RF/ER-96-0012.UN

ADMIN RECORD

KAISER•HILL
COMPANY

FINAL PHASE I RFI/RI REPORT WOMAN CREEK PRIORITY DRAINAGE, OPERABLE UNIT 5

RMRS Rocky Mountain Remediation Services, LLC
...protecting the environment

VOLUME 1

SECTIONS 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, AND 11.0 TEXT, FIGURES, AND TABLES

• Environmental Restoration •
Rocky Flats Environmental Technology Site

DOCUMENT CLASSIFICATION
REVIEW WAIVER PER
CLASSIFICATION OFFICE

April 1996

A-OU05-000594

TABLE OF CONTENTS

APPENDICES

FIGURES

TABLES

EXECUTIVE SUMMARY

This report presents the results obtained during implementation of the Work Plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) of the Woman Creek Priority Drainage (Operable Unit 5 ([OU 5]) at the Rocky Flats Environmental Technology Site (RFETS), formerly known as the Rocky Flats Plant (RFP), Jefferson County, Colorado, as amended. This investigation is pursuant to a Compliance Agreement among the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Colorado Department of Public Health and Environment (CDPHE) dated July 31, 1986 and an Interagency Agreement (IAG) among DOE, EPA, and CDPHE dated January 22, 1991.

The purpose of the OU 5 Phase I RFI/RI is to assess the potential contamination associated with the Individual Hazardous Substance Sites (IHSSs) that are located within the Woman Creek drainage. Data collected under the field investigation portion of the RFI/RI were used to estimate risks to human health and the environment, to begin developing and screening remedial alternatives, and to evaluate the need for further studies of the OU 5 IHSSs.

Eleven IHSSs, geographically located along or within the drainage areas of Woman Creek, have been designated as OU 5. These IHSSs include the Original Landfill (IHSS 115); Ash Pits, Former Incinerator Area, and Concrete Wash Pad (IHSSs 133.1 through 133.6); Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11); and a Surface Disturbance (IHSS 209). Ponds C-1 and C-2 are the only IHSSs located on Woman Creek. The remaining IHSSs are located along the banks and/or upland areas that drain into Woman Creek or into the South Interceptor Ditch (SID). In addition to these IHSSs, two additional surface disturbances are being investigated in the Phase I OU 5 investigation: a Surface Disturbance West of IHSS 209; and a Surface Disturbance South of the Ash Pits.

On May 27, 1993, EPA and CDPHE notified DOE that IHSS 196, Water Treatment Plant Filter Backwash Pond, was to be included in the OU 5 investigation. This IHSS was previously scheduled to be investigated as part of OU 16, Low Priority Sites. Because of its proximity to IHSS 115, the investigation of IHSS 196 was conducted concurrently with IHSS 115.

The OU 5 Phase I RFI/RI was conducted in two phases of distinct field programs. The first program was the field investigation specified in the OU 5 Phase I RFI/RI Work Plan. This investigation was conducted from September 1992 through August 1993 and included as many as four phases of work performed at each IHSS. During the course of this investigation, ten technical memoranda (TMs) were prepared to evaluate the data collected under each stage of the investigation and to further define the activities to be performed in subsequent investigations.

Upon completion of the field investigation specified in the OU 5 Phase I RFI/RI Work Plan, as amended by the TMs, the data collected under this investigation were evaluated. It was determined from this evaluation that additional data were required to assist in the definition of the nature and extent of contamination associated with each IHSS and to collect data required for the evaluation of potential remedial alternatives for the OU 5 Feasibility Study. Technical Memorandum No. 15 (TM15) was prepared to document the evaluation of the data collected during the OU 5 Work Plan investigation and to provide an amended Field Sampling Plan. This TM enabled the additional data required to be collected under the Phase I RFI/RI for OU 5 rather than proceeding with a Phase II RFI/RI. This additional field program was conducted from September 1994 through August 1995.

The Phase I RFI/RI Work Plan for the OU 5 Woman Creek Priority Drainage is a Controlled Document available for viewing in the Public Reading Rooms as specified in the IAG. TM15 - Amended Field Sampling Plan is included as Volume III, IV, and V of the Phase I RFI/RI Work Plan of OU 5 Woman Creek Priority Drainage: Text to TM15 - Amended Field Sampling Plan (Vol. I - Text); Text to TM15- Amended Field Sampling Plan (Vol. II - Text); Text to TM15 - Amended Field Sampling Plan (Vol. III - Appendices A-G).

Field investigations indicate that the site physical characteristics are complex. Site meteorologic, geologic, hydrologic, and hydrogeologic processes worked interactively to provide mechanisms and pathways for surface and subsurface constituents to migrate through the environment. For example, because some upper hydrostratigraphic unit groundwater pathways discharge to surface water within OU 5, there is limited potential for migration of volatile organic compounds (VOCs) to offsite locations.

The nature and extent of environmental contamination within OU 5 have been characterized through the collection, analysis, and assessment of hundreds of samples (Tables 2-1 through 2-10) of various environmental media. Environmental samples were analyzed for a comprehensive suite of chemicals to help characterize potential contamination associated with waste handling and disposal practices conducted during the operating history of RFETS. The OU 5 data assessment process, including rigorous data validation, was designed to be conservative to ensure a comprehensive understanding of potential contamination conditions in OU 5.

The results of the OU 5 data assessment indicated the presence of potential chemicals of concern (PCOCs) in surface soil; subsurface soil; groundwater; pond, seep, and stream water; and pond, seep, and stream sediments. PCOCs identified in one or more of these environmental media include VOCs, semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs)/pesticides, metals and other nonradioactive inorganic constituents, and radionuclides. The list of PCOCs for each medium was then screened using risk-based and other screening methods to identify chemicals of concern (COCs) for both the Human Health Risk Assessment (HHRA) and the Ecological Risk Assessment (ERA). COCs were identified as the chemicals in each medium that were likely to contribute at least one percent of overall risk. For the HHRA, COCs were selected on an OU-wide basis; for the ERA, the COCs were identified for the Woman Creek watershed. In groundwater and surface water, metals and radionuclides are the primary COCs; however, in seep water, the COCs are all VOCs. The COCs in surface soil and subsurface soil include uranium isotopes, several metals, polynuclear aromatic hydrocarbons, and PCBs. The COCs identified in stream and pond sediments are radionuclides and metals. Table 6-25, in Section 6, presents the COCs identified for OU 5.

The presence of COCs in all media is a result of historical releases to the environment. Under the hydrogeochemical conditions of OU 5, metals and radionuclides are not expected to be very mobile via the groundwater pathway. However, storm-water runoff may transport contaminated soils to surface waters, with subsequent transport to downstream receptors. The presence of COCs in stream, seep, and pond sediments is likely a result of surface-water transport of contaminated surface soils to Woman Creek. Fugitive dust emissions from OU 5 surface soils and dry sediments may contribute contaminated particulates to future onsite receptors. Exposure to subsurface soils by future onsite construction workers may result in contaminant inhalation and ingestion. Numerical modeling was used to examine the migration of COCs along pathways in groundwater, surface water, and air. The numerical models provided COC concentration tables for the HHRA.

The OU 5 HHRA indicates that there are estimated health risks and annual radiation doses for current and future onsite receptors as a result of indirect or direct exposure from sources in OU 5. The following exposure scenarios were evaluated: a current industrial worker (security guard); a future industrial/office worker; a future ecological researcher; a future open-space recreational user; and a future construction worker. Future onsite residential receptors were not considered in the HHRA because future land-use plans do not include residential use. It was determined during HHRA negotiations with the regulatory agencies that health risks to offsite receptors would not be addressed on an OU-specific basis, but on a sitewide basis prior to issuance of the final Sitewide Record of Decision.

For the HHRA, exposure media that were evaluated included surface soil; subsurface soil; outdoor and indoor air; stream, seep, and pond water; and stream, seep, and pond sediments. Groundwater was not evaluated as an exposure pathway because there are no current or future receptors.

Risks were evaluated for three Areas of Concern (AOCs). AOC No. 1 (AOC1) is the Original Landfill (IHSS 115/196 Source Area); AOC No. 2 (AOC2) includes the Ash Pits (IHSS 133 Source Area); AOC No. 3 (AOC3) includes the SID, Ponds C-1 and C-2 Source Areas, and the Woman Creek.

The risk characterization process combines average and reasonable maximum estimates of exposure with upperbound estimates of toxicity to yield conservative (protective) estimates of health risk. Estimates of health risk for average (central tendency or CT) and reasonable maximum exposure (RME) conditions are provided so that risk management decisions can be based on a range of potential risks for different exposure scenarios.

The following are the major conclusions of the HHRA:

- AOC1: Cumulative hazard indices (HIs) were below 1 and RME cancer risk estimates were 3E-05 or below for all receptors. The maximum cancer risk estimate of 3E-05 is for the future office worker. This risk is within the EPA target risk range of 1E-06 to 1E-04. External irradiation due to exposure of uranium-238 in surface soil is the primary contributor to this estimate of cancer risk.

- AOC2: Cumulative HIs were below 1 and RME cancer risk estimates were 4E-06 or below for all receptors. The maximum cancer risk estimate of 4E-06 is for the future office worker. This risk is at the low end of the EPA target risk range of 1E-06 to 1E-04. External irradiation due to exposure of uranium-238 in surface soil is the primary contributor to this estimate of cancer risk.

- AOC3: Cumulative HIs were below 1 and the RME cancer risk estimates were below the EPA "point of departure" of 1E-06 for both receptors. These results indicate that no adverse noncarcinogenic health hazards and negligible cancer risk are expected for all receptors evaluated.

The ERA for Woman Creek was conducted for aquatic and terrestrial biota exposed to contaminants in OUs 1, 2, and 5. The assessment of ecological risks was based on evaluating exposure of biological receptors to PCOCs in designated ERA-source areas. Source areas include individual or groups of IHSSs within an OU and were based on abiotic and biotic sampling locations in and around IHSSs. A preliminary exposure and risk calculation was conducted for PCOCs in source areas. The analysis was conducted to estimate the contribution of each PCOC and each source area to overall risk in the watershed. Ecological chemicals of concern were identified from preliminary risk calculations and evaluated further in risk characterization.

Ecotoxicological risk to terrestrial receptors in OU 5 was minimal. Concentrations (activities) of uranium-233/234 and uranium-238 in soils exceeded the risk-based screening criteria developed for RFETS. However, the criteria were exceeded in only two locations, both of which are in the Old Landfill source area and which represent a negligible portion of habitat in the watershed. Maximum concentrations of radionuclides in small mammals were not associated with levels that exceed the benchmarks for "safe" radiological doses. Thus, risk from exposure to radionuclides appears to be minimal.

The screening-level assessment also indicated that concentrations of mercury, antimony, and Aroclor-1254 could represent risks to aquatic-feeding birds if they acquired all of their food from the SID, Pond C-1, and segments of Woman Creek. However, it is unlikely that birds would spend all of the time in the areas of concern, because the size and quality of habitat in these areas is inadequate to support their needs.

The results of the HHRA and the ERA support the conclusions that environmental contamination within OU 5 does not pose a significant threat to public health or the environment under the evaluated exposure scenarios, and that remediation of environmental media to address risk to public health and the environment may not be warranted, pending an evaluation of the AOCs using the No Further Remedial Action decision criteria developed for RFETS.

ABBREVIATIONS, ACRONYMS, AND INITIALISMS

°C	degrees Celsius
°F	degrees Fahrenheit
µg/kg	micrograms per kilogram
µg/l	micrograms per liter
µm	microns
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
95% UCL	95 percent upper confidence limit
ac-ft	acre-feet
ACGIH	American Conference of Governmental Industrial Hygienists
ACM	asbestos-containing material
AEC	U.S. Atomic Energy Commission
Ag	silver
Al	aluminum
AOC	Area of Concern
AOC1	AOC No. 1
AOC2	AOC No. 2
AOC3	AOC No. 3
Am	americium
ARAR	applicable or relevant and appropriate requirement
Ba	barium
BaP	benzo(a)pyrene
BAT®	Bengt-Arne Tortensson
Be	beryllium
BGCR	Background Geochemical Characterization Report
BOD	biochemical oxygen demand
bQ	becquerel
BRA	Baseline Risk Assessment
BUTL	Background Upper Tolerance Limit
bw	body weight
Cd	cadmium
CDPHE	Colorado Department of Public Health and Environment
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CLP	Contract Laboratory Program
cm	centimeter
CMP	corrugated metal pipe
CMS/FS	corrective measures study/feasibility study
cm/sec	centimeters per second
cm^2/sec	square centimeters per second
cm^3/sec	cubic centimeters per second
COC	chemicals of concern
cpm	counts per minute
CPT	cone penetrometer testing
CRAVE	Carcinogenic Risk Assessment Verification Endeavor
CRQL	contract required quantitation limit

CSF	cancer slope factor
CSM	Conceptual Site Model
CSU	Colorado State University
CT	central tendency
Cu	copper
DCF	dose conversion factors
DCM	dichloromethane
DCN	Document Change Notice
DLG	Digital Line Graph
DMR	Document Modification Request
DOE	U.S. Department of Energy
DQO	data quality objective
ECAO	Environmental Criteria and Assessment Office
ECOC	ecological chemicals of concern
ECOCTM	ecological chemicals of concern screening methodology TM
EDE	effective dose equivalent
EEC	environmental effects criteria
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERA	Ecological Risk Assessment
ERDA	Energy Research and Development Administration
f_1	fractional uptake
FB	field blank
FDM	Fugitive Dust Model
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FS	Feasibility Study
FSP	Field Sampling Plan
ft	feet
ft^2	square feet
ft^3	cubic feet
ft/day	feet per day
ft^3/m	cubic feet per minute
g	gram
g/m^2	grams per square centimeter
gpm	gallons per minute
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
Gy	Gray (u/l case)
HEAST	Health Effects Assessment Summary Tables
Hg	mercury
HHRA	Human Health Risk Assessment
HI	hazard index
HPGe	high purity germanium
HQ	hazard quotient
HRR	Historical Release Report
H&S	health and safety
HSA	hollow-stem auger
HSPF10	Hydrologic Simulation Program - Fortran, Version 10
HQ	hazard quotient
IAG	Interagency Agreement

IA/PA	industrial area/protected area
IHSS	Individual Hazardous Substance Site
IHSS 115	Original Landfill
IHSS 133.1	Ash Pit 1
IHSS 133.2	Ash Pit 2
IHSS 133.3	Ash Pit 3
IHSS 133.4	Ash Pit 4
IHSS 133.5	Incinerator
IHSS 133.6	Concrete Wash Pad
IHSS 142.10	Pond C-1
IHSS 142.11	Pond C-2
IHSS 196	Water Treatment Plant Filter Backwash Pond
IHSS 209	Surface Disturbances
IM	interim measure
IRA	interim remedial action
IRIS	Integrated Risk Information System
kg	kilogram
LHSU	lower hydrostratigraphic unit
Li	lithium
LOAEL	lowest observed adverse effect level
LR	laboratory replicate
m	meter
ME	matrix effect
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
ml/g	milliliters per gram
mm	millimeter
mmhos/m	millimhos per meter
Mn	manganese
Mo	Molybdenum
mph	miles per hour
mrem/yr	millirem per year
MS	matrix spike
MSD	matrix spike duplicate
m/sec	meters per second
MSL	mean sea level
nCi/g	nanocuries per gram
NCP	National Contingency Plan
n.d.	no date
Ni	nickel
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
ORNL	Oak Ridge National Laboratory
OU	Operable Unit
OU 5	Operable Unit 5
PAH	polynuclear aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, completeness, and comparability
PC	permeability constants
PCB	polychlorinated biphenyl
PCE	tetrachloroethene

pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/m^3	picocuries per cubic meter
PCOC	potential chemical of concern
PET	potential evapotranspiration
ppb	parts per billion
ppm	parts per million
Pu	plutonium
PVC	polyvinyl chloride
QA	quality assurance
QAA	Quality Assurance Addendum
QC	quality control
Ra	radium
RAAMP	Radioactive Ambient Air Monitoring Program
RAGS	Risk Assessment Guidance Superfund
RBC	risk-based concentration
RCA	radiologically controlled area
RCRA	Resource Conservation and Recovery Act
RFA	Rocky Flats Alluvium
RfC	reference concentration
RfD	reference dose
RFEDS	Rocky Flats Environmental Database System
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RFP	Rocky Flats Plant
RME	reasonable maximum exposure
RPD	relative percent difference
Sb	antimony
SBDC	South Boulder Diversion Canal
SCMTM	sitewide conceptual model TM
SEP	Systematic Evaluation Program
SID	South Interceptor Ditch
SOP	standard operating procedure
Sr	Strontium
SV/Bq	sievert/becquerel
SVOC	semivolatile organic compound
TAL	target analyte list
TB	trip blank
TCE	trichloroethene
TCL	toxic compound list
TDEM	time domain electromagnetic
TEDE	total effective dose equivalent
TIC	tentatively identified compound
TM	Technical Memorandum
TM1	Technical Memorandum No. 1
TRV	toxicity reference values
TSS	total suspended solids
U	uranium
UCL	upper confidence limit
UHSU	upper hydrostratigraphic unit

USCS	Unified Soil Classification System
USGS	United States Geological Survey
UTL	upper tolerance limit
V	vanadium
VOC	volatile organic compound
WDM	Watershed Data Management
wy	water years
Zn	zinc

This page intentionally left blank.

1.0 INTRODUCTION

This report presents the results obtained during implementation of the Work Plan (DOE, 1992a) for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) of the Woman Creek Priority Drainage (Operable Unit 5 [OU 5]) at the Rocky Flats Environmental Technology Site (RFETS), formerly known as the Rocky Flats Plant (RFP), Jefferson County, Colorado, as amended (DOE, 1992a, 1994a). This investigation is pursuant to a Compliance Agreement among the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Colorado Department of Public Health and Environment (CDPHE) dated July 31, 1986 and an Interagency Agreement (IAG) among DOE, EPA, and CDPHE dated January 22, 1991. The IAG addresses RCRA and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) issues and has been integrated with DOE's Environmental Restoration (ER) Program (IAG, 1991).

Technical Memorandum (TM) 15, Addendum to the Field Sampling Plan of the OU 5 Phase 1 Work Plan is a primary reference for this report and has been reviewed and approved by the EPA. A copy is maintained in the Administrative Record. Copies of the Administrative Record can be found in the following libraries:

Rocky Flats Citizens Advisory Board
9035 N. Wadsworth, Suite 2250
Westminster, CO 80021
(303) 420-7855

Rocky Flats Reading Room, Front Range Community College
3645 W. 112th Avenue
Westminster, CO 80030
(303) 469-4435

Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver, CO 80222
(303) 692-3312

Environmental Protection Agency
Superfund Records Center
999 18th Street
Denver, CO 80202
(303) 294-7691

1.1 PURPOSE OF PROJECT

The purpose of the OU 5 Phase I RFI/RI is to assess the potential contamination associated with the Individual Hazardous Substance Sites (IHSSs) that are located within the Woman Creek drainage. The data collected under the field investigation portion of the RFI/RI are used to estimate risks to human health and the environment, to begin developing and screening remedial alternatives, and to evaluate the need for further studies of the OU 5 IHSSs.

1.2 BACKGROUND

1.2.1 Plant Operations

RFETS (Figure 1-1) is a government-owned and contractor-operated facility that is part of the nationwide-nuclear weapons production complex. RFP was operated for the U.S. Atomic Energy Commission (AEC) from its construction in 1951 until the AEC was dissolved in January 1975. At that time, responsibility for the RFP was assigned to the Energy Research and Development Administration (ERDA), which was succeeded by the DOE in 1977. Dow Chemical USA, an operating unit of the DOW Chemical Company, was the prime operating contractor of the facility from 1951 until June 30, 1975. Rockwell International succeeded Dow Chemical USA from July 1, 1975 to January 1, 1990, when EG&G Rocky Flats, Inc. succeeded Rockwell International. On July 1, 1995, Kaiser-Hill, L.L.C., succeeded EG&G Rocky Flats, Inc. as the prime operating contractor.

Currently, the primary mission at RFETS is environmental restoration. The name was changed from RFP to Rocky Flats Environmental Technology Site in September 1994. Historically, the primary mission at Rocky Flats was to produce metal components for nuclear weapons. These components were fabricated from plutonium, uranium, and nonradioactive metals, principally beryllium and stainless steel. Metal components were shipped elsewhere for final assembly. When nuclear weapons production ceased, components of the weapons were returned for special processing to recover plutonium and americium. Other activities included research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Both radioactive and nonradioactive wastes have been and are generated in these research and production processes. Current waste-handling practices involve onsite and offsite recycling of hazardous materials, onsite storage of hazardous and radioactive mixed wastes, and disposal of solid radioactive materials at other DOE facilities. However, historically, the site operating procedures included both onsite storage and disposal of hazardous and radioactive wastes.

1.2.2 OU 5 (Woman Creek)

Eleven IHSSs, geographically located along or within the drainage areas of Woman Creek (Figure 1-2), are collectively designated as OU 5. These IHSSs include the Original Landfill (IHSS 115); Ash Pits, Incinerator, and Concrete Wash Pad (IHSSs 133.1 through 133.6); Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11); and a Surface Disturbance (IHSS 209). Ponds C-1 and C-2 are the only IHSSs located on Woman Creek. The remaining IHSSs are located along the banks and/or upland areas that drain into Woman Creek or into the South Interceptor Ditch (SID). In addition to these IHSSs, two additional surface disturbances are being investigated in the Phase I OU 5 investigation, a Surface Disturbance West of IHSS 209 and a Surface Disturbance South of the Ash Pits.

In 1980, the South Interceptor Ditch (SID) (Figure 1-7) was constructed upslope (to the north) of Woman Creek to intercept surface-water runoff from the southern portion of the Industrialized Area, and more specifically from the 881 Hillside. The SID begins near the east end of an Ash Pit (IHSS 133.2), parallels the creek, cuts through the toe of the Original Landfill (IHSS 115) and continues below the 881 Hillside French Drain. The SID crosses under the Woman Creek Diversion Ditch then empties into Pond C-2. A berm was constructed on the downslope side of the SID to contain the water flowing into the ditch. The construction of the SID through the toe of the Original Landfill has contributed to the formation of slump features that are apparent within that area.

On May 27, 1993, EPA and CDPHE notified DOE that IHSS 196, Water Treatment Plant Filter Backwash Pond, was to be included in the OU 5 investigation. This IHSS was previously scheduled to be investigated as part of OU 16, Low Priority Sites. Because of its proximity to IHSS 115, the investigation of IHSS 196 was conducted concurrently with that of IHSS 115.

1.2.2.1 OU 5 IHSS Descriptions and Histories

The following sections describe the locations, physical features, and histories of each of the OU 5 IHSSs. These discussions are primarily based on the information provided in the OU 5 Work Plan (DOE, 1992a), and additional information that was obtained during the course of the investigation of the IHSSs and that provide further detail regarding the location, description, and history of the IHSSs.

IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Pond) - The Original Landfill is located within the buffer zone just south of RFETS industrialized area and south of the west access road (Figure 1-3). It is located north of Woman Creek on a moderately to steeply sloping south-facing hillside.

The Original Landfill was in operation from 1952 to 1968 and was used to dispose of general wastes generated at RFETS. It is estimated that 2 million cubic feet (ft^3) of miscellaneous RFETS wastes are buried in the landfill, including such things as solvents, paints, paint thinners, oil, pesticides, cleaners (Rockwell, 1988), construction related debris, waste metal, and glass. These wastes were not considered hazardous prior to 1968, when they were placed in the landfill. The landfill also received beryllium and/or uranium wastes and used graphite. It has been reported that ash containing an estimated 20 kilograms (kg) of depleted uranium (DOE, 1986), produced when 60 kg of depleted uranium were inadvertently burned and only 40 kg were recovered, was buried within the landfill. Chemicals that may have been placed in this landfill include commonly used solvents, such as trichloroethene (TCE), carbon tetrachloride, tetrachloroethene (PCE), petroleum distillates, 1,1,1-trichloroethane (1,1,1-TCA), dichloromethane (DCM), benzene, paint and paint thinners. Metals such as beryllium, uranium, lead, and chromium may also be present (Rockwell, 1988). Accurate and verifiable records of any further wastes placed in this landfill are not available.

IHSS 196, an evaporation/settling pond that was used for backflushing sand filters from the water treatment facility (Building 124), was located within the boundaries of the Original Landfill near the western edge (Figure 1-3). It appears that a second pond (visible in a 1955 aerial photograph in the approximate location of the SID) was constructed, but by 1964 this pond was no longer present and the area had been covered by fill (DOE, 1992a).

By 1980, the SID had been built across the southern part of the landfill. Several other activities at the landfill are apparent from aerial photographs of the area presented in EPA (1988a). A 1964 aerial photograph shows an active area of surface disturbance east of the landfill. Little documented historical information is available concerning this area; however, this area may have served as a storage yard for pipes and scrap metal. In addition, soil appears to have been placed in this area based on the substantial mounds of debris shown in 1969 and 1971 aerial photographs (EPA, 1988a).

The landfill was closed with a soil cover; however, a bottom liner was not installed. Details of the construction of the surface cover are not available, nor is the year the cover was installed. The slope on the south side of the landfill was regraded to correct sloughing and erosion-related problems.

Two storm-sewer pipes protrude from the landfill area (Figure 1-3). The west pipe is no longer connected to a drainage system. The pipe that cuts diagonally across the landfill from west to east, appears to be connected to storm drains and possibly to foundation drains in the 400 Area (Section 2.2.1.5). This pipe discharges to the SID just east of the surface disturbance and east of the landfill.

<u>IHSS 133 (Ash Pits, Former Incinerator Area, and Concrete Wash Pad)</u> - The Former Incinerator Area, Ash Pits, and Concrete Wash Pad are located south-southwest of the industrialized area of RFETS, south of the west access road and north of Woman Creek (Figure 1-4). The locations of these IHSSs are defined from historic aerial photographs. The Former Incinerator, which had a 10- to 20-foot (ft) stack, was located along the original western boundary of RFETS, off the west access road. Two additional ash pits were identified using electromagnetic geophysical techniques and are referred to as TDEM-1 and TDEM-2 in this report. Ash Pits 1, 2, 3, 4 (IHSSs 133.1, 133.2, 133.3, 133.4) and time domain electromagnetic area (TDEM)-1 and TDEM-2 are approximately 20 ft wide by 150 ft long and 8-18 ft deep. The Ash Pits are located on a relatively flat surface and are currently covered by tall grasses.

The Former Incinerator Area (IHSS 133.5) occupies approximately 4,000 square feet (ft^2) and the Concrete Wash Pad (IHSS 133.6) covers an area of about 33,000 ft^2. These two IHSSs are located west of the four original Ash Pits. The area surrounding the Concrete Wash Pad has an extremely irregular hummocky surface that slopes gently to the south toward Woman Creek.

The Incinerator was used to burn general site wastes between the 1950s and 1968. Note that the Incinerator is not believed to be a regulatory-defined incinerator. Depleted uranium is also believed to have been burned in the Incinerator (Rockwell, 1988). A review of aerial photographs revealed that the Incinerator was removed by 1971 and the entire area was beginning to revegetate (EPA, 1988a). Ashes from the Incinerator were placed into the Ash Pits or were pushed over the side of the hill into the Woman Creek drainage and/or onto the Concrete Wash Pad (Rockwell, 1988). Following the shutdown of the Incinerator (after 1968), the Ash Pits were covered with fill (Rockwell, 1988); however, information about the material used in the construction of the cover is unavailable.

The history of the Concrete Wash Pad has not been documented as well as the Ash Pits or Former Incinerator area. It appears that this area was used to dispose of waste concrete from the concrete trucks involved in the construction activities of the site. It is also likely that the concrete trucks were washed down in this area after delivering concrete.

The histories of the Ash Pits, Incinerator, and Concrete Wash Pad are not entirely known because few records were kept of their operations. General combustible wastes from the site were burned in the Incinerator along with an estimated 100 grams of depleted uranium (Owen and Steward, 1973), which were disposed of into the ash pits. A total of 60 kg of combustible waste was burned, of which 20 kg was disposed into the original landfill. The ashes from the Incinerator were disposed in the Ash Pits. At the Concrete Wash Pad, potentially contaminated materials consist of concrete debris and small amounts of ash from the Incinerator that were reported to have been pushed over the side of the hill onto the Concrete Wash Pad area (Rockwell, 1988).

A rayscope survey (an unknown type of survey) was conducted over Ash Pit 3 (IHSS 133.3) prior to 1973 and the results of this survey detected metals (type unknown) (DOE, 1987). No documentation exists as to whether the other Ash Pits (IHSSs 133.1, 133.2, and 133.4) had a rayscope survey done over their surfaces.

IHSS 142.10 and 142.11 (C Ponds) - Ponds C-1 (IHSS 142.10) and C-2 (IHSS 142.11) are located along Woman Creek, southeast of the RFETS industrialized area and within the buffer zone (Figure 1-2). These ponds are approximately 2,000 ft apart, with Pond C-1 to the west of Pond C-2. The estimated capacities for Ponds C-1 and C-2 are approximately 5 acre-feet (ac-ft) and 69.8 ac-ft, respectively.

The natural drainage of Woman Creek has been somewhat modified in the OU 5 area by the construction of Ponds C-1 and C-2 and the SID south of the industrial area. Currently, Woman Creek flows eastward through OU 5 in its natural stream channel to Pond C-1 (Figure 1-2). Filter backwash water from the water treatment facility was discharged in Pond C-1 between the plant start-up in 1952 and December 21, 1973 (DOE, 1980). In addition, the cooling tower blowdown water was discharged to Pond C-1 until the latter part of 1974. In the early 1970s, the plant operations were changed and Pond C-1 was used principally to manage the surface-water runoff in the Woman Creek drainage. Water is rarely retained within this pond because the outlet or gate is usually open and the water is allowed to flow through the pond. The water consequently flows in its natural channel until just west of Pond C-2 where it is diverted around Pond C-2 by a diversion canal. During low flows, downgradient and to the east of Pond C-2, all of the water is diverted from Woman Creek's main channel into an unnamed ditch that flows into Mower Reservoir. During high flows, some flow continues to flow downstream in Woman Creek and into Standley Lake Reservoir.

In 1980, the SID was constructed upslope (to the north) of Woman Creek (Figure 1-2) to intercept surface-water runoff from the site. A berm was constructed on the downslope side of the SID to contain the water flowing in this ditch. Since the construction of the SID in 1980, Woman Creek has not received runoff directly from the southern part of the site. Surface-water flow in the SID is intermittent and usually occurs only following precipitation events or snow melt. When flow is low, water tends to pond in several areas of the ditch. The SID begins approximately 200 ft east of the Ash Pits and runs for almost two miles to Pond C-2 (Figure 1-2). The SID is approximately 4 to 8 ft in depth and is not lined. Just upslope of Pond C-2, the water flowing in the SID crosses over Woman Creek and flows into Pond C-2. In Pond C-2, the water is sampled, analyzed, and discharged into the Broomfield Diversion Ditch that diverts water around Great Western Reservoir according to a National Pollutant Discharge Elimination System (NPDES) agreement (Permit No. CO-0001333).

