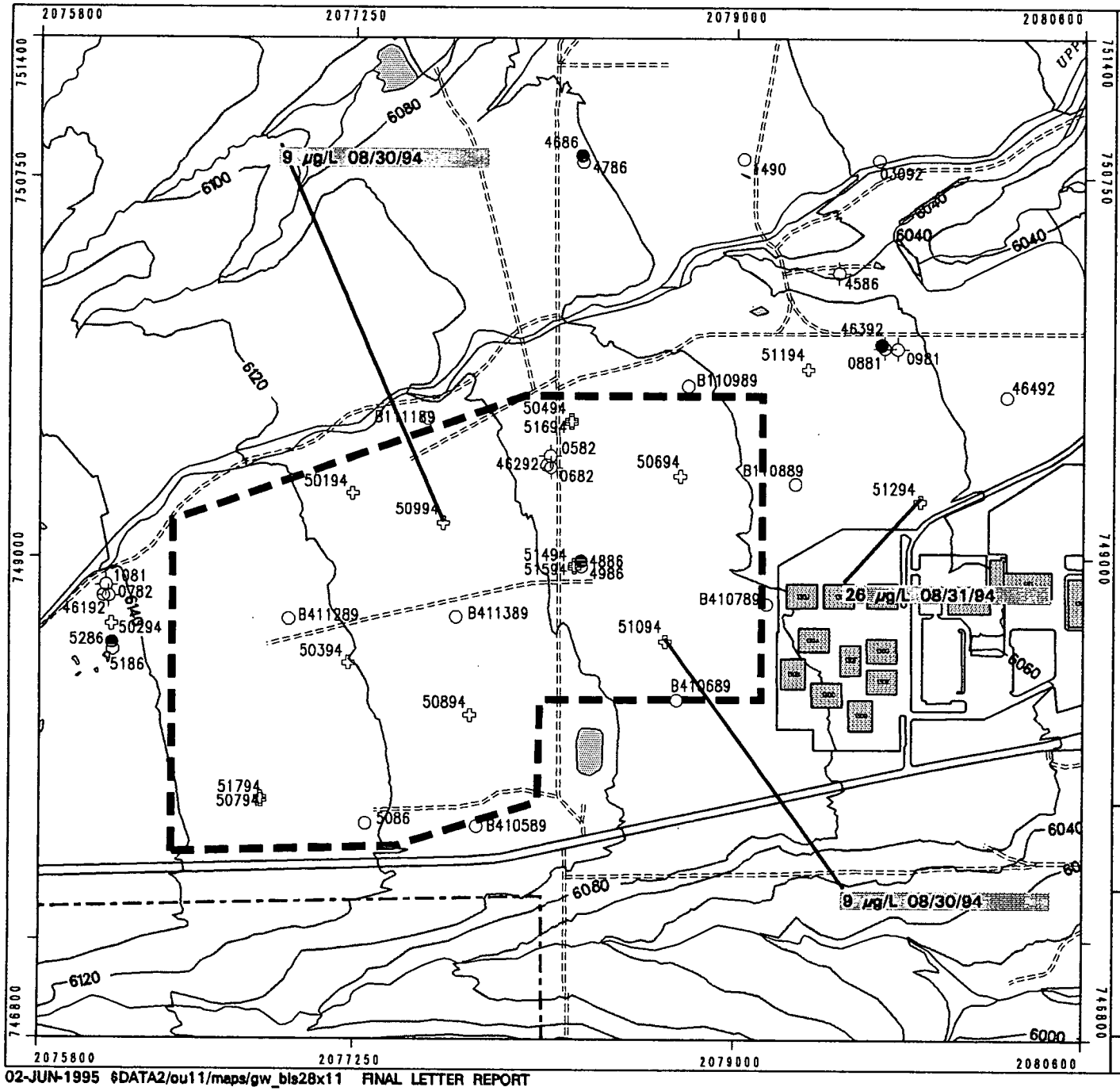
350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
BIS(2-ETHYLHEXYL)PHTHALATE
Concentrations*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-89



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

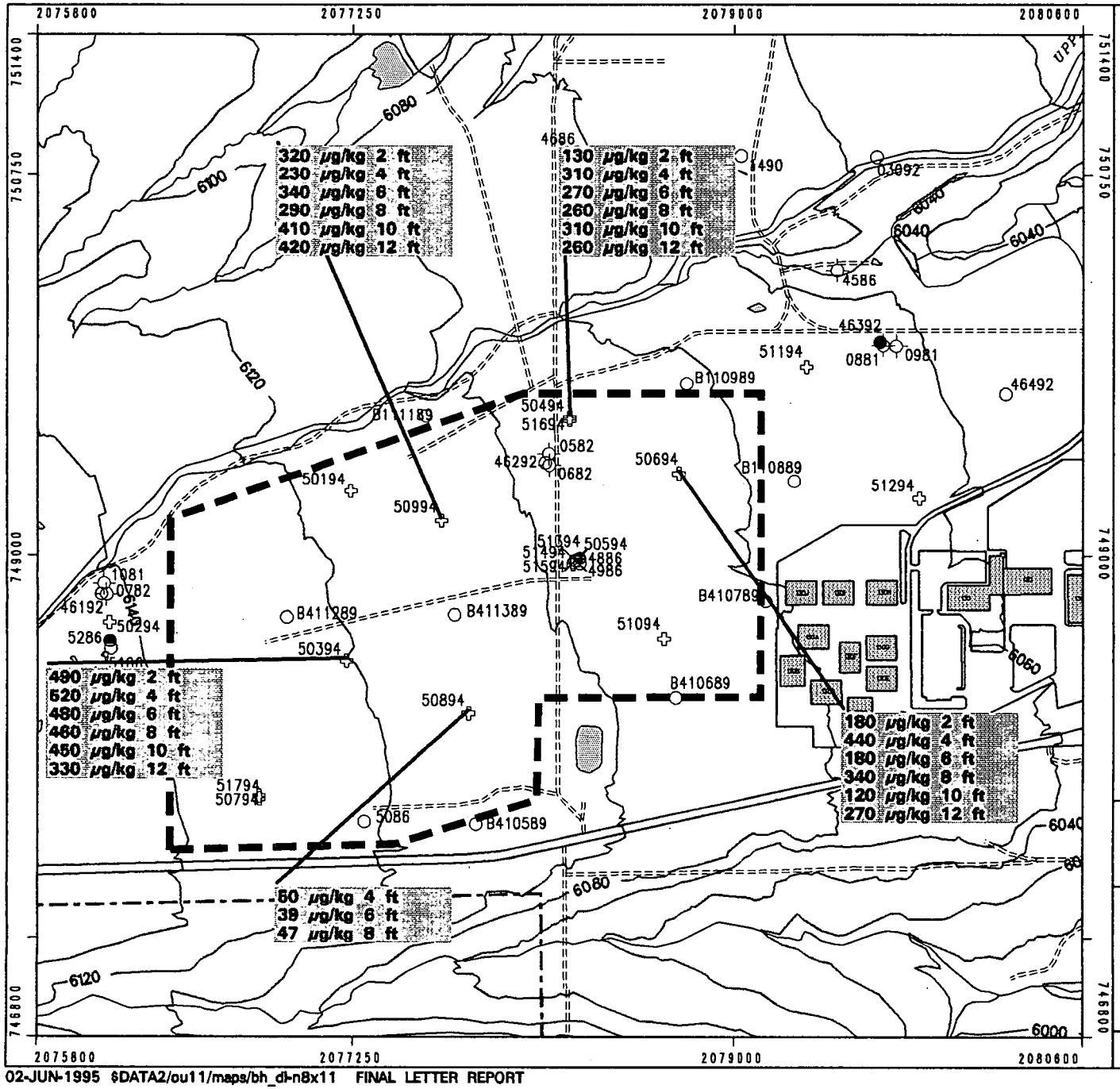
350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
BIS(2-ETHYLHEXYL)PHTHALATE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-90



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

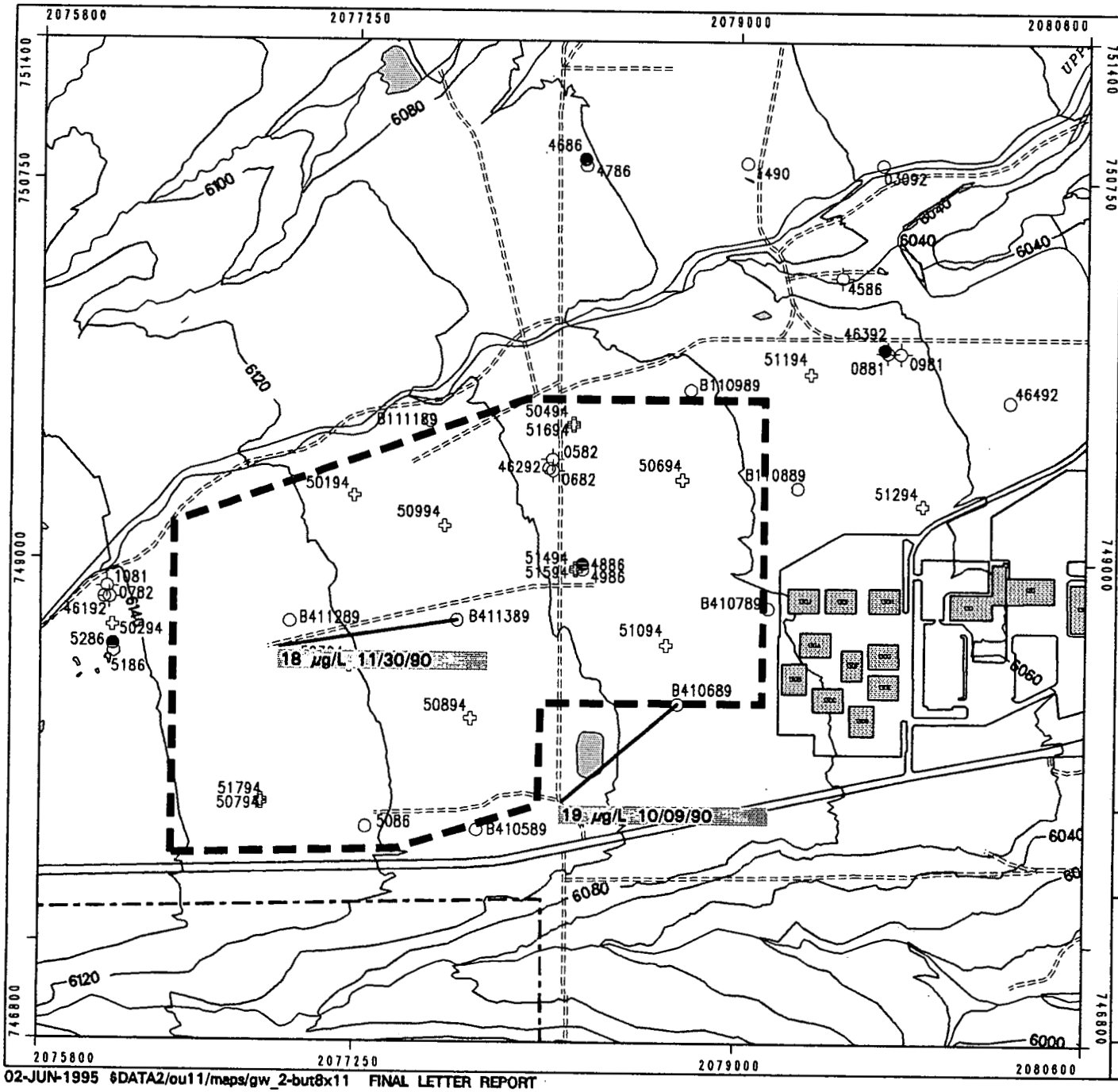
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
DI-n-BUTYL PHTHALATE
Concentrations*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-91

02-JUN-1995 $DATA2/ou11/maps/bh_di-n8x11 FINAL LETTER REPORT



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

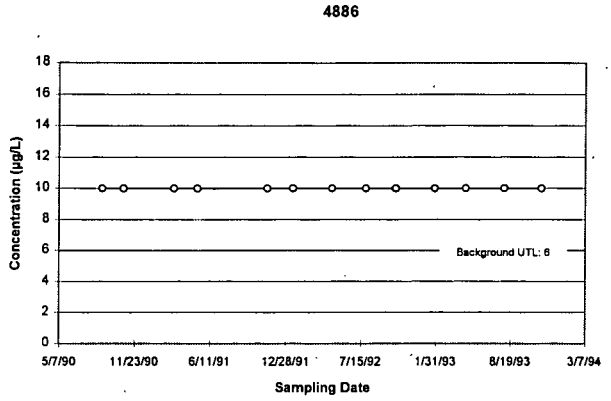
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

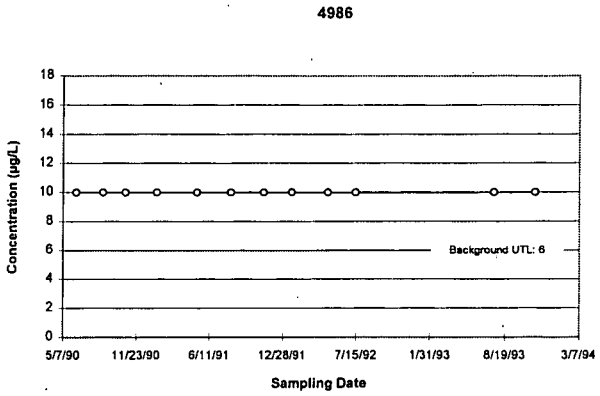
OU 11--West Spray Field
2-BUTANONE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

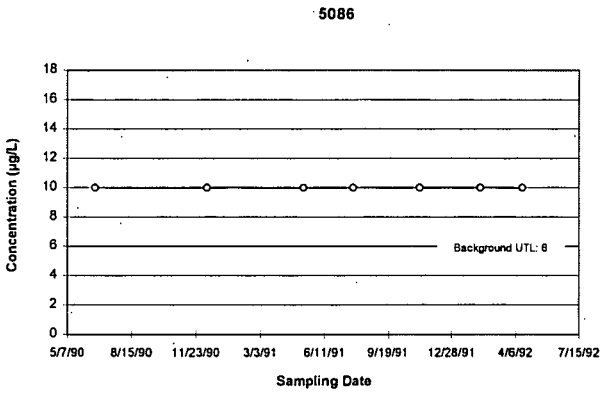
June 1995 | Figure D-92

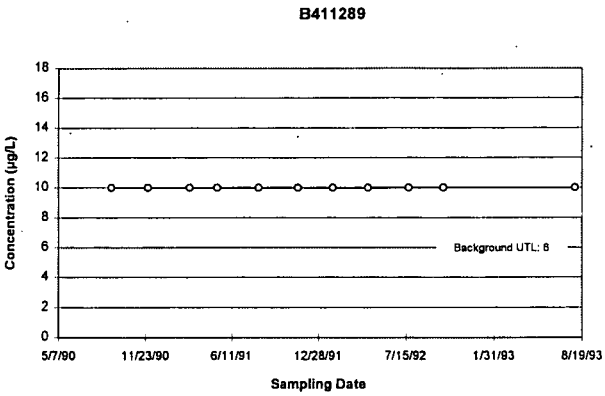
02-JUN-1995 $DATA2/ou11/maps/gw_2-but8x11 FINAL LETTER REPORT

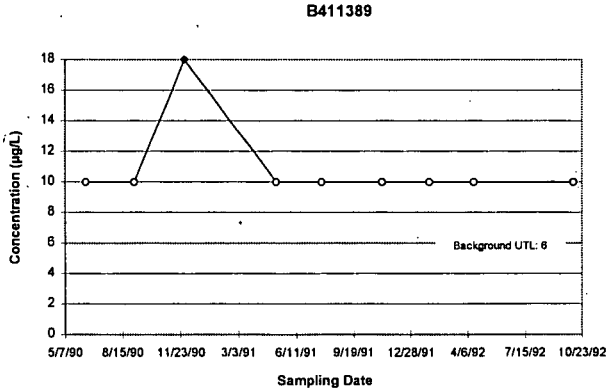
Figure D-93
Time Series Plots - Total 2-Butanone











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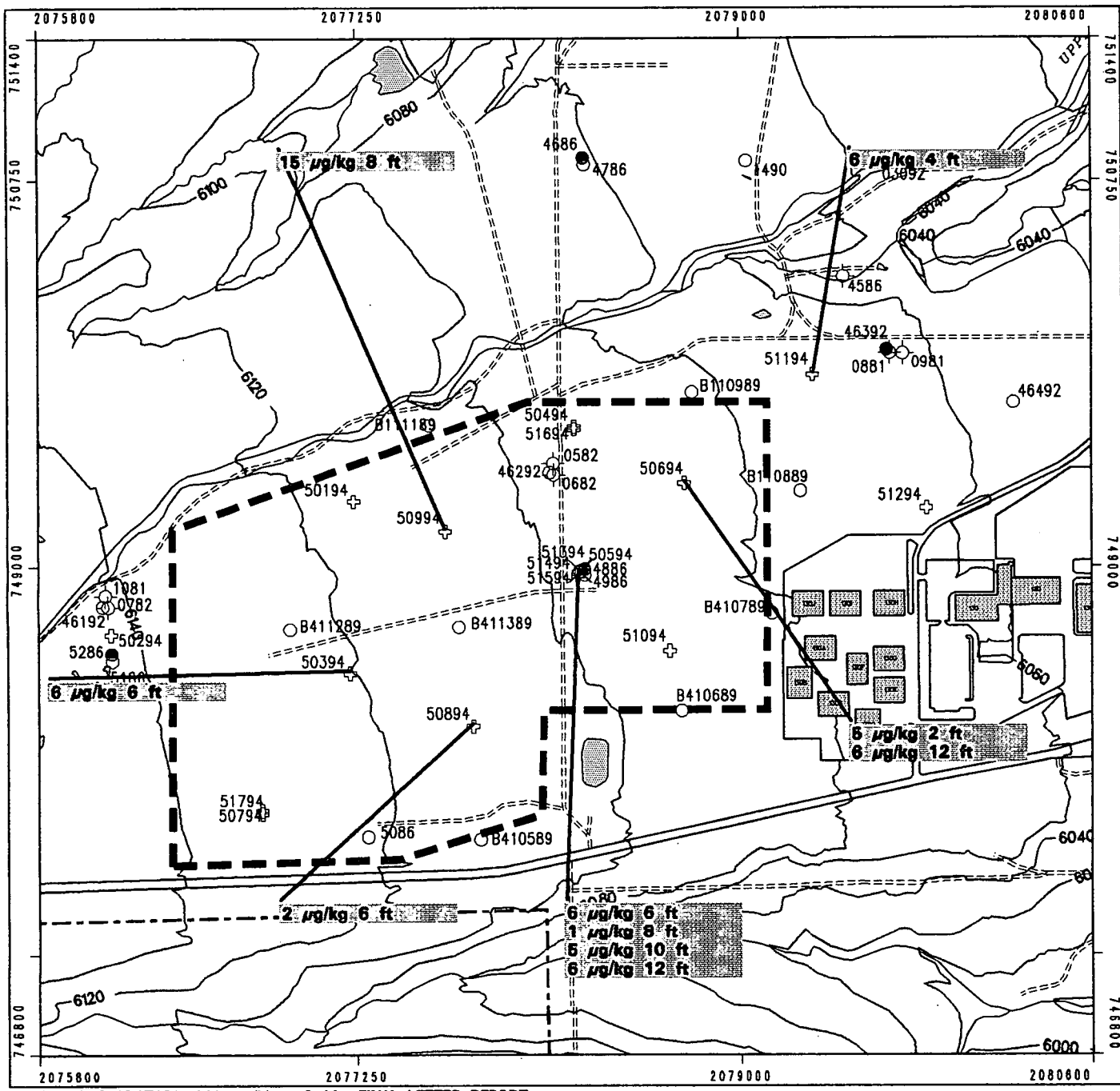
MEP C:\.VALL_TS.XLS 2-Butanone 3/21/95