<u>IHSS 209 and Other Surface Disturbances</u> - Three separate surface disturbances are described in this section: (1) IHSS 209; (2) the Surface Disturbance West of IHSS 209; and (3) the Surface Disturbance South of the Ash Pits. IHSS 209 is located to the southeast of the RFETS industrialized area, south of Woman Creek and approximately 1,000 ft southeast of Pond C-1 (IHSS 142.10) (Figure 1-5). This area was included as an IHSS because unknown activities took place in this area of shallow excavations and surface disturbances (DOE, 1992a). IHSS 209 covers approximately 225,000 ft^2 (5.2 acres) and is located on a long narrow plateau bounded to the north, east, and south by a slope leading

into the Woman Creek drainage. A dirt road transects this IHSS and loops near the eastern boundary. Three excavations are located within the boundary of this IHSS. Two depressions, which periodically retain water, are present near the northern and southwestern boundary of the IHSS.

A second surface disturbance, the Surface Disturbance West of IHSS 209, located approximately 1,500 ft west of IHSS 209, is also included in the OU 5 investigation. The area consists of several small disturbed areas in a somewhat symmetric arrangement (Figure 1-5). This disturbance covers an area of approximately 62,500 ft^2 (approximately 1.4 acres).

A third surface disturbance area, the Surface Disturbance South of the Ash Pits, is also being investigated under the OU 5 RFI/RI. This area is located 1,200 ft south of IHSS 133 and south of Woman Creek. This area consists of several former excavation areas (Figure 1-6). These surface disturbances were identified in aerial photographs taken between 1955 and 1988 (EPA, 1988a). There is still surface evidence of some of these disturbances. Two former excavations trend along northeast-southwest axes. Each excavation is approximately 30 ft wide by 400 ft long. A third area is located northeast of the parallel excavations and a fourth excavation (3 ft wide by approximately 2 ft deep) is located to the southwest. This excavation trends in a north-south direction across the plateau. An additional disturbed area is approximately 150 ft wide by 600 ft long and is located upslope (southwest) from the other disturbances.

It is not known what activity or activities may have taken place at IHSS 209 or at the other surface disturbances. However, the time period in which these areas were disturbed has been estimated from aerial photographs (EPA, 1988a).

IHSS 209 first appears as a disturbed area seen in a 1955 aerial photograph (EPA, 1988a). The ground was disturbed both west and east of the dirt road; however, no obvious features or equipment can be seen in the photo. By 1961, three excavations existed within this IHSS. The depression located near the southwestern boundary of this IHSS appears as a pond in 1980, 1983, and 1988 aerial photographs (EPA, 1988a). A 1980 aerial photograph also reveals that the western half of the IHSS was beginning to revegetate. By 1988, the only recognizable features on or near this surface disturbance were the presence of the eastern-most excavation and the pond located near the northern boundary of this IHSS (Figure 1-5).

The OU 5 Work Plan stated that the Surface Disturbance West of IHSS 209 appears to have been the location of a radio tower installation, based on the geometry of the five disturbances at this site. This surface disturbance was observed in a 1955 aerial photograph and was still evident on photographs until about 1971, when the area started revegetating. A radio tower, however, was never viewed in the aerial photographs.

The east excavation area was the first area to be noted as active in the Surface Disturbance South of the Ash Pits. This was observed in a 1955 aerial photograph. The two parallel excavations became active prior to 1978, and they are visible in a 1978 photo (EPA, 1988a). After 1983, the excavated areas started to revegetate. The west area, located approximately 400 ft southwest of the parallel excavations, became active prior to 1969 (EPA, 1988a) and is now backfilled with large rocks. It is not known when these rocks were placed.

1.2.3 Other Investigations

To the extent of which they are applicable, the results of other site investigations were incorporated into this investigation. The scope of these other investigations is briefly described in the following sections.

1.2.3.1 Sitewide Geological Characterization

The Sitewide Geoscience Characterization Study was performed to compile and integrate all available information in order to develop a conceptual model of the geologic, hydrogeologic, and geochemical conditions at the site. The results of this study were documented in three reports: the Geologic Characterization Report (EG&G, 1995a); the Hydrogeologic Characterization Report (EG&G, 1995b); and the Groundwater Geochemistry Report (EG&G, 1995c). The information presented in these reports was integrated into the discussions of the geology and hydrogeology of OU 5 presented in Section 3.0.

1.2.3.2 Sitewide Background Geochemical Characterization

The IAG required DOE to conduct a background study to establish representative background concentrations for various environmental media and to prepare background study reports periodically to document the results of this study. The 1993 Background Geochemical Characterization Report (BGCR), (DOE, 1993a), presents the final results of this program and provides background data for surface water, sediments, groundwater, and borehole materials. These data are necessary to support RFI/RIs, as well as RCRA interim measures (IMs) and CERCLA interim remedial actions (IRAs).

Analytical results for samples collected under the OU 5 RFI/RI were compared to the background data provided in the 1993 BGCR to determine whether or not the concentrations detected in OU 5 environmental media statistically exceeded those of background. Section 4.2 discusses the methodology used for this comparison.

1.2.3.3 Sitewide Surface Water Studies

Several studies have been or continue to be conducted pertaining to analyses of surface water, stream sediments, and pond sediments in the Woman Creek drainage and Ponds C-1 and C-2. The historical data for these media were evaluated in Technical Memorandum No. 1 (TM1) to assist in the design of a monitoring network for the OU 5 Phase I RFI/RI (DOE, 1993b; also, see Section 1.4.2.1) and were also used to determine the nature and extent of contamination within the Woman Creek drainage. The surface-water and sediment investigations and associated results are described in detail in Appendix A and are discussed in Sections 2.0, 3.0, and 4.0.

1.2.3.4 Sitewide Groundwater Characterization

Prior to the OU 5 Phase I RFI/RI field investigations, a total of 64 alluvial and bedrock wells existed in the vicinity of the Woman Creek drainage. Many of these wells have been or continue to be sampled as part of the sitewide groundwater monitoring program or for the investigation of other operable units (OUs) in the vicinity of OU 5. In addition, water levels are routinely measured in most of these wells. To the extent that the data from these wells met the quality requirements of the OU 5 RFI/RI, they were incorporated into this investigation. Appendix A provides a discussion of the available historical data from these wells. These data are also discussed, where appropriate, in Sections 2.0, 3.0, and 4.0.

1.3 SUMMARY OF PHASE I RFI/RI WORK PLAN AND TECHNICAL MEMORANDA

The Phase I RFI/RI Work Plan for OU 5 presents a Field Sampling Plan (FSP) that defines a staged approach to investigating each IHSS. The Work Plan outlines the use of an "Observational Approach" to achieve the objectives of the RFI/RI. This technique provides for continually reassessing site conditions as additional data are obtained. Sampling plans for subsequent stages of investigation are formulated to build on existing information. These sampling plans are submitted as TMs to the EPA and CDPHE for review prior to implementation. The OU 5 Work Plan contains nine TMs to be prepared to outline sampling plans for investigations of the OU 5 IHSSs and four TMs to be prepared to discuss Human Health Risk Assessment (HHRA) activities. A total of eleven TMs were prepared to describe planned field investigations during the implementation of the Phase I FSP at OU 5 (TMs 1-10 and 15). Three TMs were also prepared to describe specific phases of the HHRA. The following paragraphs summarize the FSP outlined by the OU 5 Work Plan and as amended by each of the TMs, as well as the scope of the TMs prepared for the HHRA.

1.4 ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment (ERA) portion of the baseline risk assessment was completed as part of an overall ERA conducted for the Walnut Creek and Woman Creek watershed. The complete ERA report for both watersheds is presented in Appendix N. An overview of the scope, approach, results, and conclusions for the Woman Creek watershed is presented in Section 7.0.

1.4.1 Phase I RFI/RI Work Plan for OU 5 (Woman Creek)

The OU 5 Work Plan identified site-specific data needs based on preliminary identification of contaminants potentially present at each IHSS, in addition to the data needs for the Phase I Baseline Risk Assessment and ERA. The FSP presented in the OU 5 Work Plan was based on these data needs and the requirements of the IAG between DOE, EPA, and CDPHE. The FSP for each IHSS required a combination of screening activities; sampling of soils, sediments, and surface water; and well installation and sampling. Table 1-1A is a matrix showing the IAG-required tasks and how these tasks were implemented as defined in the OU 5 Work Plan, as amended by the TMs. Table 1-1B is a matrix showing TM15-required tasks and Document Modification Requests (DMRs) to the FSP.

Stage 1 activities at each IHSS consisted primarily of the review of existing data, such as the results of previous investigations, aerial photographs, and other historical documents. Stage 2 activities were screening activities that included radiological, geophysical, and soil-gas surveys. Sampling of surface and subsurface soils were the predominant Stage 3 activities, and Stage 4 activities were primarily associated with groundwater investigations. If other activities were to be performed that did not fall into Stages 1 to 4, these activities were conducted under Stage 5. The site-specific FSPs outlined in the OU 5 Work Plan are briefly summarized below.

IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Pond) - Review and screening activities specified for the Original Landfill, including the area of IHSS 196, consisted of a review of a gamma radiation survey completed in 1990, review of aerial photographs, and completion of a soil gas survey and geophysical surveys. Sampling identified included surface-soil sampling, subsurface-soil sampling in borings, and sediment and surface-water sampling adjacent to the IHSS. The OU 5 Work Plan also specified that cone penetrometer testing (CPT) and Bengt-Arne Tortensson (BAT®) sampling be performed, and wells be installed and sampled downgradient of the IHSS and in selected soil borings, if plumes were encountered. Additionally, pipes protruding from the landfill were to be investigated and, if present, effluent sampled. The OU 5 Work Plan specified that TMs be prepared to present site-specific FSPs for the soil gas survey, geophysical surveys, surface-soil sampling, CPT, and monitoring-well installation and sampling.

IHSS 133.1-6 (Ash Pits 1-4, Incinerator, and Concrete Wash Pad) - Tasks specified by the FSP for the IHSS 133 sites included a review of aerial photographs and radiological and geophysical surveys to identify the extent of these IHSS sites. Sampling activities specified included surface-soil sampling, subsurface-soil sampling in borings, and installation and sampling of wells. The preparation of TMs was specified for the geophysical surveys, surface-soil sampling, subsurface-soil sampling, and monitoring-well installation and sampling.

IHSS 142 (C Ponds) - Activities specified by the FSP for IHSS 142.10 (C-1 Pond) and IHSS 142.11 (C-2 Pond) included a review of existing data collected by ongoing monitoring activities to assess potential overlap between the ongoing programs and the proposed OU 5-specific program. Contingent upon the results of the review of ongoing monitoring programs, the FSP also specified that surface-water and sediment samples be collected from the ponds, Woman Creek, and the SID. In addition, monitoring wells were to be installed and sampled downgradient of each pond.

IHSS 209 (Surface Disturbance Southeast of Building 881), the Surface Disturbance West of IHSS 209, and the Surface Disturbance South of the Ash Pits - Screening activities to be conducted at these sites included reviews of historical use information pertaining to these sites, visual inspections, and radiological surveys. Sampling activities specified by the FSP included surface-soil sampling from the excavations present at each site, subsurface-soil sampling from borings, and collection of sediment and/or surface-water samples from each of the former pond areas at IHSS 209.

The FSP defined in the OU 5 Work Plan was amended by 10 TMs at various stages during the field investigation. As is discussed in detail below, the scope of each TM does not agree in all cases with that described in the Work Plan. Because some of the activities to be described in the TMs specified by the Work Plan were similar, a single TM to address the same activity at more than one IHSS was prepared rather than preparing individual TMs for each IHSS. In addition, during the course of investigating each IHSS, it became apparent that the scope of subsequent Work Plan activities was not appropriate or adequate, thus necessitating the preparation of additional TMs. Similarly, the scope of several field investigation activities was clarified in letters submitted to EPA and CDPHE prior to implementing these activities. These letters were prepared for activities where the Work Plan did not require a TM, but additional definition or clarification of the scope of the activity was necessary. The scope of each TM and letter prepared during the implementation of the Phase I RFI/RI is summarized below.

1.4.2 Addenda to the Phase I RFI/RI Work Plan

1.4.2.1 Technical Memorandum 1 - Revised Network Design (Surface Water and Sediment)

TM1 (DOE, 1993b) documented the results of the review and assessment of ongoing surface-water and sediment monitoring programs discussed in IHSS 142 of Section 1.4.1. Based upon this assessment of the ongoing programs, this TM provided an amended FSP for the collection and analysis of surface-water and sediment samples from the C-1 and C-2 Ponds, Woman Creek and its tributaries, and the SID. In addition to addressing sampling activities for the ponds, this TM also addressed surface-water and sediment sampling activities for all other OU 5 IHSSs. This TM also specified the installation of shallow well points along Woman Creek to augment ongoing groundwater/surface-water interaction studies. The sampling and monitoring programs defined by this TM are summarized in Section 2.2.3.3.

1.4.2.2 Technical Memorandum 2 - Surface Geophysical Surveys (Original Landfill and Ash Pits)

TM2 (DOE, 1992b) described the approach for performing magnetic and electromagnetic (EM) surveys at IHSS 115 and the IHSS 133 sites. Because of the similarities in these surveys at both IHSSs, one TM was prepared to describe these surveys rather than the two TMs identified in the Work Plan. This TM documented the results of the review of the 1990 radiological survey of IHSS 115 and reviews of existing information, including aerial photographs, for both IHSS 115 and the IHSS 133 sites. It also provided the details of the procedures to be followed for performing geophysical surveys at both IHSSs. The methodology for and results of these surveys are summarized in Sections 2.2.1.2 and 2.2.2.2.

1.4.2.3 Technical Memorandum 3 - Surface-Soil Sampling Plan (Original Landfill)

TM3 (DOE, 1993c) presented the sampling and analytical program for surface soils within IHSS 115. The sampling and analytical program defined in this TM consisted of collection of samples for analysis of radionuclides from anomalies identified by the 1990 radiological survey of IHSS 115 and collection of samples for analyses of chemicals and radionuclides from the disturbed area east of the landfill and from landfill cover material. The surface-soil sampling program is summarized in Section 2.2.1.3.

1.4.2.4 Technical Memorandum 4 - Surface-Soil Sampling (Ash Pits, Incinerator and Concrete Wash Pad)

TM4 (DOE, 1993d) specified the sampling and analytical program for surface soils within the IHSS 133 sites. Similar to the program defined by TM3 for IHSS 115, the program defined by this TM included sample collection for analysis of radionuclides from anomalies identified by a radiological survey of these sites conducted as part of the OU 5 RFI/RI (see Section 2.2.2.2). It also involved sample collections for analyses of chemicals and radionuclides from areas believed to have been impacted by disposal operations at the IHSS 133 sites. The methodology and results of this sampling program are summarized in Section 2.2.2.3.

1.4.2.5 Technical Memorandum 5 - Soil Gas Survey (Original Landfill)

Based on the results of other soil gas surveys conducted at the site and on the review of historical data and other screening activities at IHSS 115, it was determined that modification of the soil gas sampling plan proposed in the OU 5 Work Plan was necessary. TM5 (DOE, 1993e) presented the results of the previous investigations at IHSS 115 and provided a revised sampling and analysis plan for the soil gas survey. The results of this survey are summarized in Section 2.2.1.2.

1.4.2.6 Technical Memorandum 6 - Cone Penetrometer Testing (Original Landfill)

The OU 5 Work Plan proposed the performance of CPT and collection of groundwater samples with a BAT® (or equivalent) sampling device. The Work Plan specified that a TM be prepared that would define the specific procedures and locations for these activities. TM6 (DOE, 1993f) specified the procedures and locations for CPT and provided a methodology for selecting locations for collection of groundwater samples contingent upon the results of the CPT and other previous and ongoing investigations at IHSS 115. Because of the advantages of this technique, this TM also specified the collection of groundwater samples from well points rather than with the BAT® sampling device. The implementation and results of these activities are summarized in Section 2.2.1.4.

1.4.2.7 Technical Memorandum 7 - Soil Borehole Sampling (Ash Pits, Incinerator, and Concrete Wash Pad)

Soil borings to be drilled in the areas of the IHSS 133 sites were proposed by the OU 5 Work Plan. The Work Plan also specified that a TM be prepared to better define the locations of these borings based on the results of preceding investigations. TM7 (DOE, 1993g) provided an FSP for the drilling and sampling of borings at the IHSS 133 sites. It also specified the collection of groundwater samples from within borings using the Hydropunch II or BAT® samplers where groundwater was present. The soil boring program and its results are summarized in Section 2.2.2.3.

1.4.2.8 Technical Memorandum 8 - Groundwater Monitoring-Well Installation (Original Landfill)

This TM provided a revised FSP for the installation and sampling of monitoring wells in the vicinity of IHSS 115 and IHSS 196 as prescribed by the OU 5 Work Plan. Subsequent to the preparation of the draft version of this TM, it was determined that the intent of the Work Plan was such that a TM was no longer required to define the locations of these monitoring wells. Therefore, a letter was prepared that described the plan for installing and sampling monitoring wells at IHSS 115. This letter is found in the appendices to TM15 (DOE, 1994a). The groundwater monitoring program is summarized in Section 2.2.1.4.

1.4.2.9 Technical Memorandum 9 - Groundwater Monitoring-Well Installation (Ash Pits, Incinerator, and Concrete Wash Pad)

The installation of monitoring wells in the area of the IHSS 133 sites was proposed in the OU 5 Work Plan, and the Work Plan specified that a TM be prepared to define the locations of these wells. TM9 (DOE, 1993h) provided a monitoring-well installation and sampling program for the installation of wells based on the results of previous investigations in the IHSS 133 area. The implementation of this TM and the results of this investigation are summarized in Section 2.2.2.4.

1.4.2.10 Technical Memorandum 10 - Surface-Soil and Soil-Borehole Sampling (IHSS 209 and Other Surface Disturbances)

TM10 (DOE, 1993i) presented a FSP for the collection of surface and subsurface soils at IHSS 209, the Surface Disturbance West of IHSS 209, and the Surface Disturbance South of the Ash Pits. The OU 5 Work Plan did not indicate that a TM would be required for these sampling programs, but information obtained in previous stages of the investigation of these areas necessitated that the soil-sampling program described in the Work Plan be modified. This information indicated that there was no evidence of waste disposal in these areas, and the soil-sampling programs were reduced in scope so as to only confirm the results of the preceding investigations. The results of the implementation of TM10 are summarized in Section 2.2.4.3.

1.4.2.11 Technical Memorandum 11 - Chemicals of Concern

TM11 (DOE, 1995a) identified the chemicals of concern (COCs) that were included in the HHRA to assess potential health risks from assumed exposure to the COCs detected in soil, groundwater, and other media sampled in OU 5. COCs are metals or radionuclides whose concentrations exceed background concentrations (or organic chemicals that are not naturally occurring), but that could pose a health risk under the assumed exposure conditions. COCs are selected from all analytes detected in each medium using risk-based and other screening methods that identify chemicals that would pose the greatest risk, and therefore warrant inclusion in the HHRA. COCs also provide the focus for fate and transport modeling and remedy selection. Section 4.2 provides a discussion of the comparison of data for OU 5 sampling locations with background values, and Section 6.2 discusses the selection of COCs.

1.4.2.12 Technical Memorandum 12 - Exposure Scenarios

TM-12 (DOE, 1995b) was prepared to identify potentially complete exposure pathways and human receptors at OU 5 and it presents quantitative values for exposure parameters and equations for estimating central tendency (CT) and reasonable maximum exposures (RMEs) to be used in the HHRA. The scenarios identified in TM12 are discussed in detail in Section 6.3.

1.4.2.13 Technical Memorandum 13 - Model Description

Fate and transport modeling was required to support the HHRA and the evaluation of potential remedial alternatives for the Feasibility Study (FS) at OU 5. TM13 (DOE, 1994b) provided a description of the models selected to perform groundwater, surface-water, and air modeling for OU 5. A Conceptual Site Model (CSM) of chemical release and transport to potential human receptors was presented in TM13. This CSM identifies the rationale for the selection of mathematical models that were used to estimate exposure-point concentrations for the HHRA. The model selection process is summarized and the model results are detailed in Section 5.0.

1.4.2.14 Technical Memorandum 14 - Toxicity

The OU 5 Work Plan also specified that a TM be prepared that identifies the toxicological information that would be used in the risk assessment. During the course of performing the OU 5 HHRA, however, it was determined that all necessary toxicological information for the identified COCs was available in the regulatory databases. Therefore, DOE, EPA, and CDPHE agreed that this TM would not be required.

1.4.2.15 Technical Memorandum 15 - Amended Field Sampling Plan

Subsequent to completion of the field program specified in the OU 5 Work Plan, it was determined that additional data were required to fully describe the nature and extent of contamination associated with all of the OU 5 IHSSs and to provide the information necessary for the evaluation of potential remedial alternatives in the OU 5 FS. Rather than proceeding with a Phase II RFI/RI (as is the traditional approach outlined in the IAG), DOE, EPA, and CDPHE agreed to perform an additional stage of field investigations under the Phase I RFI/RI. Therefore, TM15 (DOE, 1994a) was prepared to present the results obtained during the implementation of the OU 5 Work Plan, to identify gaps in the data obtained during the Work Plan investigation, and to provide an amended Phase I FSP for obtaining the information necessary to fill those gaps.

1.5 REPORT ORGANIZATION

The following sections of this report describe the field investigations performed at OU 5 and the results of those investigations, provide a description of the nature and extent of contamination associated with each IHSS, and discuss the risk to human health and the environment posed by contamination at each IHSS.

- Section 2.0 describes the stages of field investigation at each IHSS and presents the results of these investigations. Those stages of the field investigation that were completed prior to the preparation of TM15 are only summarized in this report. Detailed discussions of these investigations are presented in TM15 (DOE, 1994a). The implementation of TM15 and the results of those activities are presented in detail for each IHSS in Section 2.0.

- Sections 3.0 and 4.0 present discussions of the physical characteristics and nature and extent of contamination, respectively, at each IHSS. These sections draw information from all stages of the Phase I RFI/RI, as well as information collected by other site programs to provide a description of the physical setting and nature and extent of contamination at each IHSS. This information is used to develop a conceptual understanding of the contamination associated with each IHSS and the potential for contaminant release and subsequent exposure to human receptors and/or the environment.

- Section 5.0 discusses the results of contaminant fate and transport modeling in groundwater, surface water, and air. This section provides a detailed discussion of the modeling process in each medium and the results of the modeling particularly where applicable to the Baseline Risk Assessment (BRA).

- Sections 6.0 and 7.0 provide discussions of the BRA. The HHRA is discussed in detail in Section 6.0, and the Environmental Risk Assessment (ERA) is discussed in Section 7.0.

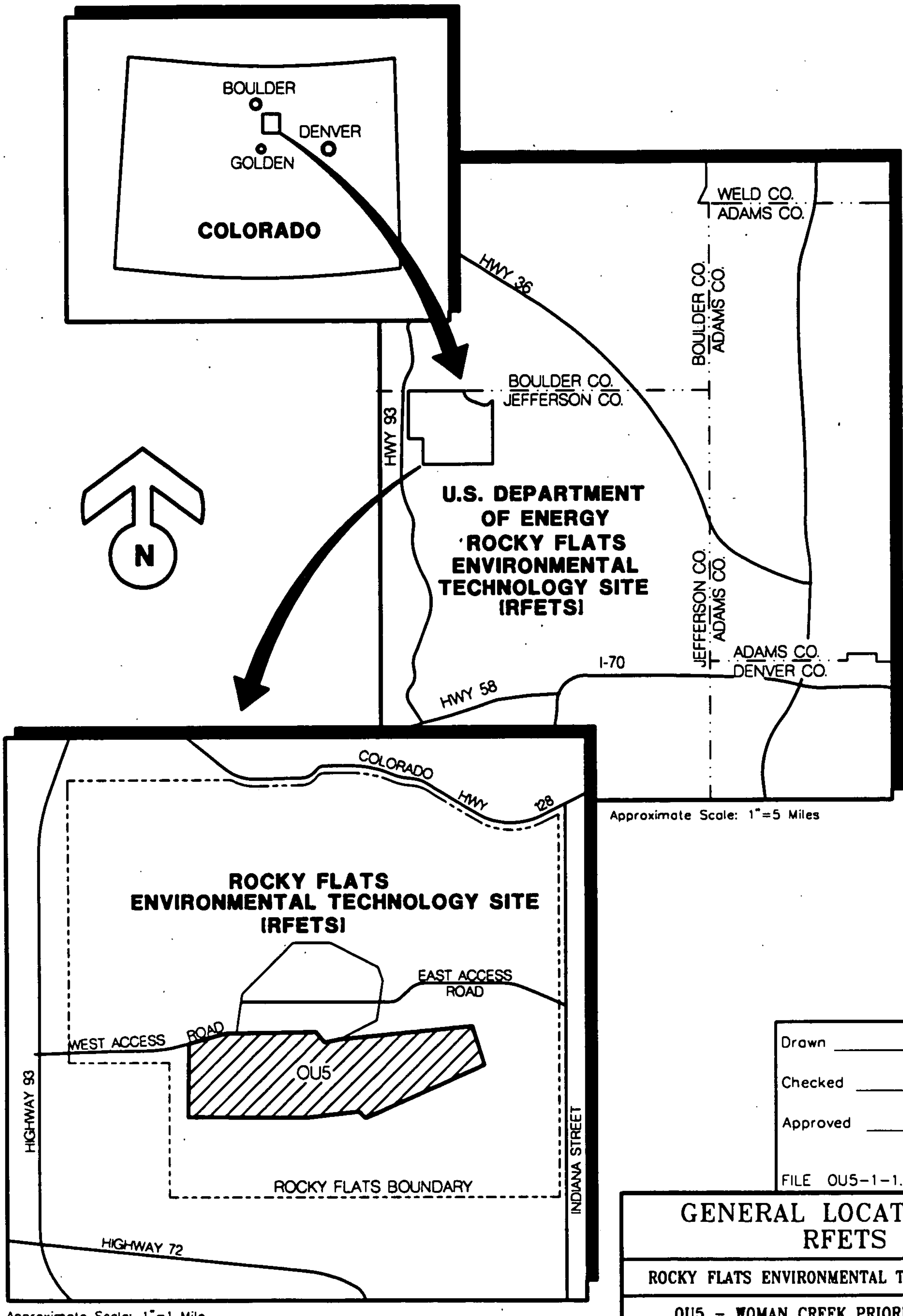
- A discussion of the process to be used for the evaluation of remedial alternatives is provided in Section 8.0. However, presentation of the evaluation of remedial alternatives will be completed under the CMS/FS process.

- Section 9.0 discusses the preliminary identification of data gaps, and Section 10.0 provides a summary and conclusions of the Phase I RFI/RI.

- Appendix A, the Hydrologic Data Summary Report, provides a detailed evaluation of surface-water, stream-sediment, pond-sediment, and groundwater data obtained from the sitewide and historical programs discussed in Section 1.2.3 and the data for these media obtained from the OU 5 Phase I RFI/RI. This appendix was issued under separate cover previously.

- The remaining Appendices, B through O, provide supporting data for the discussions provided in Sections 2.0 through 7.0.

Section 1.0
Figures



Drawn NM 8/1/95 Date
Checked 8/1/95 Date
Approved Date
FILE OU5-1-1.DWG

GENERAL LOCATION OF RFETS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 1-1

Tables 1-1A and 1-1B

14 pages

Table 1-1A
Matrix of OU 5 RFI/RI FSP Requirements from IAG, Work Plan, and Technical Memoranda

IHSS	ACTIVITY	IAG		WORK PLAN		MODIFIED BY TM		Comments
		TASK	Analytes (1)	TASK	Analytes (1)	TASK	Aanlytes (1)	
115 Original Landfill (OLF)	Rad Survey	FIDLER	N/A	HPGe-Fall 90	N/A	Data reviewed in TM 2 FIDLER SURVEY over hot spots	N/A	
	Magnetometer	Not addressed	N/A	2490 points	N/A	Data reviewed in TM 2	N/A	
	EM Survey	Not addressed	N/A	2490 points	N/A	Data reviewed in TM 2	N/A	
	Soil Gas (SG) Survey	Over OLF	Not addressed	Not Determined	28-33	TM 4 - 343 samples, 10% resampled for a maximum of 27	28-33	
	Surficial Soil	Not addressed	Not addressed	2 per Rad Anomaly in OLF	Random - 1-4, 8, 11, 12x, 21; Rad Anomalies - 1-4	TM 3 - Min: 11 locations @ Hot Spots; 3 Locations east of OLF; & 51 Locations over OLF	Hot Spots - 1-7, East of OLF -1-8, 8x, 11-16, 21; over OLF 1-4, 6-8, 11-17, 21	A total of 67 samples were collected along with 5 dups for a total of 72
	Soil Cores	1 per/50 SGS pts.	Not addressed	1/15 SG Sam.	not addressed	TM 5 Deleted program	N/A	
	Soil Borings	If (+) SG results, drill soil borings at locations which may have GW	1-4,8,9,11,14	3 per SG plume, 1 at each of 2 ponds, 6-Disturbed Area	2 FT Grab - 9, 6Ft 1-4, 11, 12x; SG Boring s - 9, 12x	In Monitoring Well File	N/A	TM 8 Canceled/Replaced by two letters which specify number and location of samples
	Monitoring Wells	If GW is found in Soil Borings	1-4,6,7, 8x, 10 11x	3 wells	1, 2, 2x, 3, 3x, 4, 4x, 6x, 7x, 8, 8x, 9, 11, 36, 38	In Monitoring Well File	Not addressed see Work Plan	TM 8 Canceled/Replaced
	Alluvial Wells	3 Wells	2, 2x, 3, 3x, 6x, 7, 8x, 10, 11x, 37	4 wells	1, 2, 2x, 3, 3x, 4, 4x, 6x, 7x, 8, 8x, 9, 11, 36, 38	6 wells	Not addressed - see Work Plan	
	Pipe Outfall	If water, then sample quarterly	2, 2x, 3, 3x, 6x, 7, 8x,10, 11x, 37	1 Sample from both pipes	1-4,1x-4x, 6x, 7x, 8, 8x, 9, 10, 12x, 36, 38	Not addressed	N/A	
	Cone Penetrometer Testing (CPT)	Not addressed	n/a	To be determined in TM 6	N/A	TM 6 - 22 CPT points; 15 well points, GW samples taken from well points	Ground Water - 1-7, 10 12, 18-27	BATÛ Sampling replaced by Well Points

(1) See Page 6 for key to codes

Table 1-1A
Matrix of OU 5 RFI/RI FSP Requirements from IAG, Work Plan, and Technical Memoranda

IHSS	ACTIVITY	IAG		WORK PLAN		MODIFIED BY TM		Comments
		TASK	Analytes (1)	TASK	Analytes (1)	TASK	Aanlytes (1)	
133.1- 133.6	Rad Survey	FIDLER	N/A	HPGe Survey	N/A	Reviewed in TM 2, FIDLER Survey over Hot Spots	N/A	Work Plan-100% HPGe
Ash Pits Incinerator and Concrete Wash Pad	Soil Borings	Does not specify	1,2	Estimated 85 Soil Borings	1-4,8	TM 7 - 46 Total, 28 Loc with exploratory boreholes	1-4,8	Coverage17 Exploratory Boreholes and 1 HPGe Anomaly completed
	Groundwater sampled from Soil Borings if water encountered	Not addressed	N/A		N/A	TM 7 - Maximum of 10 samples	1-4,8	Field Parameters: pH, s.c., D.O., Barometric Pressure
	Magnetometer	Not addressed	N/A	4864 points	N/A	Reviewed in TM 2	N/A	
	EM Survey	Not addressed	N/A	4864 points	N/A	Reviewed in TM 2	N/A	
	Surficial Soil	At hot spots	1,2	To be determined	Random - 1-4, 8, 21; Rad Anomalies - 1-4	TM 4 - 20 samples, 8 previously sampled for environmental evaluation	1-4, 8, 21	
	Alluvial GW Wells	3 Locations	2, 2x, 3, 3x, 6x, 7, 8x,10, 11x	3 Locations	1-4,1x-4x, 6x, 7x, 8, 9, 1	TM 9 - 4 Locations	Soil Samples - 1-4, 8; GW Samples - 1, 2, 8	Field Measurements - pH, S.C., Temp., D.O., Bar Pressure

(1) See Page 6 for key to codes

Table 1-1A
Matrix of OU 5 RFI/RI FSP Requirements from IAG, Work Plan, and Technical Memoranda

IHSS	ACTIVITY	IAG		WORK PLAN		MODIFIED BY TM		Comments
		TASK	Analytes (1)	TASK	Analytes (1)	TASK	Aanlytes (1)	
142.10,11, C-1 and C-2 Ponds	Pond Surface Water	5 Locations at each pond	1-7,1x-4x, 6, 6x, 7x, 8x,10, 11x, 38	5 Locations at each pond	1-4,1x-4x, 5, 6, 7x, 8, 8x, 9, 11, 38	TM 1 - C-1 Field Parameters, no field work in Pond C-2	Field Parameters: Temp, S.C., pH, D.O.	NPDES data used for characterization of both ponds
	Pond Sediment	5 Locations at each pond	1-7, 8x, 10, 11 38	5 Locations at each pond	1-5, 8, 9, 11, 12x, 38	TM 1 - 3 Locations in each pond	5-8, 9, 11, 37, 38	These analyses only apply to the top 6". Note: the maximum amount of sediment sampled was less than 6"
	GW Wells	4 Wells	1-4, 1x-4x, 5, 6, 6x, 7, 7x, 8x, 10, 11x, 38	Min. of 4	1-5,1x-4x, 6x, 7x, 8, 8x, 9,11, 37, 38	Not addressed	N/A	

(1) See Page 6 for key to codes

Table 1-1A
Matrix of OU 5 RFI/RI FSP Requirements from IAG, Work Plan, and Technical Memoranda

IHSS	ACTIVITY	IAG		WORK PLAN		MODIFIED BY TM		Comments
		TASK	Analytes (1)	TASK	Analytes (1)	TASK	Aanlytes (1)	
209 Surface Disturbances	Rad Survey	Not addressed	N/A	FIDLER Survey	N/A	Not addressed	N/A	
	Sediment Sample in former ponds	Not Addressed	N/A	1 Location in each pond	1-4, 8, 9, 11, 12x	Not addressed	N/A	
	SW if present in former ponds	Not addressed	N/A	1 Location in each pond	1-4, 8, 9, 11	Not addressed	N/A	
	Surface Soil	Not addressed	N/A	19 Locations	1-4, 8, 9, 11, 21	TM 10 - 19 Locations	2-4, 8, 11, 12x, 13-15,17,21	
	Boreholes	Not addressed	N/A	19 Boreholes	2 ft Intervals - 9; 6 ft intervals - 1-4, 8, 9, 11, 21	TM 10 - 4 Boreholes	2 ft Intervals - 9; 6 ft intervals - 1-4, 8, 9, 1	
	Soil in Small Depressions	Not addressed	N/A	Not determined	1-4, 8, 9, 11, 12x, 21	TM 10	N/A	Include with Surface Soil Sampling in TM 10

(1) See Page 6 for key to codes

Table 1-1A
Matrix of OU 5 RFI/RI FSP Requirements from IAG, Work Plan, and Technical Memoranda

IHSS	ACTIVITY	IAG		WORK PLAN		MODIFIED BY TM		Comments
		TASK	Analytes (1)	TASK	Analytes (1)	TASK	Aanlytes (1)	
Stream Sampling Program								
115	Stream SW	Not Determined	2, 2x, 3, 3x, 6x, 7, 8x,10,11x, 37	6 Locations	1-4,1x-4x, 6x, 7x, 8, 8x, 9, 11, 12x, 36	see TM 1 below	N/A	TM 1 specifies 4 synoptic
	Stream Sed	Not Determined	2, 3, 8x, 6, 7,10,11x, 37	4 Locations	1-4,8,9,11,12x	see TM 1 below	N/A	
133	Seds Down stream of Ash Pits	Not Addressed	N/A		1-5, 8, 21, 38	see TM 1 below	N/A	
142		28 Locations	1-7, 8x,10, 11x, 38	12 Locations, and 18 from Site Wide	1-5, 8, 21, 38	see TM 1 below	N/A	
TM 1 for all OU5	Stream Surface Water	N/A	N/A	N/A	N/A	14 Locations per TM 1, 9 for storm events	1-4, 2x-4x, 6x, 7x, 8, 8x, 9, 11,12x, 36, 39	
							9,11,12x	These analytes for base flow events only
							39 (Microtoxicity)	SW040, SW041, SW50193, SW50293, SW033, SW034, SW026, SW027
	Stream Sediments	N/A	N/A	N/A	N/A	9 Locations per TM1	1-4, 8, 21, 38	All Locations
							5	SW027, SW024 Only
							39	Only Analyte collected at SED501, 505 &506

(1) See Page 6 for key to codes

Table 1-1A
Matrix of OU 5 RFI/RI FSP Requirements from IAG, Work Plan, and Technical Memoranda

ANALYTE	Code	ANALYTE	Code
Gross A/B	1	COD	22
Filtered A/B	1x	Orthophosphate	23
U 233/234/235/238	2	NO_3/No_2 as N	24
Dissolved U 233/234/235/238	2x	Ra 226/228	25
Plutonium 239/240	3	TDS, Cl, SO_4, CO_3, HCO_3	26
Dissolved Plutonium 239/240	3x	Cyanide	27
Americium 241	4	1,1,1 Trichloroethane (TCA)	28
Dissolved Americium 241	4x	Dichloromethane	29
Tritium	5	Benzene	30
Cesium 137	6	Carbon Tetrachloride (CCl_4)	31
Dissolved Cesium 137	6x	Tetrachloroethene (PCE)	32
Strontium	7	Trichloroethene (TCE)	33
Dissolved Strontium	7x	Dissolved Anions, TDS	36
TAL Metals	8	Chromium	37
Dissolved TAL Metals	8x	Nitrate	38
HSL Metals	8y	Micro/Acute Toxicity	39
Dissolved HSL Metals	8z		
TCL Volatiles	9		
HSL Volatiles	10		
TCL Semivolatiles	11		
HSL Semivolatiles	11x		
TCL Pesticides - PCB's	12		
TCL Pesticides	12x		
Bulk Density	13		
Particle Size Analysis	14		
Specific Conductance	15		
Carbonate	16		
pH	17		
CLP Metals w/ Cs, Li, Sn, Mo, Si	18		
BNA	19		
TSS	20		
TOC	21		

Table 1-1B
Matrix of OU 5 FSP Requirements from TM15

ORIGINAL SCOPE OF TM15 WORK PLAN AUGUST 1994	94-DMR(1)-ERM-0139, 11/10/94, DEEP BEDROCK WELL LOCATIONS, REVISED GEOTECHNICAL PROGRAM AND IHSS133 DRILLING	94-DMR(1) -ERM-0144, 12/16/94, TEMPORARY FILL ROAD	94-DMR(1)-ERM-0146, 12/21/94, TRIP BLANK QA/QC REQUIREMENTS	94-DMR(1)-ERM-0148,12/20/94, CONVERT GEOTECH BORINGS TO DEEP MONITORING WELL	95-DMR(1)-ERM-0015, 2/7/95, MODIFY GEOTECH LOCATIONS CONVERT GEOTECH BORINGS TO DEEP WELL/IHSS 209 SOIL SAMPLING
GEOTECHNICAL PROGRAM, IHSS 115					
5 HSA BOREHOLES (one with a piezometer installed); 8 Kansas Sampler Boreholes (one with a piezometer installed); two piezometers to be checked for water levels monthly.	19 HSA BOREHOLES (up to 9 piezometers/monitoring wells installed). Addressed changes to the geotechnical sample parameters to be collected.	Addressed access to boring locations by constructing a temporary fill road into IHSS 115.	Addressed trip blank QC requirement of one VOC trip blank per groundwater VOC collection per day.	Addressed EPA concerns regarding UHSU and LHSU interaction in the area of the former ponds (IHSS 196). Location also selected to evaluate possible inferred fault zone.	Address FS team proposed changes to remaining geotech boring locations. Convert locations at western end of temporary fill road to a fifth deep bedrock monitoring well on the basis of the results of the LHSU well 71194.
Install 3 deep bedrock monitoring wells at locations to be specified in a future letter.	Piezometers/monitoring wells to have water levels checked monthly and sampled quarterly for one year for TCL VOCs, SVOC, Pesticides and PCBs, TAL metals and radionuclides			Converted the geotechnical boring to be located in the area of the former ponds into a deep bedrock monitoring well and revised the workplan to allow construction of a shallow UHSU well adjacent to the LHSU well.	Location selected to evaluate possible inferred fault zone. Attempt to collect Shelby tube sample of slide plane at 4 ft in shallow UHSU well offset.
				The UHSU well to be constructed within a second geotechnical boring drilled in the area due to the historical landslide present and the need for additional geotechnical data.	

Table 1-1B
Matrix of OU 5 FSP Requirements from TM15

ORIGINAL SCOPE OF TM15 WORK PLAN AUGUST 1994	95-DMR(1)-ERM-0022, 2/10/95, ADD ONE SHALLOW LHSU WELL IN IHSS 115	95-DMR(1)-ERM-0151, 4/5/95, DELETE PESTICIDES AND PCBs FROM GROUNDWATER ANALYTE LIST	TM15 WORK COMPLETED
GEOTECHNICAL PROGRAM, IHSS 115			
5 HSA BOREHOLES (one with a piezometer installed); 8 Kansas Sampler Boreholes (one with a piezometer installed); two piezometers to be checked for water levels monthly.	Address upper water bearing interval observed in geotech/fifth deep well at west end of temp. road; also try and collect shelby tube sample of slide plane at 4', previous attempt did not succeed.		Completed 20 geotechnical borings, 8 converted to monitoring wells and three for surface casings for three deep bedrock monitoring wells in IHSS 115. Completed the location adjacent to IHSS 196 as one UHSU well (59794) and one LHSU well (71194).
Install 3 deep bedrock monitoring wells at locations to be specified in a future letter.			Location at west end of temporary fill road completed with one UHSU well (58394) and two LHSU wells (57194 deep LHSU and 71494 shallow LHSU).

Table 1-1B
Matrix of OU 5 FSP Requirements from TM15

ORIGINAL SCOPE OF TM15 WORK PLAN AUGUST 1994	94-DMR(1)-ERM-0139, 11/10/94, DEEP BEDROCK WELL LOCATIONS, REVISED GEOTECHNICAL PROGRAM AND IHSS133 DRILLING	94-DMR(1) -ERM-0144, 12/16/94, TEMPORARY FILL ROAD	94-DMR(1)-ERM-0146, 12/21/94, TRIP BLANK QA/QC REQUIREMENTS	94-DMR(1)-ERM-0148,12/20/94, CONVERT GEOTECH BORINGS TO DEEP MONITORING WELL	95-DMR(1)-ERM-0015, 2/7/95, MODIFY GEOTECH LOCATIONS CONVERT GEOTECH BORINGS TO DEEP WELL/IHSS 209 SOIL SAMPLING
<u>GROUNDWATER INVESTIGATION, IHSS 115</u>					
Install and sample 5 miniwells. Sample quarterly for TCL VOC's, SVOCs, Pesticides and PCBs, TAL metals and radionuclides.	Three borehole/deep bedrock monitoring well locations are addressed. Deep wells are to have water levels monitored and water quality samples collected quarterly for one year for TCL VOCs, SVOCs, Pesticides and PCB's, TAL metals and radionuclides.				Deleted tritium, TOC and COD from groundwater analyte list.
Measure 46 water levels monthly. Sample existing well points/miniwells quarterly for TCL VOCs, SVOCs, Pesticides and PCBs, TAL metals and radionuclides. Installed three piezometers to characterize bedrock surface. Perform one aquifer test.	Locations selected as closure/ compliance monitoring points and to collect subsurface data for the evaluation of a possible inferred fault in IHSS 115.				

Table 1-1B
Matrix of OU 5 FSP Requirements from TM15

ORIGINAL SCOPE OF TM15 WORK PLAN AUGUST 1994	95-DMR(1)-ERM-0022, 2/10/95, ADD ONE SHALLOW LHSU WELL IN IHSS 115	95-DMR(1)-ERM-0151, 4/5/95, DELETE PESTICIDES AND PCBs FROM GROUNDWATER ANALYTE LIST	TM15 WORK COMPLETED
GROUNDWATER INVESTIGATION, IHSS 115 Install and sample 5 miniwells. Sample quarterly for TCL VOC's, SVOCs, Pesticides and PCBs, TAL metals and radionuclides. Measure 46 water levels monthly. Sample existing well points/miniwells quarterly for TCL VOCs, SVOCs, Pesticides and PCBs, TAL metals and radionuclides. Installed three piezometers to characterize bedrock surface. Perform one aquifer test.		Delete Pesticides and PCBs from Groundwater Analyte List to conform to OU5 Work Plan.	Completed 3 LHSU bedrock monitoring wells; converted three geotechnical borings to three LHSU wells; installed 8 miniwells. Completed first and second quarter groundwater sampling. Collected Nov through June water levels.

Table 1-1B
Matrix of OU 5 FSP Requirements from TM15

ORIGINAL SCOPE OF TM15 WORK PLAN AUGUST 1994	94-DMR(1)-ERM-0139, 11/10/94, DEEP BEDROCK WELL LOCATIONS, REVISED GEOTECHNICAL PROGRAM AND IHSS133 DRILLING	94-DMR(1) -ERM-0144, 12/16/94, TEMPORARY FILL ROAD	94-DMR(1)-ERM-0146, 12/21/94, TRIP BLANK QA/QC REQUIREMENTS	94-DMR(1)-ERM-0148,12/20/94, CONVERT GEOTECH BORINGS TO DEEP MONITORING WELL	95-DMR(1)-ERM-0015, 2/7/95, MODIFY GEOTECH LOCATIONS CONVERT GEOTECH BORINGS TO DEEP WELL/IHSS 209 SOIL SAMPLING
ASH PITS, IHSS 133 Additional work to characterize TDEM anomalies to be proposed in a future letter based on visual survey. Seven Kansas Sampler soil borings, collection of one groundwater sample from borehole (location to be determined)	Addressed collection of soil sample for solidification treatability study.				Addresses one additional boring in TDEM anomaly, west side of IHSS 133.
GROUNDWATER INVESTIGATION, IHSS 133 Install 9 miniwells. Measure monthly water levels. Sample piezometers quarterly for TAL metals, SVOC, Pesticides and PCB's and radionuclides. Perform one aquifer test.					

Table 1-1B
Matrix of OU 5 FSP Requirements from TM15

ORIGINAL SCOPE OF TM15 WORK PLAN AUGUST 1994	95-DMR(1)-ERM-0022, 2/10/95, ADD ONE SHALLOW LHSU WELL IN IHSS 115	95-DMR(1)-ERM-0151, 4/5/95, DELETE PESTICIDES AND PCBs FROM GROUNDWATER ANALYTE LIST	TM15 WORK COMPLETED
<u>ASH PITS, IHSS 133</u> Additional work to characterize TDEM anomalies to be proposed in a future letter based on visual survey. Seven Kansas Sampler soil borings, collection of one groundwater sample from borehole (location to be determined)			Completed original 7 plus 3 Kansas Sampler borings; two borings mislocated, one converted to miniwell. Two borings were drilled to replace mislocated borings. Collected 25 real, 6 rinse and 1 dup sample.
<u>GROUNDWATER INVESTIGATION, IHSS 133</u> Install 9 miniwells. Measure monthly water levels. Sample piezometers quarterly for TAL metals, SVOC, Pesticides and PCB's and radionuclides. Perform one aquifer test.			Installed 9 miniwells, completed 1st and 2nd quarter groundwater sampling, collected Nov through June water levels; collected 11 moisture content samples. Collected rinse from 55594 for analysis. Did not collect a sample from 57894.

Table 1-1B
Matrix of OU 5 FSP Requirements from TM15

ORIGINAL SCOPE OF TM15 WORK PLAN AUGUST 1994	94-DMR(1)-ERM-0139, 11/10/94, DEEP BEDROCK WELL LOCATIONS, REVISED GEOTECHNICAL PROGRAM AND IHSS133 DRILLING	94-DMR(1) -ERM-0144, 12/16/94, TEMPORARY FILL ROAD	94-DMR(1)-ERM-0146, 12/21/94, TRIP BLANK QA/QC REQUIREMENTS	94-DMR(1)-ERM-0148,12/20/94, CONVERT GEOTECH BORINGS TO DEEP MONITORING WELL	95-DMR(1)-ERM-0015, 2/7/95, MODIFY GEOTECH LOCATIONS CONVERT GEOTECH BORINGS TO DEEP WELL/IHSS 209 SOIL SAMPLING
HPGe SURVEY, IHSS 209 AND OTHER SURFACE DIST. Perfrom HPGe survey; perform FIDLER Survey; collect surface soil samples on basis of FIDLER Survey results.					Provided results of HPGe and FIDLER Surveys. Proposed 8 surface soil sample locations.

(1) DMR= Document Modification Request

Table 1-1B
Matrix of OU 5 FSP Requirements from TM15

ORIGINAL SCOPE OF TM15 WORK PLAN AUGUST 1994	95-DMR(1)-ERM-0022, 2/10/95, ADD ONE SHALLOW LHSU WELL IN IHSS 115	95-DMR(1)-ERM-0151, 4/5/95, DELETE PESTICIDES AND PCBs FROM GROUNDWATER ANALYTE LIST	TM15 WORK COMPLETED
HPGe SURVEY, IHSS 209 AND OTHER SURFACE DIST. Perfrom HPGe survey; perform FIDLER Survey; collect surface soil samples on basis of FIDLER Survey results.			Completed HPGe Survey of 24 points; completed FIDLER survey of 24 points. Collected 8 surface soil samples and 2 QC samples to verify HPGe and FIDLER survey results.

2.0 OU 5 FIELD OPERATIONS AND INVESTIGATIONS

This section discusses the methods and results of the field investigations performed under the Phase I RFI/RI of OU 5. As discussed in Section 1.0, the performance and results of the field investigations outlined in the OU 5 Work Plan (DOE, 1992a) are described in detail in TM15 (DOE, 1994a). The FSP was implemented in stages; Historical Review; Screening Level Surveys, Intrusive Sampling; and Well Installation and Groundwater Sampling. These investigations are summarized briefly in this section.

2.1 FIELD INVESTIGATION PROCEDURES

All field investigations conducted during the OU 5 Phase I RFI/RI were performed in accordance with the applicable RFETS Standard Operating Procedures (SOPs), and are contained in the following volumes of the Environmental Management Division Operating Procedures Manual (5-21000-OPS):

- Volume I: Field Operations (5-21000-OPS-FO) (EG&G, 1992a)
- Volume II: Groundwater (5-21000-OPS-GW) (EG&G, 1992b)
- Volume III: Geotechnical (5-21000-OPS-GT) (EG&G, 1992c)
- Volume IV: Surface Water (5-21000-OPS-SW) (EG&G, 1992d)

During the course of this project, several Document Modification Requests (DMRs, formerly known as Document Change Notices [DCNs]) were prepared to modify the existing procedures for specific application to the OU 5 sites.

2.2 PHASE I RFI/RI FIELD INVESTIGATION

This section provides a summary of the work conducted during implementation of the FSP defined by the OU 5 Work Plan (DOE, 1992a) and as amended by several TMs during various stages of the field investigation. Work conducted prior to January 1994 is discussed in detail in TM15 (DOE, 1994a); a summary of that work and results of additional work proposed and outlined in TM15 are discussed in this section.

The objectives of the Phase I RFI/RI were to:

- Characterize the physical and hydrogeological setting of the IHSSs
- Assess the presence or absence of contamination at the IHSSs
- Characterize the nature and extent of contamination at the IHSSs, if present
- Determine contamination migration rate and transport characteristics
- Support the Phase I Human and Environmental Risk Assessment, and
- Provide a basis for the Feasibility Study, if required

Preliminary evaluation of data collected during Phase I consisted of comparisons with background upper tolerance limits (UTLs) presented in the BGCR (DOE, 1993a). These UTLs were calculated with outliers being excluded, as provided in the Background Geochemical Characterization Report Appendix E (DOE, 1993a). Comparisons with those UTLs were performed and documented in TM15. Since these initial comparisons, the project has continued with the data cleanup process and evaluation processes progressing. As a result of the preliminary evaluations, background UTLs have been recalculated including outliers for both lognormal and normal distributions. This was done so that site data and background data were treated similarly for the risk assessment. Calculated values of background UTLs have changed since TM15 was finalized, which has resulted in comparisons of site data to two sets of background UTLs through time. Because of this, this section is primarily a summary of the work completed, and the analytical results of that work are discussed in general terms. Where background UTLs are referenced in this section, the values presented in Appendix C of the BGCR values are used. (Analytical data are discussed in additional detail in Section 4.0, Nature and Extent of Contamination.)

The discussions of analytical data provided in the following sections are summarized in Tables 2-1 through 2-9, which includes data collected during all stages of this investigation. The data presented in these tables were organized so that the data generated by the investigation specified by the OU 5 Work Plan (DOE, 1992a) were provided for comparison to data generated by the investigation outlined in TM15 (DOE, 1994a). Appendix E provides the Rocky Flats Environmental Database System (RFEDS) data for TM15. As noted previously, the value substituted for nondetects in those data sets with relatively great (greater than 50%) nondetect rates will strongly affect the calculated value of the apparent mean. Both the data analyst and the reader should keep in mind the uncertainty of statistical parameters calculated for any data set containing a high proportion of nondetect data. In the case of TM15, those constituents (metals, in particular), detected at relatively low to very low frequencies (less than 50% to less than 20% detects) tend to have mean concentrations that are artificially greater than those reported for pre-TM15 data. This apparent increase in mean values is the result of greater values substituted for nondetects. In these cases, the range of detected concentrations (reported in Tables 2-1 to 2-8) gives a better indication of the comparability of metal concentrations in TM15 and pre-TM15 samples. In these cases, the range of detected concentrations reported on Tables 2-1 through 2-8 gave a better indication of whether the samples collected under TM15 contain similar concentrations to the pre-TM15 samples.

The data generated by the OU 5 Work Plan field investigation (amended by TMs 1-10), and the data collected prior to 1994, were used for the HHRA (Section6.0). TM15 data (which also amended the Work Plan) was collected after August 1994. Therefore, a comparison of the data generated under the TM15 investigation, to the HHRA data was necessary to evaluate any potential impacts to the HHRA conclusions that would result from the collection of the additional data. A discussion of the potential impacts is provided in Section 6.6.3.1.

The following discussions refer to the stages of the Field Investigation prior to 1994, followed by the investigation outlined in TM15.

2.2.1 IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Pond)

Volume II of TM15 (DOE, 1994a) provides detailed discussions of the methodology for, and results of, the Phase I investigation conducted at IHSSs 115 and 196 (IHSS 115/196) prior to implementation of work outlined in Volume I of TM15. A summary of the information related to IHSS 115/196 and presented in Volume II of TM15 is also presented in this section, along with a discussion of the results of implementation of the activities proposed in TM15. Figure 1-2 shows the relation of these IHSSs to RFETS; Figure 2-1 is a larger scale map of the IHSS 115/196 area showing locations sampled prior to the implementation of TM15.

2.2.1.1 Stage 1

Stage 1 activities conducted for IHSS 115/196 included reviewing vertical aerial photographs from the Aerial Photographic Analysis Comparison Report (EPA, 1988a), and a series of oblique aerial photographs obtained from the RFETS archives taken during the operation of the Original Landfill. This review resulted in some modifications to the dimensions and boundaries of IHSS 115/196 shown in the OU 5 Work Plan. These modifications are discussed in detail in TM15 (DOE, 1994a), and the current boundaries are shown on Figure 2-1.

Stage 1 also involved review of the results of a gamma-radiation survey conducted from October 25, 1990 through December 8, 1990. The survey was conducted using a 20 percent N-type, high-purity germanium (HPGe) detector (DOE, 1992a). These activities are discussed in detail in Section 2.4.1 of Volume II of TM15 (DOE, 1994a). This investigation found that radiation in the soil was contributed from potassium, uranium, and thorium. Review of these data indicated that activities from these radioisotopes were consistent with natural background activities. However, there were areas that exhibited elevated uranium-238 activity (hot spots). These hot spots were surveyed and marked with stakes for subsequent sampling activities (Section 2.2.1.3) and radiological surveys (Section 2.2.1.2).

2.2.1.2 Stage 2

Stage 2 activities at IHSS 115/196 consisted of geophysical and soil-gas surveys, as specified in the OU 5 Work Plan. In addition, a radiological survey with a Field Instrument for the Detection of Low Energy Radiation (FIDLER) was conducted to supplement the 1990 HPGe survey discussed in the previous section. Section 2.4.2 of Volume II of TM15 (DOE, 1994a) discusses the Stage 2 activities in detail, and they are summarized in this section.

<u>Geophysical Surveys</u> - Frequency-domain EM and magnetometer geophysical surveys were conducted in IHSS 115/196 from October through December 1992. Results of these surveys

confirmed the known location of the Original Landfill and did not identify additional areas requiring investigation. Useful data could not be acquired beneath the power lines near the southern boundary of the Original Landfill because of the EM interference produced by the lines.

Soil-Gas Survey - A real-time, soil-gas survey was performed at IHSS 115/196 as proposed by the OU 5 Work Plan. The survey involved the collection and analysis of more than 300 soil-gas samples. Anomalous readings encountered during the survey were further investigated by additional soil-gas sampling. Plumes of volatile organic compounds (VOCs) identified by the soil-gas survey were further assessed by the subsequent drilling of boreholes within the plumes and installation of groundwater monitoring wells downgradient of the plumes, as discussed in Section 2.2.1.3. Results of the soil-gas survey are discussed in detail in Section 2.4.2.2 of Volume II of TM15 (DOE, 1994a). Briefly, the survey resulted in the identification of three areas of anomalous concentrations of 1,1,1-TCA, TCE, and PCE as shown on Figure 2-2.

In July 1993 (subsequent to completion of the soil-gas survey), a small-scale intrinsic air permeability study was conducted in, and adjacent to, IHSS 115/196. Evaluation of results of the intrinsic air permeability study are presented in Section 2.2.1.7.

FIDLER Surveys - Several areas of IHSS 115/196 were surveyed with a FIDLER during March to June 1993. The purpose of this survey was to further characterize anomalies identified by the 1990 HPGe survey discussed in Section 2.2.1.1. Section 2.4.2.3 of Volume II of TM15 (DOE, 1994a) details the performance and results of this survey.

The FIDLER surveys identified nine areas of anomalous radioactivity. Each of these areas has been posted as a radiologically controlled area (RCA). In areas where a piece of landfilled material was not identified as the source of the detected radiation, surface-soil samples were collected to characterize the contamination present. Several pieces of radioactive material were removed from these areas on May 28, 1993 during an emergency removal action and were placed in an area designated for the storage of radioactive material. Measurements performed by EG&G Radiological Engineering indicated that the principal isotope present in these materials was uranium-238, although no quantification of the activity present was provided.

2.2.1.3 Stage 3

Stage 3 activities at IHSS 115/196 consisted of the collection and analysis of surface-soil samples, drilling and sampling characterization boreholes, and further investigation of the soil-gas anomalies. The results of Stage 3 activities are discussed in detail in Section 2.4.3 of Volume II of TM15 (DOE, 1994a) and are summarized in this section.

Surface-Soil Sampling - Details of surface-soil sampling at IHSS 115/196 are presented in Section 2.4.3.1 of Volume II of TM15 (DOE, 1994a). Surface-soil samples were collected at 66 locations in IHSS 115/196, as shown in Figure 2-3. Analyses of surface-soil samples identified samples with elevated concentrations of a limited number of metals, and several radionuclides were identified with activities that exceeded background activities. Pesticides, polychlorinated biphenyls (PCBs), and a wide variety of semivolatile organic compounds (SVOCs) were also detected in several surface-soil samples. Locations where the concentrations of both inorganic and organic compounds exceed background levels are centered around the abandoned storm-sewer outfall near the center of the Original Landfill. This may be due to the disturbance of the surface soil during installation of the outfall pipe.

Characterization Boreholes - Eight boreholes were installed in IHSS 115/196 for subsurface characterization. The results of this work are discussed in detail in Section 2.4.3.2 of Volume II of TM15 (DOE, 1994a). Briefly, metals analyses resulted in the detection of a limited number of metals at concentrations exceeding background UTLs. Radiological analyses identified several samples from the upper 6 feet with activities greater than background. Also a variety of SVOCs, VOCs, pesticides, and PCBs were detected in samples from these boreholes.

Investigation of Soil-Gas Anomalies - Four boreholes were installed within the soil-gas anomalies located adjacent to the former ponds (IHSS 196) and two 0.5-inch diameter wells (small diameter wells, 60993 and 61093) were installed within the anomaly near the center of the Original Landfill. Details of installation, sampling, and results of these activities are discussed in Section 2.4.3.3 of Volume II of TM15 (DOE, 1994a).

Results of the analyses of the soil and groundwater samples collected from the boreholes and small-diameter wells drilled within each soil-gas anomaly confirmed the results of the soil-gas survey. In addition, several metals and radionuclides were detected at concentrations exceeding background UTLs. Some pesticides, PCBs, and SVOCs were detected at these soil-gas anomaly locations.

Surface-Water and Sediment Sampling - Results of surface-water sampling are discussed in Section 2.2.3.3 because these sampling locations are all part of a single system.

2.2.1.4 Stage 4

Stage 4 activities conducted at IHSS 115/196 consisted of a CPT program and the investigation of groundwater quality through the use of wellpoints and monitoring wells. Implementation and results of these activities are discussed in detail in Section 2.4.4 of Volume II of TM15 (DOE, 1994a) and are summarized in this section.

Cone-Penetrometer Testing - Specifics of the proposed CPT program are provided in TM6 (DOE, 1993f). TM6 was prepared based upon evaluation of work conducted during Stages 1, 2, and 3. Section 2.4.4.1 of Volume II of TM15 (DOE, 1994a) discusses the CPT program and its results in detail. Five significant topographic lows in the bedrock surface (or migration pathways) were identified by the CPT program. Water was found to be present in three of the topographic lows in the bedrock surface; the other two topographic lows in the bedrock were dry. Water was also found at two areas identified as topographic highs in the bedrock surface. Information provided by CPT was used to subsequently locate wellpoints and monitoring wells.

Wellpoints - Ten wellpoints were installed along the downgradient perimeter of IHSS 115/196 and are discussed in Section 2.4.4.2 of Volume II of TM15 (DOE, 1994a). Elevated concentrations of a few metals, common anions, radionuclides, and water-quality parameters were detected in unfiltered groundwater samples from within the footprint of the Original Landfill. VOCs including acetone, 1,1-dicholoroethene (1,1-DCE), 1,2-dichloroethene (1,2-DCE), 1,1,1-TCA, TCE, and PCE were also detected in these samples.

Groundwater Investigation - Detailed descriptions of five monitoring wells (59393, 59493, 59593, 59793, and 61293) and two boreholes (59193 and 59293) installed as part of the groundwater investigation of IHSS 115/196 are provided in Section 2.4.4.3 of Volume II of TM15 (DOE, 1994a).

The two boreholes were drilled at locations originally intended for monitoring wells, but groundwater was not encountered during drilling, and the boreholes were abandoned.