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

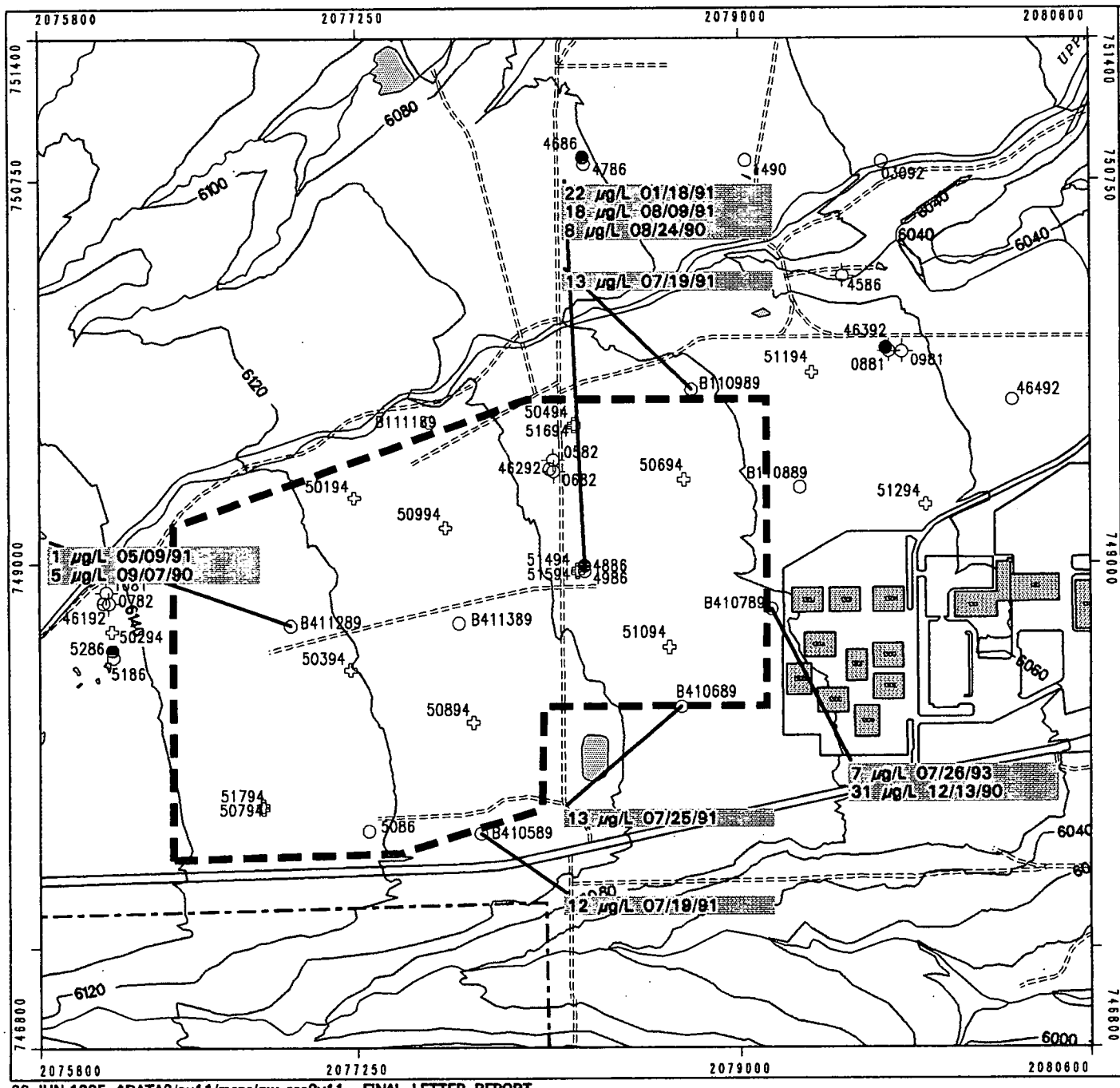
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
ACETONE
Concentrations*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-94

02-JUN-1995 $DATA2/ou11/maps/bh_ace8x11 FINAL LETTER REPORT



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

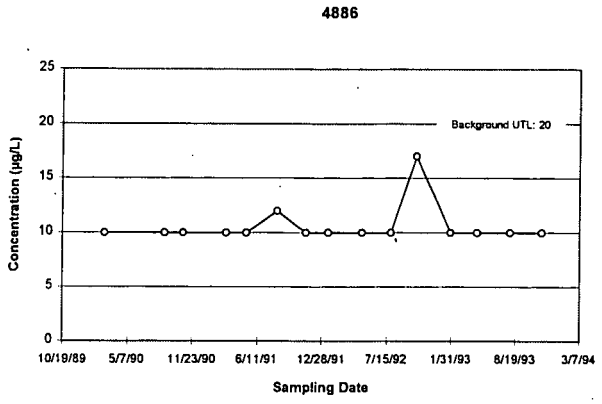
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

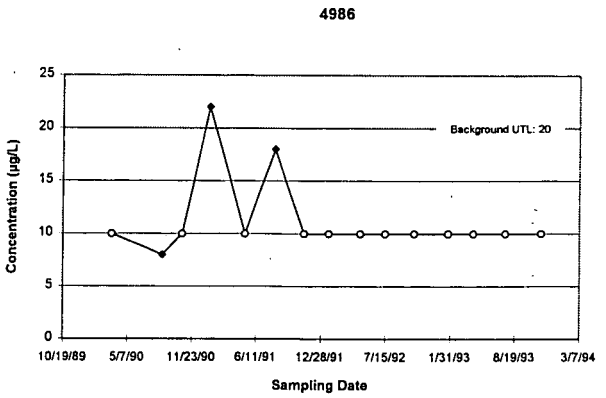
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

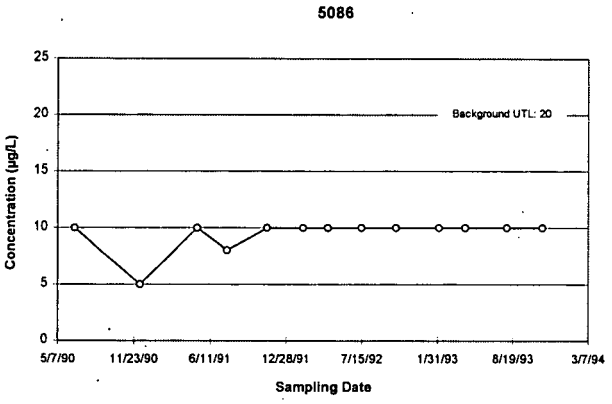
OU 11--West Spray Field
ACETONE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

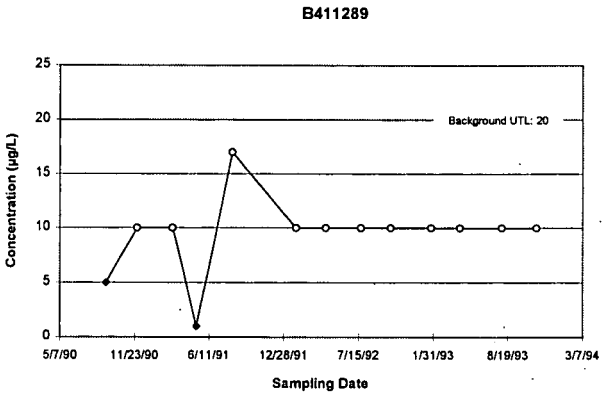
June 1995 | Figure D-95

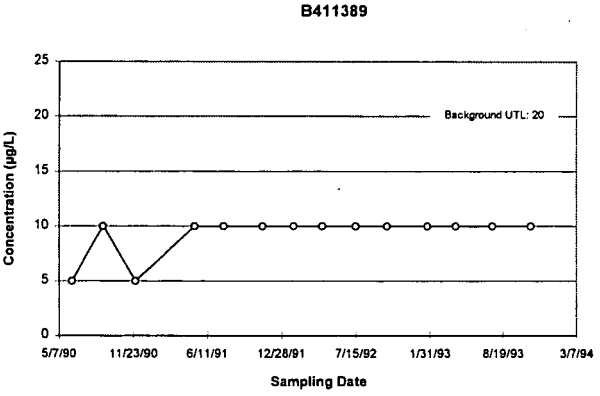
Figure D-96
Time Series Plots - Total Acetone











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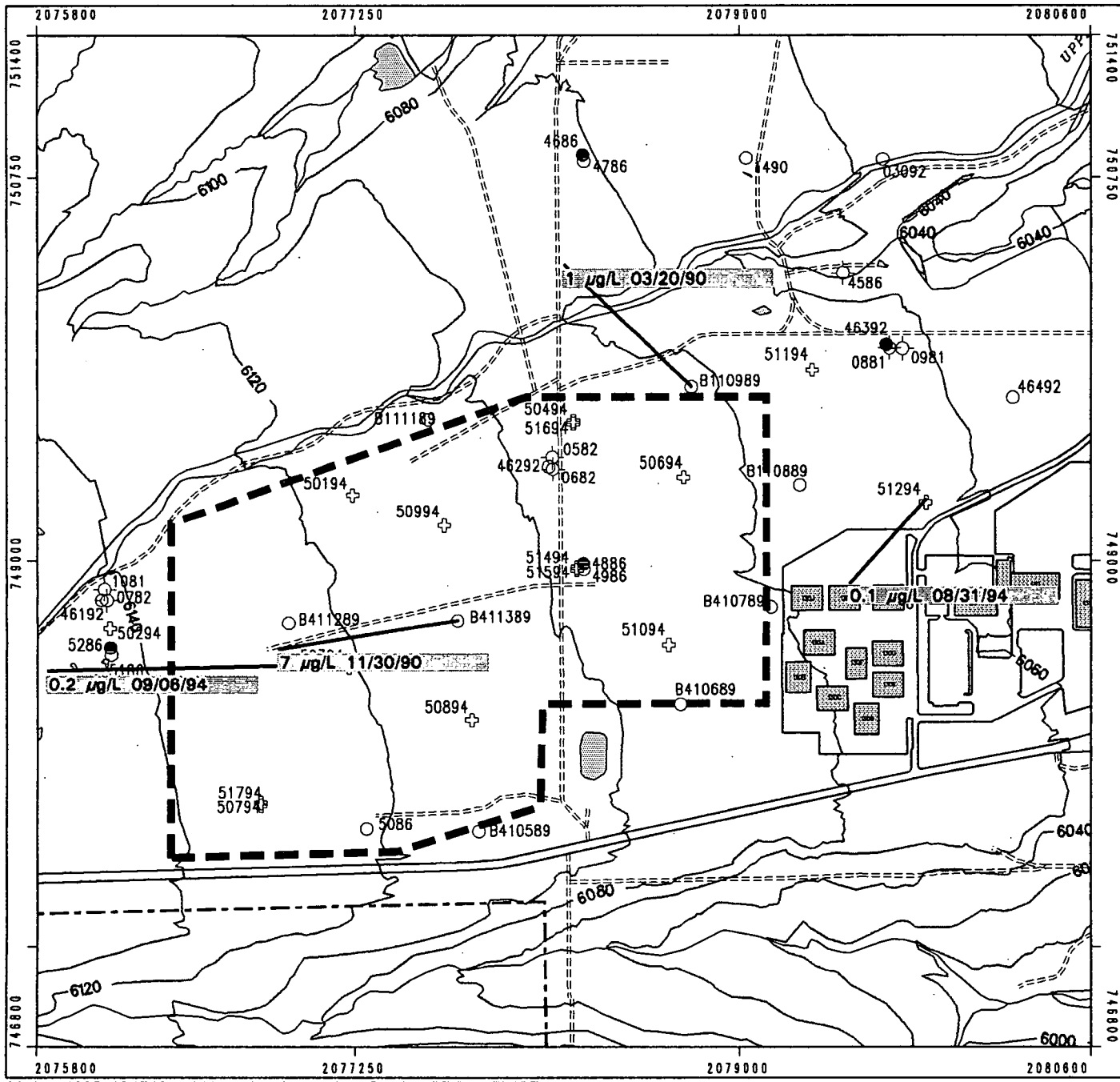


EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

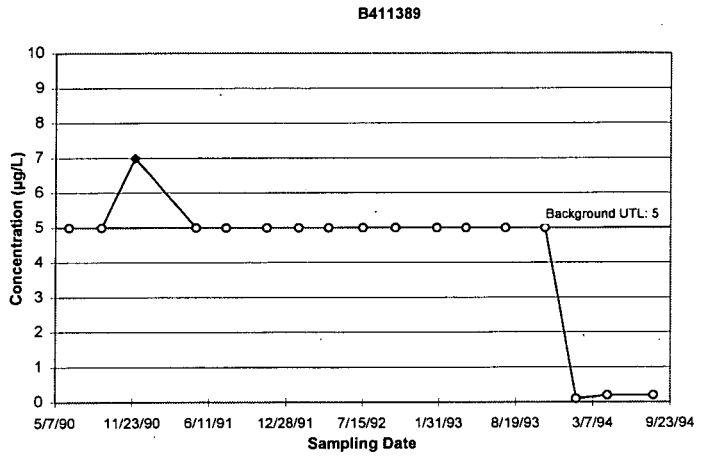
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

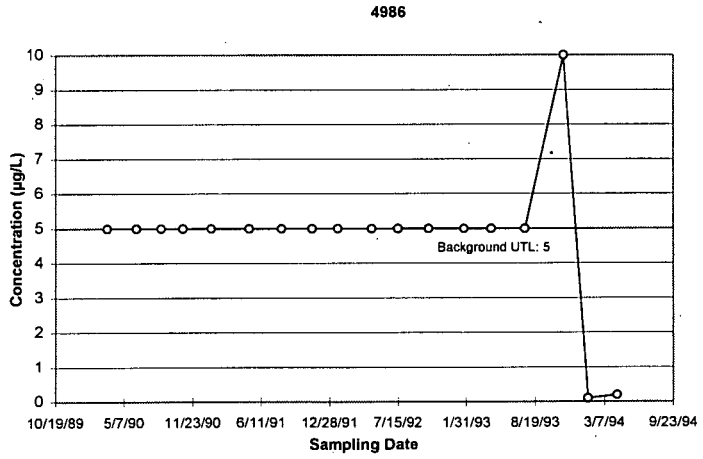
OU 11--West Spray Field
BENZENE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

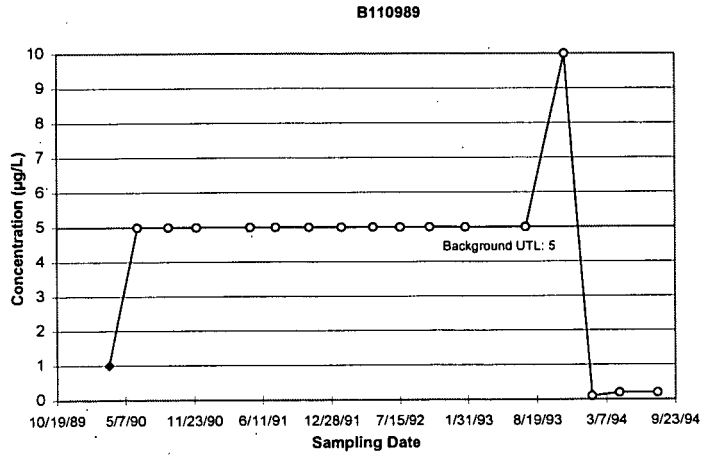
June 1995 | Figure D-97

02-JUN-1995 $DATA2/ou11/maps/gw_benz8x11 FINAL LETTER REPORT

Figure D-98
Time Series Plots - Total Benzene







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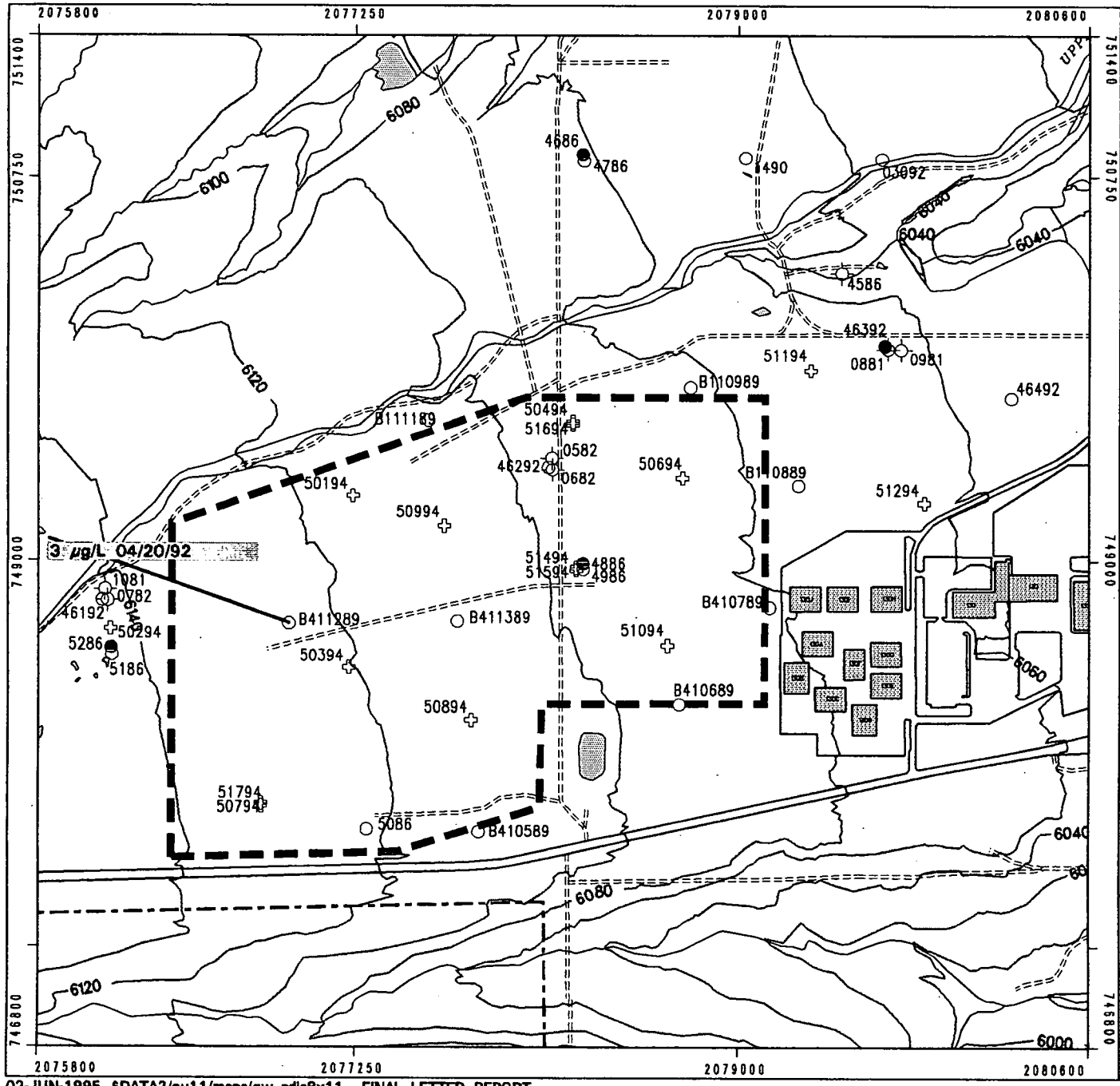


EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

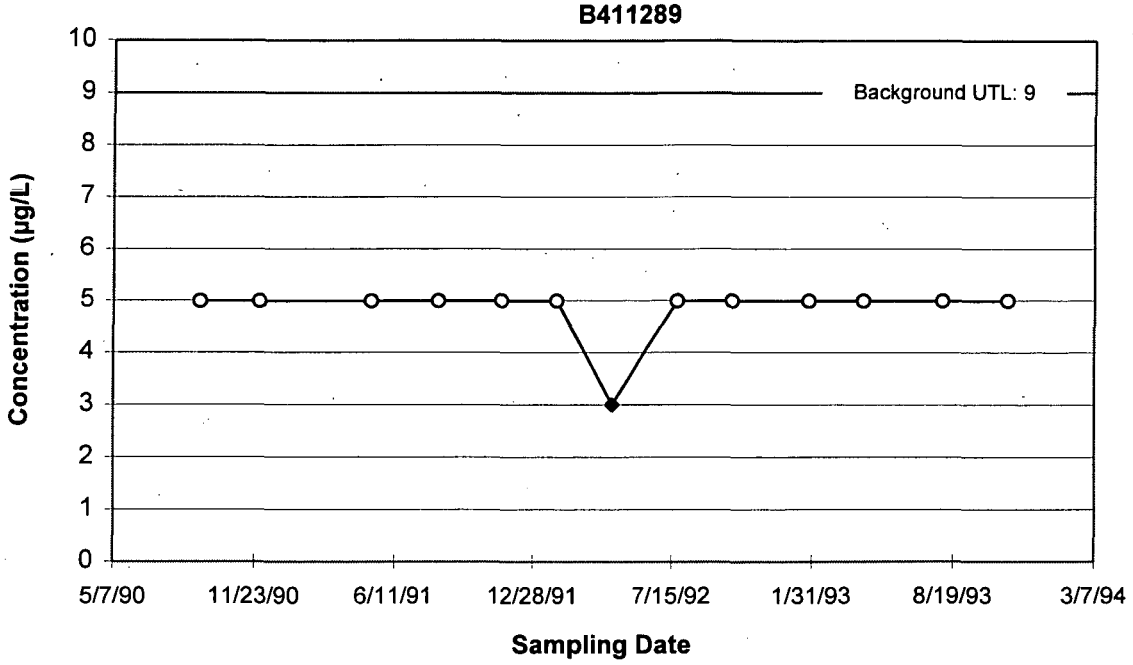
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
CARBON DISULFIDE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-99