Several metals were detected in subsurface-soil samples collected from these wells and boreholes at concentrations exceeding background UTLs. Plutonium-239/240 was also detected at activities exceeding the background UTL. Aroclor-1254 (a PCB) was detected in a subsurface-soil sample from well 59493, which was installed within IHSS 196. A variety of SVOCs and VOCs were also detected in several subsurface-soil samples from these wells and boreholes.

Groundwater samples collected from these five wells have contained a number of metals at concentrations exceeding background UTLs. A few radionuclides were also detected at activities exceeding background UTLs. No pesticides or PCB constituents were detected in the groundwater samples collected in the IHSS 115/196 monitoring wells. A variety of SVOCs have been detected in groundwater samples, primarily those from well 59493, which was installed within IHSS 196. Also, the VOC methylene chloride, a common laboratory contaminant, was detected in one sample from well 59493.

Two of the five wells installed at IHSS 115/196 were selected for hydraulic parameter testing. A multiple-well pumping test was performed at IHSS 196 in well 59493, and a single-well slug test was performed in one well (59593) downgradient of IHSS 115. The multiple well test appears to have been successful. The slug test data, however, indicates that this location may not be representative of the formation characteristics, but may instead represent the hydraulic conductivity of the filter pack (see Section 2.4.4.3 of Volume II of TM15 (DOE, 1994a). The slug test was repeated during the implementation of TM15 (DOE, 1994a). Six of the wells installed in IHSS 115/196 during the implementation of TM15 were tested as part of the 1995 Aquifer Testing Program (EG&G, 1995i). The results are discussed in Sections 2.2.1.7 and 3.8.1.

2.2.1.5 Stage 5 - Investigation of Storm-Sewer Pipelines

Stage 5 activities at IHSS 115/196 involved investigation of the storm-sewer pipelines that protrude from the Original Landfill area. These activities are discussed in detail in Section 2.4.5 of Volume II of TM15 (DOE, 1994a) and are summarized below.

Activities performed to investigate the storm-sewer pipelines included collecting a one-time sample of the water discharging from the active pipeline and performing a video-camera survey of the storm-sewer system to determine and/or verify the connections and source of the constant discharge from the system. Analytical results of the single sample obtained during dry weather from the storm-sewer outfall did not indicate elevated concentrations for radionuclides, metals, or organic constituents.

The video-camera survey of the pipeline indicated that, for the most part, the storm-sewer system had only small rocks and sediment along its invert. There were some slight groundwater inflows at joints and manholes, and an occasional 6-inch polyvinyl chloride (PVC) roof drain connection entering through the top portion of the pipe. A continuous dry-weather discharge was seen entering the system through a 12-inch corrugated metal pipe (CMP) at a manhole from the Building 447 foundation underdrain system (Jacobs, 1994). Another manhole had an intermittent high-velocity inflow that entered the manhole through a 6-inch PVC pipe located at the southeast corner of the manhole. This inflow appeared to be pumped into the manhole from a sump pump. Based on the location of the pipe, the flow was assumed to be coming from Building 440 or the evaporative-cooling tower located along the west side of Building 440.

2.2.1.6 Ambient-Air Monitoring

Data from the monitoring network known as the Radioactive Ambient Air Monitoring Program (RAAMP) and from three samplers installed specifically to monitor ambient-radionuclide levels around OU 5 were analyzed to evaluate whether airborne releases are significant from IHSS 115/196. Information collected by health and safety (H&S) personnel during the implementation of field investigations was also reviewed. Section 2.5.5 of Volume II of TM15 (DOE, 1994a) presents detailed discussions of this analysis. Briefly, the analysis concluded that the presence of multiple sources throughout the facility and the placement of the RAAMP samplers limits the specific applicability of RAAMP data to OU 5.

Examination of the special OU 5 sampler data indicated that the uranium-233/234 and uranium-235 results were within the same order of magnitude for both the sampler downwind of IHSS 115/196 and the sampler upwind of OU 5. The americium-241, plutonium-239/240, and uranium-238 average activities for the downwind sampler were one order of magnitude greater than the average activities of the upwind sampler.

Results of the H&S monitoring that was done during the field investigations of IHSS 115/196 provided a qualitative indication of potential air-pathway risks attributable to this source. Elevated organic vapor readings were observed during investigations at only two borehole locations during drilling operations. During field investigation of HPGe anomalies B-7 and B-8, near the center of the Original Landfill, beta-gamma monitoring registered 60,000 counts per minute (cpm) on one occasion and 10,000-80,000 cpm on another.

2.2.1.7 Implementation of TM15

Implementation of field work outlined in TM15 (DOE, 1994a) for IHSS 115/196 began in September 1994. In summary, the work consisted of:

- Evaluation of Intrinsic Air Permeability Tests
- Geotechnical Evaluation
- Groundwater Investigation
- Air Programs and Wind Resuspension Investigation

Specific work elements and results of implementing the work are summarized in the following sections. The results of these investigations are presented in additional detail, where applicable, in Sections 3.0 and 4.0 of this report.

<u>Evaluation of Intrinsic Air Permeability Tests</u> - A small-scale, intrinsic, air-permeability study resulted in calculated permeabilities that were orders of magnitude greater than expected for clayey soils. Intrinsic air permeability was estimated by the method presented in *A Practical Approach to the Design, Operation, and Monitoring of In Situ Soil Venting Systems* (Johnson et al., 1990). Two possible explanations for this discrepancy were that the soils at the test sites were not clayey or that short circuiting of the vapor flow path occurred during the test (e.g., gas flows from surface down along probe and into sampler). Because the test was conducted in the same manner as the soil-gas survey, it is possible that short-circuiting occurred during the survey, and that the observed soil-gas concentrations are lower than those actually occurring in the subsurface formation.

To assess the likelihood of each explanation, recorded survey vacuum pressures were reviewed, along with the borehole logs for nearby areas. In those locations where vacuum readings are not greater than background and the soil lithology is known to be of low permeability, short circuiting may have occurred. This situation may also be explained by fractures (e.g., desiccation cracks) or macropores (e.g., worm burrows and root channels). Analytical laboratory data for soils in those areas were also reviewed for correlation.

For each borehole, nearby soil-gas survey locations were identified. For each borehole for which a log was available, the data for the soil-gas vacuum versus time were analyzed as described in Johnson et al., (1990). Calculated values were then compared to values reported (Johnson et al., 1990) for similar types of soils as identified on the borehole logs at corresponding depths (see Table 2-10). In each case, the calculated permeability (k) values either concurred with the borehole logs or indicated a less-permeable soil type. Therefore, it may be concluded that short-circuiting did not occur at locations near boreholes.

Although most of the soil-gas samples were collected by the hydraulic-probing and purging system, several soil-gas survey locations were purged with a manual pump. This manual apparatus was not equipped to monitor vacuum levels. Manual purging takes more time than the hydraulic purging system. This greater length of time is less likely to induce short-circuiting.

For soil-gas sample locations that are not near boreholes, there are no known lithologic data to which calculated k values may be compared. However, the vacuum readings for the entire soil-gas survey were reviewed to evaluate occurrences that did not exceed background. Background vacuum (for the probe and tubing system in ambient air) was recorded at 3.5 inches Hg (mercury) during the intrinsic air-permeability study. Data from the soil-gas survey revealed the lowest 5-minute vacuum reading to be 4.1 inches Hg, a value 17 percent greater than background.

Because background vacuum levels were significantly exceeded at all locations of the soil-gas survey where the hydraulic system was used, calculation-derived soil types generally concur with those described in borehole logs, and manual purging is unlikely to induce short circuiting, therefore, it was concluded that short circuiting did not occur during the soil-gas survey at IHSS 115. Results of the soil-gas survey are considered to be representative of actual field conditions.

Geotechnical Evaluation - Section 3.1.2.2 in Volume I of TM15 (DOE, 1994a) outlined a geotechnical program to evaluate the stability of the slopes along IHSS 115. The following two work elements were completed.

- Obtain subsurface geometry.
- Collect subsurface soil-samples to characterize geotechnical properties of subsurface materials.

This section describes the methodology for obtaining subsurface data and the collection of geotechnical samples for analysis. Results of the geotechnical sample analysis including the final stability analysis will be presented in subsequent FS reports for OU 5.

The subsurface geometry was evaluated from existing data and from drilling 20 additional boreholes. Locations shown in Figure 2-4 were based on the overall visible width of the existing failures and the accessibility. Soil samples were collected in accordance with SOP GT.2, Drilling and Sampling Using Hollow-Stem Auger Techniques. Table 2-11 is a summary of borehole information for the TM15 field investigation, including the geotechnical borehole program.

To facilitate the access of the hollow-stem auger drill rig to the geotechnical boreholes located in the central landslide area, a temporary fill road was constructed. The temporary fill road was located between the well cluster for 58394, 57194, and 71494 and boring 56894 as shown on Figures 2-4 and 3-16. The temporary fill road was placed using clean fill and without excavating the existing hillside.

Core samples collected from the geotechnical boreholes were retained in core boxes and logged, and are provided in Appendix B. Core samples were not submitted for environmental chemical analysis on the basis of the field screening results, which indicated no contamination. If field screening results had indicated the potential for contaminants, environmental samples would have been collected for analysis for OU 5 target analytes, as described in Table 3.1.2-1 of Volume I of TM15 (DOE, 1994a).

Composite samples were obtained from drill cuttings and analyzed for OU 5 target analytes, and also are included in Table 3.1.2-1 of Volume I of TM15 (DOE, 1994a). These samples were collected to characterize the drummed cuttings and to determine the proper method for disposal of the cuttings. A summary of the data from these composite samples is included in Tables 2-1 through 2-3, and other summary tables in this section provide an indication of the difference in concentrations for each constituent in samples collected during the TM15 field investigation and those collected during the investigation outlined in the OU 5 Work Plan (DOE, 1992a). This information is provided to assist in evaluating whether the results of the TM15 field investigation would impact the results of the HHRA and ERA which were based on the data collected prior to the implementation of TM15 (see Section 6.0).

With the exception of thallium, concentrations of metals in the composite samples were within the range of either the background or pre-TM15 data (Table 2-1). Thallium concentrations, however, are of the same magnitude as those detected in background and pre-TM15 samples. Detected radionuclide activities were within the ranges of the pre-TM15 data (Table 2-2). As listed on Table 2-3, there were several organic compounds detected in these drum characterization samples. However, these organic compounds were primarily detected at concentrations below those detected in pre-TM15 samples or the reporting limit or were common laboratory contaminants (e.g., acetone, methylene chloride, and the phthalates). Table 2-12 presents a comparison of organic chemical concentrations in subsurface soil with risk-based concentrations (RBCs).

As part of the groundwater investigation, 2-inch nominal diameter PVC piezometers were installed in nine geotechnical borehole locations (Figure 2-4) for groundwater sampling. These piezometers were sampled for OU 5 target analytes, as described in Table 3.1.2-1 of Volume I of TM15 (DOE, 1994a), provided sufficient groundwater was present during sampling events.

Groundwater Investigation - The groundwater investigation consisted of characterization of the thickness of alluvial material along Woman Creek and performing hydraulic parameter testing. The primary activity of the investigation, however, centered around evaluating the presence and quality of groundwater. Various installation types (wellpoints, monitoring wells, small-diameter wells, and piezometers) were utilized for these activities. Small-diameter wells are defined as ½-inch to 1-inch nominal diameter PVC installed in 1- to 1.5-inch nominal diameter boreholes. These work elements and their results are presented in the following paragraphs.

To further characterize the bedrock surface and thickness of the valley-fill alluvium and colluvium along Woman Creek, three small-diameter (nominal 1-inch) boreholes were advanced approximately two feet into weathered bedrock. These three locations (58094, 58194, and 58594) were located as close to the creek bed as practical (Figure 2-4). Soil samples (core) were collected continuously with a Kansas sampler. Core was retained in core boxes and logged (see Appendix B). Because these locations are outside the IHSS boundary, core was screened by field instruments and no environmental analytical samples were collected. However, one soil sample from each location was collected for soil-moisture analysis. Piezometers were installed in each borehole and subsequently developed.

A single-well pumping test was performed at well 59593 on May 11, 1994. This test was performed when the static water level was higher than at the time of the previous slug test. This allowed the hydrostratigraphic unit to be stressed more than in the previous test. The results of this test are presented in Appendix D.

To completely evaluate the presence and quality of groundwater at and downgradient of IHSS 115/196, additional groundwater samples were collected. Because the presence and quantity of groundwater appeared to be limited, this task consisted of three work elements:

- Installation and development of nine upper hydrostratigraphic unit (UHSU) monitoring wells/piezometers, five small-diameter monitoring wells, and six bedrock (LHSU) monitoring wells (Figures 2-4 and 3-16)

- Measurement of water levels in all wellpoints, small-diameter wells, piezometers, and monitoring wells that are along or north of Woman Creek, south of the south buffer-zone access road, east of the western edge of IHSS 115 (approximately location CPT07393), and west of the eastern edge of IHSS 115 (approximately location CPT05393) on a monthly basis for one year

- Collection and analysis of groundwater samples from any location that was downgradient of IHSS 115/196 provided water-level measurements indicated the presence of a sufficient quantity of water

Installation of Groundwater Monitoring Locations - Nine monitoring wells were installed in geotechnical boreholes where groundwater was or could possibly be encountered.

Five small-diameter wells (57994, 58294, 58494, 58694, and 58794) were placed in the two-day bedrock topographic lows identified during the CPT investigation, and in between existing wellpoints. Five small-diameter wells installed; four were installed downgradient of IHSS 115/196, and one was installed in the surface disturbance east of the Original Landfill in the vicinity of borehole 50792. These small-diameter wells were installed using a small hydraulic drill rig that does not produce soil cuttings. Composite soil samples were collected during drilling and submitted for analysis in accordance with the procedures outlined in TM7 (DOE, 1993g). Analytical parameters for soil samples are specified in the OU 5 Work Plan and Table 3.1.2-1 of Volume I of TM15 (DOE, 1994a). Twenty-five composite samples were collected in this manner. In addition, discrete samples were collected at 2-foot intervals for VOC analyses. Forty-three VOC samples were obtained. Groundwater was observed at locations 57994, 58494, and a one-time measurement from 58794.

Table 2-1 presents summary statistics for metals data from subsurface-soil samples obtained from boreholes where monitoring wells were installed. With the exception of selenium, metals were detected at concentrations that were within the ranges of both the background and pre-TM15 data. Selenium was detected at concentrations exceeding the pre-TM15 data but were within the range of background concentrations. Radionuclides were detected at activities that were within ranges of both background and pre-TM15 data, except americium-241 and plutonium-239/240 (Table 2-2). Activities of americium-241 and plutonium-239/240 were above those of background data, but were within the pre-TM15 data range. As listed on Table 2-3, there were several organic compounds detected in subsurface-soil samples. However, these organic compounds were primarily detected at concentrations below those detected in pre-TM15 samples or the reporting limit, or were common laboratory contaminants.

Six bedrock monitoring wells (57194, 57594, 59394, 59894, 71194, and 71494) were installed at IHSS 115/196. Three (57194, 71194, and 71494) were installed as part of the geotechnical program, and three (57594, 59394, and 59894) were installed specifically as part of the groundwater investigation. Figure 2-4 shows the locations of the six bedrock monitoring wells around IHSS 115/196. Data from these monitoring wells have been used to evaluate the hydraulic interaction between the upper hydrostratigraphic unit (UHSU) and the lower hydrostratigraphic unit (LHSU), (see Section 3.8.1).

Five of the six boreholes for bedrock wells were geophysically logged with neutron, natural gamma, gamma-gamma density, EM-induction, and caliper tools. On the basis of the recovered core and the geophysical logs, construction details were selected. Wells were constructed with 2-inch, nominal-diameter PVC casing, with a 0.01-inch slotted screen. Table 2-11 provides a summary of well completion details. Bedrock well 59394 was originally scheduled to be installed in borehole 56694, but because 56694 caved in after being geophysically logged, 59394 was drilled.

Data acquired from all six bedrock monitoring wells were helpful in evaluating the presence of an inferred fault trace in the area of the Original Landfill, as presented in Section 3.8.1.2 of this report (also in Section 7 of EG&G (1995a) as inferred Fault 2). From the logs, it appears that a marker bed is approximately 60 feet higher in location 71194 (west of the inferred fault) than in location 57194 (east of the inferred fault).

Bedrock wells 57194 and 71494 are adjacent to UHSU piezometer 58394, and well 71194 is adjacent to UHSU piezometer 59794. Two potential water-bearing intervals were identified on the geophysical logs from well 57194. Well 71494 was installed adjacent to well 57194 to screen this separate water-bearing interval. Water levels at these locations indicate a downward vertical gradient. On the basis of the analytical data, well 71494 appears to be screened across a weathered siltstone that is in apparent hydrologic connection with the UHSU. No contaminants were observed in LHSU bedrock wells 57194, 57594, or 59894, which had sufficient groundwater for sampling.

Measurement of Groundwater Levels - Water levels have been measured in all the monitoring wells, wellpoints, small-diameter wells, and piezometers located in the immediate vicinity of IHSS 115/196, including the small-diameter wells along Woman Creek. Appendix C presents a summary of these water-level measurements for the period September 1994 through August 1995. Groundwater contour maps and discussions of groundwater flow are presented in Section 3.8.1.3.

Collection and Analysis of Groundwater Samples - Groundwater samples were obtained from any wellpoint or small-diameter well downgradient of IHSS 115/196 if water-level measurements indicated the presence of a sufficient quantity of water. The first quarter of groundwater samples was collected from December 21, 1994 to February 1, 1995 and the results are summarized in this section. Groundwater samples have been collected in the priority listed on Table 3.1.2.3-1 of Volume I of TM15 (DOE, 1994a). Table 2-4 presents a summary of locations that were sampled, and includes a checklist of requested analyses for each location. Tables 2-5 through 2-8 present summary statistics for data from groundwater samples obtained from wells around IHSS 115/196; these data are discussed below.

With the exception of thallium, total concentrations of metals in unfiltered samples are within the ranges of the background data or the pre-TM15 data (Table 2-5). Thallium was detected in only one sample and it was detected at a similar, but greater, total concentration than both background and pre-TM15 data ranges. The constituents in unfiltered samples that were detected above either the background or pre-TM15 data were detected at concentrations of similar magnitude to those data.

Concentration ranges of dissolved of antimony, calcium, cobalt, and magnesium in groundwater samples exceeded ranges of both the background and pre-TM15 data (Table 2-6). These concentrations were of similar magnitude to both the background and pre-TM15 data. Concentrations of the remaining metals were within the ranges of the background or pre-TM15 data for groundwater.

Activities of radionuclides in unfiltered groundwater samples at IHSS 115 were within the ranges of the background or pre-TM15 data (Table 2-7). The radionuclides that had activities above either the background or pre-TM15 data, had activities of similar magnitude to those data. With the exception of strontium-89/90, activities of dissolved radionuclides in groundwater samples were within the ranges of either the background or pre-TM15 data (Table 2-7). The maximum activity of dissolved strontium-89/90 activity was 2.2 picocuries per liter (pCi/L) as compared to 1.8 and 1.83 pCi/L for the background and pre-TM15 data, respectively.

As listed on Table 2-8, there were 39 organic compounds detected in groundwater samples. Only 17 of these organic compounds were detected with a frequency of detection greater than 5 percent or in more than three samples. Moreover, these organic compounds were primarily detected at concentrations below the contract-required reporting limit. Table 2-13 presents a comparison of detected organic chemicals in groundwater with RBCs.

Air Program and Wind-Resuspension Investigation - TM15 (DOE, 1994a) described four air-quality investigations: RAAMP, special OU 5 ambient-air samplers, an investigation of the wind-resuspension potential, and an examination of the volatilization of soil gases. Operation of the RAAMP and OU 5 samplers has continued as part of the routine air-quality monitoring programs at RFETS. Figure 2-5 shows the locations of offsite (OU 3) wind-resuspension sampling locations. Figures 2-6 through 2-9 show the locations of wind-resuspension studies in IHSS 115, IHSS 133, the soil disturbance area south of the Ash Pits, and the area of IHSS 209. Table 2-9 presents the results of the wind-resuspension potential study. Table 2-14 presents a comparison of the wind-tunnel study and the results of the rapid-assessment method. TM15 (DOE, 1994a) recommended the investigation into the volatilization of gases from OU 5 only if inhalation of volatile chemical species was determined to be an exposure pathway of concern. The inhalation of volatile organic compounds by current or future receptors has not been designated a complete exposure pathway (Section 6.0). Wind-resuspension potentials for all the OU 5 IHSSs are discussed in Section 5.3.3.2.

2.2.2 IHSS 133 (Ash Pits, Incinerator, and Concrete Wash Pad)

Section 2.5 of Volume II of TM15 (DOE, 1994a) provides a detailed discussion of the methodology for and results of the Phase I investigation conducted at the IHSS 133 group prior to implementation of TM15 (DOE, 1994a). A summary of the information related to the IHSS 133 group and presented in Volume II of TM15 (DOE, 1994a), is provided in this section, along with the results of implementation of the activities proposed in TM15. Figure 1-2 shows the relation of these IHSSs to RFETS; Figure 2-10 is a larger scale map of the IHSS 133 group showing locations sampled prior to the implementation of TM15.

2.2.2.1 Stage 1

Stage 1 activities at the 133-series IHSSs consisted of a review of historical aerial photographs to evaluate the extent of each disposal area. The results of this review are discussed in detail in Section 2.5.1 of Volume II of TM15 (DOE, 1994a). In summary, IHSSs 133.1 and 133.3 were incorrectly located on maps prior to TM15 (DOE, 1994a). The corrected locations are shown on Figure 2-10.

2.2.2.2 Stage 2

Stage 2 activities at the IHSS 133 sites included surface radiological and geophysical surveys, as were specified by the OU 5 Work Plan. These activities are discussed in detail in Section 2.5.2 of Volume II of TM15 (DOE, 1994a) and are summarized in the following paragraphs.

HPGe and FIDLER Surveys - A radiological survey of the IHSS 133 area was initiated in the summer of 1992 using tripod-mounted, HPGe gamma-ray detector instruments. This initial survey did not cover the entire IHSS 133 area and was followed by a second truck-mounted HPGe survey to provide full coverage for each IHSS 133 site. In addition to the HPGe surveys, FIDLER was used to focus sampling investigations within anomalies identified by the HPGe surveys.

The 1992 tripod-mounted HPGe survey identified two areas of anomalous uranium-238 activity. One of these areas also displayed an elevated uranium-235 activity. The 1993 truck-mounted survey corroborated the anomalous activity detected by the 1992 survey at one location but not at the other. The area identified by both HPGe surveys and the FIDLER survey was located immediately to the south and downslope of a small mound and depression. As shown on Figure 2-10, it was identified as an area approximately 35-ft wide and 76-ft long. The area has been posted as an RCA. No historical information regarding the origin of the mound and depression was found during investigation of this area, however, borehole (58093) was drilled within the mound and encountered waste fill material, as discussed in Section 2.2.3.2 in Volume II of TM15 (DOE, 1994a).

The anomaly associated with the 1992 tripod-mounted HPGe survey that was not identified by the 1993 truck-mounted survey was also not confirmed by the FIDLER survey. However, the FIDLER survey identified an anomalous area near this HPGe anomaly.

Geophysical Surveys - Frequency-domain EM and magnetometer geophysical surveys were conducted in IHSS 133 from October through December 1992. In addition, a time-domain electromagnetic (TDEM) survey was conducted in IHSS 133 from January through February 1994. This TDEM survey was performed with a Geonics EM61 instrument, which was not available at the time the other geophysical surveys were performed. The results of these surveys are discussed in detail in Section 2.5.2.2 in Volume II of TM15 (DOE, 1994a).

The success of the frequency-domain EM and magnetometer surveys in confirming the locations of the known ash pits or identifying unknown disposal sites was limited. The magnetic survey indicated an anomaly on the west side of the IHSS 133 area, with dimensions similar to those of the Ash Pits. The TDEM survey produced excellent results (Figure 2-11), confirming the locations of several pits previously identified and corroborating the results of the borehole program (Section 2.2.2.3). The TDEM survey identified several anomalous areas that required further investigation, as specified in Section 3.2.2.1 in Volume I of TM15 (DOE, 1994a). The soil-borehole program and the investigation of TDEM anomalies are discussed later in this report.

2.2.2.3 Stage 3

Stage 3 activities at the IHSS 133 sites included the collection of surface- and subsurface-soil samples in and around each IHSS. In addition, subsurface-soil samples were collected from within the anomaly west of the IHSS 133 area identified by the magnetic survey. These activities are discussed in detail in Section 2.5.3 in Volume II of TM15 (DOE, 1994a), and are summarized in this section.

Surface-Soil Sampling - The scope of work for the Stage 3 surface-soil sampling program is described in TM4 (DOE, 1993d). There were two phases of surface-soil sampling:

- Characterize concentrations of metals and polynuclear aromatic hydrocarbons (PAHs) and confirm the results of the initial HPGe survey for radionuclides.

- Assess areas of elevated radioactivity that were identified after the second radiation survey was completed.

The surface-soil sampling program is discussed in Section 2.5.3.1 of Volume II of TM15 (DOE, 1994a). A total of 20 surface-soil samples were collected at 20 locations in IHSS 133. Two sediment samples from seeps were also collected. Figure 2-10 shows the locations of the surface-soil and seep-sediment samples.

Elevated concentrations of zinc and silver were detected in only a few surface-soil samples. Gross alpha, uranium-233/234, and uranium-238 were detected with activities exceeding background UTLs. The ratio of uranium-235 to uranium-238 indicated that the uranium present in surface soils is primarily depleted uranium-238. None of the surface-soil samples contained detectable concentrations of PAHs.

Zinc, antimony, and uranium-238 were detected at levels exceeding background UTLs in the seep-sediment samples. The SVOC, bis(2-ethylhexyl)phthalate, was detected in one of the seep-sediment samples. Neither seep-sediment sample contained detectable concentrations of PAHs or VOCs.

Soil Boreholes - Based on the results of the aerial photograph review and geophysical survey, TM7 (DOE, 1993g) proposed a soil-borehole program that included drilling 28 boreholes and an undesignated number of shallow offset boreholes to be used in locating the Ash Pit(s). TM7 also proposed placing a borehole in the central location of any anomalous areas detected by the HPGe survey. Section 2.5.3.2 of Volume II of TM15 (DOE, 1994a) discusses drilling, sampling, and results of the borehole program.

The completed soil-boring program consisted of 53 boreholes (Figure 2-10):

- Two were placed in the mound north of a hot spot detected during the HPGe survey.
- Six were originally intended to be wells as part of the groundwater investigation, however, no groundwater was encountered and they were reclassified as boreholes.
- Seventeen were 10- to 12-foot deep offsets drilled to assist in locating the ash pits.
- The remaining 28 boreholes were drilled in the locations specified in TM7 (DOE, 1993g).

Soil samples were collected from all of the boreholes except the offsets, and four one-time groundwater samples were collected with a Hydropunch II sampling device during drilling from boreholes located within waste-fill material that contained groundwater.

Soil and groundwater samples from boreholes that encountered waste-fill material typically contained concentrations of metals and radionuclides that exceeded background UTLs. One sample contained some asbestos-containing material (ACM). Samples from boreholes that did not encounter waste material generally contained background levels of most constituents.

Investigation of Magnetic Anomaly - A magnetic anomaly west of IHSS 133 was investigated by drilling three boreholes (64493, 64593, and 64693) along the long axis of the anomaly. No ash, waste material, or groundwater were encountered in these boreholes. The unconsolidated material encountered appeared to be undisturbed colluvium. The analysis of soil samples collected from these boreholes indicated one barium result, one nickel result, and two plutonium-239/240 results greater than background UTLs.

Results of the drilling investigation of the magnetic anomaly west of IHSS 133 indicated that there was no ash pit or other disposal unit in this area. This conclusion was further supported by the results of the TDEM survey, which do not indicate the presence of any buried waste material in this area.

2.2.2.4 Stage 4

Stage 4 activities at the IHSS 133 sites consisted of the installation and sampling of groundwater monitoring wells and aquifer testing. The implementation and results of these activities are discussed in Section 2.5.4 of Volume II of TM15 (DOE, 1994a), and are summarized in this section.

Groundwater Investigation - Nine locations were drilled in the IHSS 133 area, in an attempt to install the four proposed monitoring wells. Groundwater was encountered in only three of the nine locations. At the time TM15 was written, groundwater samples were being collected on a quarterly basis from only one well, 58793. During the implementation of TM15, the other two wells, 59093 and 63093, were sampled. The results for these wells are included in the following paragraphs.

A few metals were detected at levels greater than background UTLs in one or two soil samples collected during drilling operations. Plutonium-239/240 was detected at concentrations exceeding the background UTL in three soil samples taken from these wells/boreholes.

Analyses of unfiltered samples from well 58793 detected 12 to 18 metals at concentrations exceeding background UTLs. Analyses of filtered portions of these same samples resulted in only manganese concentrations greater than the background UTL. This well has also contained above-background activities of americium-241 and radium-226 in unfiltered samples.

A multiple-well pumping test was unsuccessfully attempted at well 58793 (see Section 2.5.4.1 of Volume II of TM15 [DOE, 1994a]). This test was repeated on May 10, 1994 and the results are presented in Appendix D.

2.2.2.5 Ambient-Air Monitoring

Ambient-air-monitoring activities associated with the site characterization of IHSS 133 were similar to those conducted for the investigation of IHSS 115 (Section 2.2.1.6). These activities are discussed in Section 2.5.5 of Volume II of TM15 (DOE, 1994a), and are summarized in the following paragraphs.

The sampling results of the special OU 5 sampler situated downwind of IHSS 133 were similar to those for the IHSS 115 downwind sampler. Examination of the data for the special OU 5 sampler indicated that the uranium-233/234 and uranium-235 results were within the same order of magnitude for both the sampler downwind of IHSS 133 and the sampler upwind of OU 5. These data seemed to indicate no discernible contributions to ambient levels of either uranium-233/234 or uranium-235 from IHSS 133. This same analysis appeared to apply also to plutonium-239/240, in the case of IHSS 133. Conversely, the americium-241 and uranium-238 average activities for the downwind sampler were one order of magnitude greater than the average activities of the upwind sampler. Contributions to ambient levels of americium-241 or uranium-238 by IHSS 133 appeared possible.

No elevated organic-vapor levels were observed during field investigations of IHSS133. Elevated beta-gamma readings exceeding a background of 250 cpm were encountered during borehole activities at four locations. None of the results for ACM monitoring exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) 8-hour Time-Weighted Average occupational exposure limit of 2 fibers per cubic centimeter. Results indicated that there were some potential for release of ACM during ground disturbance activities.

2.2.2.6 Implementation of TM15

Implementation of field work outlined in TM15 (DOE, 1994a) for the IHSS 133 area began in September of 1994 and was completed in August 1995. In summary, the work consisted of:

- Investigation of TDEM Anomalies

- Groundwater Investigation

- Air Monitoring

Details of this additional work, as well as the results, are presented in the following subsections.