Figure D-100
Time Series Plot - Total Carbon Disulfide
B411289



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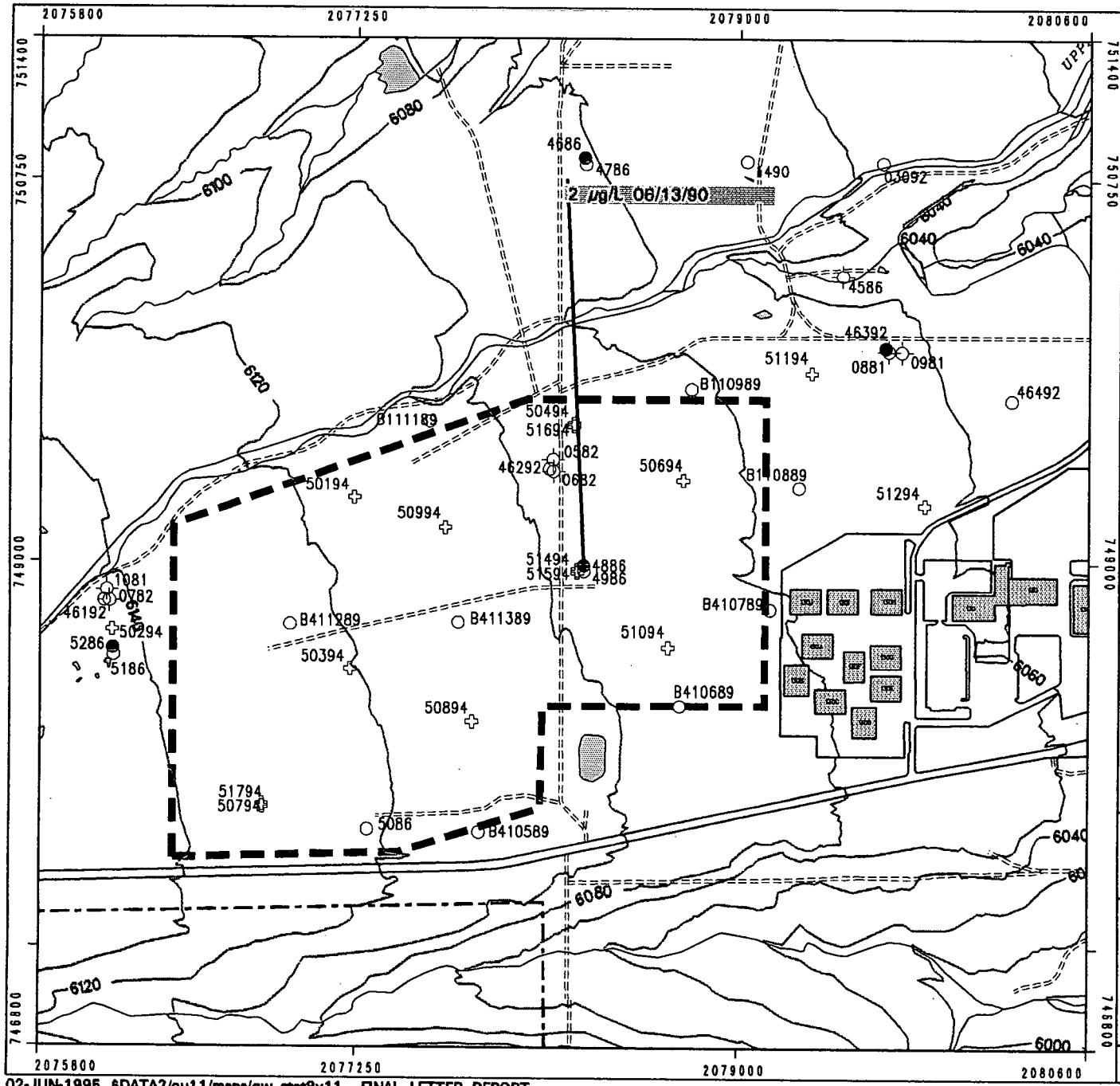


EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

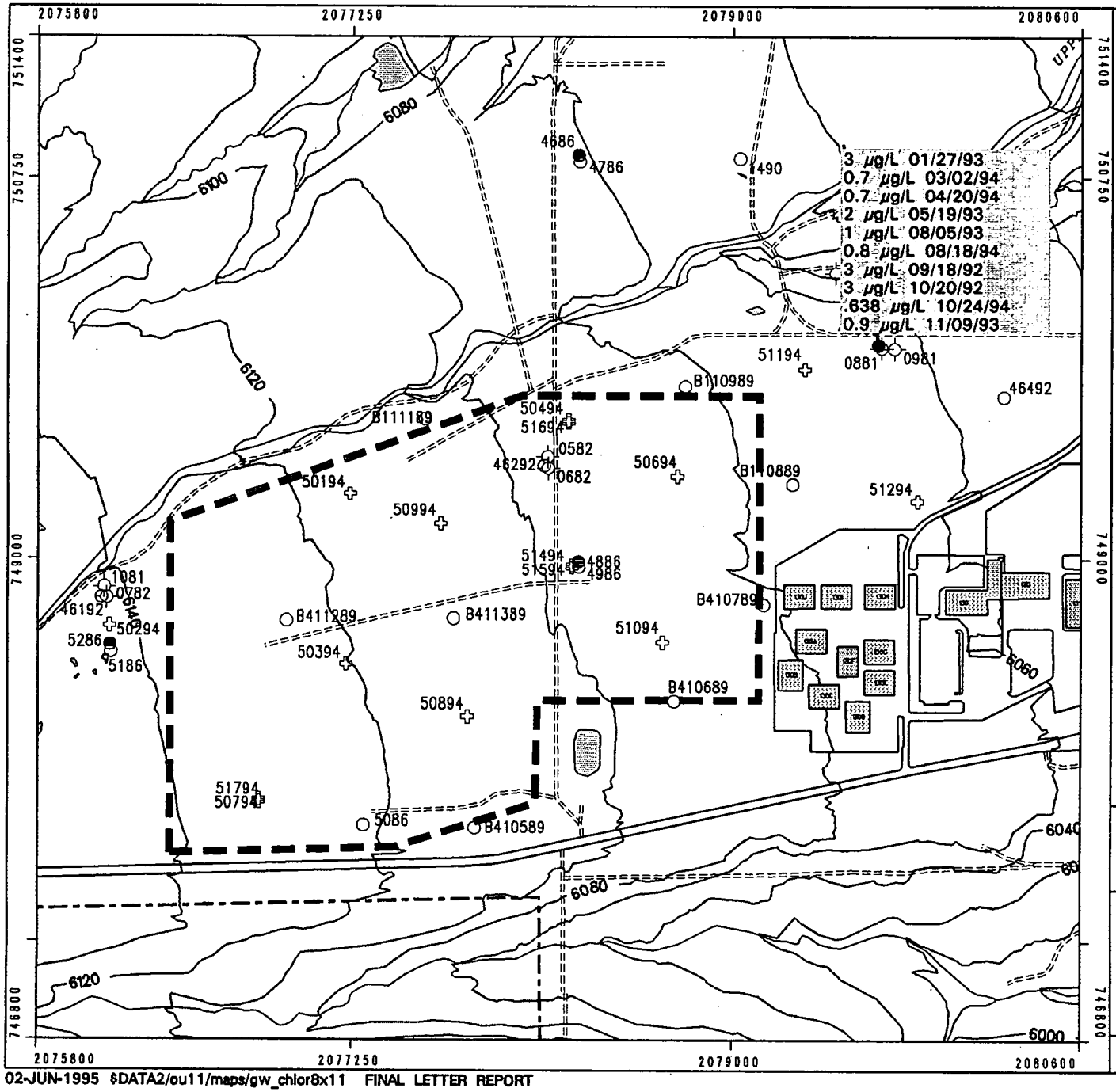
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
CARBON TETRACHLORIDE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-101

02-JUN-1995 $DATA2/ou11/maps/gw_ctet8x11 FINAL LETTER REPORT



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
CHLOROFORM
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-102

02-JUN-1995 $DATA2/ou11/maps/gw_chlor8x11 FINAL LETTER REPORT

Figure D-103
Time Series Plot - Total Chloroform
46392

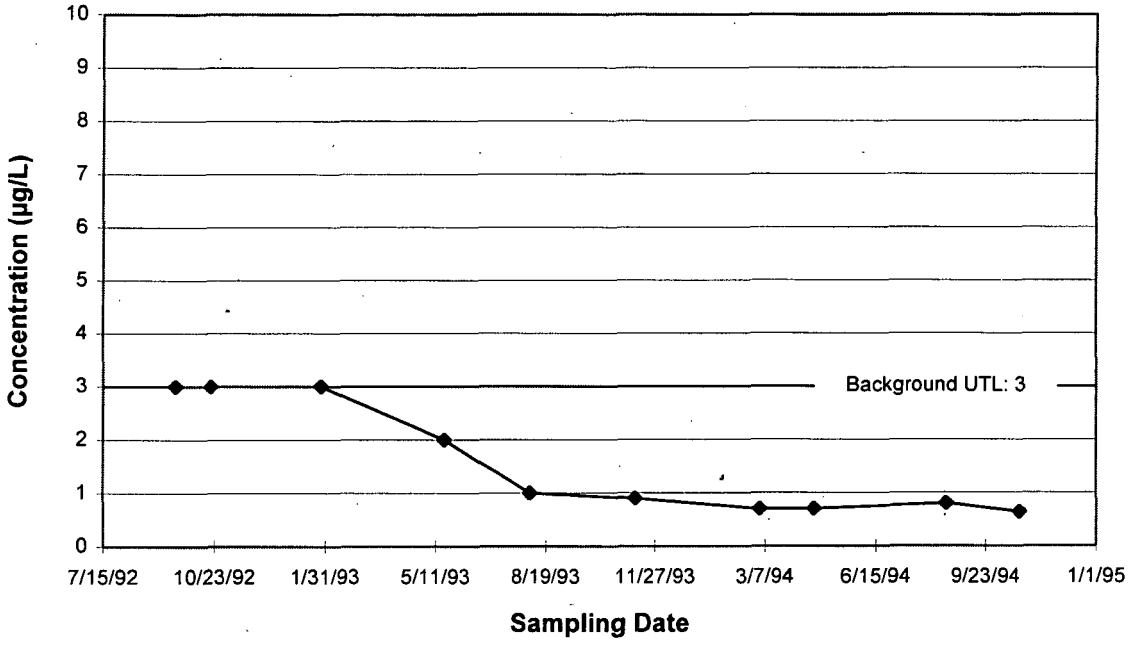


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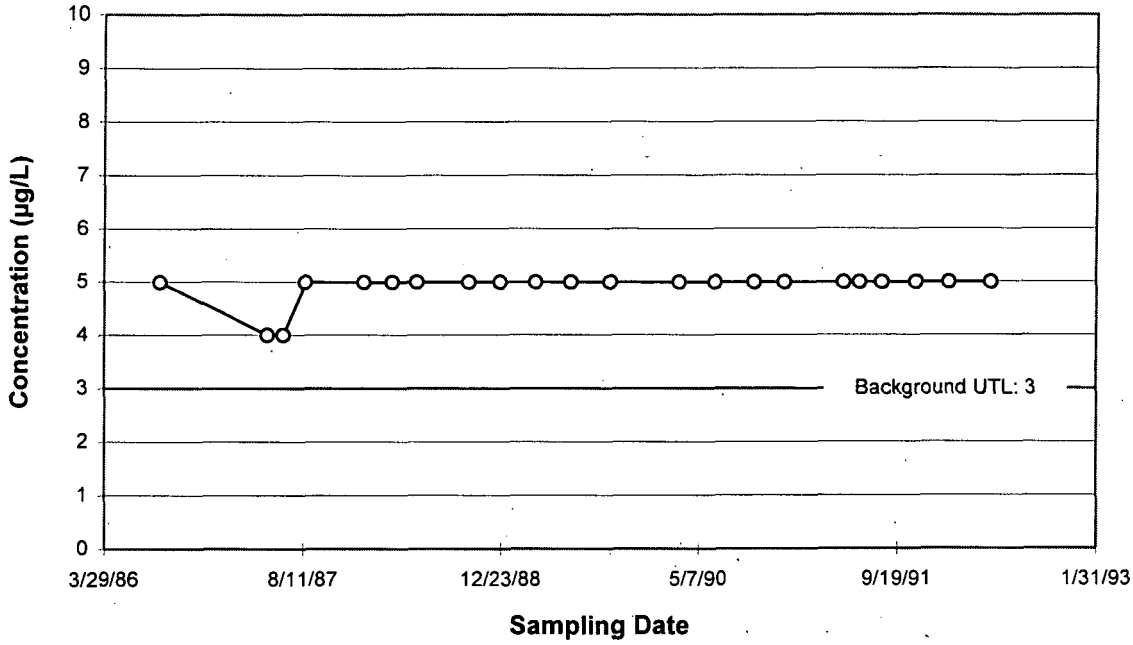
Figure D-104
Time Series Plots - Total Chloroform
0881



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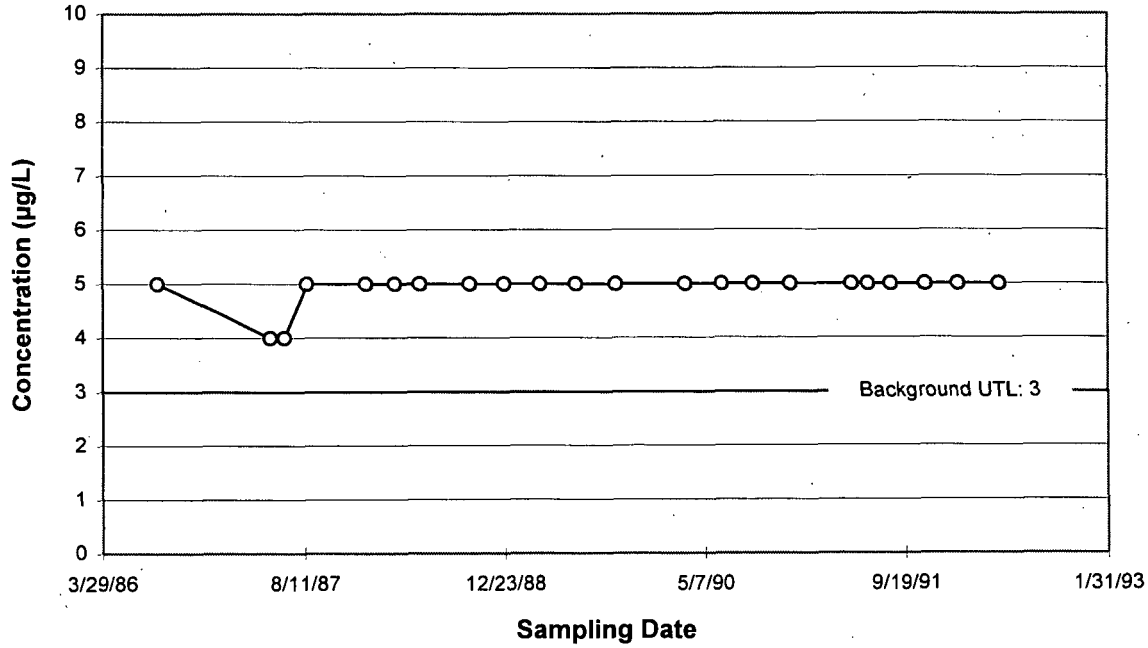
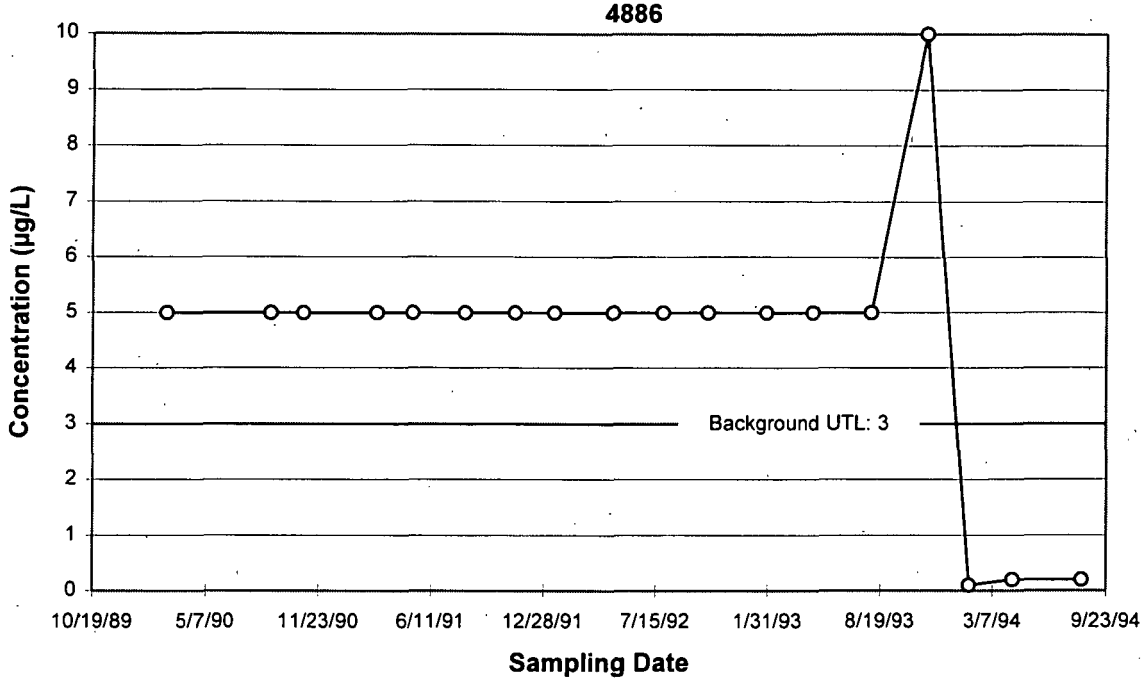


◆ Hit - Y
o Hit - N

MEP C:\..\ALL_TS.XLS Chloroform, Toluene, Nitrate 3/22/95

Figure D-105
Time Series Plots - Total Chloroform

4886



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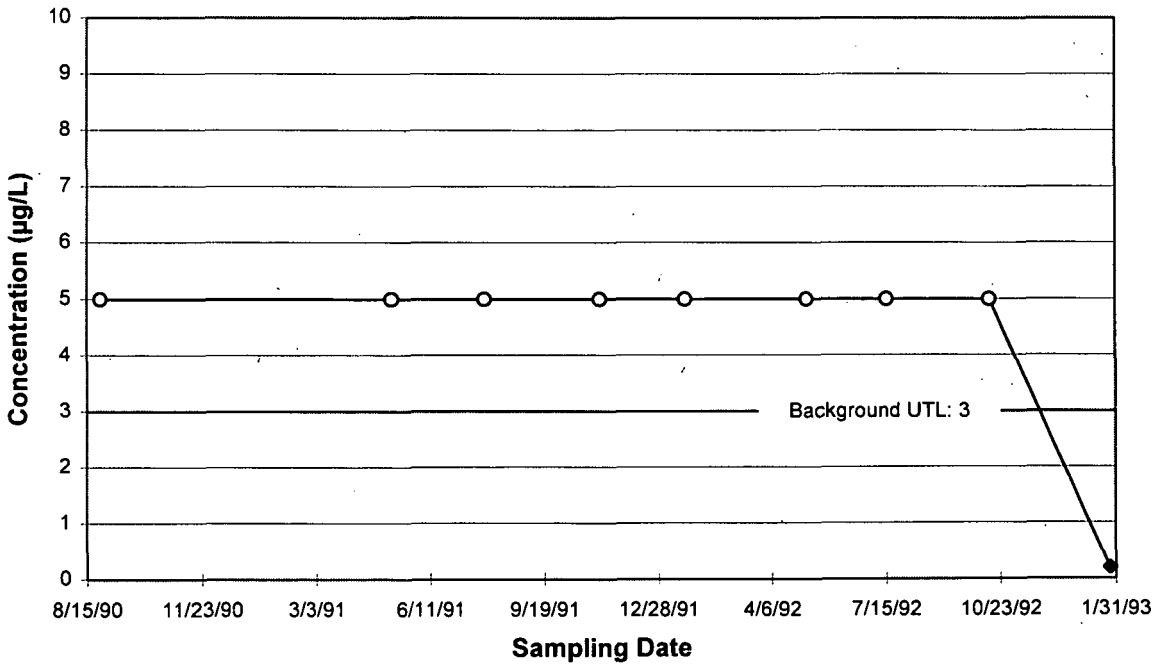

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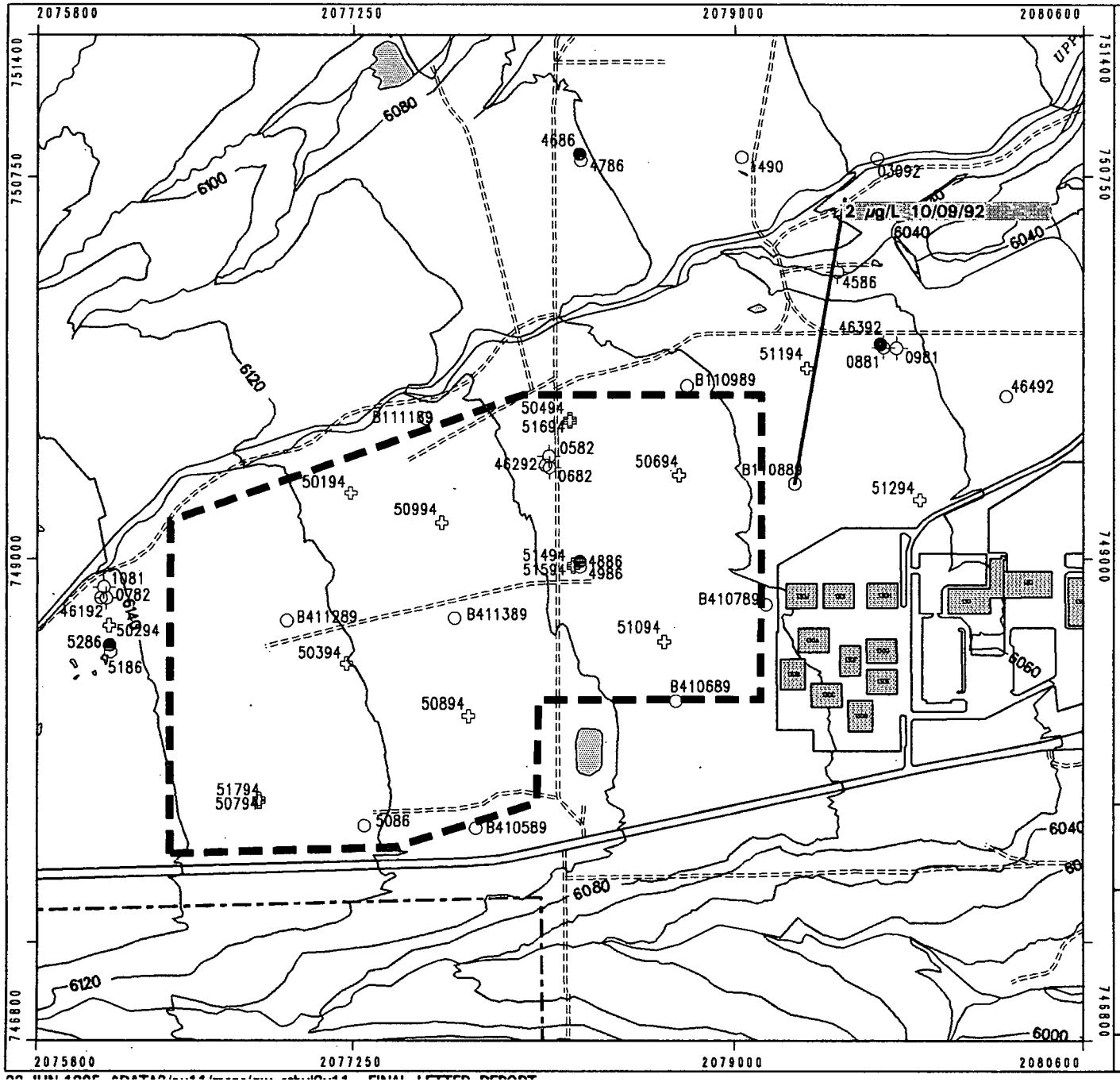


EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

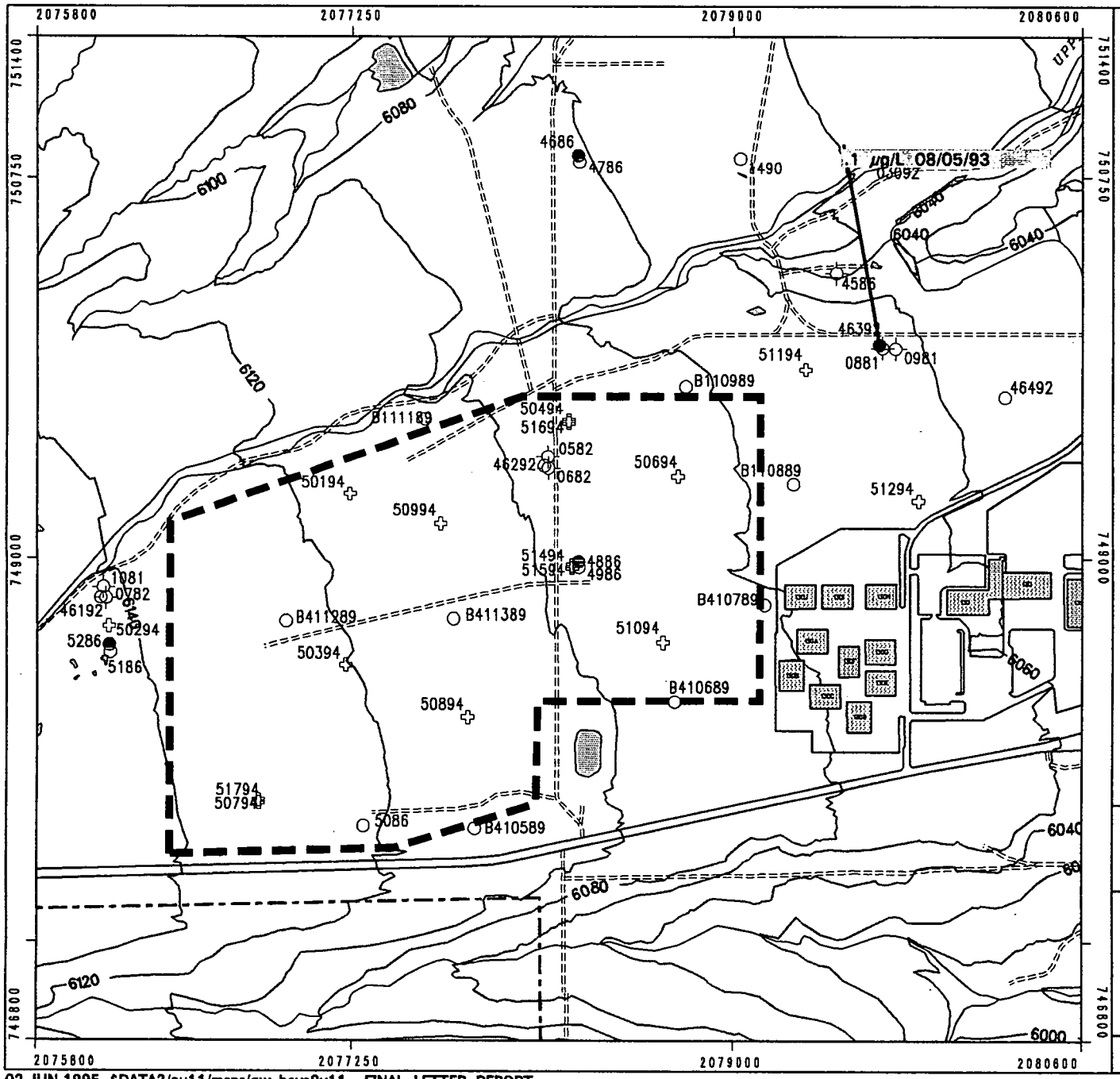
350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
ETHYLBENZENE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-106



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

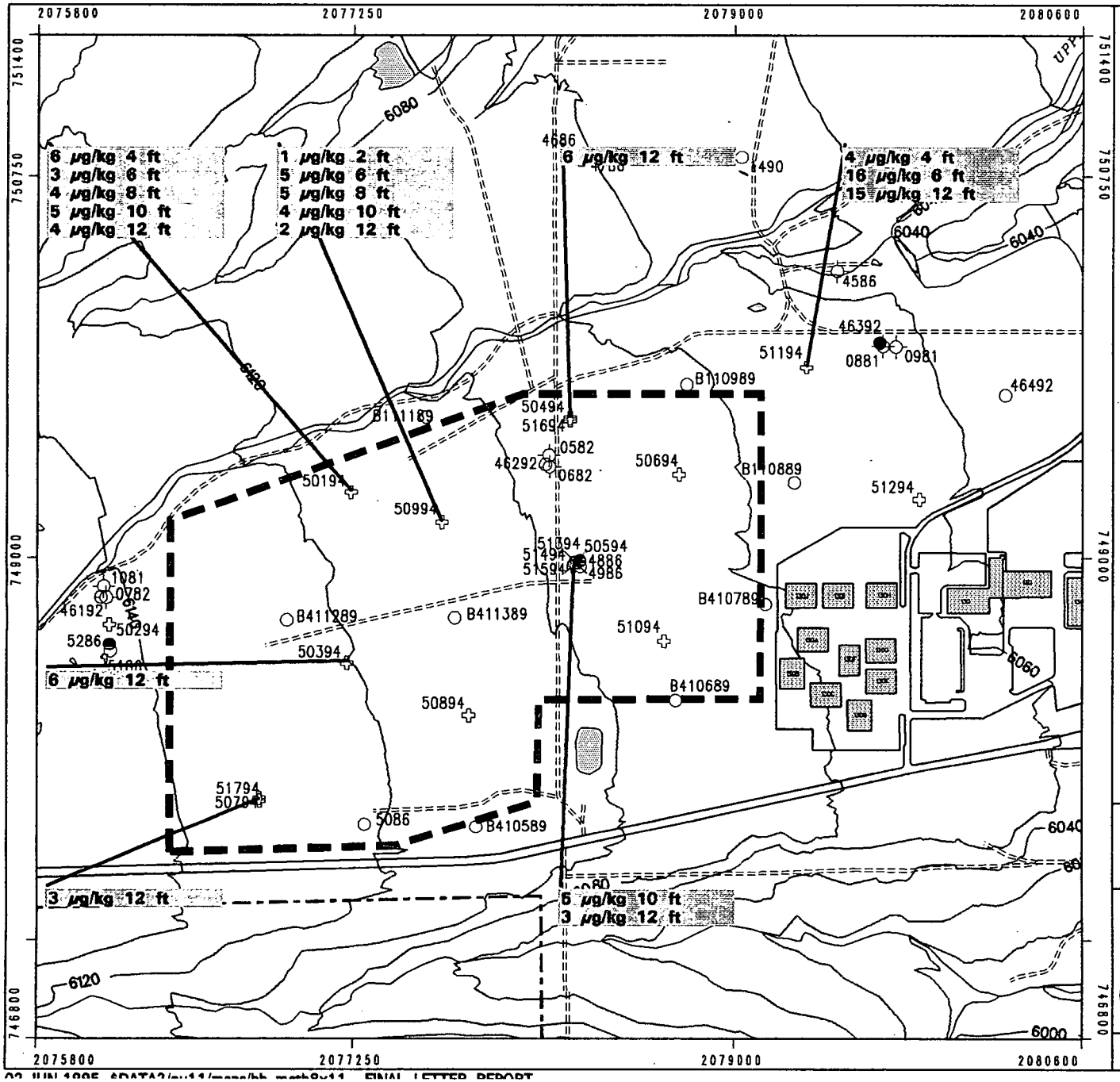
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
HEXACHLOROBUTADIENE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-107

02-JUN-1995 $DATA2/ou11/maps/gw_hexa8x11 FINAL LETTER REPORT



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

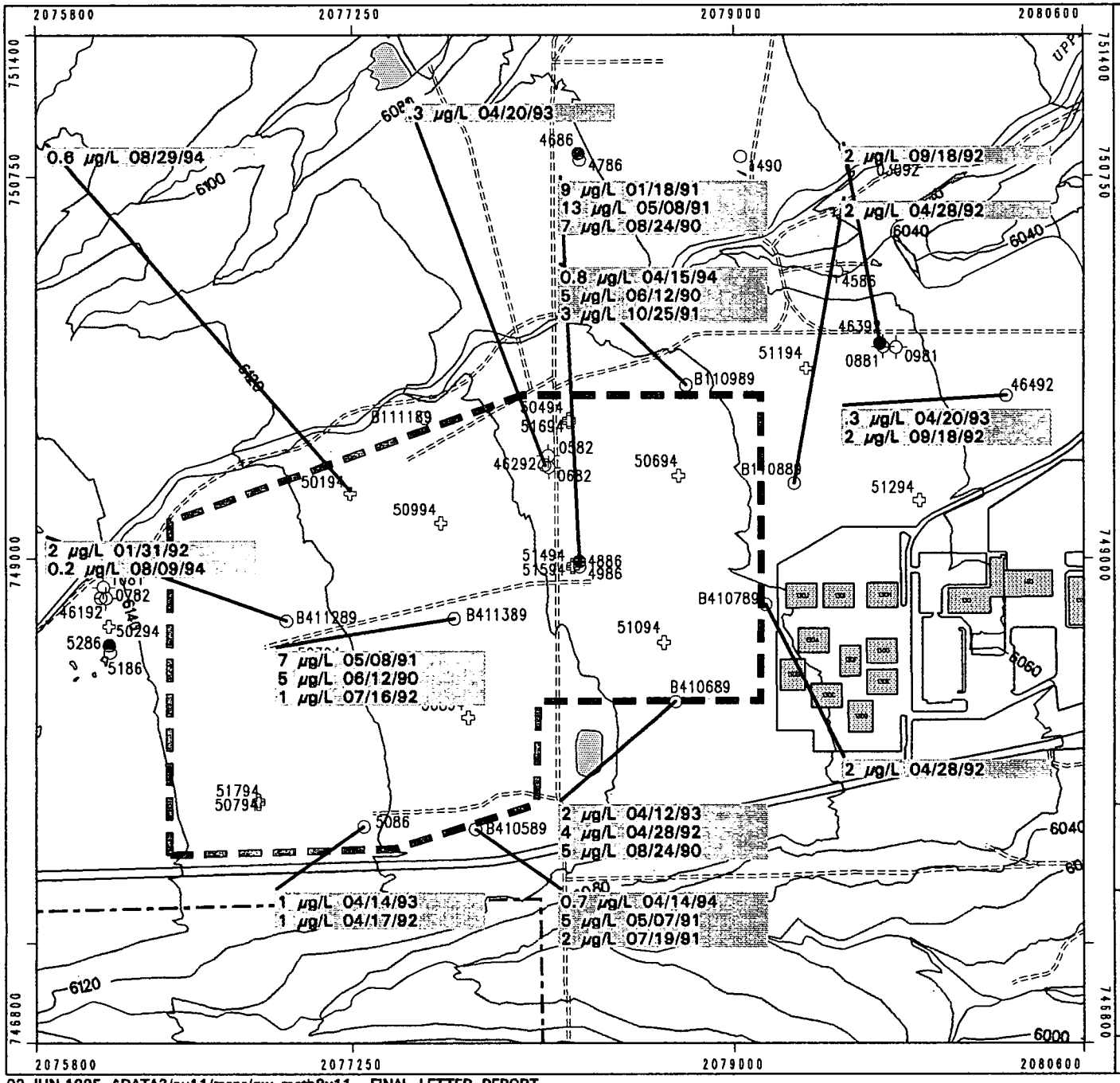
350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
METHYLENE CHLORIDE
Concentrations*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-108



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

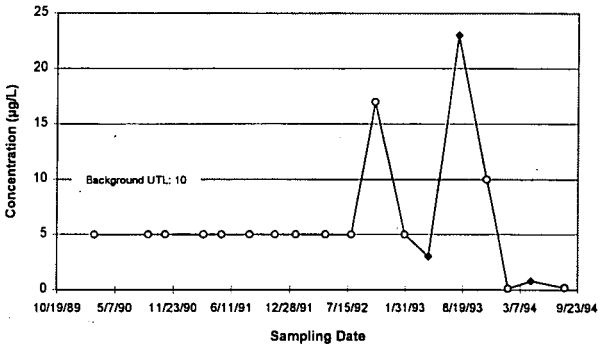
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
METHYLENE CHLORIDE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

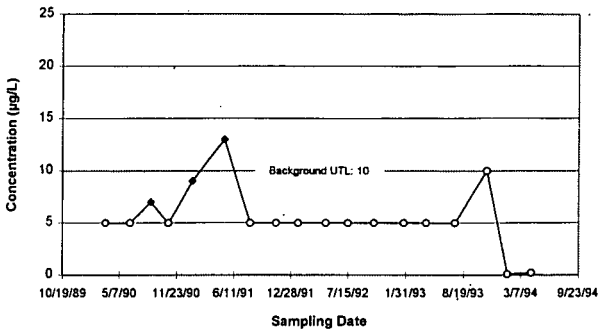
June 1995 | Figure D-109

Figure D-110
Time Series Plots - Total Methylene Chloride

4886



4986



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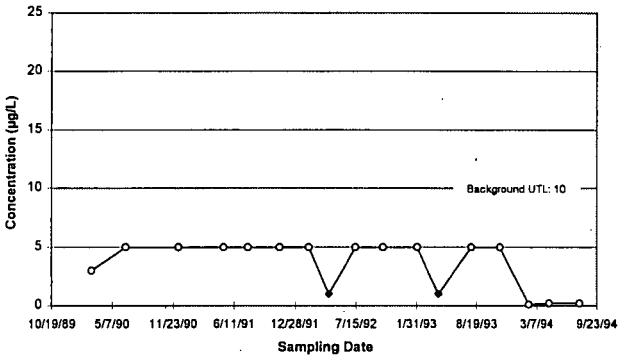

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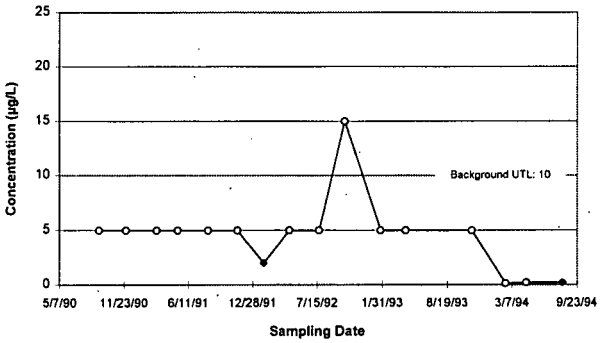

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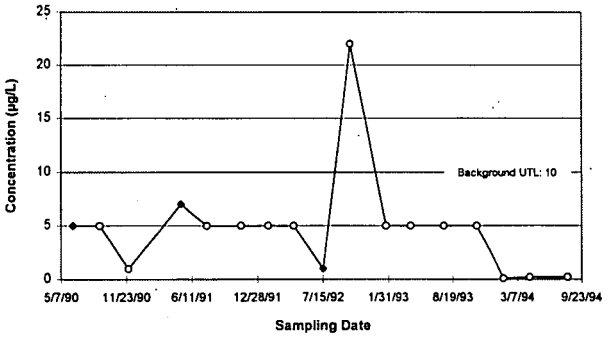

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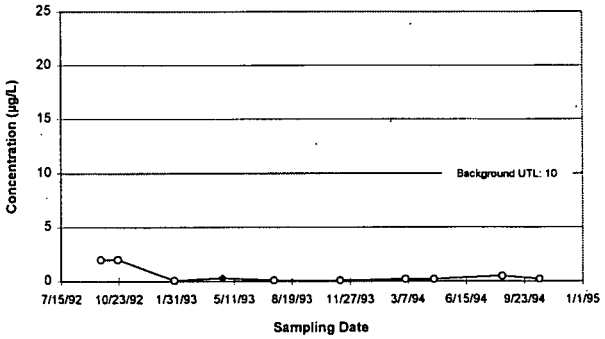

◆ Hit - Y
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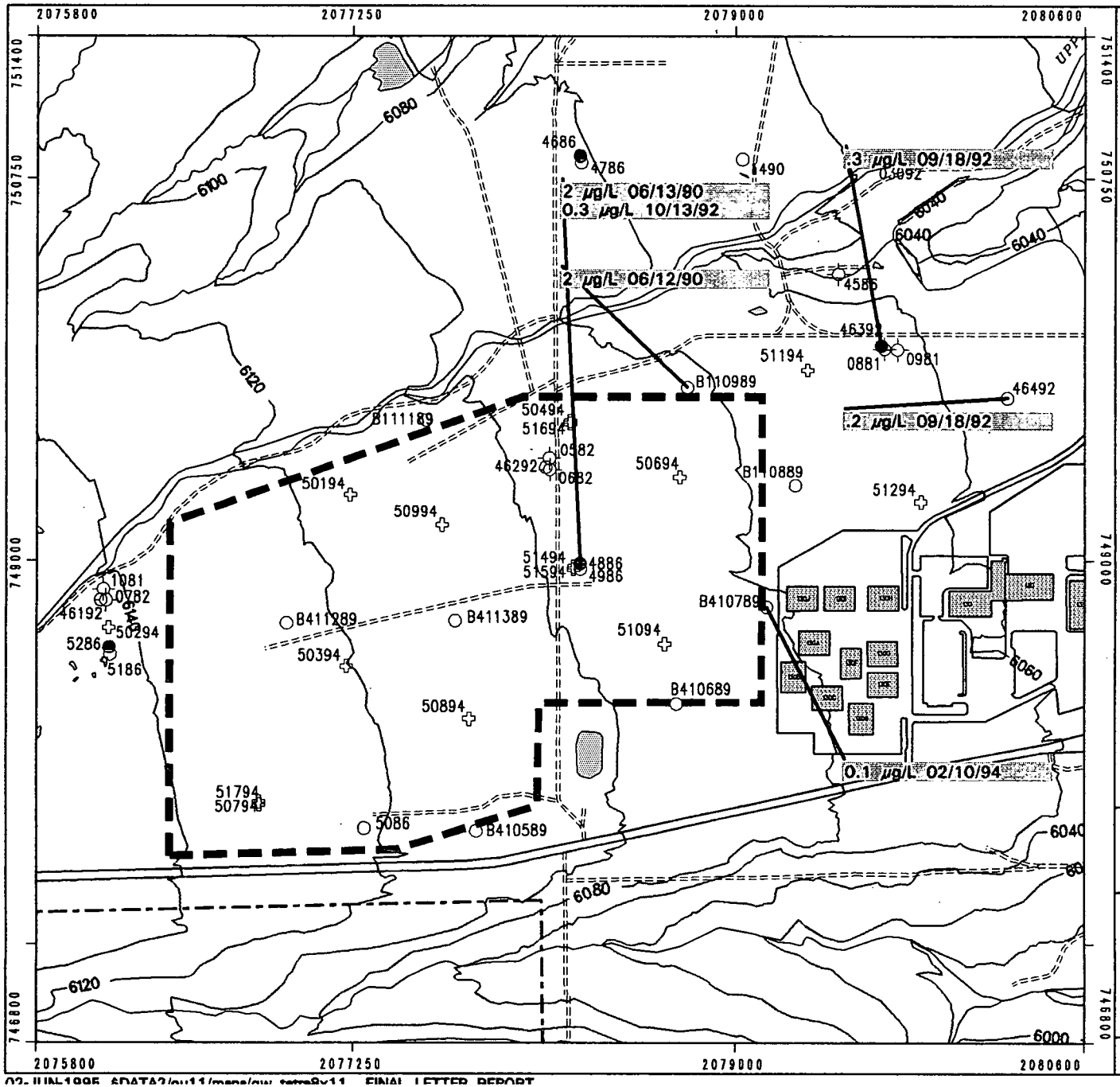
MEP C:\ \ALL_T8 XLS Methylene Chloride 3/21/95