Investigation of TDEM Anomalies - The TDEM survey identified many geophysical anomalies throughout IHSS 133. A comprehensive visual inspection was performed over the entire geophysical-survey grid to identify areas where surface metallic debris (i.e., cans and fence posts) was present. Nine boreholes (Figure 2-12) were drilled in four anomalous areas identified by the TDEM survey that could not be associated with surface debris. Specifically,

- Borehole 56194 is located approximately 10 ft southeast of the concrete pad, in the north-central portion of IHSS 133;

- Boreholes 55194, 55294, 59994, and 60094 are located approximately 25 ft north of IHSS 133.6 and 25 ft south of the dirt road underneath the power lines (55194 was converted to a small-diameter well) (59994 and 60094 are located in the anomaly identified as TDEM-1);

- Borehole 55694 is at IHSS 133.4, in the center of the TDEM anomaly associated with the northern trench, approximately midway between existing boreholes 55993 and 56093C; and

- Boreholes 55894, 55994, and 56094 were advanced on either end, and in the center of the geophysical anomaly (TDEM-2) between IHSS 133.3 and IHSS 133.4, approximately 20 ft south of the dirt road beneath the power lines.

A tenth borehole (58894) was drilled in an additional TDEM anomaly identified at TDEM survey coordinates 540 East and 180 South (Figure 2-12). The area is approximately 5 by 8 feet in area and described as a small oblong mound. Borehole 57294 was drilled in the northern half of IHSS 133.1, adjacent to boring 56893, to obtain bulk ash samples of the waste fill for treatability studies being conducted for the OU 5 FS. Table 2-11 includes a summary of these boreholes, and Table 2-15 presents the treatability analytical results from the bulk ash sample from boring 57294, IHSS 133.2.

Toxic characteristic leaching potential (TCLP) metal results from five composite subsamples from the bulk sample indicated only one result for lead at 18 mg/L greater than the Land Disposal Restrictions (LDRs) for metals.

Tables 2-1 through 2-3 presents summary statistics for subsurface-soil samples obtained while investigating the TDEM anomalies at IHSS 133. Barium, beryllium, cadmium, cobalt, copper, lead, molybdenum, selenium, thallium, and zinc were detected in subsurface-soil samples at concentrations which exceeded the ranges detected in background and pre-TM15 data (Table 2-1). Typically, the greatest concentration detected was in sample BH00034AS from borehole 55994 drilled in TDEM-2. Concentrations of the remaining metals were within the ranges of either the background or pre-TM15 data for subsurface-soil samples.

With the exception of plutonium-239/240 and uranium-233/234, activities of radionuclides in subsurface-soil samples from boreholes within the TDEM anomalies were within the ranges of either the background or pre-TM15 data (Table 2-2). The elevated activities of plutonium-239/240 and uranium-233/234 detected were of similar magnitude to the pre-TM15 data.

Table 2-3 presents summary statistics for organic compounds that were detected in subsurface-soil samples from TDEM anomalies in IHSS 133. The only organic compounds detected were the VOC/PCE; and the SVOCs/benzoic acid, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and phenanthrene. These five organic compounds were detected in all but one sample at concentrations greater than the maximum concentration detected in the pre-TM15 samples.

Groundwater Investigation - Based on information from geologic logs of boreholes and monitoring wells in and around the IHSS 133 area, there were several areas where insufficient bedrock topography and extent of saturated area data existed after completion of the FSP outlined in the OU 5 Work Plan (DOE, 1992a). Consequently, 10 boreholes (55194, 55394, 55494, 55594, 55794, 56294, 56394, 56494, 56594, and 57894) were drilled and small-diameter piezometers installed at locations around IHSS 133 (Figure 2-12). Four piezometers (55494, 55594, 56294, and 56494) were installed downgradient of ash pits. Five of these piezometers (55394, 55794, 56394, 56594, and 57894) were located as close to the stream bed as possible. Borehole 56394 could not be completed as a small-diameter piezometer, therefore 71394 was drilled with an HSA drill rig and a well was installed. These five locations were installed as piezometers to measure water levels, not as water-quality monitoring points. Small-diameter well 55194 was installed near TDEM-1 at the west end of IHSS 133. Subsurface-soil samples (core) were collected continuously during drilling with a Kansas sampler (except 71394, which was a twin of borehole 56394), retained in core boxes, and logged (see Appendix B). Because these locations were outside the IHSS boundaries, core was only screened by field instruments. No above-background readings were obtained on any field instruments.

Water levels were measured in all the monitoring wells, wellpoints, and piezometers that are along or north of Woman Creek, south of the West Access Road, east of the west-perimeter road, and west of the eastern extent of the IHSS 133 area from September 1994 through August 1995. These water-level measurements are summarized in Appendix C.

Groundwater samples were obtained from any monitoring wells, small-diameter well, and wellpoints that were adjacent to or downgradient of an IHSS or TDEM anomaly if water-level measurements indicated presence of a sufficient quantity of water (58793, 59093, 63093, 63693, 63793, 55394, and 56594). Piezometers along Woman Creek were not sampled. Table 2-4 presents a checklist of which locations were sampled and for which analytical groups they were analyzed. Tables 2-5 through 2-8 present summary statistics for the analytical data from these groundwater samples. The results of these analyses are discussed below.

Concentrations of total metals were within the ranges of either the background or pre-TM15 data (Table 2-5). Only aluminum, beryllium, iron, potassium, silicon, and vanadium were detected exceeding the background range. These concentrations from samples of unfiltered groundwater were of similar magnitude to both the background and pre-TM15 data. Mean concentrations of metals in these groundwater samples were similar to those for the pre-TM15 data.

Concentrations of dissolved metals were within the ranges of either the background or pre-TM15 data (Table 2-6). Concentrations of dissolved nickel exceeded the dissolved groundwater background range but were detected with similar frequency and concentrations. Selenium was detected in one groundwater sample at a concentration exceeding the pre-TM15 data, but the concentration detected was well within the range of background concentrations.

With the exception of radium-226, activities of radionuclides in samples of unfiltered groundwater for IHSS 133 were within the range of both the background and pre-TM15 data (Table 2-7). Radium-226 had an activity that exceeded the background range but those activities were within the pre-TM15 range.

With the exception of cesium-137, activities of dissolved radionuclides in the recent groundwater data for IHSS 133 were within the range of both the background and pre-TM15 data (Table 2-7). Dissolved cesium-137 had an activity that exceeded the pre-TM15 range, but was within the background range.

Volatile organic compounds, methylene chloride and acetone, were detected in two groundwater samples from IHSS 133 (Table 2-8). Acetone was detected at a concentration marginally above the detection limit in one sample. SVOCs, bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, di-n-butyl phthalate, and di-n-octyl phthalate were detected in one groundwater sample from IHSS 133. These four constituents were detected at concentrations below the contract-required reporting limits and are common field or laboratory contaminants. Four tentatively identified compounds (TICs) were also detected in groundwater samples from IHSS 133 at concentrations less than contract-required reporting limits: cyclohexane (DOT); dodecanoic acid; hexadecanoic acid; and octadecanoic acid.

A visual survey to characterize where bedrock crops out in the stream channel along the length of Woman Creek downgradient of the IHSS 133 series area was conducted on October 14, 1994. This information was used to revise the bedrock topography map and provide input to the hydrogeologic model. The survey did not identify any locations where bedrock crops out in the stream channel.

A pumping test was performed at 58793 while water levels were monitored in 63593, 63693, and 63793. The test was conducted on May 10, 1994. Data are presented in Appendix D. The results of this test were comparable to those from the previous test reported in TM15 (DOE, 1994a). Both tests were unsuccessful in obtaining the hydrogeologic characteristics of the water-producing strata at this location.

<u>Air Monitoring</u> - TM15 (DOE, 1994a) described four air-quality investigations: RAAMP, special OU 5 ambient-air samplers, an investigation of the wind-resuspension potential, and an examination of the volatilization of soil gases. Operation of the RAAMP and OU 5 samplers has continued as part

of the routine air-quality monitoring programs at RFETS. The potential for resuspension of contaminated soil was not directly addressed in the investigation of IHSS 133. To make this evaluation required an estimation of the corrected threshold friction velocity of the soil. The phased investigation procedures to acquire corrected threshold friction velocity data for IHSS 115 are applicable to IHSS 133 and are discussed in Section 2.2.1.7.

Because any VOCs would have been destroyed during the incineration process, volatile chemical species were not a concern in IHSS 133. Therefore, no field work to measure the emission rates of volatile species was conducted for IHSS 133.

2.2.3 IHSS 142.10 and 142.11 (C Ponds)

Section 2.6 of Volume II of TM15 (DOE, 1994a) provides a detailed discussion of the methodology for and results of the Phase I investigation conducted at IHSS 142.10 (C-1 Pond) and 142.11 (C-2 Pond) prior to implementation of work outlined in TM15. A summary of the information presented in Volume II of TM15 is provided below, along with the results of implementation of activities proposed in TM15. Figure 1-2 shows the relation of these IHSSs to RFETS; Figure 2-13 is a larger-scale map of the IHSS 142 area.

2.2.3.1 Stage 1

Stage 1 activities consisted of evaluating the existing data. The results of Stage 1 evaluations were used to develop surface-water and sediment sampling activities as presented in TM1 (DOE, 1993b). The results of this evaluation are discussed in Section 2.6.1 of Volume II of TM15 (DOE, 1994a) and are also presented in detail in TM1 (DOE, 1993b).

2.2.3.2 Stage 2

There were no Stage 2 activities.

2.2.3.3 Stage 3

Stage 3 investigation activities at Ponds C-1 and C-2 consisted of additional surface-water and sediment sampling and the installation and monitoring of wellpoints along Woman Creek and its tributaries. These activities are discussed in detail in Section 2.6.2 of Volume II of TM15 (DOE, 1994a), the Hydrogeologic Data Summary Report (Appendix A), and are summarized in the following paragraphs.

Surface-Water and Sediment Sampling - This section presents a summary of surface water and sediment sampling along the Woman Creek drainage, including Woman Creek, the South Intercept Ditch, the C-Series Ponds, and the pond-like depressions in IHSS 209. These various sampling locations are discussed together rather than with their associated IHSS because they are all part of a single system. Volume II of TM15 (DOE, 1994a) presents detailed discussions of the result of each sampling event by IHSS. Also the results of the surface-water and sediment sampling activities at Ponds C-1 and C-2 are detailed in Appendix A.

Twenty-eight surface-water samples were collected from various locations in the Woman Creek drainage. Water samples were obtained during two base-flow sampling events (November 1992 and March 1993) and three high-flow sampling events (March and May 1993 and April 1994). Water sampling activities conducted at the ponds consisted of two HydroLab surveys to develop depth profiles of the surface water sediment interface at both ponds. In addition, surface-water samples were collected from the pond-like depressions at IHSS 209.

Analyses of the data from the two base-flow and first high-flow sampling events indicate that only a few samples contained some analytes at concentrations greater than those of background. This indicated that constituents were probably not seeping into the creek and were probably not being washed into the creek at rates sufficient to be detected at elevated concentrations.

A general conclusion regarding the ponds was that both thermal and chemical stratification of the C-ponds was very weak to nonexistent during all months of the year. No concentrations exceeding background UTLs were noted for radionuclides, metals, or organic constituents associated with the samples from the pond-like depressions.

Stream-sediment samples were also collected during a one-time sampling event at various locations in the Woman Creek drainage. One-time sediment samples were also collected from both ponds. "Sediment" samples were collected from the pond-like depressions at IHSS 209 when no water was present in them during the surface-soil sampling discussed in Section 2.2.4.3.

Several constituents were detected at concentrations exceeding background UTLs in stream-sediment samples from various locations in Woman Creek. Based upon the pond-sediment concentrations and comparisons with background UTLs, mercury, barium, calcium, and zinc were detected at concentrations exceeding background.

Wellpoint Installation and Monitoring - Thirty-six wellpoints were installed along Woman Creek, as outlined in TM1 (DOE, 1993b). The wellpoints were located to coincide with the Woman Creek channel gain/loss sites previously used to measure streamflows in Woman Creek by CSU and EG&G (Fedors and Warner, 1993a) The results of the well-point and gain/loss measurements are summarized in Section 3.4 and discussed in detail in Section 2.6.2.2 of Volume II of TM15 (DOE, 1994a) and Appendix A.

2.2.3.4 Stage 4

Stage 4 activities at IHSSs 142.10 (Pond C-1) and 142.11 (Pond C-2) consisted of the installation and sampling of groundwater monitoring wells. Section 2.6.4 of Volume II of TM15 (DOE, 1994a) discusses the results of these activities, and they are summarized in the following subsections.

Groundwater Investigation - Two monitoring wells were installed immediately downgradient of each dam at Ponds C-1 and C-2 to monitor the saturated alluvium (Figure 2-13). Wells 50092 and 51193, below Pond C-1 have been sampled on a quarterly basis when sufficient groundwater is present. The wells below Pond C-2 (50192 and 50292) have not produced sufficient water for sampling.

None of the soil samples collected from the wells contained target analyte list (TAL) metal concentrations exceeding background levels. Plutonium-239/240 and americium-241 were detected in soil samples and in composite samples from drums of cuttings that represented the upper 15 feet of the borehole. None of the soil samples collected from the wells contained pesticides or PCBs. No SVOCs were detected in soil samples collected from any of the wells, however, tentatively identified compounds (TICs) were detected in soil samples from all four of the groundwater monitoring well boreholes. VOCs (acetone, methylene chloride, and toluene) were detected in soil samples collected from all four monitoring well boreholes.

Three groundwater samples collected from the wells below Pond C-1 had metal concentrations exceeding background UTLs. Most of the results that exceeded background UTLs were from unfiltered samples. Samples from these same wells also had radium-226 (total) and gross beta (dissolved) activities that exceeded background UTLs and detectible concentrations of SVOCs. Samples from the wells have contained elevated concentrations of chloride and total suspended solids. None of the groundwater samples collected from these wells contained pesticides, PCBs, or VOCs.

A multiple-well pumping test was successfully completed on well 51193 located below Pond C-1. Water levels were monitored in small-diameter wells 63293, 63393, and 63493. The resulting transmissivities ranged from 0.021 to 0.030 square ft per minute (DOE, 1994a).

2.2.3.5 Implementation of TM15

No additional work at IHSSs 142.10 and 142.11 was proposed in TM15 (DOE, 1994a).

2.2.4 IHSS 209 and Other Surface Disturbances

Section 2.7 of Volume II of TM15 (DOE, 1994a) provides a detailed discussion of the methodology for and results of the Phase I investigation conducted at IHSS 209, the Surface Disturbance West of IHSS 209, and the Surface Disturbance South of the Ash Pits prior to implementation of work outlined in Volume I of TM15 (DOE, 1994a). A summary of the information presented in Volume II of TM15 (DOE, 1994a) is provided in this section, along with the results of implementation of activities proposed in TM15 (DOE, 1994a). Figure 1-2 shows the relation of these areas to RFETS; Figures 2-14 and 2-15 are larger-scale maps of these areas.

2.2.4.1 Stage 1

Aerial photographs and oblique photographs covering IHSS 209 and the two other surface disturbance areas were reviewed to assess the location and history of the surface disturbances. The results of the aerial photograph review are discussed in detail in Section 2.7.1 of Volume II of TM15 (DOE, 1994a) and are summarized below.

Aerial photographs indicate that the vegetation and upper sediments had been stripped from IHSS 209 prior to 1955, and that prior to 1964, several pits had been opened within the site. The review of the photographs subsequently resulted in both an extension of the overall length of IHSS 209, as compared to the dimensions shown on Figure 2-7 of the OU 5 Work Plan, and some adjustments to the locations of the pits that were shown on Figure 2-7 of the OU 5 Work Plan. Specifically, Stage 1 aerial photo-review resulted in relocating the eight pits in the Surface Disturbance West of IHSS 209 approximately 250 ft to the north (Figure 2-14). Three additional pits were identified as a result of Stage 1 activities and confirmed during the Stage 2 field reconnaissance.

The Surface Disturbance South of the Ash Pits is shown on Figure 2-15 and consists of an area of disturbed ground, as well as an area that contains two open and two reclaimed pits. The locations of the reclaimed pits shown on Figure 2-15 have been corrected as a result of Stage 1 activities, according to scaled locations from the aerial photographs, and do not agree with the locations shown on Figure 2-6 of the OU 5 Work Plan (DOE, 1992a).

2.2.4.2 Stage 2

Stage 2 activities at IHSS 209 and the other surface disturbances consisted of a visual inspection of each site to confirm the information obtained in Stage 1 and to evaluate if any debris or staining indicative of waste disposal are present. Stage 2 also involved the performance of surface radiological surveys over each site. The results of these activities are discussed in detail in Section 2.7.2 of Volume II of TM15 (DOE, 1994a), and summarized in this section.

<u>Visual Inspection</u> - A visual inspection/site reconnaissance of IHSS 209 and the other surface disturbances was conducted on September 24, 1992. The features described in these paragraphs are shown on Figures 2-14 and 2-15.

IHSS 209 - The pond southwest of the road near the center of the site was found to be dry, with a basin at least 10 ft in depth. The pits shown throughout the area are small, shallow excavations that are still open or partially backfilled. There was no evidence that these pits were ever used for the disposal of waste materials. The Stage 2 field reconnaissance confirmed that no significant debris or staining exist to indicate that waste disposal had occurred. It appears that the largest disturbance on the northeast end of the area may have been used as a source of gravel prior to 1955.

Surface Disturbance West of IHSS 209 - Stage 2 field reconnaissance confirmed the locations of all eight pits identified on aerial photographs. The largest pit is located near the center of the site and was found to be several feet deep. The largest pit was dry at the time of the inspection but holds water during periods of wet weather or snow melt, and is now the host to a fairly large cottonwood tree indicating that the site has been open for a long period of time. The remaining pits are small and shallow, appear to be capable of holding water during wet weather, and are heavily revegetated. There is no indication that any of these pits had ever been used as disposal sites. It is unclear what use the pits may have served. The OU 5 Work Plan speculated that these pits may have been part of a planned radio-tower installation. However, the configuration of these pits and the fact that the pits are located on a hillside rather than the top of the hill indicate that this may not be the case.

Surface Disturbance South of the Ash Pits - The field reconnaissance of the Surface Disturbance South of the Ash Pits confirmed the existence of the features noted in the OU 5 Work Plan and identified on the aerial photographs. The disturbed area located in the southwest half of the site consists of large cobbles and small boulders of the Rocky Flats Alluvium, and appears to have been disturbed for a possible borrow area. However, there is no staining or debris associated with the site that would indicate disposal of any waste had occurred.

FIDLER Surveys - Section 7.2.4 of the OU 5 Work Plan specified that IHSS 209 and the other surface disturbances be surveyed with a FIDLER. These surveys were performed on a grid as described in Section 2.7.2.2 of Volume II of TM15 (DOE, 1994a). The FIDLER surveys of IHSS 209 and the other surface disturbances did not identify any areas of above-background radiation. The random survey of the pond/seep area on the northeast side of IHSS 209 also did not indicate any above-background levels of radiation.

2.2.4.3 Stage 3

Stage 3 activities at IHSS 209 and the other surface disturbances consisted of the collection of samples of surface water and sediments in the water-filled pits. Surface- and subsurface-soil samples were also collected at IHSS 209 and the other surface disturbances under Stage 3. These activities are discussed in Section 2.7.3 of Volume II of TM15 (DOE, 1994a), and summarized in this section.

Surface-Water and Sediment Sampling - Results of surface-water and sediment sampling were discussed in Section 2.2.3.3.

Surface-Soil Sampling - The surface-soil sampling program for IHSS 209 and the other surface disturbances is described in the OU 5 Work Plan and in TM10 (DOE, 1993i). Samples were collected at 19 locations, as shown on Figures 2-14 and 2-15. Table 2-16 presents a summary of radionuclide data for surface soils. None of the samples contained metals in concentrations that exceeded background UTLs and did not contain detectable concentrations of pesticides or PCBs. Approximately half of the 19 surface-soil samples contained plutonium-239/240 activities exceeding the background UTL, and approximately half of these samples also contained americium-241 activities greater than the background UTL. The samples with above-background activities of radionuclides were collected from all three of the surface-disturbance sites. The plutonium-239/240 activity (approximately 5 pCi/g) of one sample collected at the Surface Disturbance West of IHSS 209 was the greatest detected in surface-soil samples from any of the OU 5 IHSSs and consequently additional sampling was conducted under the implementation of TM15. Seven of the surface-soil samples also contained detectable concentrations of SVOCs.

Subsurface-Soil Sampling - Section 2.7.3.3 of Volume II of TM15 (DOE, 1994a) discusses the results of the borehole program as well as the rationale for the number of boreholes. One borehole (57693) was drilled in the Surface Disturbance West of IHSS 209 (Figure 2-14) and three boreholes (57793, 57893, and 57993) were drilled in the Surface Disturbance South of the Ash Pits (Figure 2-15).

None of the boreholes drilled at the surface disturbances encountered groundwater. The analyses of the subsurface-soil samples identified one sample in which the concentration of chromium exceeded the background UTL. One sample contained a plutonium-239/240 activity greater than the background UTL. Pesticides and PCBs were not detected in any of the samples. Benzoic acid, a

SVOC, was detected in at least one sample from each of the boreholes. Methylene chloride was also detected in several samples.

2.2.4.4 Implementation of TM15

Implementation of field work outlined in Section 3.4 of TM15 (DOE, 1994a) for IHSS 209 and the Surface Disturbances began in September 1994. In summary the work consisted of:

- Surface Radiological Surveys
- Surface-Soil Sampling
- Air Programs and Wind-Resuspension Study

Surface Radiological Survey - Because Stage 3 surface-soil sampling and analysis indicated elevated levels of radionuclides (specifically plutonium-239/240), the following surface radiological surveys were conducted at IHSS 209 and the other surface disturbances:

- An HPGe survey
- A FIDLER survey of HPGe anomalies

To provide full HPGe coverage of the areas of interest a grid spacing of 150 ft was used. In addition to providing full coverage, this geometry also reduced the size of the areas requiring a FIDLER survey to a manageable size. The HPGe survey indicated 24 anomalous areas with detectable americium-241 within IHSS 209, the Surface Disturbance West of IHSS 209, and the Surface Disturbance South of the Ash Pits (Figures 2-16 and 2-17). The HPGe detector is not capable of measuring plutonium-239/240. Therefore, americium-241, a daughter product of plutonium-239/240, was used as an indicator to identify those locations where plutonium-239/240 may be present in surface soils.

FIDLER surveys of the HPGe anomalous areas detected readings above background levels at six locations. These six HPGe anomalies and "above-background" FIDLER areas are as follows:

IHSS 209

- **HPGe K-56:** FIDLER K-56A (25 West/4 North), approximately 46 ft south of HPGe station K-56, was frisked with a Bicron B-50 beta/gamma probe with readings of 66 cpm, 35 cpm, 70 cpm, and 61 cpm above-background levels.

- **HPGe K-57:** FIDLER K-57A (10 West/90 North), approximately 60 ft northeast of HPGe station K-57, showed FIDLER counts of 350 cpm above-background levels.

- **HPGe L-55:** FIDLER L-55A (0 West/100 North), located at the NNE corner of L-55 grid, showed elevated FIDLER counts of 500-600 cpm above-background levels.

- **HPGe H-60:** The following are coordinates with FIDLER counts above-background levels.

(0 West/10 North) 600 cpm	(8 West/65 North) 750 cpm
(16 West/60 North) 600 cpm	(28 West/55 North) 600 cpm
(28 West/96 North) 650 cpm	(36 West/25 North) 625 cpm

- **HPGe I-62:** The following are coordinates with FIDLER counts above-background levels.
  (100 West/50-100 North) 350 cpm
  (92 West/50 North) 600 cpm
  (66 West/30 North) 600 cpm

Surface Disturbance West of IHSS 209

- No areas with activity above-background levels.

Surface Disturbance South of the Ash Pits

- **HPGe M-14:** FIDLER M-14A (90 West/90 North), located approximately 70 ft northwest of HPGe station M-14, showed elevated FIDLER counts of approximately 750 cpm above-background levels.

Surface-Soil Sampling - Surface-soil samples were collected from locations with the greatest activity, as identified by the surface radiological surveys. Samples were analyzed for americium-241 and plutonium-239/240. A total of six samples were collected from the five HPGe anomalies within IHSS 209 (Figure 2-16). One sample was collected at each of the FIDLER anomalies K-56A and L-55A (SS133194 and SS133294). Two samples were collected from each of the HPGe anomalies identified at stations H-60 (SS133594 and SS133694) and I-62 (SS133394 and SS133494). The relatively low activities detected with the FIDLER at these two stations did not warrant the collection of surface-soil samples at the location of each FIDLER anomaly. Therefore, one sample was collected at the two FIDLER anomalies with the greatest number of counts. At HPGe anomaly H-60, one sample was collected at coordinates 8 West/65 North (SS133594) and one was collected at coordinates 28 West/96 North (SS133694). Similarly, samples were collected from the two FIDLER anomalies with the greatest number of counts within HPGe anomaly I-62 (coordinates 92 West/50 North SS133494, and 66 West/30 North, SS133394). Because of the relatively low activities detected with the FIDLER at anomaly K-57A, the collection of surface-soil samples was not warranted.

One sample (55133894) was collected from FIDLER anomaly M-14A at the Surface Disturbance South of the Ash Pits (Figure 2-17). As discussed in Section 2.2.4.3, a relatively great activity of plutonium-239/240 was detected in a surface-soil sample collected from the Surface Disturbance West of IHSS 209 (sample SS50075AS). The plutonium-239/240 activity detected at this location was the primary reason that additional radiological surveys and surface-soil sampling were necessary at these sites. Although, the HPGe survey did not detect americium-241 and plutonium-239/240 in the vicinity of this location, an additional surface-soil sample was collected at this location (Figure 2-16) as a verification and quality-control check.

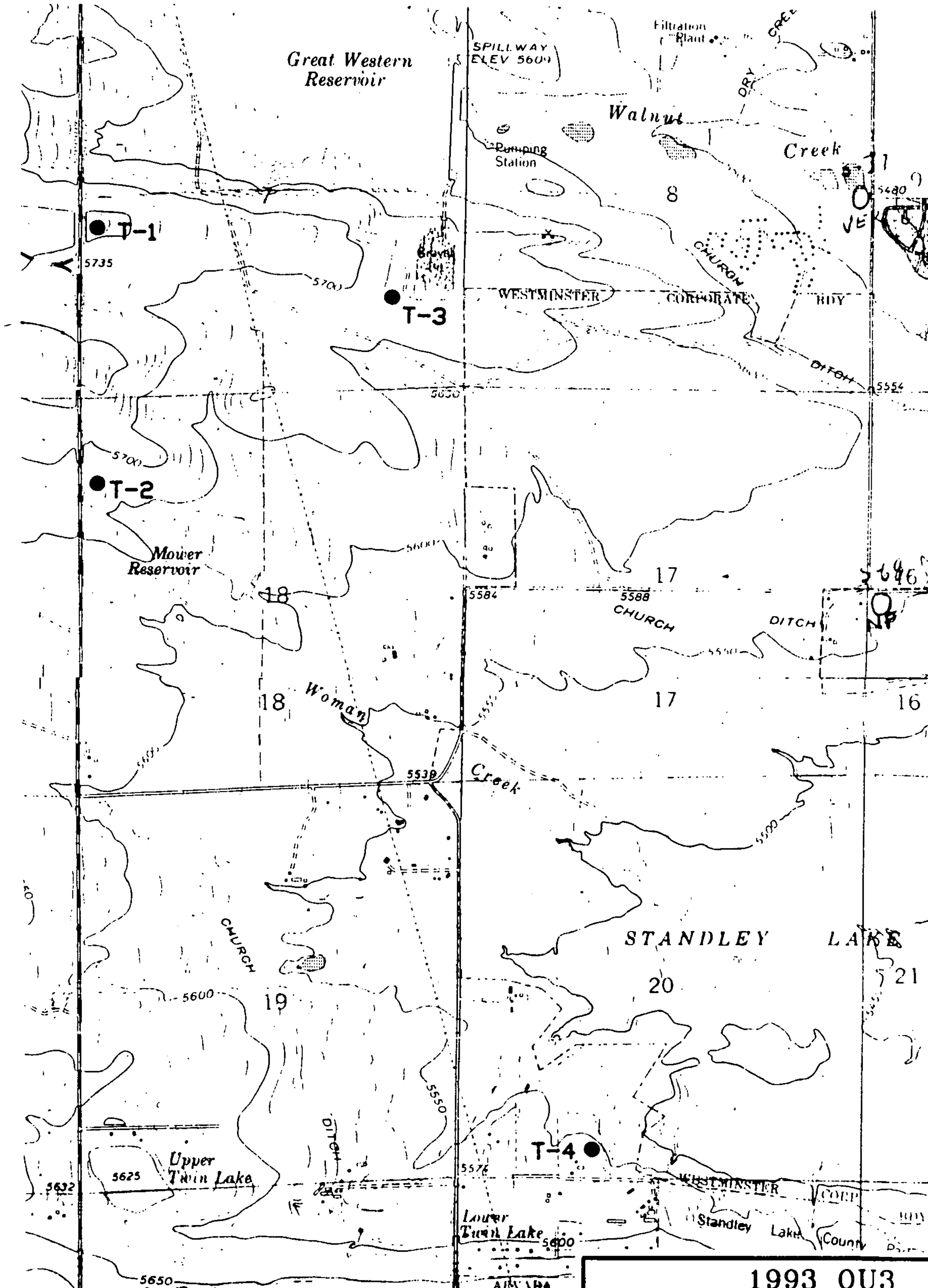
Detected activities in these surface-soil samples were within the range of activities of previous work (Section 2.2.4.3). However, both plutonium-239/240 and americium-241 activities typically exceeded all but the greatest activity from previous soil samples (Table 2-16). None of these samples had activities that exceed the lognormal background UTL (7.66 pC/g for americium-241 and 25.86 pCi/g for plutonium-239/240).

Air Monitoring - TM15 (DOE, 1994a) described an investigation for estimating the wind-resuspension potential of surface soil. However, the potential for resuspension of contaminated soil was not directly addressed in the investigation of IHSS 209 and the surface disturbances. To make this evaluation, it would require an estimation of the corrected threshold friction velocity of the soil. The phased investigation procedures to acquire corrected threshold friction velocity data for IHSS 115 are applicable to IHSS 209 and the surface disturbances, and are discussed in Section 2.2.1.7.

2.2.5 Ecological Risk Assessment Investigation

Section 9 of the OU 5 Work Plan, was designed to describe the requirements for carrying out an ERA. The initial FSP was intended for screening purposes and baseline site characterization. Section 9 describes an iterative approach with revisions planned after chemicals of concern, receptors, and contaminant pathways were identified. Section 9 was modified in February 1993. The 1993 revised FSP was transmitted to the EPA and CDPHE by the DOE, but approval of the document was not requested and the regulatory agencies did not provide a formal review or approval.

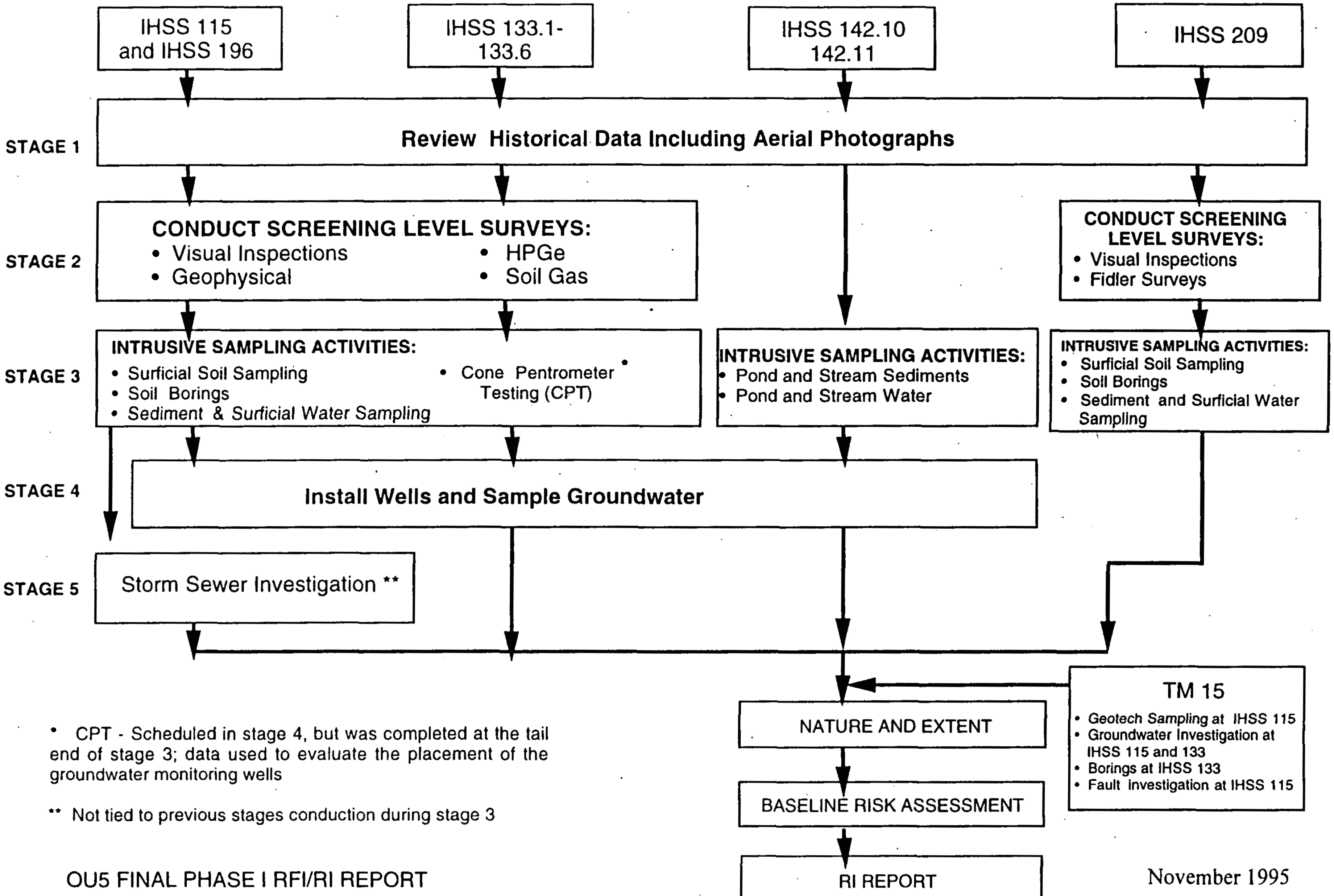
In October of 1994, the approach to ERAs for RFETS changed from an OU-based approach to a watershed approach for Woman Creek and Walnut Creek. To accomplish this, a sitewide ERA methodology was drafted and approved by the regulatory agencies. As a result, the scope of the Woman Creek ERA expanded from OU 5 to include OU 1, part of OU 2, and part of OU 11. Figure 2-18 shows the investigative stages of the OU 5 FSP, and OU-specific FSP requirements are summarized in Appendix N.



1993 OU3 WIND TUNNEL STUDY TERRESTRIAL SAMPLING SITES

Drawn SAB 7/27/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Checked TEJ 7/27/95 Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
Approved ______ Date	RFI/RI REPORT
FILE OU5-2-5.DWG	FIGURE 2-5

FIGURE 2-18 - INVESTIGATIVE STAGES OF THE OU5 FIELD SAMPLING PLAN



* CPT - Scheduled in stage 4, but was completed at the tail end of stage 3; data used to evaluate the placement of the groundwater monitoring wells

** Not tied to previous stages conduction during stage 3

Tables 2-1 through 2-16

35 pages

Table 2-1
Summary Statistics for Metals Data from Subsurface Soil Samples

Constituent (COCs are Bold/Italic)	OU 5* or Background Data	Number of Samples	Range of Reporting Limits (mg/kg)	Percent Detection	Range of Non-detected Concentrations (mg/kg)	Range of Detected Concentrations (mg/kg)	Mean** Concentration (mg/kg)	Standard Deviation**
Aluminum	Background	98	40 – 504	98.98	7,690	279 – 102,000	12,712.80	11,334.96
	Geotech	26	200	100	N/A	5,710 - 12,400	8,514.04	1,699.63
	115-GW	25	40 – 200	100	N/A	2,350 – 20,700	9,779.40	4640.47
	133-TDEM	22	6.36 – 200	100	N/A	4,660 – 28,600	11,776.82	5,738.99
	Pre-TM15	239	40	100	N/A	1,740 – 32,800	10,839.58	5,630.95
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –		10,626.92	-2%
Antimony	Background	66	12 – 29.1	15.15	1.9 – 47	2.35 – 8.2	4.54	3.66
	Geotech	2	60	100	N/A	6.2 - 13.6	9.90	5.23
	115-GW	15	12 – 60	0	6 – 30	N/A	23.60	10.99
	133-TDEM	18	0.43 – 60	22	0.22 – 30	0.57 – 16.3	20.03	13.30
	Pre-TM15	223	12	12.11	12 – 22.1	6.7 – 149	8.49	11.05
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –		10.18	20%
Arsenic	Background	99	2 – 4.9	70.71	0.54 – 17.9	0.92 – 41.8	3.65	4.42
	Geotech	26	10	100	N/A	2.9 - 16.8	6.61	2.69
	115-GW	25	2 – 10	100	N/A	1.8 – 9.4	5.63	1.64
	133-TDEM	22	0.644 – 10	100	N/A	2.3 – 14.9	5.70	3.31
	Pre-TM15	239	2	99.58	2	0.47 – 18.9	3.91	2.40
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –		4.40	13%
Barium	Background	99	40 – 96.8	88.89	25.8 – 50.1	18.8 – 777	96.12	96.62
	Geotech	26	200	100	N/A	81.9 - 162	112.67	21.71
	115-GW	25	40 – 200	100	N/A	35.9 – 203	126.03	45.1
	133-TDEM	22	2.15 – 200	100	N/A	27.9 – 1,610	187.05	327.34
	Pre-TM15	239	40	100	N/A	26.6 – 683	130.30	92.10
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –		132.49	2%
Beryllium	Background	99	1.0 – 2.4	81.82	0.91 – 5.2	1.0 – 23.5	4.66	4.77
	Geotech	26	5	100	N/A	0.54 - 0.96	0.74	0.10
	115-GW	25	1 – 5	84	0.5 – 1.3	0.33 – 1.1	0.81	0.28
	133-TDEM	20	0.215 – 5	95	0.5	0.29 – 446	24.35	99.37
	Pre-TM15	239	1	69.46	1 – 1.25	0.23 – 131	1.48	8.46
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –		2.84	92%
Cadmium	Background	81	1 – 2.4	7.41	0.18 – 2.4	1.1 – 1.5	0.58	0.30
	Geotech	26	5	3.85	2.5 - 2.5	0.56 - 0.56	2.43	0.38
	115-GW	24	1 – 5	0	0.5 – 2.5	N/A	2.17	0.76
	133-TDEM	24	0.644 – 5	33	0.5 – 2.5	1.4 – 71	7.84	15.28
	Pre-TM15	239	1	11.3	1 – 1.32	0.62 – 56.9	1.45	5.75
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –		2.08	43%
Calcium	Background	99	110 – 2,420	98.99	1,160	1,170 – 157,000	7,052.58	16,178.79
	Geotech	26	5,000	100	N/A	3,240 - 20,400	7,821.92	3,901.68
	115-GW	25	1,000 – 5,000	100	N/A	1,730 – 14,000	6,580.00	2,993.72
	133-TDEM	23	4.89 – 5,000	100	N/A	1,140 – 18,900	4,153.48	3,841.19
	Pre-TM15	239	1,000	99.58	1,000	1,080 – 35,000	5,462.93	4,228.23
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –		5,651.89	3%
Cesium	Background	95	2.5 – 484	1.05	163.5 – 2,830	274	130.37	135.15
	Geotech	26	1,000	23.08	500 - 500	4.2 - 19.4	386.37	211.58
	115-GW	24	200 – 1,000	4	100 – 500	8.7	412.86	174.35
	133-TDEM	24	5.09 – 1000	33	100 – 500	4.3 – 18.7	319.67	238.5
	Pre-TM15	212	200	2.36	200	1.9 – 12.6	97.80	14.17
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –		169.09	73%
Chromium	Background	99	2 – 4.8	84.85	4.1 – 17.8	5.6 – 176	18.75	24.66
	Geotech	26	10	100	N/A	5.3 - 163	24.94	32.88
	115-GW	25	2 – 10	100	N/A	3.8 – 48.9	14.60	9.01
	133-TDEM	22	0.644 – 10	100	N/A	7 – 434	37.54	89.42
	Pre-TM15	239	2	99.58	5.6	2.7 – 8,310	51.20	536.73
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –		45.12	-12%
Cobalt	Background	99	10 – 24.2	22.22	3.8 – 93.9	4.5 – 16.4	6.45	7.11
	Geotech	26	50	100	N/A	3.9 - 12.6	8.32	2.10
	115-GW	25	10 – 50	100	N/A	3 – 13.2	7.76	2.45
	133-TDEM	24	1.29 – 50	96	5	2.3 – 701	36.55	141.60
	Pre-TM15	239	10	96.65	10	2.1 – 67.6	8.86	6.33
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –		10.84	22%

Table 2-1 (continued)

Constituent (COCs are Bold/Italic)	OU 5* or Background Data	Number of Samples	Range of Reporting Limits (mg/kg)	Percent Detection	Range of Non-detected Concentrations (mg/kg)	Range of Detected Concentrations (mg/kg)	Mean** Concentration (mg/kg)	Standard Deviation**
Copper	Background	99	5 -- 12.1	94.95	5 -- 11	2.2 -- 123	12.59	12.77
	Geotech	26	25	100	N/A	13.9 - 31.2	21.92	3.95
	115-GW	25	5 -- 25	80	12.5 -- 17.45	8.8 -- 42.4	19.25	6.83
	133-TDEM	24	0.43 -- 25	96	7.1	5.6 -- 8,850	601.63	1,843.23
	Pre-TM15	239	5	98.74	5 -- 10.25	3.6 -- 6,920	82.45	501.93
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --		112.09	36%
Iron	Background	99	20 -- 252	100	N/A	1,300 -- 132,000	14,531.98	13,257.27
	Geotech	26	100	100	N/A	5,820 - 25,800	17,821.92	4,496.93
	115-GW	25	20 -- 100	100	N/A	7,020 -- 24,000	16,833.00	4,656.74
	133-TDEM	24	1.47 -- 100	100	N/A	6,460 -- 106,000	23,430.42	25,540.06
	Pre-TM15	239	20	100	N/A	2,340 -- 107,000	16,383.49	12,090.98
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --		17,077.00	4%
Lead	Background	99	1 -- 6.1	98.99	4	2.6 -- 39.8	10.85	7.07
	Geotech	26	3	100	N/A	6.5 - 21	16.82	3.47
	115-GW	25	0.6 -- 3	100	N/A	5.3 -- 22.3	15.20	4.67
	133-TDEM	22	0.43 -- 3	100	N/A	3.9 -- 5,200	316.50	1,106.69
	Pre-TM15	239	0.6 -- 15	100	N/A	2.9 -- 935	31.49	98.39
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --		49.06	56%
Lithium	Background	99	2.1 -- 26.1	61.62	2.9 -- 26.1	3.7 -- 83.2	9.99	8.51
	Geotech	26	100	100	N/A	3.6 - 10.9	7.41	1.88
	115-GW	25	20 -- 100	92	10	2.45 -- 15.7	8.97	3.88
	133-TDEM	24	2.58 -- 100	96	10 -- 10	2.8 -- 17.9	8.57	4.44
	Pre-TM15	237	20	85.65	20	1.4 -- 29	8.55	4.79
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --		8.49	-1%
Magnesium	Background	99	110 -- 2,420	95.96	713 -- 1,175.5	1,180 -- 32,500	2,852.83	3,246.35
	Geotech	26	5,000	100	N/A	1,450 - 5,480	3,289.42	1,024.00
	115-GW	25	1,000 -- 5,000	100	N/A	882 -- 5,335	3,243.08	1,193.54
	133-TDEM	24	7.52 -- 5,000	100	N/A	828 -- 9,480	2,762.38	1,875.29
	Pre-TM15	239	1,000	100	N/A	392 -- 6,900	2,786.53	1,353.51
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --		2,862.67	3%
Manganese	Background	99	3 -- 7.3	100	N/A	37 -- 3,330	217.64	341.96
	Geotech	26	15	100	N/A	41.7 - 486	281.99	120.60
	115-GW	25	3 -- 15	100	N/A	102 -- 488	250.46	118.97
	133-TDEM	22	0.245 -- 15	100	N/A	42.2 -- 2,150	300.06	450.27
	Pre-TM15	239	3	100	N/A	26.4 -- 1,540	261.81	245.07
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --		265.28	1%
Mercury	Background	86	0.08 -- 0.3	25.58	0.05 -- 5.9	0.1 -- 0.64	0.19	0.34
	Geotech	26	0.2	42.31	0.1 - 0.1	0.064 - 0.1	0.09	0.01
	115-GW	24	0.1 -- 0.2	33	0.05 -- 0.1	0.06 -- 0.11	0.09	0.02
	133-TDEM	18	0.1 -- 0.2	44	0.1	0.06 -- 0.36	0.11	0.06
	Pre-TM15	223	0.1	21.52	0.1 -- 0.13	0.05 -- 1.4	0.09	0.16
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --		0.09	1%
Molybdenum	Background	99	2.1 -- 40	50.51	2 -- 28.9	2.5 -- 67.6	10.90	8.61
	Geotech	26	200	30.77	100 - 100	1.2 - 3.5	69.84	46.13
	115-GW	24	40 -- 200	25	20 -- 100	1.3 -- 7.1	65.73	45.49
	133-TDEM	24	3.44 -- 200	33	1.75 -- 100	1.6 -- 470	83.76	92.78
	Pre-TM15	238	40	8.4	40	0.9 -- 190	20.19	13.73
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --		32.72	62%
Nickel	Background	96	8 -- 19.4	85.42	9.4 -- 52.1	4.3 -- 193	19.81	20.56
	Geotech	26	40	100	N/A	8.3 - 37	19.55	6.21
	115-GW	25	8 -- 40	88	16.4 -- 24.3	4.5 -- 102	22.54	20.62
	133-TDEM	24	2.58 -- 40	100	N/A	6.6 -- 355	50.99	82.86
	Pre-TM15	239	8	95.4	8 -- 9.9	2.7 -- 4,750	37.58	306.57
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --		35.91	-4%
Potassium	Background	98	110 -- 2,420	52.04	373 -- 15,400	654 -- 18,700	1,403.90	2,064.24
	Geotech	26	5,000	100	N/A	735 - 1,780	1,274.92	253.06
	115-GW	25	1,000 -- 5,000	84	500 -- 2,140	473 -- 3,750	1,437.38	665.78
	133-TDEM	24	78.2 -- 5,000	96	500	470 -- 3,030	1,218.46	593.01
	Pre-TM15	239	1,000	88.7	1,000 -- 1,658.5	327 -- 7,040	1,341.99	748.86
					Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --		1,334.59	-1%

Table 2-1 (continued)

Constituent (COCs are Bold/Italic)	OU 5* or Background Data	Number of Samples	Range of Reporting Limits (mg/kg)	Percent Detection	Range of Non-detected Concentrations (mg/kg)	Range of Detected Concentrations (mg/kg)	Mean** Concentration (mg/kg)	Standard Deviation**
Selenium	Background	82	1 -- 12.2	2.44	0.21 -- 13.7	2.15 -- 2.8	0.91	1.15
	Geotech	26	5	34.62	2.5 - 2.5	0.71 - 2.5	2.00	0.77
	115-GW	24	1 -- 5	13	0.5 -- 2.5	1.1 -- 1.9	2.10	0.69
	133-TDEM	24	0.734 -- 19.6	13	1.1 -- 9.8	0.87 -- 6.1	3.14	2.21
	Pre-TM15	233	1	9.44	1 -- 1.4	0.24 -- 0.78	0.49	0.06
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				0.95	94%
Silver	Background	83	1 -- 4.8	39.76	0.54 -- 6.8	1.45 -- 40.9	5.57	9.46
	Geotech	26	10	30.77	3.15 - 5	1 - 3.1	3.93	1.57
	115-GW	25	2 -- 10	16	1 -- 5	1.3 -- 2	3.77	1.73
	133-TDEM	20	0.644 -- 10	65	1 -- 5	0.59 -- 209	20.48	47.01
	Pre-TM15	203	2	14.29	2	0.8 -- 311	5.96	28.94
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				6.63	11%
Sodium	Background	99	110 -- 2,420	17.17	126 -- 2,720	161 -- 3,680	303.62	421.97
	Geotech	26	5,000	80.77	2,500 - 2,500	74.5 - 677	675.06	917.81
	115-GW	25	1,000 -- 5,000	100	N/A	28.2 -- 1,140	281.36	287.33
	133-TDEM	24	5.63 -- 5,000	92	500 -- 2,500	54 -- 3,360	594.98	796.52
	Pre-TM15	239	1,000	94.14	1,000	42 -- 3,220	299.83	333.89
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				351.99	17%
Strontium	Background	99	21.6 -- 484	36.36	20.3 -- 484	25.1 -- 226	52.02	48.27
	Geotech	26	200	100	N/A	21.3 - 119	65.42	24.78
	115-GW	25	40 -- 200	100	N/A	13.7 -- 111	61.10	27.32
	133-TDEM	22	0.245 -- 200	100	N/A	9.9 -- 92.6	30.50	22.19
	Pre-TM15	239	40 -- 400	100	N/A	6.4 -- 148	37.58	21.46
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				41.29	10%
Thallium	Background	75	2 -- 20	4	0.18 -- 4.9	0.22 -- 0.4	0.50	0.54
	Geotech	26	10	19.23	2.91 - 5	0.39 - 0.78	4.07	1.79
	115-GW	24	2 -- 10	0	1 -- 5	N/A	4.33	1.52
	133-TDEM	24	0.734 -- 10	17	1 -- 5	0.5 -- 6.3	4.09	1.77
	Pre-TM15	238	2	29.41	2	0.2 -- 0.55	0.79	0.32
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				1.59	101%
Tin	Background	92	10 -- 110	27.17	20.2 -- 48.4	25.7 -- 441	62.49	112.04
	Geotech	26	200	19.23	100 - 100	3.2 - 4.6	81.48	38.70
	115-GW	24	40 -- 200	4	20 -- 100	2.8	80.66	35.06
	133-TDEM	24	5.16 -- 200	38	2.62 -- 100	8.9 -- 102	67.39	43.37
	Pre-TM15	239	40	4.6	40	2.4 -- 579	23.10	37.16
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				35.76	55%
Vanadium	Background	99	10 -- 24.2	97.98	8.45 -- 11.6	11.1 -- 283	31.49	28.50
	Geotech	26	50	100	N/A	13.9 - 36.3	22.63	4.22
	115-GW	25	10 -- 50	100	N/A	6.1 -- 38.7	26.35	9.59
	133-TDEM	24	0.644 -- 50	100	N/A	12.2 -- 60.4	31.28	12.52
	Pre-TM15	239	10	100	N/A	7.6 -- 93.5	30.37	12.73
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				29.48	-3%
Zinc	Background	98	4 -- 9.7	92.86	9.7 -- 25.9	0.52 -- 486	36.31	51.36
	Geotech	26	20	100	N/A	18.3 - 87.1	65.04	15.58
	115-GW	25	4 -- 20	100	N/A	13.8 -- 121	58.78	22.27
	133-TDEM	24	0.489 -- 20	100	N/A	8 -- 6,920	441.26	1,414.47
	Pre-TM15	239	4	100	N/A	7.6 -- 2,390	90.38	251.58
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				112.58	25%

Notes: * = OU 5 data where;

Geotech refers to samples collected from the geotechnical program at IHSS 115 as detailed in TM15.

115-GW refers to samples collected from boreholes from the groundwater monitoring program at IHSS 115 as detailed in TM15.

133-TDEM refers to samples collected from boreholes used to investigate the TDEM anomalies at IHSS 133 as detailed in TM15

Pre-TM15 refers to samples collected within OU 5 prior to January 1994.

** = Mean and Standard Deviation are calculated assuming data are normally distributed.

mg/kg = milligrams per kilogram. N/A = not applicable.

Table 2-2
Summary for Radionuclide Data from Subsurface-Soil Samples

Constituent (COCs are ***Bold/Italic)***	OU 5* or Background Data	Number of Samples	Range of Activities (pCi/g)	Mean** Activity (pCi/g)	Standard Deviation**
Total Activites					
Americium-241	Background	28	-0.015 -- 0.01	-0.002	0.007
	Geotech	24	-0.0119 - 0.2572	0.033	0.065
	115-GW	25	0 -- 0.08	0.01	0.02
	133-TDEM	21	0 -- 0.2	0.05	0.06
	Pre-TM15	239	-0.016 -- 0.61	0.014	0.053
	Mean of OU 5 Data % Change from Pre-TM15 Mean --			**0.02**	**26%**
Plutonium-239/240	Background	99	-0.01 -- 0.03	0.004	0.007
	Geotech	24	-0.0019 - 0.0382	0.007	0.009
	115-GW	25	0 -- 0.08	0.01	0.02
	133-TDEM	25	0 -- 5.16	0.31	1.03
	Pre-TM15	231	-0.03 -- 3.2	0.053	0.251
	Mean of OU 5 Data % Change from Pre-TM15 Mean --			**0.07**	**26%**
Uranium-233/234	Background	99	0.2 -- 8.9	0.779	0.932
	Geotech	24	0.78915 - 1.576	1.157	0.212
	115-GW	29	0.58 -- 1.51	0.96	0.25
	133-TDEM	27	0.38 -- 288.29	25.01	70.38
	Pre-TM15	244	0.35 -- 126	3.95	15.811
	Mean of OU 5 Data % Change from Pre-TM15 Mean --			**5.23**	**32%**
Uranium-235	Background	99	0.00 -- 0.2	0.02	0.046
	Geotech	24	-0.0031 - 0.1214	0.05	0.023
	115-GW	29	0.01 -- 0.13	0.04	0.02
	133-TDEM	27	0.01 -- 36.12	2.30	7.49
	Pre-TM15	245	-0.006 -- 37.68	0.49	3.017
	Mean of OU 5 Data % Change from Pre-TM15 Mean --			**0.57**	**16%**
Uranium-238	Background	99	0.2 -- 3.2	0.733	0.376
	Geotech	24	0.8265 - 1.576	1.150	0.192
	115-GW	29	0.62 -- 1.45	0.97	0.23
	133-TDEM	27	0.37 -- 933.04	78.59	237.96
	Pre-TM15	245	0.43 -- 1,160	17.928	113.988
	Mean of OU 5 Data % Change from Pre-TM15 Mean --			**20.22**	**13%**
Alpha	Background	99	5 -- 48	24.915	9.284
	Geotech	25	9.354 - 19.33	13.973	2.614
	115-GW	29	9.59 -- 29	15.00	5.33
	133-TDEM	28	5.8 -- 418.28	65.76	110.61
	Pre-TM15	221	5.59 -- 742	26.573	65.713
	Mean of OU 5 Data % Change from Pre-TM15 Mean --			**28.05**	**6%**
Beta	Background	99	6 -- 44	24.717	6.061
	Geotech	25	22.86 - 37.81	27.188	2.915
	115-GW	29	19.78 -- 38.42	27.03	4.09
	133-TDEM	28	13.64 -- 898.92	115.97	216.25
	Pre-TM15	222	7.5 -- 1,580	45.759	125.611
	Mean of OU 5 Data % Change from Pre-TM15 Mean --			**48.91**	**7%**

Notes: * = OU 5 data where;

Geotech refers to samples collected from the geotechnical program at IHSS 115 as detailed in TM15.

115-GW refers to samples collected from boreholes from the groundwater monitoring program at IHSS 115 as detailed in TM15.

133-TDEM refers to samples collected from boreholes used to investigate the TDEM anomalies at IHSS 133 as detailed in TM15.

Pre-TM15 refers to samples collected within OU5 prior to January 1994.

** = Mean and Standard Deviation are calculated assuming data are normally distributed.

pCi/g = picocuries per gram.

Table 2-3
Summary of Detected Organic Compounds in Subsurface-Soil Samples

TM15 Program* Chemical (COCs are in ***Bold/Italics***)	Number of Samples	Range of Reporting Limits (ug/kg)	Percent of Samples Above Detection Limit TM15	 *Pre-TM15*	Range of Nondetected Concentrations (ug/kg)	Range of Detected Concentrations (ug/kg)	Maximum Concentration *PRE-TM15* (ug/kg)
Geotech				**Volatile Organic Compounds**			
2-Butanone	27	10	7	*5.1*	11 -- 31	3 -- 40	*69*
Acetone	27	10	44	*9.9*	12 -- 60	17 -- 110	*280*
Chloroform	27	5 -- 10	11	*0*	2.5 -- 13	5.5 -- 14	*<6.3*
Methylene Chloride	27	5 -- 10	41	*14.4*	2.5 -- 31	3 -- 13	*66*
Tetrachloroethene	27	5 -- 10	19	*13.3*	2.5 -- 16	2 -- 12	*920*
Toluene	27	5 -- 10	19	*45.4*	2.5 -- 16	1 -- 6	*310*
Trichloroethene	27	5 -- 10	11	*11.3*	2.5 -- 31	1 -- 2	*440*
				Semi-Volatile Organic Compounds			
Anthracene	25	330	4	*23.2*	350 -- 1,000	212.5	*46,000*
Benzo(a)Anthracene	***25***	***330***	***20***	***26.8***	***360 -- 1,000***	***43 -- 96***	***48,000***
Benzo(a)Pyrene	***25***	***330***	***52***	***25.6***	***365 -- 400***	***40 -- 320***	***43,000***
Benzo(b)Fluoranthene	***25***	***330***	***20***	***26.8***	***360 -- 1,000***	***75 -- 125***	***48,000***
Benzo(k)Fluoranthene	25	330	8	*24.4*	350 -- 1,000	40 -- 44	*19,000*
Bis(2-Ethylhexyl)Phthalate	25	330	52	*15.9*	203.5 -- 530	39 -- 180	*290*
Butly Benzyl Phthalate	25	330	92	*<5*	360 -- 550	94 -- 2,100	*360*
Chrysene	25	330	20	*26.8*	360 -- 1,000	52 -- 115	*53,000*
Di-n-Butyl Phthalate	25	330	36	*<5*	350 -- 1,000	43 -- 215.5	*300*
Diethyl Phthalate	25	330	4	*0*	350 -- 1,000	890	*<330*
Fluoranthene	25	330	28	*30.5*	370 -- 1,000	60 -- 260	*160,000*
Indeno(1,2,3-cd)Pyrene	25	330	8	*21*	350 -- 1,000	47 -- 54	*22,000*
Phenanthrene	25	330	20	*31.7*	365 -- 1,000	70 -- 205	*220,000*
Pyrene	25	330	28	*31.7*	370 -- 1,000	46 -- 215	*150,000*
				Pesticides and PCBs			
Aroclor-1254	***18***	***33 -- 160***	***11***	***11.8***	***36.5 -- 185***	***320 -- 540***	***960***
115-GW				**Volatile Organic Compounds**			
2-Butanone	43	10	2	*5.1*	5 -- 27	7	*69*
Acetone	43	10	14	*9.9*	11 -- 190	16 -- 56	*280*
Bromoform	43	5 -- 10	2	*0*	2.5 -- 14	2	*<6.3*
Chloroform	43	5 -- 10	14	*0*	2.5 -- 7	2 -- 36	*<6.3*
Methylene Chloride	43	5 -- 10	9	*14.4*	2.5 -- 29	4 -- 150	*66*
Tetrachloroethene	43	5 -- 10	21	*13.3*	2.5 -- 14	3 -- 30	*920*
Toluene	43	5 -- 10	14	*45.4*	2.5 -- 14	1 -- 3	*310*
Trichloroethene	43	5 -- 10	2	*11.3*	2.5 -- 14	1	*440*
				Semi-Volatile Organic Compounds			
Benzo(a)Pyrene	***24***	***330***	***29***	***25.6***	***350 -- 390***	***58 -- 480***	***43,000***
Benzoic Acid	22	1,600	23	*21.3*	1,700 -- 4,300	64 -- 210	*974*
Bis(2-Ethylhexyl)Phthalate	24	330	46	*15.9*	350 -- 390	42 -- 540	*290*
Butyl Benzyl Phthalate	24	330	17	*<5*	350 -- 1,135	170 -- 1,400	*360*
Di-n-Butyl Phthalate	24	330	8	*<5*	350 -- 700	120 -- 190	*300*
Di-n-Octyl Phthalate	24	330	8	*0*	350 -- 890	39 -- 50	*<330*
Diethyl Phthalate	24	330	8	*0*	350 -- 890	63 -- 305	*<330*
Fluoranthene	24	330	4	*30.5*	350 -- 890	39	*160,000*
133-TDEM				**Volatile Organic Compounds**			
Tetrachloroethene	1	5	100	*13.3*	N/A	18	*920*
				Semi-Volatile Organic Compounds			
Benzoic Acid	2	1,600	50	*21.3*	1,900	140	*974*
Bis(2-Ethylhexyl)Phthalate	2	330	50	*15.9*	380	100	*290*
Di-n-Butyl Phthalate	2	330	50	*2.4*	380	190	*300*
Phenanthrene	2	330	50	*31.7*	380	41	*220,000*

Notes: * = OU 5 data where;
Geotech refers to samples collected from the geotechnical program at IHSS 115 as detailed in TM15.
115-GW refers to samples collected from boreholes from the groundwater monitoring program at IHSS 115 as detailed in TM15.
133-TDEM refers to samples collected from boreholes used to investigate the TDEM anomalies at IHSS 133 as detailed in TM15
** = Mean and Standard Deviation are calculated assuming data are normally distributed.
ug/kg = micrograms per kilogram. N/A = not applicable.