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

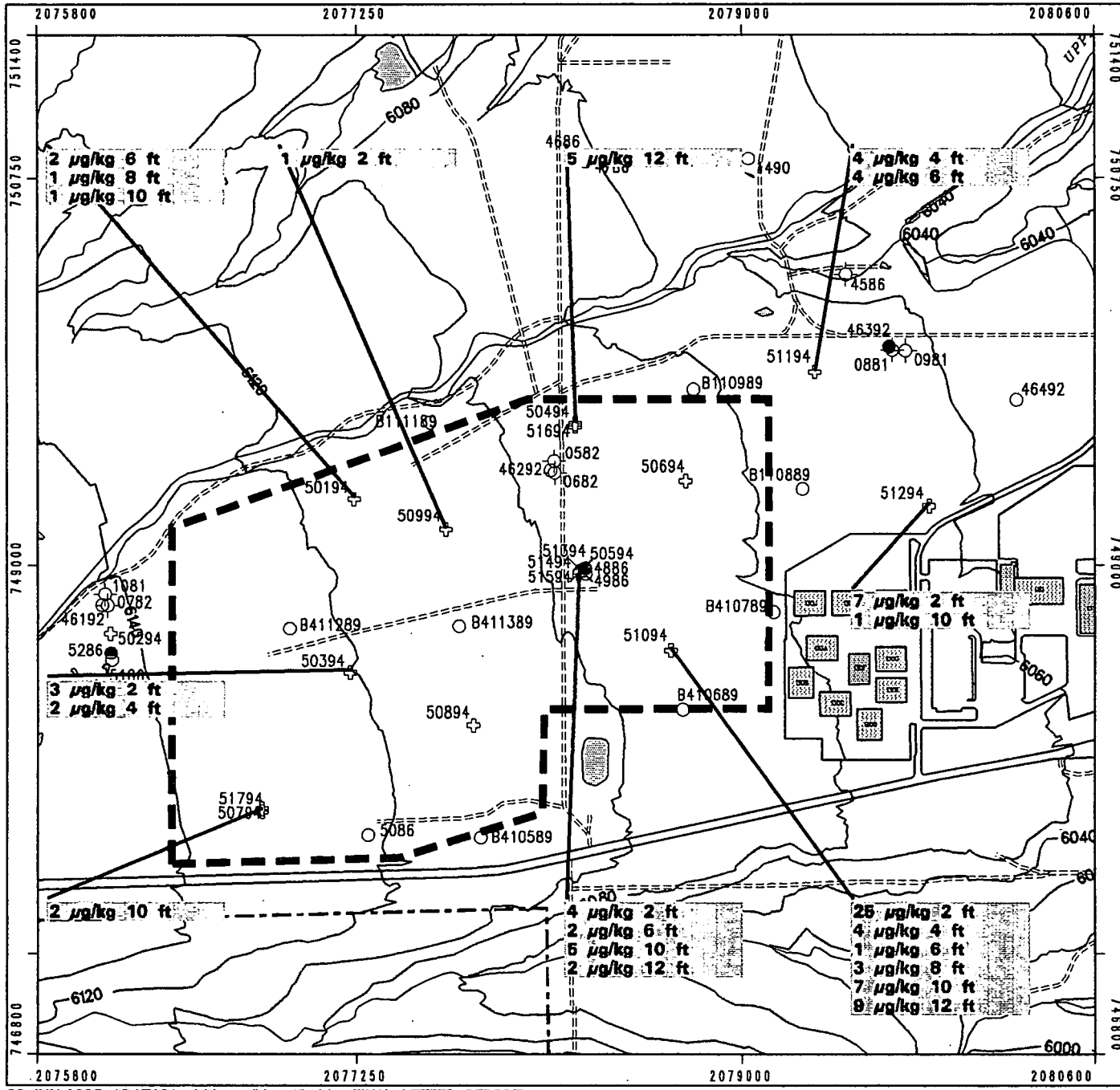
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
TETRACHLOROETHENE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-111

02-JUN-1995 &DATA2/ou11/maps/gw_tetra8x11 FINAL LETTER REPORT



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above reporting limits

N

Scale = 1 : 8400
1 inch = 700 feet

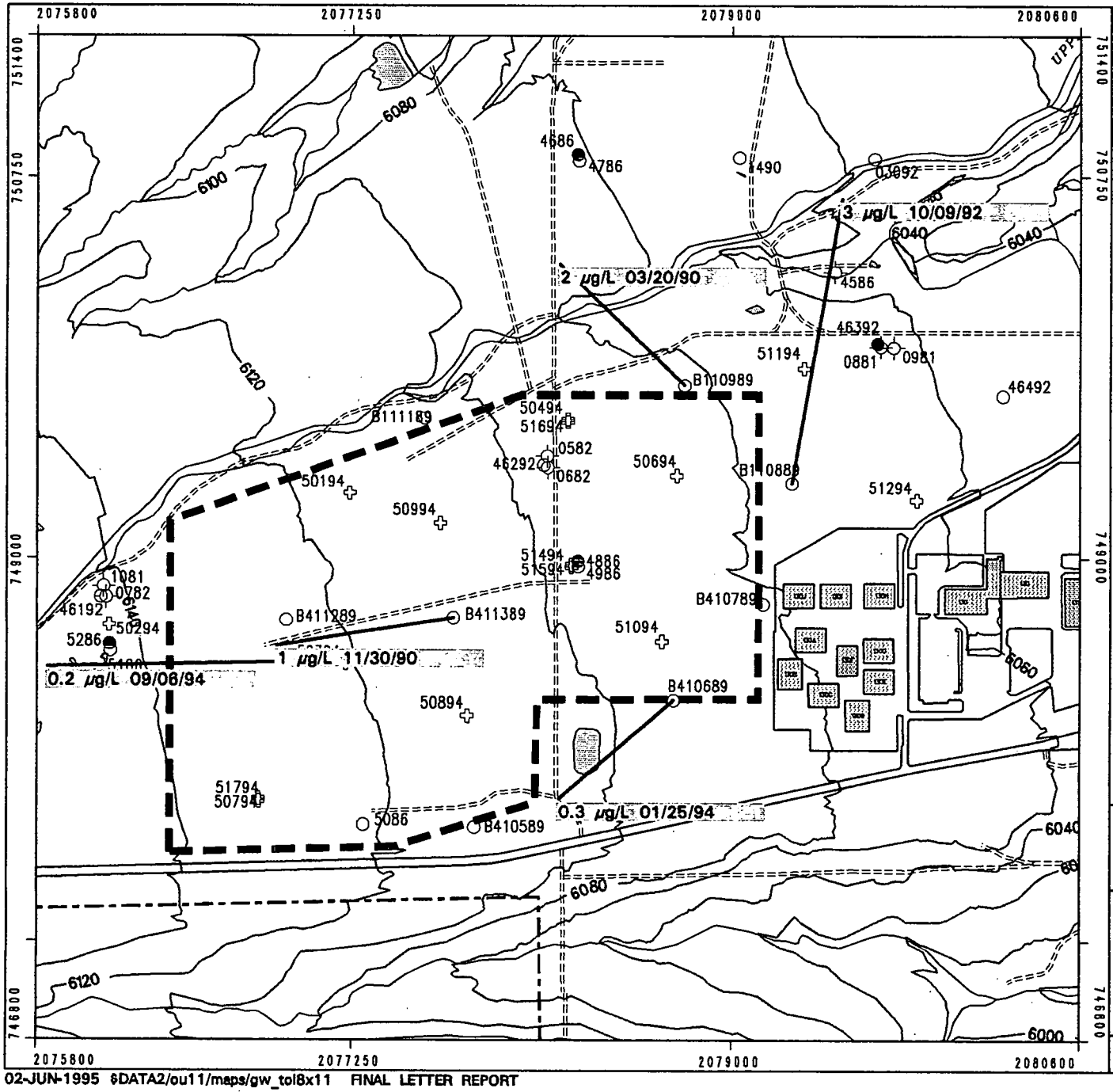
350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
TOLUENE
Concentrations*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-112



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

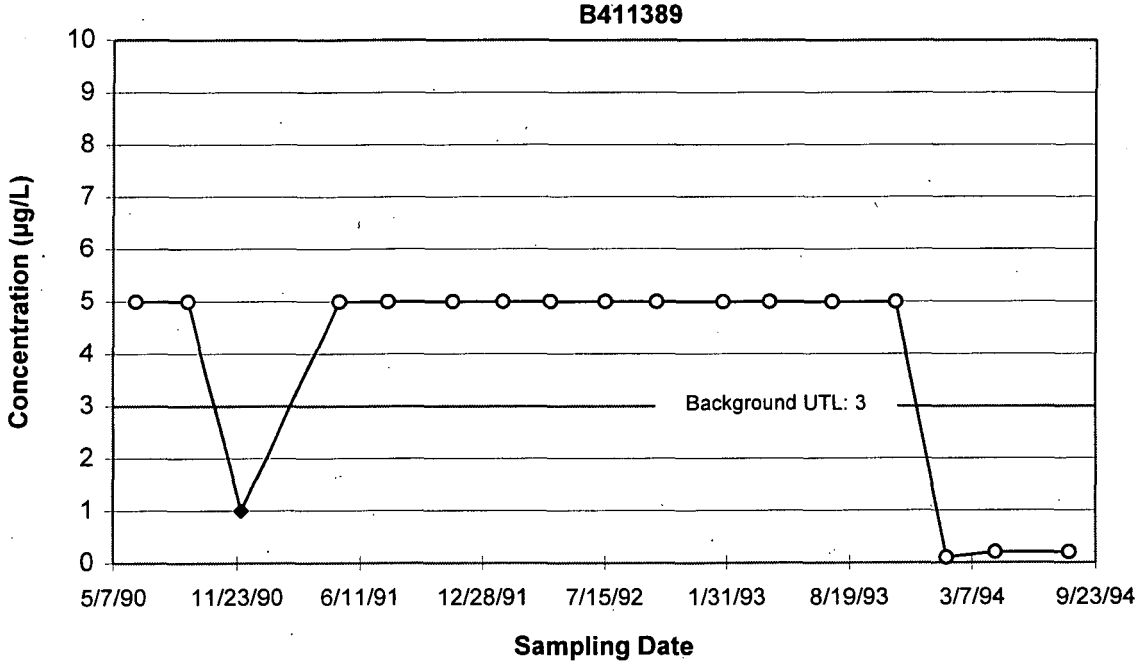
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
TOLUENE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

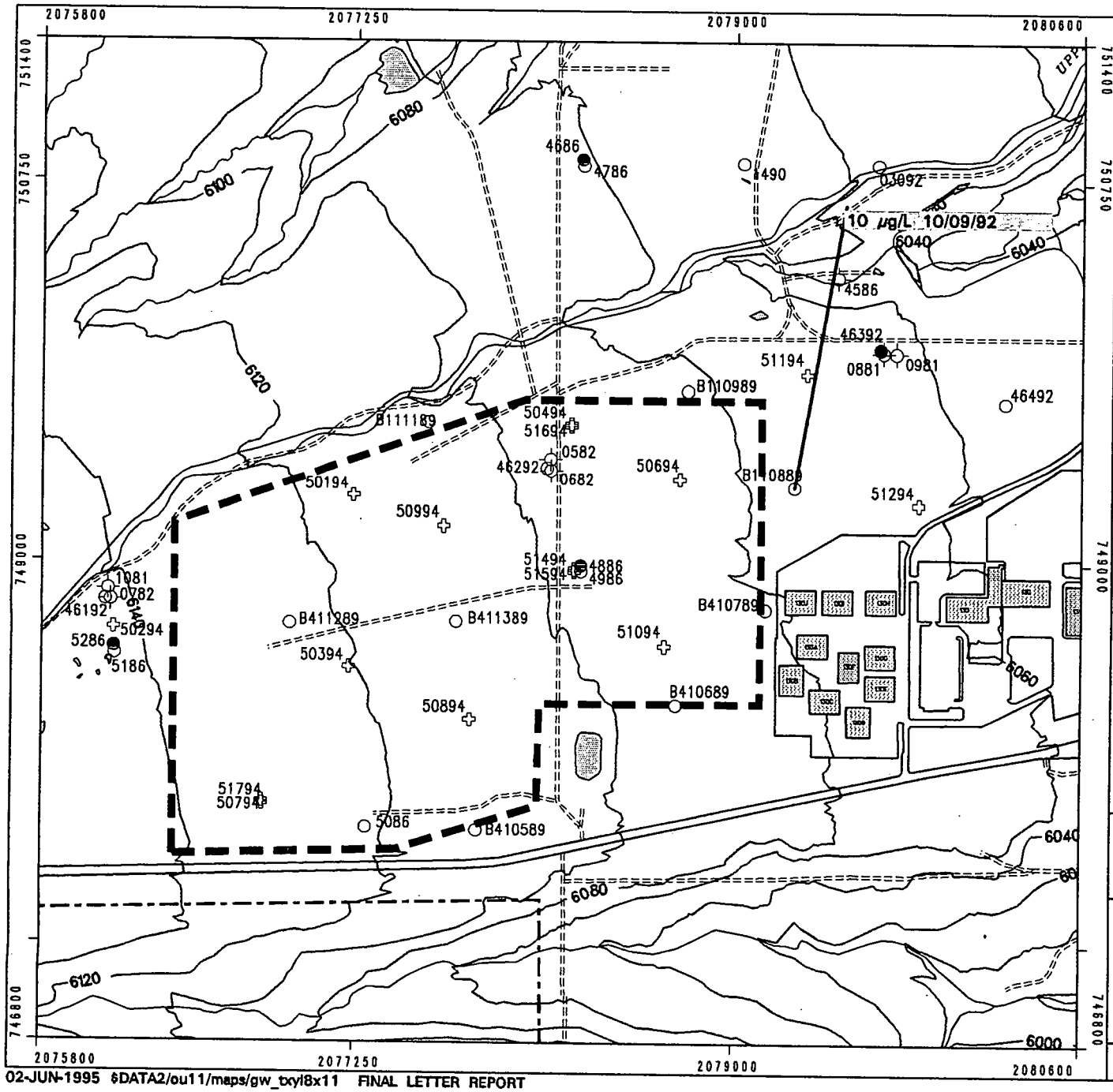
June 1995 | Figure D-113

02-JUN-1995 $DATA2/ou11/maps/gw_tol8x11 FINAL LETTER REPORT

Figure D-114
Time Series Plot - Toluene
B411389



◆ Hit - Y
o Hit - N



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

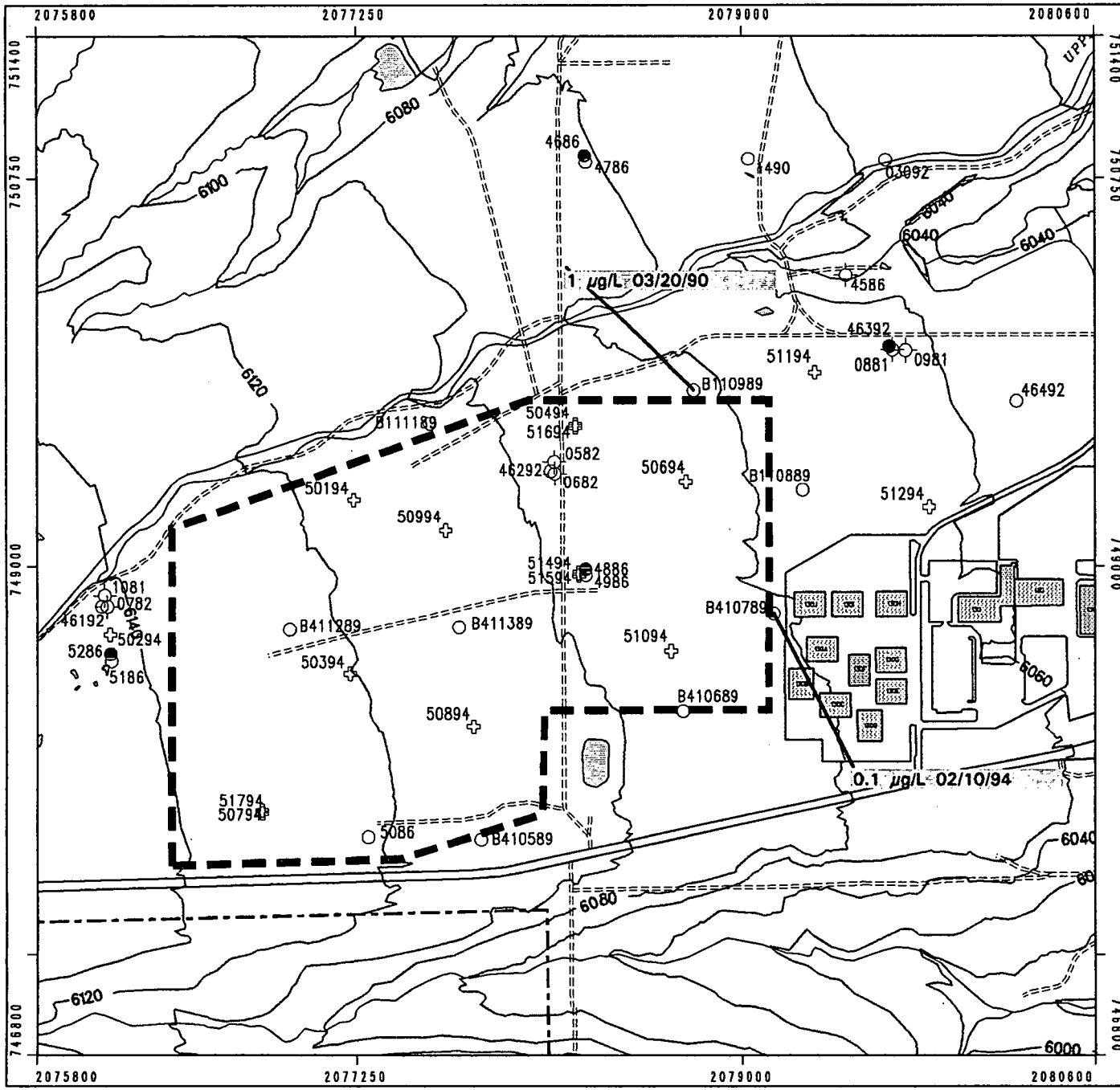
280 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
TOTAL XYLENES
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-115



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

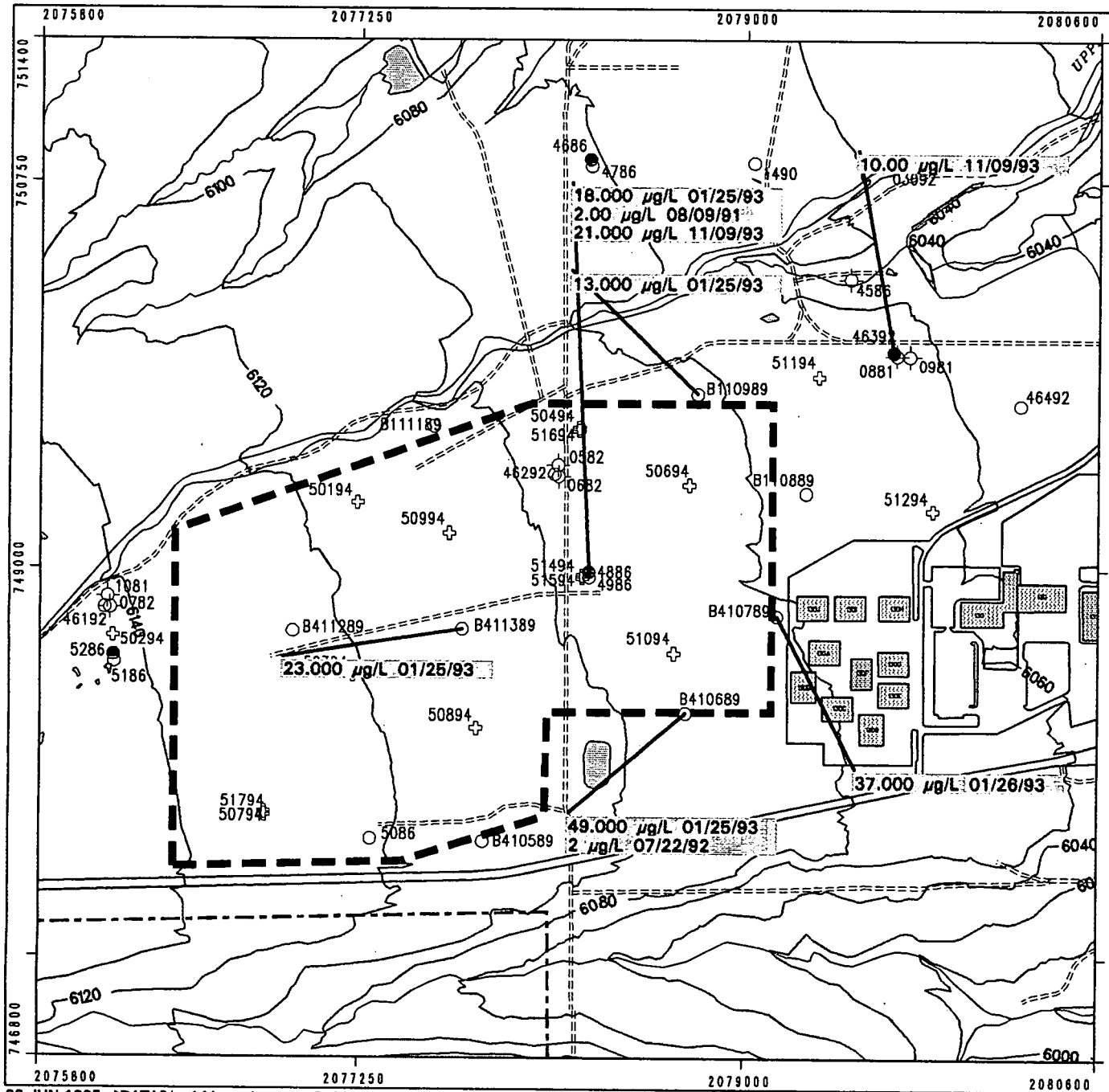
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
TRICHLOROETHENE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-116