Table 2-4
TM15 Sampling Summary

Location	TM15 Program	Sample Number	QC Code	QC Partner	Sample Type	Completion Type	IHSS	Analyses Requested						
								Rads	Metals	VOA	SVOA	Pest\PCB	Water Qual	Geotech
58793	GW	GW50123AS	REAL		GW	WELL	133	X	X	X	X	X	X	
58793	GW	GW50124AS	RNS	GW50123AS	GW	WELL	133	X		X			X	
59393	GW	GW50127AS	REAL		GW	WELL	115/196		X	X	X	X	X	
59393	GW	GW50134AS	TB	GW50127AS	GW	WELL	115/196			X				
59493	GW	GW50113AS	REAL		GW	WELL	115/196	X	X	X	X	X	X	
59493	GW	GW50113AS	REAL		GW	WELL	115/196	X	X	X	X	X	X	
59493	GW	GW50114AS	DUP	GW50113AS	GW	WELL	115/196	X	X	X	X	X	X	
59493	GW	GW50114AS	DUP	GW50113AS	GW	WELL	115/196	X	X	X	X	X	X	
59593	GW	GW50131AS	REAL		GW	WELL	115/196	X	X	X	X	X	X	
59793	GW	GW50133AS	REAL		GW	WP	115/196			X			X	
59793	GW	GW50136AS	RNS	GW50133AS	GW	WP	115/196	X	X	X	X	X	X	
59893	GW	GW50222AS	REAL		GW	WP	115/196						X	
59993	GW	GW50148AS	REAL		GW	WP	115/196			X			X	
59993	GW	GW50224AS	REAL		GW	WP	115/196		X				X	
60093	GW	GW50218AS	REAL		GW	WP	115/196	X	X	X	X		X	
60093	GW	GW50219AS	TB	GW50218AS	GW	WP	115/196			X				
60293	GW	GW50143AS	REAL		GW	WP	115/196	X	X	X	X	X	X	
60293	GW	GW50144AS	DUP	GW50143AS	GW	WP	115/196	X	X	X	X	X	X	
60293	GW	GW50170AS	REAL		GW	WP	115/196	X	X	X	X		X	
60293	GW	GW50171AS	DUP	GW50170AS	GW	WP	115/196	X	X	X	X		X	
60293	GW	GW50181AS	TB	3W50170-171A:	GW	WP	115/196			X				
60393	GW	GW50220AS	REAL		GW	WP	115/196		X	X			X	
60393	GW	GW50221AS	TB	GW50220AS	GW	WP	115/196			X				
60493	GW	GW50156AS	REAL		GW	WP	115/196						X	
60493	GW	GW50226AS	REAL		GW	WP	115/196						X	
60593	GW	GW50155AS	REAL		GW	WP	115/196						X	
60593	GW	GW50212AS	REAL		GW	WP	115/196	X	X	X	X		X	
60593	GW	GW50213AS	TB	GW50212AS	GW	WP	115/196			X				
60693	GW	GW50160AS	REAL		GW	WP	115/196						X	
60693	GW	GW50214AS	REAL		GW	WP	115/196	X	X	X	X		X	
60693	GW	GW50215AS	TB	GW50214AS	GW	WP	115/196			X				
60893	GW	GW50157AS	REAL		GW	WP	115/196						X	
60893	GW	GW50158AS	RNS	GW50157AS	GW	WP	115/196		X		X		X	
60893	GW	GW50175AS	REAL		GW	WP	115/196	X	X	X	X		X	
60993	GW	GW50210AS	REAL		GW	MINI	115/196		X	X			X	
60993	GW	GW50211AS	TB	GW50210AS	GW	MINI	115/196			X				
61093	GW	GW50150AS	RNS	GW50151AS	GW	MINI	115/196	X	X	X	X	X	X	
61093	GW	GW50151AS	REAL		GW	MINI	115/196	X	X	X	X	X	X	
61093	GW	GW50154AS	DUP	GW50151AS	GW	MINI	115/196	X	X	X	X	X	X	
61093	GW	GW50164AS	TB	GW50151AS	GW	MINI	115/196			X				
61093	GW	GW50176AS	REAL		GW	MINI	115/196	X	X	X	X		X	
61093	GW	GW50177AS	DUP	GW50176AS	GW	MINI	115/196	X	X	X	X		X	
61093	GW	GW50194AS	TB	GW50176AS	GW	MINI	115/196			X				
61293	GW	GW50125AS	RNS	GW50126AS	GW	WELL	115/196	X	X	X	X	X	X	
61293	GW	GW50126AS	REAL		GW	WELL	115/196		X	X			X	
62593	GW	GW50216AS	REAL		GW	WP	133	X	X		X		X	
62693	GW	GW50217AS	REAL		GW	WP	133	X	X		X		X	
62793	GW	GW50147AS	REAL		GW	WP	115/196			X			X	
62793	GW	GW50149AS	DUP	GW50147AS	GW	WP	115/196			X			X	
62793	GW	GW50152AS	TB	GW50147AS	GW	WP	115/196			X				
62793	GW	GW50228AS	REAL		GW	WP	115/196		X	X			X	
62793	GW	GW50229AS	TB	GW50228AS	GW	WP	115/196			X				
62893	GW	GW50122AS	REAL		GW	WP	115/196	X	X	X	X	X	X	
62893	GW	GW50140AS	REAL		GW	WP	115/196						X	
62893	GW	GW50163AS	TB	GW50165AS	GW	WP	115/196			X				
62893	GW	GW50165AS	REAL		GW	WP	115/196						X	
62893	GW	GW50180AS	REAL		GW	WP	115/196	X	X	X	X		X	

Table 2-4 (continued)

Location	TM15 Program	Sample Number	QC Code	QC Partner	Sample Type	Completion Type	IHSS	Analyses Requested: Rads	Metals	VOA	SVOA	Pest\PCB	Water Qual	Geotech
62893	GW	GW50200AS	TB	GW50180AS	GW	WP	115/196			X				
63093	GW	GW50129AS	RNS	GW50135AS	GW	WELL	133						X	
63093	GW	GW50135AS	REAL		GW	WELL	133	X	X	X	X	X	X	
63093	GW	GW50168AS	TB	GW50135AS	GW	WELL	133			X				
63193	GW	GW50128AS	REAL		GW	MINI	115/196	X	X	X	X	X	X	
63193	GW	GW50130AS	DUP	GW50128AS	GW	MINI	115/196	X	X	X	X	X	X	
63193	GW	GW50132AS	RNS	GW50128AS	GW	MINI	115/196	X	X	X	X	X	X	
63193	GW	GW50182AS	REAL		GW	MINI	115/196	X	X	X	X		X	
63193	GW	GW50183AS	DUP	GW50182AS	GW	MINI	115/196	X	X	X	X		X	
63193	GW	GW50184AS	RNS	GW50182-183A	GW	MINI	115/196	X	X	X	X		X	
63193	GW	GW50200AS	TB	GW50182-183A	GW	MINI	115/196			X				
63693	GW	GW50137AS	REAL		GW	WP	133			X			X	
63693	GW	GW50139AS	DUP	GW50137AS	GW	WP	133			X			X	
63693	GW	GW50166AS	REAL		GW	WP	133						X	
63693	GW	GW50167AS	TB	GW50166AS	GW	WP	133			X				
63693	GW	GW50207AS	REAL		GW	WP	133						X	
63793	GW	GW50115AS	REAL		GW	MINI	133	X	X	X	X	X	X	
63793	GW	GW50115AS	REAL		GW	WP	133	X	X	X	X	X	X	
63793	GW	GW50116AS	RNS	GW50115AS	GW	WP	133	X	X	X	X	X	X	
63793	GW	GW50117AS	TB	GW50115AS	GW	WP	133			X				
63793	GW	GW50206AS	REAL		GW	WP	133	X	X		X		X	
63893	GW	GW50120AS	REAL		GW	WP	115	X	X	X	X	X	X	
63893	GW	GW50121AS	REAL		GW	WP	115		X	X	X	X	X	
63893	GW	GW50187AS	REAL		GW	WP	115	X	X	X	X		X	
63893	GW	GW50196AS	TB	GW50187AS	GW	WP	115			X				
63993	GW	GW50119AS	REAL		GW	WP	115	X	X	X	X	X	X	
63993	GW	GW50188AS	REAL		GW	WP	115	X	X	X	X		X	
63993	GW	GW50197AS	TB	GW50188AS	GW	WP	115			X				
64093	GW	GW50118AS	REAL		GW	WP	115	X	X	X	X	X	X	
64093	GW	GW50189AS	REAL		GW	WP	115	X	X	X	X		X	
64093	GW	GW50198AS	TB	GW50189AS	GW	WP	115			X				
55194	TDEM	BH00028AS	REAL		BH	MINI	133	X	X					
55194	TDEM	BH00029AS	REAL		BH	MINI	133	X	X					
55194	TDEM	BH00030AS	REAL		BH	MINI	133	X	X					
55194	TDEM	BH00101AS	RNS		BH	MINI	133	X	X					
55294	TDEM	BH00031AS	REAL		BH	BH	133	X	X					
55294	TDEM	BH00032AS	REAL		BH	BH	133	X	X					
55294	TDEM	BH00033AS	REAL		BH	BH	133	X	X					
55394	GW	BH00055AS	REAL		GEOTECH	MINI	133							X
55394	GW	GW50106AS	REAL		GW	MINI	133	X	X	X	X	X	X	
55394	GW	GW50107AS	RNS		GW	MINI	133	X	X	X	X	X	X	
55394	GW	GW50111AS	TB		GW	MINI	133			X				
55494	TDEM	BH00023AS	REAL		GEOTECH	MINI	133							X
55494	TDEM	BH00024AS	REAL		GEOTECH	MINI	133							X
55594	TDEM	BH00025AS	REAL		GEOTECH	MINI	133							X
55594	TDEM	BH00100AS	RNS		BH	MINI	133	X	X					
55694	TDEM	BH00041AS	REAL		BH	BH	133	X	X					
55694	TDEM	BH00042AS	REAL		BH	BH	133	X	X					
55794	GW	BH00057AS	REAL		GEOTECH	MINI	133							X
55894	TDEM	BH00036AS	REAL		BH	BH	133	X	X					
55894	TDEM	BH00103AS	RNS		BH	BH	133	X	X					
55994	TDEM	BH00034AS	REAL		BH	BH	133	X	X					
55994	TDEM	BH00035AS	REAL		BH	BH	133	X	X					
55994	TDEM	BH00102AS	RNS		BH	BH	133	X	X					
56094	TDEM	BH00037AS	REAL		BH	BH	133	X	X					
56094	TDEM	BH00038AS	REAL		BH	BH	133	X	X					
56094	TDEM	BH00039AS	REAL		BH	BH	133	X	X					

Table 2-4 (continued)

Location	TM15 Program	Sample Number	QC Code	QC Partner	Sample Type	Completion Type	IHSS	Analyses Requested						
								Rads	Metals	VOA	SVOA	Pest\PCB	Water Qual	Geotech
56094	TDEM	BH00040AS	REAL		BH	BH	133	X	X					
56094	TDEM	BH00104AS	RNS		BH	BH	133	X	X					
56194	TDEM	BH00043AS	REAL		BH	BH	133	X	X					
56194	TDEM	BH00072AS	REAL		BH	BH	133	X	X					
56194	TDEM	BH00073AS	REAL		BH	BH	133	X	X					
56194	TDEM	BH00074AS	REAL		BH	BH	133	X	X					
56194	TDEM	BH00075AS	REAL	BH00076AS	BH	BH	133	X	X					
56194	TDEM	BH00076AS	DUP	BH00075AS	BH	BH	133	X	X					
56194	TDEM	BH00077AS	REAL		BH	BH	133	X	X					
56194	TDEM	BH00105AS	RNS		BH	BH	133							
56194	TDEM	BH00107AS	RNS		BH	BH	133	X	X					
56294	GW	BH00026AS	REAL		GEOTECH	MINI	133							X
56294	GW	BH00027AS	REAL		GEOTECH	MINI	133							X
56394	GW	BH00056AS	REAL		GEOTECH	BH	133							X
56494	GW	BH00021AS	REAL		GEOTECH	MINI	133							X
56494	GW	BH00022AS	REAL		GEOTECH	MINI	133							X
56594	GW	BH00058AS	REAL		GEOTECH	MINI	133							X
56594	GW	GW50105AS	REAL		GW	MINI	133	X	X	X	X	X	X	
56594	GW	GW50110AS	TB		GW	MINI	133			X				
56694	GW	BH00092AS	REAL		BH	BH	115/196			X				
56694	GW	BH00093AS	REAL		BH	BH	115/196			X				
56694	GW	BH00094AS	REAL		BH	BH	115/196			X				
56694	GW	BH00095AS	REAL	BH00096AS	BH	BH	115/196	X	X		X	X		
56694	GW	BH00096AS	DUP	BH00095AS	BH	BH	115/196	X	X		X	X		
56694	GW	BH00097AS	REAL		BH	BH	115/196			X				
56694	GW	BH00098AS	REAL		BH	BH	115/196	X	X		X	X		
56694	GW	BH00099AS	REAL		BH	BH	115/196			X				
56694	GW	BH00109AS	RNS		BH	BH	115/196	X	X	X	X	X		
56694	GW	BH00110AS	RNS		BH	BH	115/196	X	X	X	X	X		
56694	GW	BH00111AS	REAL		DRUM	BH	115/196	X	X	X	X	X		
56694	GW	BH00112AS	REAL		DRUM	BH	115/196	X	X	X	X	X		
56694	GW	BH00113AS	REAL		DRUM	BH	115/196	X	X	X	X	X		
56694	GW	BH00115AS	RNS		DRUM	BH	115/196	X	X	X	X	X		
56694	GW	BH00116AS	FB		BH	BH	115/196			X				
56694	GW	BH00122AS	REAL		DRUM	BH	115/196	X	X	X	X	X		
56694	GW	BH00134AS	REAL		GEOTECH	BH	115/196							X
56794	GEOTECH	BH00228AS	REAL		GEOTECH	BH	115/196							X
56794	GEOTECH	BH00229AS	REAL		GEOTECH	BH	115/196							X
56794	GEOTECH	BH00230AS	REAL		GEOTECH	BH	115/196							X
56794	GEOTECH	BH00231AS	REAL		GEOTECH	BH	115/196							X
56794	GEOTECH	BH00232AS	REAL		GEOTECH	BH	115/196							X
56794	GEOTECH	BH00233AS	REAL		GEOTECH	BH	115/196							X
56794	GEOTECH	BP00034AS	REAL	BP00035AS	DRUM	BH	115/196	X	X	X	X	X		
56794	GEOTECH	BP00035AS	DUP	BP00034AS	DRUM	BH	115/196	X	X	X	X	X		
56794	GEOTECH	BP00036AS	RNS		DRUM	BH	115/196	X	X	X	X	X		
56894	GEOTECH	BH00216AS	REAL		GEOTECH	BH	115/196							X
56894	GEOTECH	BH00217AS	REAL		GEOTECH	BH	115/196							X
56894	GEOTECH	BH00218AS	REAL		GEOTECH	BH	115/196							X
56894	GEOTECH	BH00219AS	REAL		GEOTECH	BH	115/196							X
56894	GEOTECH	BH00220AS	REAL		GEOTECH	BH	115/196							X
56894	GEOTECH	BH00221AS	REAL		GEOTECH	BH	115/196							X
56894	GEOTECH	BH00222AS	REAL		GEOTECH	BH	115/196							X
56894	GEOTECH	BH00244AS	TB		BH	BH	115/196			X				
56894	GEOTECH	BP00032AS	REAL		DRUM	BH	115/196	X	X	X	X	X		
56894	GEOTECH	BP00033AS	RNS		DRUM	BH	115/196	X	X	X	X	X		
56994	GEOTECH	BH00185AS	REAL		GEOTECH	WELL	115/196							X
56994	GEOTECH	BH00186AS	REAL		GEOTECH	WELL	115/196							X

Table 2-4 (continued)

Location	TM15 Program	Sample Number	QC Code	QC Partner	Sample Type	Completion Type	IHSS	Analyses Requested						
								Rads	Metals	VOA	SVOA	Pest\PCB	Water Qual	Geotech
56994	GEOTECH	BH00187AS	REAL		GEOTECH	WELL	115/196							X
56994	GEOTECH	BH00188AS	REAL		GEOTECH	WELL	115/196							X
56994	GEOTECH	BH00189AS	REAL		GEOTECH	WELL	115/196							X
56994	GEOTECH	BH00190AS	REAL		GEOTECH	WELL	115/196							X
56994	GEOTECH	BH00191AS	REAL		GEOTECH	WELL	115/196							X
56994	GEOTECH	BP00013AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
57094	GEOTECH	BH00138AS	REAL		GEOTECH	WELL	115/196							X
57094	GEOTECH	BH00139AS	REAL		GEOTECH	WELL	115/196							X
57094	GEOTECH	BH00140AS	REAL		GEOTECH	WELL	115/196							X
57094	GEOTECH	BH00141AS	REAL		GEOTECH	WELL	115/196							X
57094	GEOTECH	BH00142AS	REAL		GEOTECH	WELL	115/196							X
57094	GEOTECH	BH00143AS	REAL		GEOTECH	WELL	115/196							X
57094	GEOTECH	BH00144AS	REAL		GEOTECH	WELL	115/196							X
57094	GEOTECH	BH00145AS	REAL		GEOTECH	WELL	115/196							X
57094	GEOTECH	BH00146AS	REAL		GEOTECH	WELL	115/196							X
57094	GEOTECH	BH00147AS	REAL	BH00148AS	DRUM	WELL	115/196	X	X	X	X	X		
57094	GEOTECH	BH00148AS	DUP	BH00147AS	DRUM	WELL	115/196	X	X	X	X	X		
57194	GEOTECH	BH00192AS	REAL		GEOTECH	WELL	115/196							X
57194	GEOTECH	BH00193AS	REAL		GEOTECH	WELL	115/196							X
57194	GEOTECH	BH00194AS	REAL		GEOTECH	WELL	115/196							X
57194	GEOTECH	BH00195AS	REAL		GEOTECH	WELL	115/196							X
57194	GEOTECH	BH00196AS	REAL		GEOTECH	WELL	115/196							X
57194	GEOTECH	BP00014AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
57194	GEOTECH	BP00015AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
57194	GEOTECH	BP00016AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
57194	GEOTECH	BP00017AS	RNS		DRUM	WELL	115/196	X	X	X	X	X		
57194	GEOTECH	BP00018AS	RNS		DRUM	WELL	115/196	X	X	X	X	X		
57194	GEOTECH	BP00029AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
57294	TREAT	BH00090AS	REAL		BH	BH	133							
57294	TREAT	BH00091AS	REAL		DRUM	BH	133	X	X					
57394	GEOTECH	BH00123AS	REAL		GEOTECH	BH	115/196							X
57394	GEOTECH	BH00124AS	REAL		GEOTECH	BH	115/196							X
57394	GEOTECH	BH00125AS	REAL		GEOTECH	BH	115/196							X
57494	GEOTECH	BH00175AS	REAL		GEOTECH	BH	115/196							X
57494	GEOTECH	BH00176AS	REAL		GEOTECH	BH	115/196							X
57494	GEOTECH	BH00177AS	REAL		GEOTECH	BH	115/196							X
57494	GEOTECH	BP00004AS	REAL		DRUM	BH	115/196	X	X	X	X	X		
57594	GW	BH00078AS	REAL		BH	WELL	115/196	X	X		X	X		
57594	GW	BH00079AS	REAL		BH	WELL	115/196			X				
57594	GW	BH00080AS	REAL		BH	WELL	115/196			X				
57594	GW	BH00081AS	REAL		BH	WELL	115/196			X				
57594	GW	BH00082AS	REAL		BH	WELL	115/196	X	X		X	X		
57594	GW	BH00083AS	REAL		BH	WELL	115/196			X				
57594	GW	BH00084AS	REAL		BH	WELL	115/196			X				
57594	GW	BH00085AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
57594	GW	BH00086AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
57594	GW	BH00087AS	REAL		BH	WELL	115/196	X	X	X	X	X		
57594	GW	BH00108AS	RNS		BH	WELL	115/196	X	X					
57594	GW	BH00117AS	RNS		DRUM	WELL	115/196	X	X	X				
57594	GW	BH00121AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
57694	GEOTECH	BH00197AS	REAL		GEOTECH	BH	115/196							X
57694	GEOTECH	BH00198AS	REAL		GEOTECH	BH	115/196							X
57694	GEOTECH	BH00199AS	REAL		GEOTECH	BH	115/196							X
57694	GEOTECH	BH00200AS	REAL		GEOTECH	BH	115/196							X
57694	GEOTECH	BH00201AS	REAL		GEOTECH	BH	115/196							X
57694	GEOTECH	BP00019AS	REAL		DRUM	BH	115/196	X	X	X	X	X		
57694	GEOTECH	BP00022AS	RNS		DRUM	BH	115/196	X	X	X	X	X		

Table 2-4 (continued)

Location	TM15 Program	Sample Number	QC Code	QC Partner	Sample Type	Completion Type	IHSS	Analyses Requested: Rads	Metals	VOA	SVOA	Pest\PCB	Water Qual	Geotech
57794	GEOTECH	BH00128AS	REAL		GEOTECH	BH	115/196							X
57794	GEOTECH	BH00129AS	REAL		GEOTECH	BH	115/196							X
57794	GEOTECH	BH00130AS	REAL		GEOTECH	BH	115/196							X
57794	GEOTECH	BH00131AS	REAL		GEOTECH	BH	115/196							X
57894	GW	GW50141AS	DUP	GW50161AS	GW	MINI	115/196	X	X	X	X	X	X	
57894	GW	GW50142AS	RNS		GW	MINI	115/196	X	X	X	X	X	X	
57894	GW	GW50145AS	TB		GW	MINI	115/196			X				
57894	GW	GW50161AS	REAL	GW50141AS	GW	MINI	115/196	X	X	X	X	X	X	
57894	GW	GW50162AS	TB		GW	MINI	115/196							
57994	GW	BH00044AS	REAL		BH	MINI	115/196			X				
57994	GW	BH00045AS	REAL		BH	MINI	115/196			X				
57994	GW	BH00046AS	REAL		BH	MINI	115/196			X				
57994	GW	BH00047AS	REAL		BH	MINI	115/196	X	X		X	X		
58094	GW	BH00061AS	REAL		GEOTECH	MINI	115/196							X
58094	GW	GW50101AS	RNS		GW	MINI	115/196	X	X	X	X	X	X	
58094	GW	GW50102AS	REAL	GW50103AS	GW	MINI	115/196	X	X	X	X	X	X	
58094	GW	GW50103AS	DUP	GW50102AS	GW	MINI	115/196	X	X	X	X	X	X	
58094	GW	GW50108AS	TB		GW	MINI	115/196			X				
58194	GW	BH00062AS	REAL		GEOTECH	MINI	115/196							X
58294	GW	BH00048AS	REAL		BH	MINI	115/196			X				
58294	GW	BH00049AS	REAL		BH	MINI	115/196			X				
58294	GW	BH00050AS	REAL		BH	MINI	115/196	X	X		X	X		
58394	GEOTECH	BH00223AS	REAL		GEOTECH	WELL	115/196							X
58394	GEOTECH	BH00224AS	REAL		GEOTECH	WELL	115/196							X
58394	GEOTECH	BH00225AS	REAL		GEOTECH	WELL	115/196							X
58394	GEOTECH	BH00226AS	REAL		GEOTECH	WELL	115/196							X
58394	GEOTECH	BH00227AS	REAL		GEOTECH	WELL	115/196							X
58394	GEOTECH	BP00046AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
58494	GW	BH00065AS	REAL		BH	MINI	115/196			X				
58494	GW	BH00066AS	REAL		BH	MINI	115/196			X				
58494	GW	BH00067AS	REAL		BH	MINI	115/196			X				
58494	GW	BH00068AS	REAL		BH	MINI	115/196	X	X		X	X		
58494	GW	BH00069AS	REAL		BH	MINI	115/196			X				
58494	GW	BH00070AS	REAL		BH	MINI	115/196			X				
58494	GW	BH00071AS	REAL		BH	MINI	115/196	X	X		X	X		
58594	GW	BH00063AS	REAL		GEOTECH	MINI	115/196							X
58594	GW	GW50104AS	REAL		GW	MINI	115/196	X	X	X	X	X	X	
58594	GW	GW50109AS	TB		GW	MINI	115/196			X				
58694	GW	BH00051AS	REAL		BH	MINI	115/196			X				
58694	GW	BH00052AS	REAL		BH	MINI	115/196	X	X		X	X		
58794	GW	BH00053AS	REAL		BH	MINI	115/196			X				
58794	GW	BH00054AS	REAL		BH	MINI	115/196	X	X		X	X		
58794	GW	BH00106AS	RNS		BH	MINI	115/196	X	X	X	X	X		
58894	TDEM	BH00064AS	REAL		BH	BH	133	X	X		X	X		
58994	GEOTECH	BH00126AS	REAL		GEOTECH	BH	115/196							X
58994	GEOTECH	BH00127AS	REAL		GEOTECH	BH	115/196							X
59094	GEOTECH	BH00202AS	REAL		GEOTECH	BH	115/196							X
59094	GEOTECH	BH00203AS	REAL		GEOTECH	BH	115/196							X
59094	GEOTECH	BP00023AS	REAL		DRUM	BH	115/196	X	X	X	X	X		
59094	GEOTECH	BP00024AS	RNS		DRUM	BH	115/196	X	X	X	X	X		
59094	GEOTECH	BP00030AS	TB		DRUM	BH	115/196			X				
59194	GEOTECH	BH00238AS	REAL		GEOTECH	WELL	115/196							X
59194	GEOTECH	BH00239AS	REAL		GEOTECH	WELL	115/196							X
59194	GEOTECH	BH00240AS	REAL		GEOTECH	WELL	115/196							X
59194	GEOTECH	BH00241AS	REAL		GEOTECH	WELL	115/196							X
59194	GEOTECH	BH00242AS	REAL		GEOTECH	WELL	115/196							X
59194	GEOTECH	BP00039AS	REAL	BP00040AS	DRUM	WELL	115/196	X	X	X	X	X		

Table 2-4 (continued)

Location	TM15 Program	Sample Number	QC Code	QC Partner	Sample Type	Completion Type	IHSS	Analyses Requested: Rads	Metals	VOA	SVOA	Pest\PCB	Water Qual	Geotech
59194	GEOTECH	BP00040AS	DUP	BP00039AS	DRUM	WELL	115/196	X	X	X	X	X		
59194	GEOTECH	BP00041AS	RNS		DRUM	WELL	115/196	X	X	X	X	X		
59194	GEOTECH	BP00052AS	TB		DRUM	WELL	115/196							
59294	GEOTECH	BH00170AS	REAL		GEOTECH	WELL	115/196							X
59294	GEOTECH	BH00171AS	REAL		GEOTECH	WELL	115/196							X
59294	GEOTECH	BH00172AS	REAL		GEOTECH	WELL	115/196							X
59294	GEOTECH	BH00173AS	REAL		GEOTECH	WELL	115/196							X
59294	GEOTECH	BP00003AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
59494	GW	BH00149AS	RNS		BH	BH	115/196	X	X	X	X	X		
59494	GW	BH00150AS	REAL		BH	BH	115/196			X				
59494	GW	BH00151AS	REAL		BH	BH	115/196			X				
59494	GW	BH00152AS	REAL		BH	BH	115/196	X	X		X	X		
59494	GW	BH00153AS	REAL		BH	BH	115/196			X				
59494	GW	BH00154AS	REAL		BH	BH	115/196			X				
59494	GW	BH00155AS	REAL		BH	BH	115/196	X	X		X	X		
59494	GW	BH00156AS	REAL		BH	BH	115/196			X				
59494	GW	BH00157AS	REAL		BH	BH	115/196			X				
59494	GW	BH00158AS	REAL		BH	BH	115/196			X				
59494	GW	BH00159AS	REAL	BH00160AS	BH	BH	115/196	X	X		X	X		
59494	GW	BH00160AS	DUP	BH00159AS	BH	BH	115/196	X	X		X	X		
59494	GW	BH00165AS	TB		BH	BH	115/196			X				
59594	GEOTECH	BH00132AS	REAL		GEOTECH	WELL	115/196							X
59594	GEOTECH	BH00133AS	REAL		GEOTECH	WELL	115/196							X
59594	GEOTECH	BH00135AS	REAL		GEOTECH	WELL	115/196							X
59594	GEOTECH	BH00136AS	REAL		GEOTECH	WELL	115/196							X
59594	GEOTECH	BH00137AS	REAL		GEOTECH	WELL	115/196							X
59594	GEOTECH	BP00001AS	REAL		DRUM	WELL	115/196			X				
59594	GEOTECH	BP00002AS	REAL		DRUM	WELL	115/196			X				
59594	GEOTECH	BP00006AS	REAL		DRUM	WELL	115/196		X					
59594	GEOTECH	BP00037AS	REAL		DRUM	WELL	115/196		X					
59594	GEOTECH	BP00038AS	RNS		DRUM	WELL	115/196		X					
59694	GEOTECH	BH00211AS	REAL		GEOTECH	WELL	115/196							X
59694	GEOTECH	BH00212AS	REAL		GEOTECH	WELL	115/196							X
59694	GEOTECH	BH00213AS	REAL		GEOTECH	WELL	115/196							X
59694	GEOTECH	BH00214AS	REAL		GEOTECH	WELL	115/196							X
59694	GEOTECH	BH00215AS	REAL		GEOTECH	WELL	115/196							X
59694	GEOTECH	BP00028AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
59694	GEOTECH	BP00031AS	RNS		DRUM	WELL	115/196	X	X					
59794	GEOTECH	BH00178AS	REAL		GEOTECH	WELL	115/196							X
59794	GEOTECH	BH00179AS	REAL		GEOTECH	WELL	115/196							X
59794	GEOTECH	BH00180AS	REAL		GEOTECH	WELL	115/196							X
59794	GEOTECH	BP00005AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
59894	GW	BH00161AS	REAL		BH	WELL	115/196			X				
59894	GW	BH00162AS	REAL		BH	WELL	115/196	X	X		X	X		
59894	GW	BH00163AS	RNS		BH	WELL	115/196	X	X	X	X	X		
59894	GW	BH00164AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
59894	GW	BH00166AS	TB		BH	WELL	115/196			X				
59894	GW	BP00007AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
59894	GW	BP00010AS	FB		DRUM	WELL	115/196			X				
59894	GW	BP00011AS	REAL		DRUM	WELL	115/196	X	X	X				
59894	GW	BP00012AS	REAL		DRUM	WELL	115/196	X	X	X				
59894	GW	BP00020AS	TB		DRUM	WELL	115/196			X				
59994	TDEM	BH00088AS	REAL		BH	BH	133	X	X	X	X	X		
60094	TDEM	BH00089AS	REAL		BH	BH	133	X	X					
71194	GEOTECH	BH00182AS	REAL		GEOTECH	WELL	115/196							X
71194	GEOTECH	BH00183AS	REAL		GEOTECH	WELL	115/196							X
71194	GEOTECH	BH00184AS	REAL		GEOTECH	WELL	115/196							X

Table 2-4 (continued)

Location	TM15 Program	Sample Number	QC Code	QC Partner	Sample Type	Completion Type	IHSS	Analyses Requested						
								Rads	Metals	VOA	SVOA	Pest\PCB	Water Qual	Geotech
71194	GEOTECH	BP00008AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
71194	GEOTECH	BP00009AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
71194	GEOTECH	BP00021AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
71194	GEOTECH	BP00025AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
71294	GEOTECH	BH00204AS	REAL		GEOTECH	BH	115/196							X
71294	GEOTECH	BH00205AS	REAL		GEOTECH	BH	115/196							X
71294	GEOTECH	BH00206AS	REAL		GEOTECH	BH	115/196							X
71294	GEOTECH	BH00207AS	REAL		GEOTECH	BH	115/196							X
71294	GEOTECH	BH00208AS	REAL		GEOTECH	BH	115/196							X
71294	GEOTECH	BH00209AS	REAL		GEOTECH	BH	115/196							X
71294	GEOTECH	BH00210AS	REAL		GEOTECH	BH	115/196							X
71294	GEOTECH	BP00026AS	REAL		DRUM	BH	115/196	X	X	X	X	X		
71294	GEOTECH	BP00027AS	RNS		DRUM	BH	115/196	X	X	X	X	X		
71394	GW	BH00245AS	REAL		GEOTECH	BH	133							X
71494	GEOTECH	BH00243AS	REAL		GEOTECH	WELL	115/196							X
71494	GEOTECH	BP00042AS	REAL	BP00043AS	DRUM	WELL	115/196	X	X	X	X	X		
71494	GEOTECH	BP00043AS	DUP	BP00042AS	DRUM	WELL	115/196	X	X	X	X	X		
71494	GEOTECH	BP00044AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
71494	GEOTECH	BP00045AS	REAL		DRUM	WELL	115/196	X	X	X	X	X		
71494	GEOTECH	BP00047AS	RNS		DRUM	WELL	115/196	X	X	X	X	X		
71494	GEOTECH	BP00048AS	REAL	BP00049AS	DRUM	WELL	115/196	X	X	X	X	X		
71494	GEOTECH	BP00049AS	DUP	BP00048AS	DRUM	WELL	115/196	X	X	X	X	X		
71494	GEOTECH	BP00050AS	RNS		DRUM	WELL	115/196	X	X	X	X	X		
71494	GEOTECH	BP00051AS	TB		DRUM	WELL	115/196			X				
SS133194	SS	SS00001AS	REAL		SS	SS	115/196	X						
SS133294	SS	SS00002AS	REAL		SS	SS	115/196	X						
SS133394	SS	SS00003AS	REAL		SS	SS	115/196	X						
SS133494	SS	SS00004AS	REAL		SS	SS	115/196	X						
SS133594	SS	SS00005AS	REAL		SS	SS	115/196	X						
SS133694	SS	SS00006AS	REAL		SS	SS	115/196	X						
SS133794	SS	SS00007AS	REAL		SS	SS	115/196	X						
SS133894	SS	SS00008AS	REAL	SS00009AS	SS	SS	115/196	X						
SS133894	SS	SS00009AS	DUP	SS00008AS	SS	SS	115/196	X						
SS133894	SS	SS00010AS	RNS		SS	SS	115/196	X						