02-JUN-1995 $DATA2/ou11/maps/gw_trich8x11 FINAL LETTER REPORT



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 1069

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
CYANIDE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

June 1995 | Figure D-117

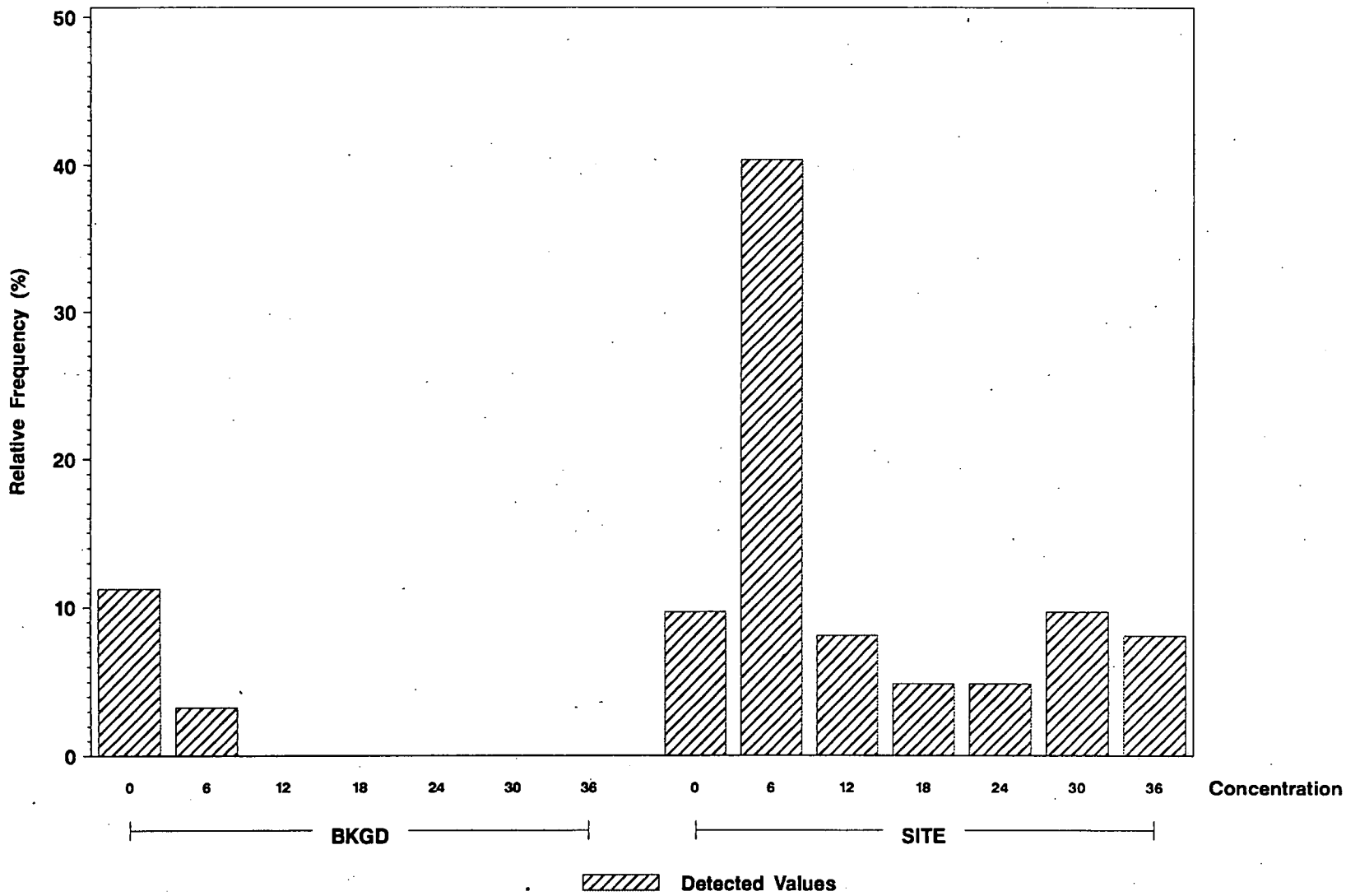
02-JUN-1995 $DATA2/ou11/maps/gw_cyan8x11 FINAL LETTER REPORT

Figure D-118

Background vs OU11 Surface Soil

Frequency Histogram

NITRATE/NITRITE (mg/kg) in Surface Soil (0 – 2 inches)

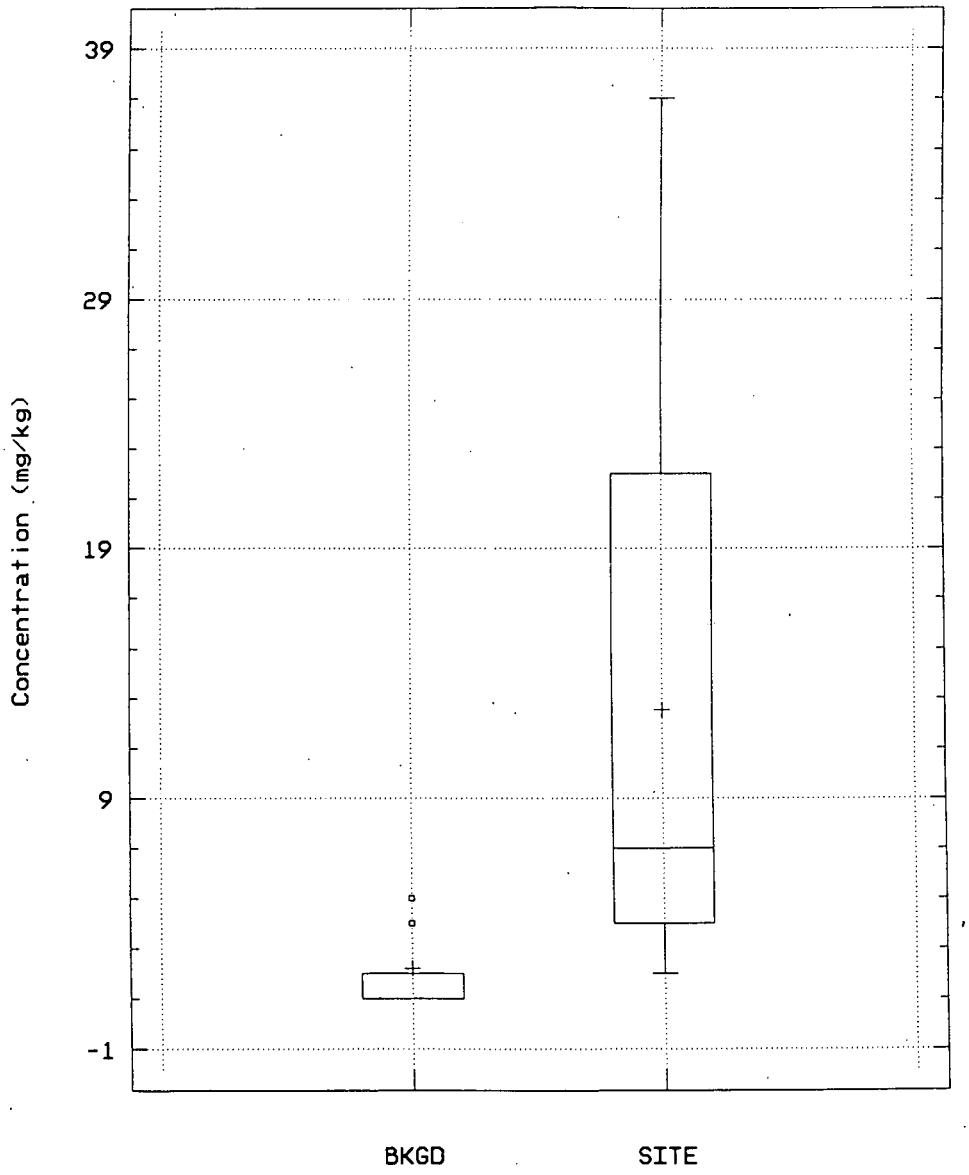


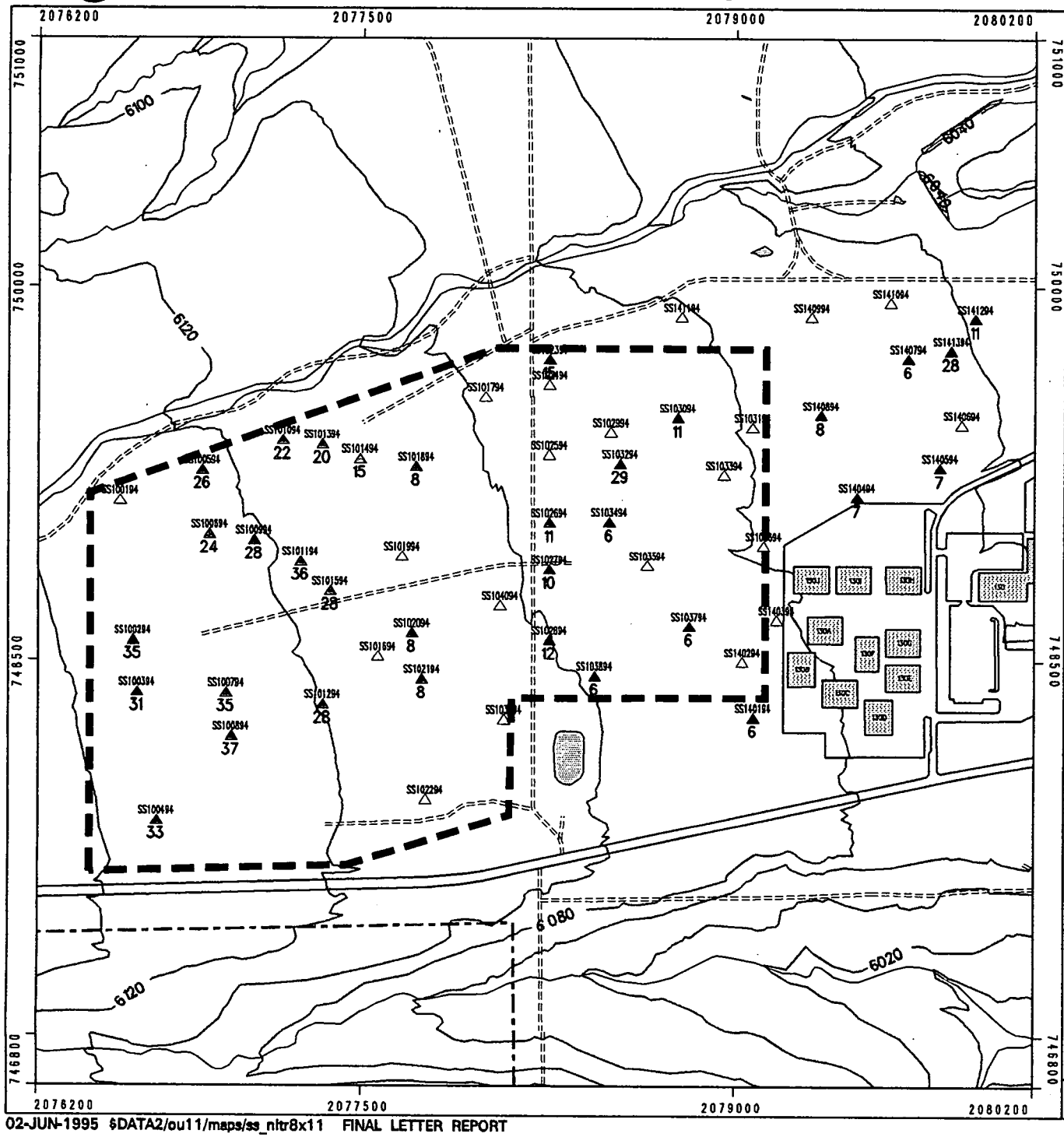
SITE = All areas sampled within OU11

Figure D-119

Background vs OU11 Surface Soil

Nitrate/Nitrite in Surface Soil (0 to 2 inches)





EXPLANATION

- △ Sample Location
- ▲ Values above the background mean +2 standard deviations (BM+2SD)
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Concentrations are in mg/kg
BM+2SD = 5

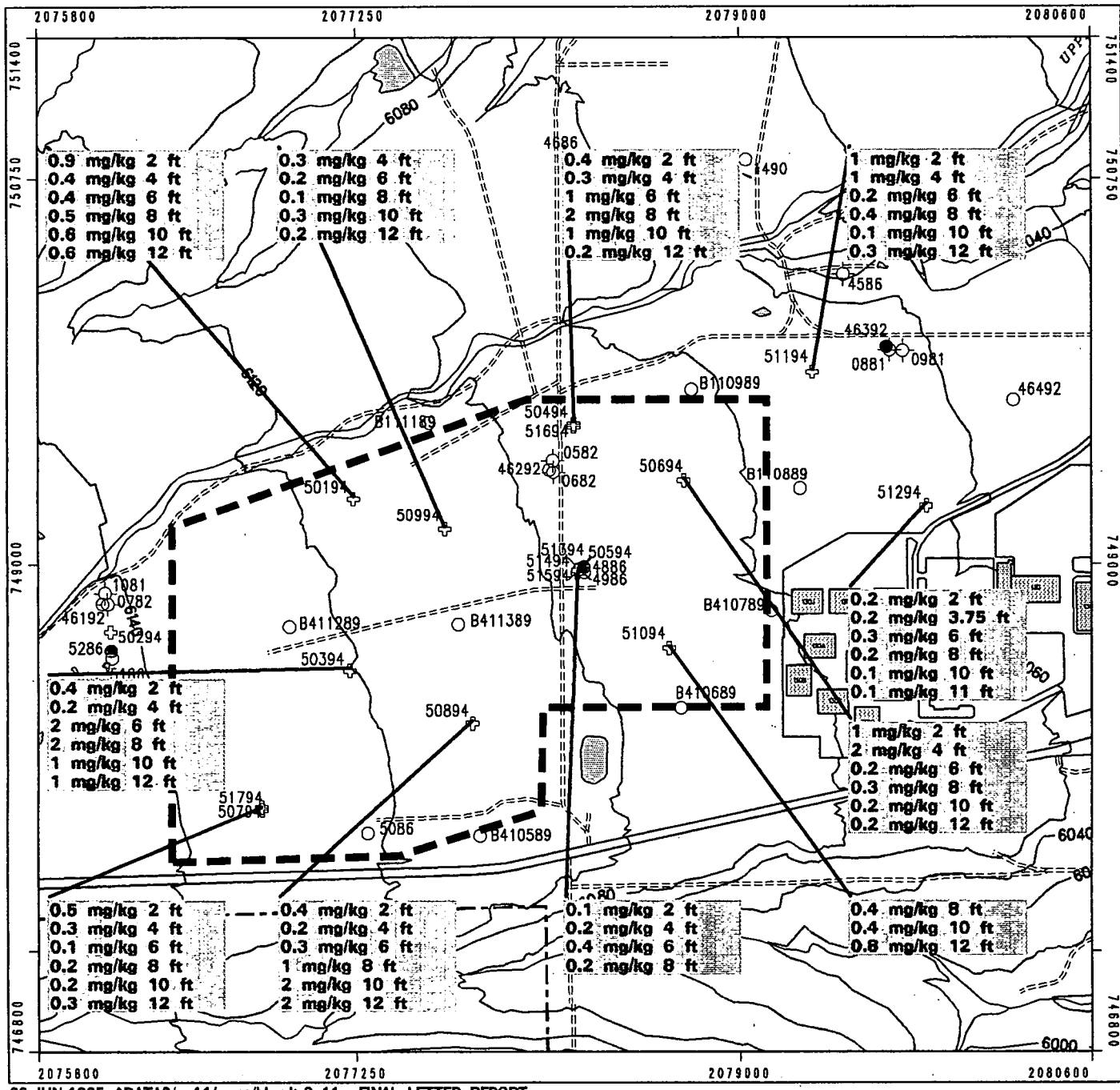
Scale = 1 : 7200
1 inch = 600 feet
300 0 600ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

Surficial Soil (0 to 2 Inches)
NITRATE/NITRITE
Concentrations*
at the
OU 11--West Spray Field

June 1995 | Figure D-120



EXPLANATION

- 1994 Borehole
- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Values above reporting limits

Scale = 1 : 8400
1 inch = 700 feet

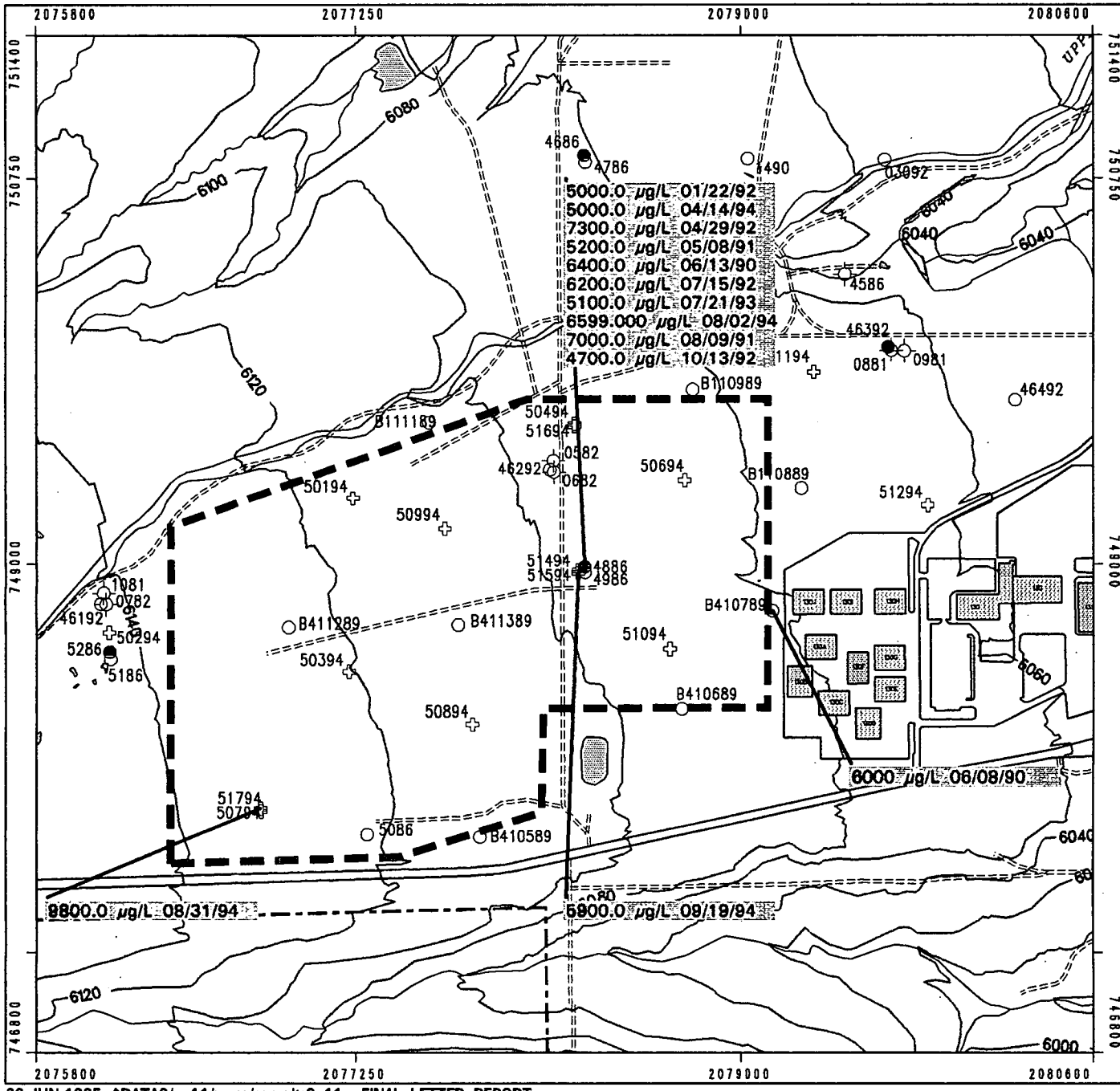
350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
NITRATE/NITRITE
Concentrations*
(and Sample Depths) in Subsurface
Geologic Materials (0 to 12 Feet)

June 1995 | Figure D-121



EXPLANATION

- 1994 Monitoring Well
- Alluvial Monitoring Well
- Bedrock Monitoring Well
- Abandoned Well
- Streams and Drainages
- Topographic Contours (20' Interval)
- Paved Roads
- Dirt Roads
- Security Fences
- Rocky Flats Boundary
- OU 11 (IHSS 168) Boundary
- Lakes and Ponds
- Buildings

*Includes values above the background mean +2 standard deviations (BM+2SD)
BM+2SD = 4551

Scale = 1 : 8400
1 inch = 700 feet

350 0 700ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

OU 11--West Spray Field
NITRATE/NITRITE
Concentrations*
(and Sample Dates) in
UHSU Ground Water

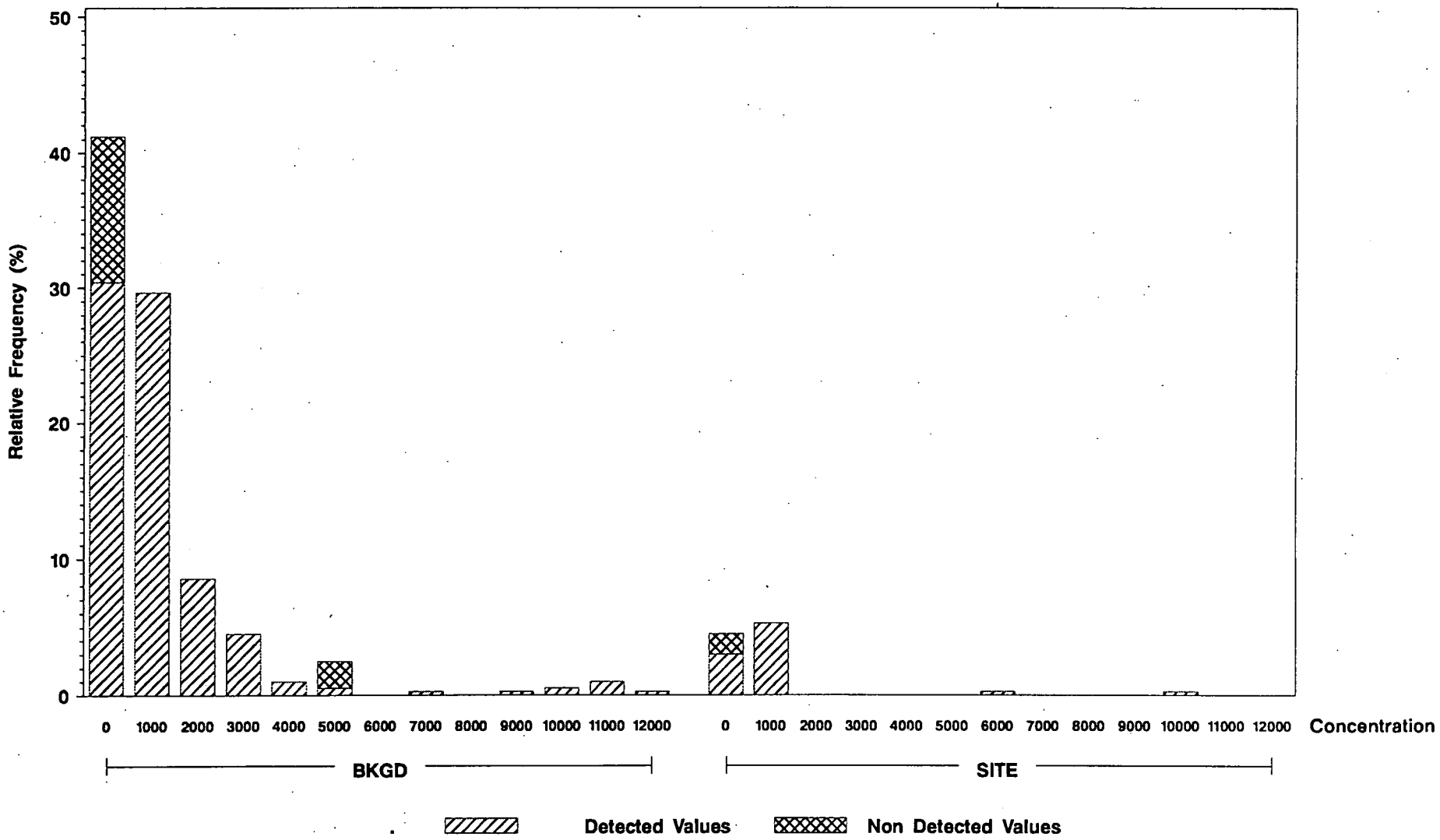
June 1995 | Figure D-122

Figure D-123

Background vs OU11 UHSU Groundwater

Frequency Histogram

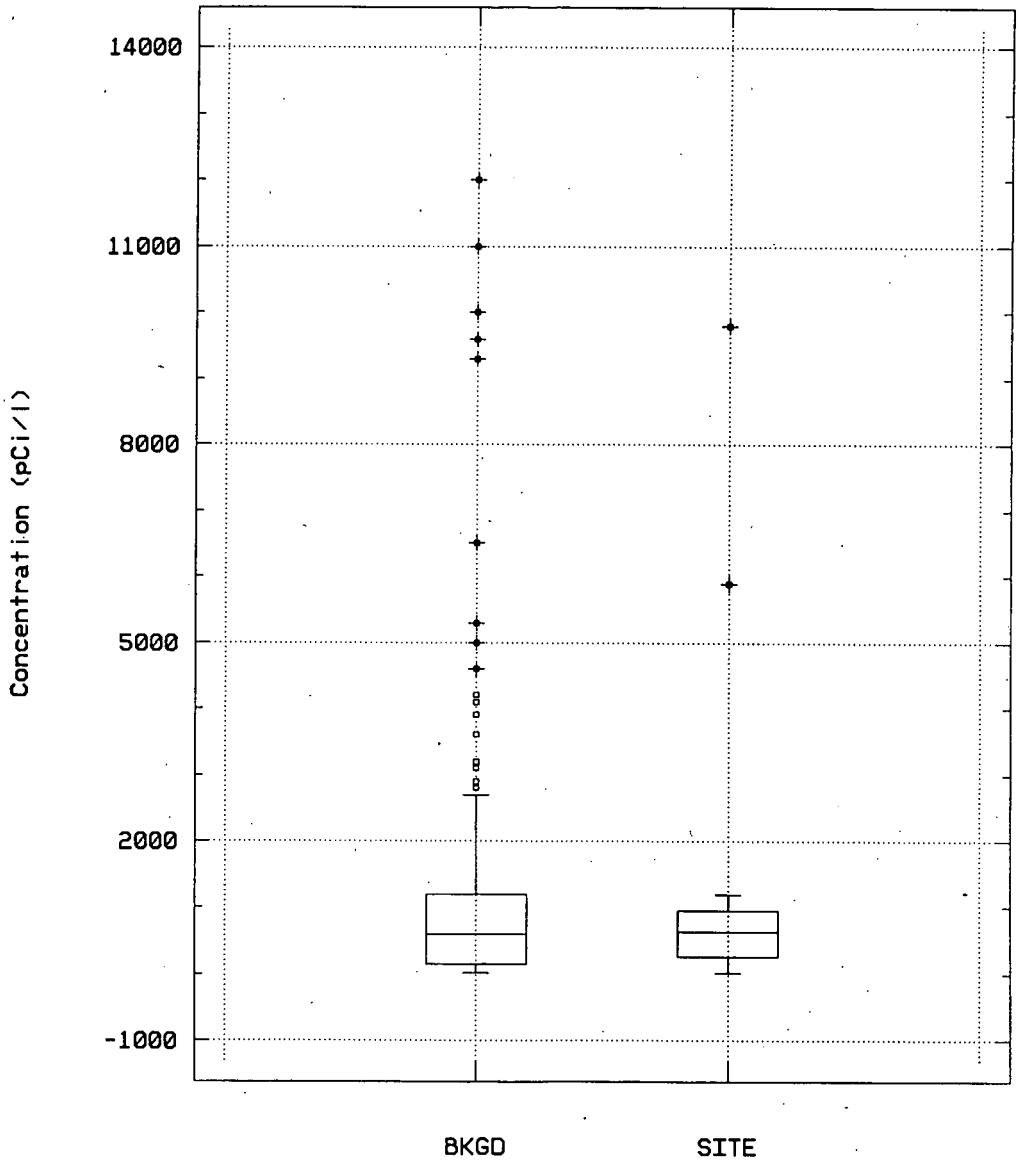
NITRATE/NITRITE (ug/l) in Groundwater (Total)



SITE = UHSU samples from saturated media within and downgradient of IHSS 168

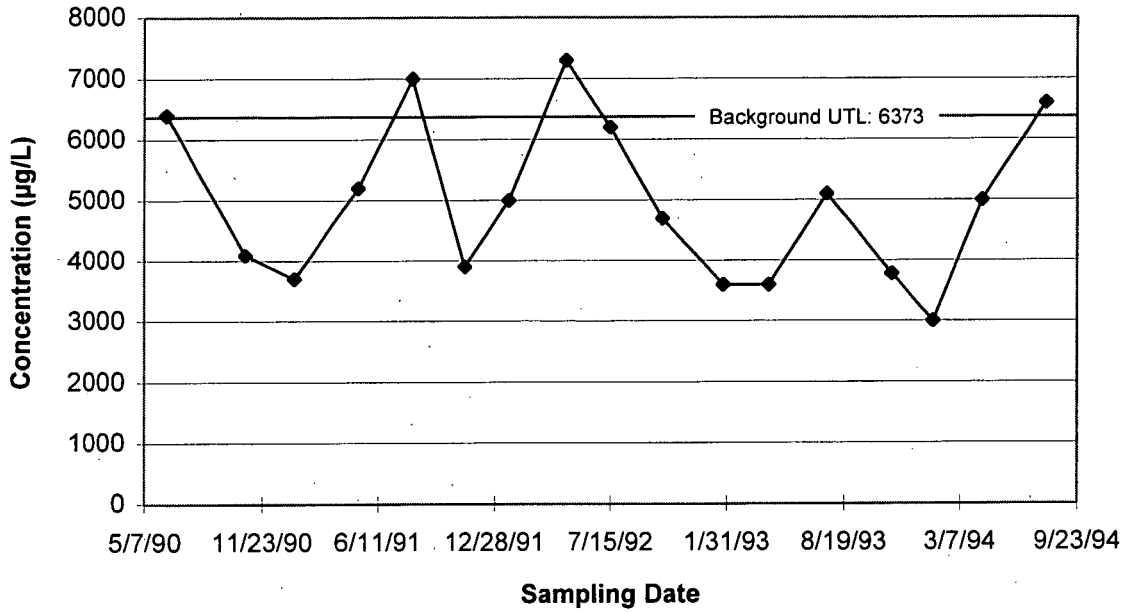
Figure D-124
Background vs OU11 UHSU Groundwater

Nitrate/Nitrite in Groundwater (Total)



Groundwater samples within and downgradient of IHSS 168

Figure D-125
Time Series Plot - Total Nitrate/Nitrite
4986



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MEP C:\..\ALL_TS.XLS Chloroform, Toluene, Nitrate 3/21/95

APPENDIX E

Evaluation of Dermal Contact

APPENDIX E—EVALUATION OF DERMAL CONTACT

This document presents results of the dermal contact evaluation for residential exposure to surface soil in the OU 11 source area. As discussed in Section 6.0 of the OU 11 CDPHE Letter Report, Comparison of Ratio Sums to CDPHE Conservative Screen Decision Criteria, any source area that has a ratio sum less than or equal to 1 warrants no further action by DOE, pending results of a dermal contact evaluation.

To conduct the dermal contact evaluation for OU 11, maximum values for potential contaminants of concern (PCOCs) in surface soil (0 to 12 feet) in the OU 11 source area (all had a maximum:PPRG ratio less than or equal to 1) were compared to risk-based concentrations (RBCs) based on dermal contact [dermal RBCs]. Carcinogenic and noncarcinogenic dermal RBCs were calculated using the following equations:

$$RBC\text{-}C\ (pCi/g) = \frac{TR}{ED \times SF_r \times EF \times SA \times ABF_i \times ADF \times CF_r}$$

$$RBC\text{-}C\ (mg/kg) = \frac{TR \times ATC \times BW}{ED \times SF \times EF \times SA \times ABF \times ADF \times CF}$$

$$RBC\text{-}NC\ (mg/kg) = \frac{THI \times ATN \times BW}{ED \times \frac{1}{RfD} \times EF \times SA \times ABF \times ADF \times CF}$$

Exposure parameters for dermal contact with surface soil in a residential exposure scenario were provided by EG&G (DOE 1995) and are defined and presented in Table E-1. Dermal RBCs for each PCOC in OU 11 source area surface soil (0 to 12 feet) are presented in Table E-2.

All maximum concentrations or activities for PCOCs in surface soil in the OU 11 source area were below the dermal RBCs (Table E-3). Results of the comparison of concentrations and activities of PCOCs in OU 11 source area surface soil to dermal RBCs confirm that dermal exposure is not a significant exposure pathway for OU 11 and that OU 11 is a candidate for no action in accordance with the CDPHE/EPA/DOE Risk Assessment Agreement (CDPHE/EPA/DOE 1994) (Figure 1-2 of the OU 11 CDPHE Letter Report).

DOE. 1995. Programmatic Risk-Based Preliminary Remediation Goals, Final, Revision 2. Rocky Flats Environmental Technology Site, Golden, Colorado. U.S. Department of Energy. February.

EPA. 1989. Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual (Part A). EPA/540/1-89/002. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. December.

Table E-1. Exposure Parameters for Dermal Contact with Surface Soil (Residential Exposure Scenario)

Exposure Parameter	Abbreviation	Value	Units
Target Risk	TR	1.0E-06	---
Target Hazard Index	THI	1	---
Averaging Time - carcinogens	ATC	25550	days
Averaging Time - noncarcinogens	ATN	10950	days
Body Weight	BW	70	kg
Exposure Duration	ED	30	yr
Oral Slope Factor - radionuclides	SF_r	chemical specific	risk/pCi
Oral Reference Dose	RfD	chemical specific	mg/kg-day
Exposure Frequency	EF	350	events/yr
Surface Area	SA	5300	cm^2/event
Absorption Factor - inorganics*	ABF_i	0.001	---
Soil-to-Skin Adherence Factor	ADF	1.0	mg/cm^2
Unit Conversion Factor - radionuclides	CF_r	1.0E-03	g/mg
Unit Conversion Factor - inorganics	CF	1.0E-06	kg/mg

* According to EPA, "dermal uptake is generally not an important route of uptake for radionuclides, which have small dermal permeability constants" (EPA 1989), however, dermal exposure to radionuclides has been quantified.

Table E-2. Dermal RBCs for PCOCs in OU 11 Source Area Surface Soil (0 to 12 Feet) (Residential Exposure Scenario)

Potential Contaminant of Concern	Carcinogenic Dermal RBC		Noncarcinogenic Dermal RBC	
	Slope Factor (risk/pCi)	RBC-C (pCi/g)	Reference Dose (mg/kg-day)	RBC-NC (mg/kg)
AMERICIUM-241	2.4E-10	7.5E+01	---	---
NITRATE/NITRITE*	---	---	1.6E+00	2.2E+07
PLUTONIUM-239/240	2.3E-10	7.8E+01	---	---
TRITIUM	5.4E-14	3.3E+05	---	---

* RfD is for nitrate because nitrate is the dominant species present.

Table E-3. Comparison of Maximum Concentrations/Activities of PCOCs in OU 11 Source Area Surface Soil (0 to 12 Feet) to Carcinogenic and Noncarcinogenic Dermal RBCs

Potential Contaminant of Concern	Maximum Concentration or Activity (Max) (mg/kg or pCi/g)	Dermal RBC		Ratio of Max to Dermal RBC	
		Carcinogen (pCi/g)	Noncarcinogen (mg/kg)	Carcinogen	Noncarcinogen
AMERICIUM-241	0.43	7.5E+01	---	0.0057	---
NITRATE/NITRITE	37	---	2.2E+07	---	0.0000017
PLUTONIUM-239/240	2.2	7.8E+01	---	0.028	---
TRITIUM	3.4	3.3E+05	---	0.000010	---

Appendix E
Ecological Measurement Endpoints and Data Files for OU 11

Note: This summary is based on the Ecological Field Sampling Plan for OU 11. This field sampling plan was designed in conjunction with the Ecological Monitoring Program (EcMP) and implemented by EG&G Rocky Flats, Inc. EcMP staff. Results of this sampling will be summarized in the EcMP annual report due in mid-1995.

Appendix E
Tables

Appendix E
Figures

OU 11 Data Files

Acronyms and Abbreviations

C	Celsius
CEC	cation exchange capacity
CHN	carbon, hydrogen, and nitrogen
cm	centimeter
CO_2	carbon dioxide
CO_3	carbonate
DOE	U.S. Department of Energy
DTPA	diethylene triaminepentacetic acid
EcMP	Ecological Monitoring Program
ECOC	ecological contaminant of concern
EE	environmental evaluation
EG&G	EG&G Rocky Flats, Inc.
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
g	grams
HCl	hydrochloric acid
HCO_3	bicarbonate
MPa	megaPascals
NH_4	ammonium
NO_3	nitrate
OU	operable unit
QA/QC	quality assurance/quality control
RFETS	Rocky Flats Environmental Technology Site

SO_4	sulfate
SOP	standard operating procedure
WSF	West Spray Field

Ecological Measurement Endpoints and Data Files for OU 11

Objectives and Approach

The assessment of the ecological effects and ecological risks associated with the Operable Unit (OU) 11 West Spray Field (WSF) at the Rocky Flats Environmental Technology Site (RFETS) resulting from site activities follows U.S. Environmental Protection Agency (EPA) guidance in the form of a Frame Work for Ecological Risk Assessment (EPA, 1992). As part of that guidance, data acquisition, verification, and monitoring occur interactively with the three phases of this approach: problem formulation, analysis (characterization of exposure and ecological effects), and risk characterization. The existing ecological data relevant to OU 11 are described in the following sections and are presented here to support the results of the ecological contaminant of concern (ECOC) screen. The results of the ECOC screen, together with the ecological measurement endpoints documented in this appendix, suggest that additional sampling activities are not warranted and a *de minimis* risk scenario exists for OU 11.

Ecological Sampling Activities in Direct Support of OU 11 EE

The status of previous field sampling activities relevant to the OU 11 ecological risk assessment (ERA) is summarized in two tables:

- Table E-1 summarizes the status of sampling activities, both completed and proposed, in direct support of the environmental evaluation (EE) for OU 11.

- Table E-2 summarizes the extensive sampling done under the EG&G Rocky Flats, Inc. (EG&G) Ecological Monitoring Program (EcMP) that may be relevant and applicable to the EE for OU 11. Given the scarcity of ecological impacts associated with OU 11 activities, EcMP staff chose to evaluate several of the sampling and analysis methods at the WSF. Many of the EcMP endpoints should be very sensitive to the effects of the addition of water and nitrate to the terrestrial ecosystem. Sampling at OU 11 provided the mutually beneficial opportunity to evaluate EcMP methods while reducing uncertainty in the ERA at this OU.

Terrestrial Ecosystem Sampling

As presented in Section 2.3 of this report, samples were collected from spray areas, non-spray areas, and reference areas. Within those areas, 5-meter-by-5-meter grids were sampled for vegetation, small mammals, and insects (see Table E-1).

Vegetation sampling included cover transects, belt transects, and production quadrants following EG&G Ecology standard operating procedures (SOPs) (EG&G, 1992).

Terrestrial arthropods were collected by sweep netting in all grids of each area following Ecology SOPs (EG&G, 1992). Samples were placed in secure storage awaiting possible identification and enumeration if indicated by the problem formulation.

One bird transect, which included portions in both affected and reference areas, was also inventoried following Ecology SOPs (EG&G, 1992).

Four grids per area were trapped for small mammals following Ecology SOPs (EG&G, 1992). To expand the relevance of the small mammal data collected, and in concurrence with current SOPs, trapping was done for three nights so that results are comparable with extensive reference data collected under the EcMP.

Large mammals were recorded during performance of relative abundance transects following Ecology SOPs (EG&G, 1992).

Vegetation tissue samples were collected from all grids within each area following Ecology SOPs (EG&G, 1992). Samples are in secure storage awaiting possible analysis as indicated by the problem formulation.

Aquatic Ecosystem Sampling

There is only one permanent surface water monitoring station with a potential aquatic receptor ecosystem associated with OU 11, SW-128. This impoundment principally receives runoff from parking lots and may only be influenced by OU 11 during rare overland flow runoff events. One qualitative benthic macroinvertebrate sample was collected from both SW-128 and Lindsay Pond following Ecology SOPs (EG&G, 1992). Potential effects of OU 11 contaminants downstream on aquatic receptors will be fully evaluated in the OU 5 and OU 6 watershed scale risk assessment.

Ecological Sampling Results in Direct Support of OU 11 EE

As a result of sample collection in direct support of the OU 11 EE, the following data are available (the EG&G scientist responsible for each data set is listed in parentheses):

- Small Mammal Capture Data (Dr. F. A. Harrington)
- Vegetation Production Summaries and Calculations (Dr. F. A. Harrington)
- Vegetation Production Plot Summary Forms (Dr. F. A. Harrington)
- Vegetation Cover Summaries and Calculations (Dr. F. A. Harrington)
- Vegetation Cover Transect Summary Forms (Dr. F. A. Harrington)
- Vegetation Belt Transect Summaries and Calculations (Dr. F. A. Harrington)
- Vegetation Belt Transect Summary Forms (Dr. F. A. Harrington)
- Bird Transect Summaries and Calculations (Dr. F. A. Harrington)

- Relative Abundance Survey Summary (B. J. Bevirt)
- Species List of Macrobenthic Organisms (Dr. F. A. Vertucci)

The data files containing the ecological sampling results from OU 11 are contained on the attached disk.

A cursory evaluation of the data shows no harmful ecological impacts on sprayed versus non-sprayed or reference areas. Some results are summarized here:

1. Small mammal capture data collected in the fall of 1993 were statistically inconclusive due to low numbers of captures in all sites: sprayed, non-sprayed, and reference. The low numbers of captures may be due to the absence of burrowing sites in these upland soils. The upland grassland habitat of OU 11 is not considered Preble's meadow jumping mouse habitat and none has been captured in similar habitats at the site.

2. Vegetative cover data showed significantly lower basal cover in sprayed versus non-sprayed and reference areas. However, the belt transect data suggest this might be due to the change in species composition resulting from supplemental nitrogen and water additions. Subsequently, the production data show higher plant biomass in sprayed versus non-sprayed and reference areas. The data also suggest a much higher litter biomass on sprayed versus non-sprayed and reference areas. This is consistent with the hypothesis that the water and nitrogen supplement has resulted in a greater biomass of large bunch grasses such as big and little bluestem. These species may increase production, reduce basal cover, and increase litter compared with the species found in reference and non-spray areas. These results may be analogous to those from watering and fertilizing a lawn heavily and then withdrawing the external additions, resulting in less cover but higher litter and biomass.

3. Breeding bird results suggest higher bird densities on the OU 11 WSF than on the reference area. The WSF had the highest abundance of grasshopper sparrows of any location sampled on the site. These birds prefer higher stratum grass habitats than other species such as the savannah sparrow.

4. No significant differences were found between transect locations associated with sprayed versus non-sprayed or reference locations in the relative abundance wildlife survey.

In summary, a cursory evaluation of the ecological data shows no evidence of adverse biotic effects between the treatment and reference areas associated with the OU 11 WSF. The absence of any measurable negative ecological impact is consistent with the ECOC screen finding of *de minimis* risk at this site.

Ecological Sampling Activities by EcMP

In addition to the sampling conducted in accordance with the OU 11 Ecological Field Sampling Plan, the EcMP consisted of additional sampling. Results of the EcMP sampling effort will be presented in the 1995 annual report of that program. An introduction to the EcMP sampling effort and a description of measurement endpoints are included here for interest and possible further evaluation should ECOCs be identified.

Terrestrial Ecosystem Sampling

As presented in Section 2.2 of this report, the EcMP is a U.S. Department of Energy (DOE)-mandated program to determine long-term ecological endpoints, exposure values, and effects at the site. This program began field operations in 1993, focusing on the testing of methodologies, experimental designs, sample scheduling, and program operations. The program was initially divided into five modules:

- Aquatic Ecology
- Terrestrial Vegetation, including cover, richness, density, production and litter biomass values, and tissue analysis
- Ecosystem Functions, including background soil physical/chemical measurements, microbial carbon and nitrogen pools, and potential rates of carbon and nitrogen transformations
- Soil Invertebrate Analysis
- Small Mammal Population Dynamics

Many of the ecological endpoints used in the EcMP are still in a state of development for adaptation to monitoring functions, but the endpoints chosen so far have been reviewed by an independent team of western university research experts and DOE's ecological consultants. There is consensus that "best available technology" is being used. In particular, functional measurements, soil invertebrate analysis, and plant tissue analysis on an area basis (rather than a species basis) have not been conducted at the site.

Much of the 1993 EcMP sampling took place in the Buffer Zone to define ecological attributes of reference areas. However, EcMP personnel recognized that the nitrogen treatment in the OU 11 area provided a unique opportunity to examine the feasibility and sensitivity of many program variables. Since many ecological measurements are affected by both carbon and nitrogen flows and pools, if impacts are indeed detectable, one would expect to find them in an area of heavy nitrogen application (OU 11) if at

all. Therefore, several EcMP measurements were taken at OU 11. Data are currently being analyzed by EcMP personnel to be included in the 1995 annual report to DOE. If needed, these data could be used to supplement the OU 11 EE/ERA. The remaining sections summarize the activities of EcMP at OU 11.

EcMP Soil Sampling Methods

Soil sampling at OU 11 began on September 21 and continued through September 28, 1993. The soil sampling locations were co-located with plant and litter tissue sampling. Soil sampling purposefully followed the same approach of vegetation sampling so that these data will be comparable (see Table E-2). Five plots (P1 through P5), in each of the four sites (MG1 through MG4), in each of the three treatment areas (sprayed, non-sprayed, and reference) were sampled, for a total of 60 sample units. Twelve additional quality assurance/quality control (QA/QC) samples were taken for functional and invertebrate samples. Functional and physical/chemical samples were taken from depths of 0 to 10 centimeters (cm). Soil invertebrate samples were taken from the 0 to 5 and 5 to 10 cm depths. In accordance with SOPs, all samples were taken with hand tools (shovels, trowels, knives) and transferred to pre-labeled resealable plastic bags, which also had labels inside the bags. Samples were then placed on blue ice in coolers, sealed, and transferred to a locked room in trailer T891G at RFETS at the end of the day. Sample information was logged onto chain-of-custody forms the same day of sampling or the next morning. Samples were delivered to laboratories within 48 hours, because of the relatively short holding time of the soil functional samples. Figure 1 illustrates the soil sampling scheme.

Vegetation samples were collected by field personnel, dried, and weighed by species from each plot. Litter was also collected, dried, and weighed by plot. Subsets of plant tissue were composited after drying (on a species basis) by plot for nutrient analysis. It was felt that species nutrient data would be less useful information than average above-ground nutrient data on an area basis. Analysis was apportioned as follows: 3 (of 5) plots x 2 (of 4) sites x 3 treatments = 18 sample units. Subsets of litter (corresponding to plant tissue) were analyzed for the same nutrient elements as plant tissue, with the exception that lignin analysis was performed on all litter samples.

Three different types of soil samples were collected: (1) ecosystem functional samples, (2) invertebrate samples, and (3) physical/chemical properties. The analytes for each area include:

1. Soil Ecosystem Functional Samples

   - extractable soil nitrate (NO_3)
   - extractable soil ammonium (NH_4)
   - total soil nitrogen

- soil particulate organic matter
- microbial nitrogen concentration (direct extraction)
- microbial carbon concentration (direct extraction)
- potentially mineralizable nitrogen (10-day incubation at field capacity moisture and 25° Celcius (C) followed by NO_3 and NH_4 analysis)
- potentially respirable carbon (carbon dioxide [CO_2] analysis following a 10-day incubation at field capacity moisture and 25°C)
- nitrogen fixation rate
- denitrification rate

2. Soil Invertebrate Samples

- soil arthropod analysis performed on all samples (identification and enumeration)
- soil nematode analysis performed on all samples (identification and enumeration)
- soil mycorrhizal analysis performed on a subset of samples (presence/absence and inoculation potential)

3. Soil Physical/Chemical Properties

- particle size - very coarse sand
- particle size - coarse sand
- particle size - medium sand
- particle size - fine sand
- particle size - very fine sand
- particle size - total sand
- particle size - total silt
- particle size - total clay
- soil field water content
- soil water content (0 megaPascals [MPa])
- soil water content (.010 MPa)
- soil water content (.033 MPa)
- soil water content (.5 MPa)
- soil water content (1.5 MPa)
- soil pH, saturated paste, measure suspension
- total soil carbon, carbon, hydrogen, and nitrogen (CHN) analyzer
- soil hydrogen, CHN analyzer
- total soil nitrogen, CHN analyzer
- soil available phosphorus, sodium bicarbonate extract
- soil available potassium, sodium bicarbonate extract
- extractable soil iron, diethylene triaminepentacetic acid (DTPA) extract
- extractable soil manganese, DTPA extract
- extractable soil copper, DTPA extract

- extractable soil zinc, DTPA extract
- extractable soil sodium, ammonium acetate extract
- extractable soil potassium, ammonium acetate extract
- extractable soil calcium, ammonium acetate extract
- extractable soil magnesium, ammonium acetate extract
- extractable soil sulfate (SO_4), hydrochloric acid (HCl) extract
- soil cation exchange capacity (CEC), ammonium acetate extract
- soil soluble sodium, water extract
- soil soluble potassium, water extract
- soil soluble calcium, water extract
- soil soluble magnesium, water extract
- soil digest aluminum, nitric acid digest, EPA Method 3050
- soil digest barium, nitric acid digest, EPA Method 3050
- soil digest beryllium, nitric acid digest, EPA Method 3050
- soil digest cadmium, nitric acid digest, EPA Method 3050
- soil digest calcium, nitric acid digest, EPA Method 3050
- soil digest chromium, nitric acid digest, EPA Method 3050
- soil digest cobalt, nitric acid digest, EPA Method 3050
- soil digest copper, nitric acid digest, EPA Method 3050
- soil digest iron, nitric acid digest, EPA Method 3050
- soil digest lead, nitric acid digest, EPA Method 3050
- soil digest magnesium, nitric acid digest, EPA Method 3050
- soil digest manganese, nitric acid digest, EPA Method 3050
- soil digest molybdenum, nitric acid digest, EPA Method 3050
- soil digest nickel, nitric acid digest, EPA Method 3050
- soil digest phosphorus, nitric acid digest, EPA Method 3050
- soil digest potassium, nitric acid digest, EPA Method 3050
- soil digest, nitric acid digest, EPA Method 3050
- soil digest sulfur, nitric acid digest, EPA Method 3050
- soil digest zinc, nitric acid digest, EPA Method 3050
- soil bicarbonate (HCO_3), saturated extract, titration
- soil carbonate (CO_3), saturated extract, titration

Plant and litter tissue were analyzed for the following elements:

- plant ash
- aluminum
- cadmium
- calcium
- chromium
- copper
- iron
- lead

- magnesium
- manganese
- molybdenum
- phosphorus
- potassium
- sodium
- sulfur
- zinc

Aquatic Ecosystem Sampling

As part of the EcMP initial field sampling effort, SW-128 and Lindsay Pond were sampled for zoobenthos, emergent insects, phytoplankton, zooplankton, and water chemistry. Table E-2 summarizes the samples that were collected. These data could be used in the problem formulation and a weight-of-evidence approach to the detection of any "impacts" on SW-128 if ECOCs are found.

References

EG&G. 1992. Environmental Management Department Standard Operating Procedures, Volumes I–VII, EG&G Rocky Flats, Inc. Golden, CO. March.

EPA. 1992. Framework for Ecological Risk Assessment. U.S. Environmental Protection Agency, EPA/630/R-92/001, Washington, D.C. February.

Table E-1
Status of Sampling Activities in Support of OU 11 EE

Taxon	Spray Areas		Non-Spray Areas		Reference Areas		Total Samples	
	PROPOSED	COMPLETED	PROPOSED	COMPLETED	PROPOSED	COMPLETED	PROPOSED	COMPLETED
Grids Needed (5x5)	4	4	4	4	4	4	12	12
Terrestrial								
Biota								
Vegetation Cover (5/grid)	20	20	20	20	20	20	60	60
Vegetation Belt Transects (5/grid)	20	20	20	20	20	20	60	60
Vegetation Quadrants (5/grid)	20	20	20	20	20	20	60	60
Arthropods (1/grid)	4	4	4	4	4	4	12	12
Birds (5, 2-ha plots x 6 replicates, 500-m transect)	30 for entire area				30 for area		60	60
Small Mammals (# of grids x 25 traps x 3 trap nights)	300	300	300	300	300	300	900	900
Large Mammals:								
Pellet Counts	4	0[1]	4	0[1]	4	0[1]	12	0[1]
Relative Abundance	1	1	1	1	1	1	3	3
Tissue								
Terrestrial Vegetation (# of grids x 3 replicates; 25-g sample)	12	12	12	12	12	12	36	36
Small Mammals (1/species/grid)	4	0[2]	4	0[2]	4	0[2]	12	0[2]
Arthropods (1, 25-g/site)	1	0[2]	1	0[2]	1	0[2]	12	0[2]
Aquatic	Surface Water Pond #128			Lindsay Pond				
Biota								
5 replicates per species								
Zoobenthos (quantitative)	1	1						
Zoobenthos (qualitative)	5	0[3]			5	0[3]	10	0[3]
Periphyton	5	0[3]			5	0[3]	10	0[3]

Taxon	Spray Areas		Non-Spray Areas		Reference Areas		Total Samples	
	PROPOSED	COMPLETED	PROPOSED	COMPLETED	PROPOSED	COMPLETED	PROPOSED	COMPLETED
Phytoplankton	5	0[3]			5	0[3]	10	0[3]
Zooplankton	5	0[3]			5	0[3]	10	0[3]
Tissue								
3 replicates, 25-g sample/taxon								
Periphyton	3	0[2]			2	0[2]	5	0[2]
Macrophyte	3	0[2]			2	0[2]	5	0[2]
Zoobenthos (not expected)	3	0[2]			2	0[2]	5	0[2]
Benthos (3 replicates x 3 species)	9	0[2]			9	0[2]	18	0[2]
Reptiles & Amphibians								
Tissue								
5 replicates, 25-g samples								
Anurans	3	0[2]			3	0[2]	6	0[2]
Uropods	3	0[2]			3	0[2]	6	0[2]
Crustaceans								
Tissue	3	0[2]			3	0[2]	6	0[2]

[1] Data not available.

[2] Sample collection depends on preliminary data, problem formulation, and agency guidance.

[3] Data not available. Preliminary sampling results under EcMP and preliminary exposure assessment indicate that the SW-128 site may not be in the contaminant pathway from OU 11 except perhaps during high flow runoff events.

Definitions:

EcMP Ecological Monitoring Program

EE environmental evaluation

g grams

OU operable unit

Table E-2
EcMP Sampling Activities at OU 11

	Spray Areas	Non-Spray Areas	Reference Areas	Total Samples
Terrestrial				
Soil Functions	20	20	20+12 QA/QC	72
Plant Tissue	6	6	6	18
Litter	6	6	6	18
Aquatic				
Emergent Insects	15		29	44
Zoobenthos (qualitative)	1		1	2
Zoobenthos (quantitative)	3		6	9
Phytoplankton	3		10	13
Zooplankton	3		11	14
Water Chemistry	8		10	18

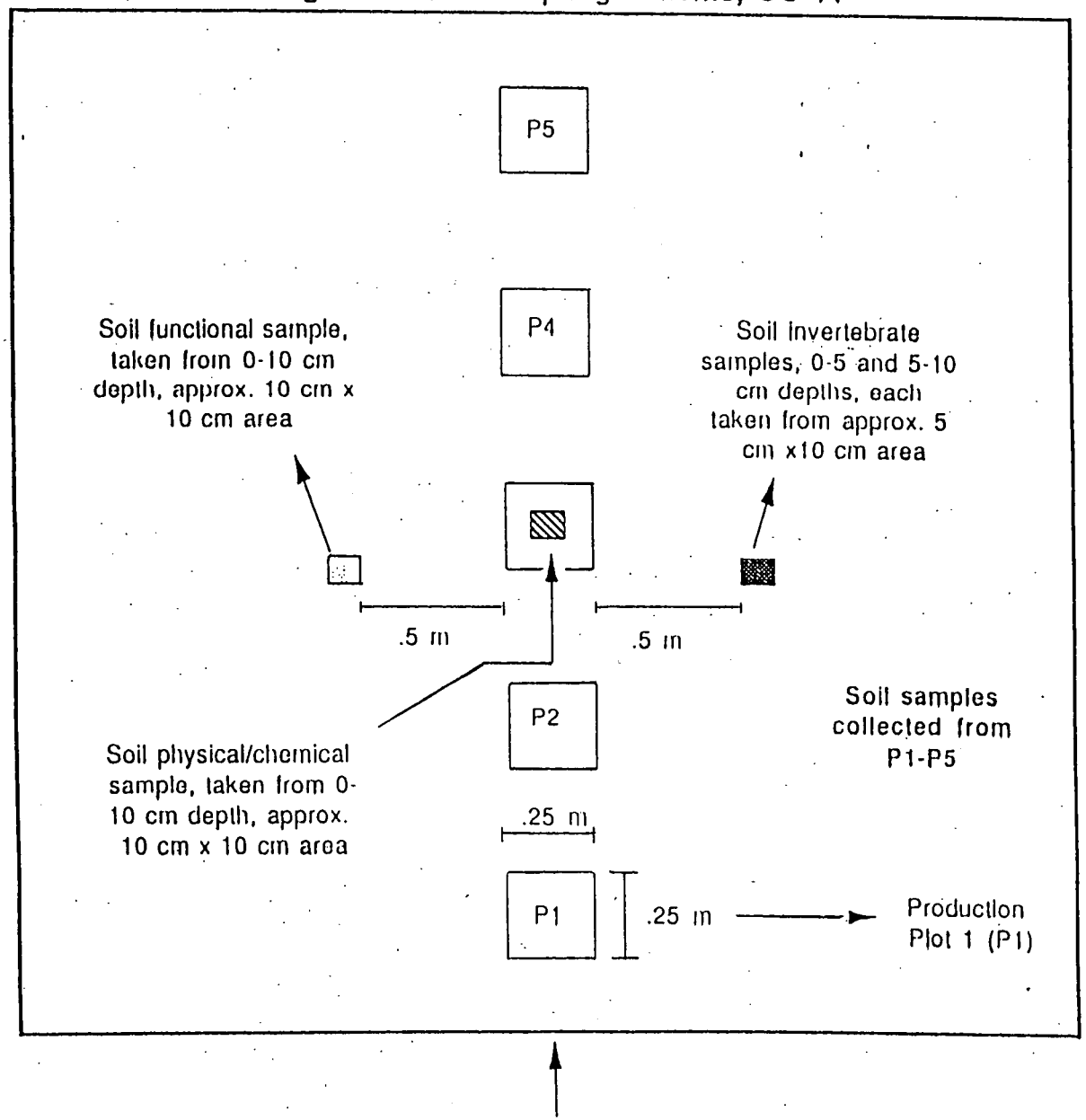
Definitions:

EcMP Ecological Monitoring Program

OU operable unit

QA/QC quality assurance/quality control

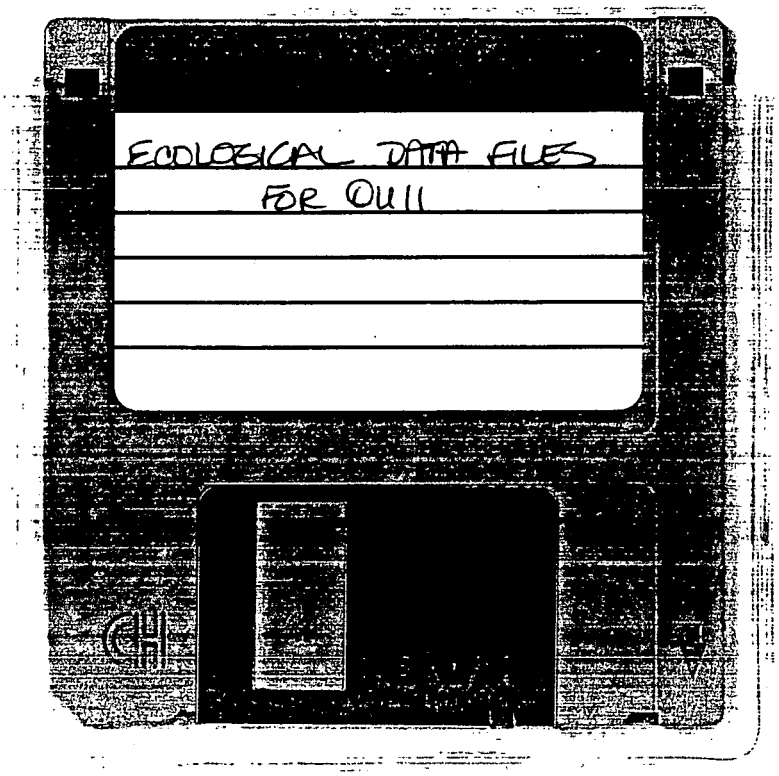
Figure 1. Soil Sampling Scheme, OU 11



One of 4 treatment replicates

Data Files Containing OU 11 Ecological Data

Data Type	File Name
Small Mammals	OU11SUM1.WB1
Production Plot Summaries	OU11PRD1.WB1
Production Plot Summary Forms Non-Spray Areas	11PRDN93.XLS
Production Plot Summary Forms Spray Areas	11PRDS93.XLS
Production Plot Summary Forms Reference Areas	11PRDR93.WK3
Cover Summaries and Calculations	OU11CVR1.WK3
Cover Transect Summary Forms	11CVRS93.WK3
Cover Transect Summary Forms	11CVRN93.WK3
Cover Transect Summary Forms	11CVRR93.WK3
Belt Summaries and Calculations	OU11BLT1.WB1
Belt Transect Summary Forms	11BLTS93.WK3
Belt Transect Summary Forms	11BLTN93.WK3
Belt Transect Summary Forms	11BLTR93.WK3


ECOLOGICAL DATA FILES
FOR OU11