Table 2-5
Summary Statistics for Total Metals from Groundwater Samples

Constituent (COCs are ***Bold/Italic***)	OU 5* or Background Data	Number of Samples	Range of Reporting Limits (ug/l)	Percent Detection	Range of Non-detected Concentrations (ug/l)	Range of Detected Concentrations (ug/l)	Mean** Concentration (ug/l)	Standard Deviation**
				Total Concentrations				
Aluminum	Background	149	18 -- 200	91.28	22.6 -- 200	26.8 -- 63,900	3,495.55	7,758.70
	IHSS 115	11	11 -- 200	100	N/A	129.75 -- 42,800	12,623.35	17,019.88
	IHSS 133	4	11 -- 26	100	N/A	47 -- 103,000	45,786.75	42733.07
	Pre-TM15	17	18 -- 200	88.24	200	1,100 -- 357,000	66,186.18	99,719.80
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**45,224.03**	**-32%**
Antimony	Background	141	17 -- 60	16.31	7 -- 70	7.1 -- 86.6	16.37	11.19
	IHSS 115	13	2 -- 60	15	1 -- 30	13.5 -- 13.7	20.22	11.71
	IHSS 133	4	2 -- 13	0	1 -- 6.5	N/A	4.90	2.63
	Pre-TM15	16	17 -- 60	12.5	27 -- 60	39.2 -- 40.8	25.44	8.69
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**20.89**	**-18%**
Arsenic	Background	138	0.7 -- 10,000	11.59	0.7 -- 10	0.8 -- 3.0	1.83	1.76
	IHSS 115	13	1 -- 10	38	1.5 -- 27.3	2.3 -- 12	8.32	7.25
	IHSS 133	3	1 -- 3	33	0.7 -- 4.7	2.6	2.67	2
	Pre-TM15	17	2 -- 10	64.71	3 -- 10	1.1 -- 13.3	5.60	2.98
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**6.41**	**14%**
Barium	Background	149	2.1 -- 200	81.21	100 -- 200	25.9 -- 752	106.13	69.40
	IHSS 115	13	0.4 -- 200	100	N/A	37.1 -- 645	322.93	220.95
	IHSS 133	4	0.4 -- 12	100	N/A	137 -- 619	364.50	197.6
	Pre-TM15	17	16 -- 200	100	N/A	23.7 -- 3,040	873.95	872.28
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**603.33**	**-31%**
Beryllium	Background	148	0.6 -- 5	7.43	0.8 -- 5	0.7 -- 4.8	1.05	0.87
	IHSS 115	13	0.2 -- 5	46	0.5 -- 2.5	0.21 -- 2.6	2.01	0.79
	IHSS 133	3	0.2 -- 1	100	N/A	2.2 -- 6.7	4.07	2.35
	Pre-TM15	17	1 -- 5	64.71	1 -- 5	1.55 -- 29.4	6.38	8.01
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**4.45**	**-30%**
Cadmium	Background	148	2.3 -- 5	11.49	1 -- 11.1	1.1 -- 7.8	1.52	1.07
	IHSS 115	13	1.6 -- 5	15	0.8 -- 2.5	2.1 -- 4.9	2.33	0.94
	IHSS 133	4	1.6 -- 3	0	0.8 -- 1.5	N/A	1.20	0.36
	Pre-TM15	17	2 -- 5	17.65	2 -- 5	4.2 -- 8.2	2.71	1.98
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**2.39**	**-12%**
Calcium	Background	149	17.4 -- 5,000	100	N/A	15,950 -- 186,000	55,030.23	31,667.78
	IHSS 115	13	3.4 -- 5,000	100	N/A	43,800 -- 237,500	100,915.38	56,451.10
	IHSS 133	4	3.4 -- 20	100	N/A	48,100 -- 61,500	53,825.00	6148.92
	Pre-TM15	17	149 -- 5,000	100	N/A	53,200 -- 413,000	117,244.10	84,416.57
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**103,539.70**	**-12%**
Cesium	Background	142	500 -- 1,000	10.56	2 -- 1,000	30 -- 90	151.81	200.34
	IHSS 115	13	20 -- 1,000	0	10 -- 500	N/A	287.29	239.61
	IHSS 133	4	22 -- 79	0	21.5 -- 39.5	N/A	31.83	7.54
	Pre-TM15	17	13 -- 1,000	17.65	32 -- 1,000	13 -- 40	285.71	215.93
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**256.45**	**-10%**
Chromium	Background	145	2 -- 10	41.38	2 -- 14.9	2.1 -- 729	12.30	60.77
	IHSS 115	13	1.8 -- 10	31	0.9 -- 35.5	28 -- 52.1	18.82	17.25
	IHSS 133	4	1.8 -- 3	75	1.5	38.6 -- 110	47.63	45.28
	Pre-TM15	17	3 -- 10	70.59	5 -- 10	9.3 -- 442	84.34	128.03
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**54.97**	**-35%**
Cobalt	Background	148	2.7 -- 50	13.51	2 -- 50	3.2 -- 39.4	7.56	9.69
	IHSS 115	12	1.4 -- 50	58	4 -- 25	5.4 -- 24.5	18.63	7.56
	IHSS 133	4	1.4 -- 7	75	3.5	15.4 -- 34.8	17.67	12.91
	Pre-TM15	17	4 -- 50	70.59	6 -- 50	5.6 -- 161	42.13	41.17
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**30.62**	**-27%**

Table 2-5 (continued)

Constituent (COCs are ***Bold/Italic***)	OU 5* or Background Data	Number of Samples	Range of Reporting Limits (ug/l)	Percent Detection	Range of Non-detected Concentrations (ug/l)	Range of Detected Concentrations (ug/l)	Mean** Concentration (ug/l)	Standard Deviation**
Copper	Background	148	2 -- 25	54.05	2 -- 77.5	1 -- 105	9.43	11.12
	IHSS 115	13	1.1 -- 25	46	7.2 -- 44.6	2.5 -- 124	41.20	40.53
	IHSS 133	4	1.1 -- 3	75	5.4	26.3 -- 75	34.43	29.25
	Pre-TM15	17	2 -- 25	82.35	25	11.15 -- 420	101.11	128.86
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**70.36**	**-30%**
Iron	Background	149	4.7 -- 100	93.29	11.8 -- 449	6.5 -- 97,000	3,906.27	9,681.12
	IHSS 115	13	2 -- 100	100	N/A	276.8 -- 71,800	25,207.33	27,234.94
	IHSS 133	4	2 -- 7.3	75	141	36,200 -- 110,000	47,435.25	45802.5
	Pre-TM15	17	5 -- 100	88.24	100	3,190 -- 418,000	90,870.00	114,363.70
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**60,653.71**	**-33%**
Lead	Background	141	0.8 -- 3,000	63.12	1 -- 5	1 -- 52.50	3.57	5.53
	IHSS 115	13	0.9 -- 3	62	1.5	1.3 -- 74.7	24.04	27.88
	IHSS 133	4	0.9 -- 2	50	0.45 -- 1	13.5 -- 34.1	12.26	15.76
	Pre-TM15	17	1 -- 5	88.24	5	1.2 -- 240	54.72	69.08
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**37.99**	**-31%**
Lithium	Background	149	2 -- 100	77.18	3.15 -- 100	1.1 -- 266	33.25	48.46
	IHSS 115	12	1 -- 100	58	5.5 -- 50	15.2 -- 181.5	55.22	48.71
	IHSS 133	4	1 -- 14	100	N/A	23.7 -- 75.8	42.23	23.15
	Pre-TM15	17	2 -- 100	82.35	17 -- 30	5 -- 306	73.72	96.52
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**63.18**	**-14%**
Magnesium	Background	149	29.6 -- 5,000	97.99	5,000	2,465 -- 47,900	10,330.61	7,943.20
	IHSS 115	13	12 -- 5,000	100	N/A	9,505 -- 68,800	23,708.08	15,766.02
	IHSS 133	4	12 -- 37	100	N/A	14,500 -- 26,800	18,675.00	5517.47
	Pre-TM15	17	45 -- 5,000	100	N/A	14,200 -- 113,000	34,694.12	27,169.76
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**28,608.97**	**-18%**
Manganese	Background	149	1 -- 15	90.6	1 -- 15	1.8 -- 1,950	92.17	187.34
	IHSS 115	13	0.5 -- 15	100	N/A	18.45 -- 3,290	1,325.64	1,224.08
	IHSS 133	4	0.5 -- 1	75	5.7	417 -- 1,120	604.18	493.99
	Pre-TM15	17	1 -- 15	100	N/A	14 -- 13,700	2,847.89	3,232.99
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**2,001.89**	**-30%**
Mercury	Background	148	0.2	2.03	0.2 -- 0.22	0.21 -- 0.27	0.10	0.02
	IHSS 115	13	0.2	23	0.1	0.2 -- 0.82	0.17	0.20
	IHSS 133	4	0.2	0	0.1	N/A	0.10	0
	Pre-TM15	17	0.2	29.41	0.2	0.24 -- 3	0.42	0.74
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**0.29**	**-32%**
Molybdenum	Background	150	3.5 -- 200	28	2 -- 200	2.2 -- 80.5	23.84	39.57
	IHSS 115	13	2.5 -- 200	8	6 -- 100	5.2	56.98	48.37
	IHSS 133	3	2.5 -- 3	33	5 -- 8.8	3.5	5.77	2.73
	Pre-TM15	17	7 -- 200	17.65	11 -- 200	11.1 -- 18	46.35	46.38
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**46.85**	**1%**
Nickel	Background	146	11 -- 40	28.08	2 -- 40	2.1 -- 334	12.49	28.44
	IHSS 115	13	3.7 -- 40	54	1.85 -- 20	20.5 -- 41	23.75	11.17
	IHSS 133	4	3.7 -- 12	75	6	25.7 -- 75.5	34.05	29.44
	Pre-TM15	17	10 -- 40	82.35	11 -- 40	13.6 -- 313.0	82.17	92.59
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**54.17**	**-34%**
Potassium	Background	150	675 -- 5,000	76.67	289 -- 5,000	243 -- 8,370	1,730.24	1,177.83
	IHSS 115	13	360 -- 5,000	62	2,500	1,190 -- 11,500	4,912.31	3,679.45
	IHSS 133	4	360 -- 680	100	N/A	1,450 -- 13,700	6,800.00	5086.98
	Pre-TM15	17	640 -- 5,000	82.35	5,000	3,670 -- 49,700	11,681.76	13,052.86
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**8,519.12**	**-27%**
Selenium	Background	145	1.4 -- 5	23.45	1 -- 5	1.05 -- 456	7.64	41.84
	IHSS 115	13	2 -- 5	8	1 -- 6.8	8.3	3.25	2.27
	IHSS 133	4	2 -- 3	0	1 -- 4.3	N/A	1.90	1.61
	Pre-TM15	16	2 -- 5	25	2 -- 5	4.7 -- 126	10.63	30.87
			Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**6.66**	**-37%**

Table 2-5 (continued)

Constituent (COCs are ***Bold/Italic***)	OU 5* or Background Data	Number of Samples	Range of Reporting Limits (ug/l)	Percent Detection	Range of Non-detected Concentrations (ug/l)	Range of Detected Concentrations (ug/l)	Mean** Concentration (ug/l)	Standard Deviation**
Silicon	Background	84	1.4 -- 1,000	100	N/A	1.31 -- 116,000	16,575.34	15,401.00
	IHSS 115	13	9 -- 100	100	N/A	4,770 -- 87,500	32,034.23	28,048.25
	IHSS 133	4	9 -- 120	100	N/A	8,050 -- 140,000	80,287.50	54614.05
	Pre-TM15	17	13 -- 100	100	N/A	7,130 -- 354,000	79,041.47	87,784.49
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --						**61,214.71**	**-23%**
Silver	Background	147	2.1 -- 10	6.8	2 -- 10	2.1 -- 4.8	2.15	1.62
	IHSS 115	12	2 -- 10	17	1 -- 5	8.2 -- 11.2	4.70	2.87
	IHSS 133	4	2 -- 4	0	1 -- 2	N/A	1.25	0.5
	Pre-TM15	17	3 -- 10	23.53	3 -- 10	3.6 -- 53.2	7.35	12.27
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --						**5.65**	**-23%**
Sodium	Background	149	28.3 -- 5,000	98.66	5,000	4,300 -- 194,000	30,081.85	40,019.71
	IHSS 115	13	10 -- 5,000	100	N/A	9,760 -- 184,000	42,593.08	50,373.11
	IHSS 133	4	10 -- 23	100	N/A	34,900 -- 47,100	39,725.00	5251.27
	Pre-TM15	17	55 -- 5,000	100	N/A	13,600 -- 120,000	38,650.00	25,878.96
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --						**40,284.12**	**4%**
Strontium	Background	146	0.8 -- 200	89.73	200	58.1 -- 1,770	313.02	270.75
	IHSS 115	12	0.2 -- 200	100	N/A	232 -- 1,485	585.17	370.58
	IHSS 133	4	0.2 -- 1	100	N/A	367 -- 478	420.75	54.05
	Pre-TM15	17	1 -- 200	100	N/A	344 -- 2,575	789.97	521.38
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --						**670.74**	**-15%**
Thallium	Background	146	0.1 -- 10	8.22	0.9 -- 10	1 -- 1.3	1.58	1.79
	IHSS 115	13	1 -- 100	8	0.5 -- 27.5	3.8	5.59	6.80
	IHSS 133	4	1 -- 4.2	0	0.5 -- 2.1	N/A	1.28	0.68
	Pre-TM15	17	2 -- 10	5.88	3 -- 10	1.3	3.05	1.70
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --						**3.81**	**25%**
Tin	Background	149	5 -- 200	8.05	9.4 -- 200	14.5 -- 53.1	30.68	36.52
	IHSS 115	12	8.9 -- 200	8	4.45 -- 100	40.3	66.10	42.96
	IHSS 133	4	8.9 -- 24	75	4.45	15 -- 29.7	18.34	11.07
	Pre-TM15	17	18 -- 200	35.29	28 -- 200	36.4 -- 300	88.91	64.34
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --						**72.06**	**-19%**
Vanadium	Background	149	3 -- 50	71.14	2 -- 50	2.2 -- 167	14.46	18.72
	IHSS 115	13	1.5 -- 50	62	25	3.6 -- 93.9	43.58	29.95
	IHSS 133	4	1.5 -- 3	75	1.5	60.4 -- 183	80.48	75.64
	Pre-TM15	17	3 -- 50	76.47	4 -- 50	19.85 -- 674	150.03	201.57
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --						**101.15**	**-33%**
Zinc	Background	149	1.7 -- 20	77.18	4.2 -- 36.6	5.9 -- 498	35.85	50.33
	IHSS 115	12	1 -- 20	92	19.8	12.75 -- 261	81.83	84.93
	IHSS 133	4	1 -- 2	75	18.1	75.4 -- 180	87.43	67.45
	Pre-TM15	17	3 -- 20	82.35	20	37.8 -- 982	248.77	288.25
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --						**168.51**	**-32%**

Notes: * = OU 5 data where;

IHSS 115 refers to groundwater samples obtained at IHSS 115 for the groundwater monitoring program as detailed in TM15.

IHSS 133 refers to groundwater samples obtained at IHSS 133 for the groundwater monitoring program as detailed in TM15.

Pre-TM15 refers to samples collected within OU 5 prior to January 1994.

** = Mean and Standard Deviation are calculated assuming data are normally distributed.

ug/l = micrograms per liter. N/A = not applicable.

Table 2-6

Summary Statistics for Dissolved Data from Groundwater Samples

Constituent (COCs are ***Bold/Italic***)	OU 5* or Background Data	Number of Samples	Range of Reporting Limits (ug/l)	Percent Detection	Range of Non-detected Concentrations (ug/l)	Range of Detected Concentrations (ug/l)	Mean** Concentration (ug/l)	Standard Deviation**
Dissolved Concentrations								
Aluminum	Background	248	10 – 200	68.15	5 – 200	5.1 – 8,610	105.38	595.50
	IHSS 115	25	8.6 – 200	24	4.3 – 291.5	26 – 4,900	437.86	1,231.98
	IHSS 133	9	8.6 – 200	0	4.3 – 100	N/A	57.79	50.06
	Pre-TM15	14	18 – 200	21.43	24 – 200	24.2 – 37.7	43.24	37.78
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**251.50**	**482%**
Antimony	Background	248	0.05 – 60	28.23	6 – 60	7.8 – 54.1	15.00	9.95
	IHSS 115	25	2 – 60	12	5.5 – 30	3.8 – 71.9	27.48	13.11
	IHSS 133	9	11 – 60	0	5.5 – 30	N/A	19.33	12.65
	Pre-TM15	14	17 – 60	7.14	27 – 60	39.4	23.17	8.06
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**24.69**	**7%**
Arsenic	Background	220	0.8 – 10	5	0.8 – 10	1 – 15	1.61	1.84
	IHSS 115	27	1 – 10	25.9	0.7 – 5	1.3 – 9.3	3.99	1.96
	IHSS 133	8	1 – 10	13	0.7 – 5	1	2.93	2.22
	Pre-TM15	14	2 – 10	42.86	2 – 10	2.8 – 8.05	3.96	2.55
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**3.81**	**-4%**
Barium	Background	256	0.02 – 200	84.38	40 – 200	23.6 – 203	83.30	33.43
	IHSS 115	25	0.6 – 200	100	N/A	16.75 – 457	196.49	121.26
	IHSS 133	8	0.6 – 200	100	N/A	61.5 – 145	113.80	31.37
	Pre-TM15	14	16 – 200	100	N/A	106 – 647	242.18	150.33
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**196.03**	**-19%**
Beryllium	Background	212	0.2 – 5	2.36	0.3 – 5	0.8 – 4	0.95	0.82
	IHSS 115	26	0.2 – 5	7.7	0.1 – 2.5	0.49 – 0.56	1.79	0.99
	IHSS 133	8	0.2 – 5	0	0.1 – 2.5	N/A	1.40	1.19
	Pre-TM15	14	1 – 5	0	1 – 5	N/A	N/A	N/A
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**1.21**	**N/A**
Cadmium	Background	240	0.1 – 5	13.33	1 – 5	1 – 8.6	1.55	0.99
	IHSS 115	25	2 – 5	4	1 – 2.5	3.1	2.30	0.51
	IHSS 133	8	2 – 5	0	1 – 2.5	N/A	1.81	0.75
	Pre-TM15	14	2 – 5	0	2 – 5	N/A	N/A	N/A
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**1.53**	**N/A**
Calcium	Background	257	15.7 – 5,000	100	N/A	1,700 – 184,000	55,205.54	32,672.70
	IHSS 115	25	7 – 5,000	100	N/A	31,000 – 235,500	98,824.00	54,032.61
	IHSS 133	8	6 – 5,000	100	N/A	25,500 – 72,900	43,850.00	14476.38
	Pre-TM15	14	29 – 5,000	100	N/A	43,300 – 156,000	79,292.86	35,514.55
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**83,648.94**	**5%**
Cesium	Background	212	5 – 2,500	8.96	2 – 2,500	30 – 400	185.41	239.92
	IHSS 115	26	20 – 1,000	0	10 – 500	N/A	393.42	198.81
	IHSS 133	9	43 – 1,000	0	21.5 – 500	N/A	291.73	247.02
	Pre-TM15	14	13 – 1,000	7.14	13 – 1,000	14	272.25	213.82
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**340.12**	**25%**
Chromium	Background	250	2 – 10	24	1 – 13.6	2.2 – 23.2	4.40	3.57
	IHSS 115	26	2 – 10	0	1 – 11.3	N/A	4.65	2.47
	IHSS 133	8	2 – 10	0	1 – 5	N/A	3.00	2.14
	Pre-TM15	14	3 – 10	0	3 – 10	N/A	N/A	N/A
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**3.02**	**N/A**
Cobalt	Background	231	0.02 – 50	9.52	2 – 50	2 – 9.5	6.08	8.53
	IHSS 115	25	2 – 50	28	3 – 25	3.4 – 13.3	17.17	9.98
	IHSS 133	9	2 – 50	11	1 – 25	5.1	12.18	12.23
	Pre-TM15	14	4 – 50	14.29	5 – 50	5.7 – 11.1	11.45	10.72
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**14.57**	**27%**
Copper	Background	250	2 – 25	28.4	1 – 168.5	1.3 – 175	5.74	12.68
	IHSS 115	26	1.6 – 25	11.5	1 – 42.8	3.1 – 12.9	10.75	8.50
	IHSS 133	9	1.6 – 25	11	0.8 – 44.7	2.3	11.09	13.8
	Pre-TM15	14	2 – 25	0	2 – 25	N/A	N/A	N/A
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**7.74**	**N/A**

Table 2-6 (continued)

Constituent (COCs are ***Bold/Italic***)	OU 5* or Background Data	Number of Samples	Range of Reporting Limits (ug/l)	Percent Detection	Range of Non-detected Concentrations (ug/l)	Range of Detected Concentrations (ug/l)	Mean** Concentration (ug/l)	Standard Deviation**
Iron	Background	256	4.7 – 100	62.5	2 – 1,106.5	2.8 – 8,790	86.61	554.79
	IHSS 115	27	1.8 – 100	85.2	3 – 167	32.7 – 29,000	6,924.68	10,872.10
	IHSS 133	9	1.8 – 100	78	0.9 – 6.8	2.1 – 628	161.23	208.91
	Pre-TM15	14	5 – 100	78.57	5 – 45.7	24.7 – 34,900	8,636.80	10,489.84
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**6,186.65**	**-28%**
Lead	Background	251	0.8 – 20	14.74	0.4 – 5.7	0.8 – 64	1.54	4.76
	IHSS 115	26	0.9 – 5	7.7	0.45 – 2.5	4.6 – 5.7	1.89	1.15
	IHSS 133	8	0.9 – 5	13	0.45 – 2.5	0.92	1.35	0.97
	Pre-TM15	14	1 – 3	0	1 – 3	N/A	N/A	N/A
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**1.25**	**N/A**
Lithium	Background	250	2 – 100	70.4	1 – 100	1.2 – 250	33.44	54.22
	IHSS 115	24	1 – 100	20.8	1 – 50	12.5 – 172	47.28	34.04
	IHSS 133	8	1 – 100	50	50	10.6 – 20	31.54	19.97
	Pre-TM15	14	2 – 100	35.71	17 – 100	4.2 – 30	14.96	11.90
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**34.71**	**132%**
Magnesium	Background	254	0.1 – 5,000	96.06	28.5 – 5,000	2,355 – 46,300	10,015.78	8,302.90
	IHSS 115	25	12 – 5,000	100	N/A	8,660 – 68,900	20,942.80	13,316.92
	IHSS 133	9	12 – 5,000	89	2,500	8,090 – 17,000	9,887.78	3903.61
	Pre-TM15	14	45 – 5,000	100	N/A	10,100 – 22,200	15,307.14	4,005.23
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**17,226.25**	**13%**
Manganese	Background	256	1 – 15	60.16	1 – 24.35	1 – 934	30.94	87.98
	IHSS 115	24	0.6 – 15	100	N/A	7.4 – 3,530	1,122.75	1,286.52
	IHSS 133	8	0.6 – 15	100	N/A	1.3 – 843	231.93	356.63
	Pre-TM15	14	1 – 15	92.86	2	286 – 10,500	2,370.71	2,750.95
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**1,347.64**	**-43%**
Mercury	Background	207	0.02 – 0.2	2.42	0.1 – 0.24	0.2 – 0.69	0.11	0.06
	IHSS 115	24	0.2	0	0.1	N/A	0.10	0.00
	IHSS 133	9	0.2	0	0.1	N/A	0.10	0
	Pre-TM15	14	0.2	0	0.2	N/A	N/A	N/A
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**0.07**	**N/A**
Molybdenum	Background	241	3.5 – 200	28.63	2 – 200	2 – 114	19.18	34.02
	IHSS 115	25	3 – 200	4	3.2 – 100	4.6	77.49	40.89
	IHSS 133	9	3 – 200	11	1.5 – 100	12.2	57.81	50.12
	Pre-TM15	14	7 – 200	0	11 – 200	N/A	N/A	N/A
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**51.20**	**N/A**
Nickel	Background	236	0.02 – 40	22.03	2 – 40	2 – 35.8	6.48	6.89
	IHSS 115	26	4.1 – 40	30.8	2.5 – 20	5.9 – 64.6	17.95	11.82
	IHSS 133	8	4.1 – 40	25	2.05 – 20	48 – 87.7	23.16	30.54
	Pre-TM15	14	10 – 40	0	10 – 40	N/A	N/A	N/A
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**13.59**	**N/A**
Potassium	Background	253	0.02 – 5,000	77.87	20 – 5,000	170 – 8,110	1,346.50	1,078.02
	IHSS 115	26	363 – 5,000	50	2,500 – 7,810	783 – 6,550	3,724.73	2,202.46
	IHSS 133	8	381 – 5,000	50	2,500	992 – 1,540	1,879.00	679.89
	Pre-TM15	14	640 – 5,000	92.86	776	813 – 6,110	2,397.07	1,696.68
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**3,029.87**	**26%**
Selenium	Background	220	1.2 – 10	28.64	1 – 5	1 – 607	8.29	44.80
	IHSS 115	27	2 – 5	11.1	1 – 6.55	3.2 – 5.2	2.19	1.31
	IHSS 133	8	2 – 5	13	1 – 2.5	3.2	2.06	0.84
	Pre-TM15	14	2 – 5	14.29	2 – 5	1.5 – 2.3	1.52	0.64
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**1.98**	**30%**
Silver	Background	236	2 – 25	19.92	2 – 10	2.4 – 13,600	60.29	885.11
	IHSS 115	24	2 – 10	4.2	1 – 5	3.8	4.11	1.45
	IHSS 133	8	2 – 10	0	1 – 5	N/A	3.06	2.07
	Pre-TM15	14	3 – 10	0	3 – 10	N/A	N/A	N/A
				Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --			**2.68**	**N/A**

Table 2-6 (continued)

Constituent (COCs are ***Bold/Italic***)	OU 5* or Background Data	Number of Samples	Range of Reporting Limits (ug/l)	Percent Detection	Range of Non-detected Concentrations (ug/l)	Range of Detected Concentrations (ug/l)	Mean** Concentration (ug/l)	Standard Deviation**
Sodium	Background	255	10 – 5,000	98.82	10 – 5,000	4,060 – 252,000	31,887.46	43,627.69
	IHSS 115	26	10 – 5,000	96.2	2,500	7,440 – 192,000	34,492.31	41,256.34
	IHSS 133	8	10 – 5,000	100	N/A	18,000 – 71,900	36,975.00	16874.13
	Pre-TM15	14	55 – 5,000	100	N/A	12,400 – 44,000	28,057.14	10,540.03
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**33,029.17**	**18%**
Strontium	Background	253	0.7 – 200	92.89	100 – 1,000	51.05 – 7,930	351.76	564.63
	IHSS 115	24	0.3 – 200	100	N/A	225.5 – 1,480	600.35	340.45
	IHSS 133	8	0.3 – 200	100	N/A	175 – 419	297.88	87.69
	Pre-TM15	14	1 – 200	100	N/A	280 – 754	475.29	157.06
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**509.69**	**7%**
Thallium	Background	214	0.1 – 200	5.14	0.6 – 10	1 – 328	3.50	23.34
	IHSS 115	26	1 – 10	7.7	0.5 – 7.15	3.9 – 4.1	4.11	1.60
	IHSS 133	9	1 – 10	0	0.5 – 5	N/A	3.41	1.95
	Pre-TM15	14	2 – 10	0	3 – 10	N/A	N/A	N/A
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**2.80**	**N/A**
Tin	Background	236	0.1 – 1,000	28.81	2 – 200	10.7 – 8,830	66.55	574.12
	IHSS 115	25	7.3 – 200	4	3.65 – 100	26.2	79.21	37.94
	IHSS 133	9	7.3 – 200	0	3.65 – 100	N/A	57.76	50.1
	Pre-TM15	13	18 – 200	7.69	28 – 200	29.7	48.60	42.49
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**66.64**	**37%**
Vanadium	Background	249	1.2 – 50	53.82	1 – 50	2.05 – 19.6	7.32	8.00
	IHSS 115	27	1.4 – 50	11.1	1 – 25	1.9 – 12.9	17.65	10.79
	IHSS 133	9	1.4 – 50	11	0.7 – 25	2	14.41	12.56
	Pre-TM15	14	3 – 50	7.14	4 – 50	6.6	10.76	11.07
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**15.14**	**41%**
Zinc	Background	256	1.7 – 20	67.19	1.1 – 48.7	1.3 – 137	13.33	17.85
	IHSS 115	26	1 – 20	73.1	1 – 10	3.4 – 69.7	18.64	16.14
	IHSS 133	9	1 – 20	78	4.4 – 14	4.1 – 23.8	12.44	7.16
	Pre-TM15	14	3 – 20	42.86	3 – 20	2.9 – 46.8	8.38	11.56
	Mean of OU 5 Data and Percent Change from Pre-TM15 Mean –						**14.57**	**74%**

Notes: * = OU 5 data where;

IHSS 115 refers to groundwater samples obtained at IHSS 115 for the groundwater monitoring program as detailed in TM15.

IHSS 133 refers to groundwater samples obtained at IHSS 133 for the groundwater monitoring program as detailed in TM15.

Pre-TM15 refers to samples collected within OU 5 prior to January 1994.

** = Mean and Standard Deviation are calculated assuming data are normally distributed.

ug/l = micrograms per liter. N/A = not applicable.

Table 2-7
Summary Statistics for Radionuclide Data from Groundwater Samples

Constituent (COCs are ***Bold/Italic***)	OU 5* or Background Data	Number of Samples	Range of Activities (pCi/l)	Mean** Activity (pCi/l)	Standard Deviation**
Total Activities					
Americium-241	Background	183	-0.007 -- 0.1	0.006	0.01
	IHSS 115	27	0 -- 0.06	0.01	0.01
	IHSS 133	6	0 -- 0.01	0.00	0
	Pre-TM15	15	-0.007 -- 0.2	0.03	0.05
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean --				**0.02**	**-50%**
Plutonium-238	Background	15	-0.001 -- 0.03	0.003	0.01
	IHSS 115	20	-0.01 -- 0.03	0.00	0.01
	IHSS 133	5	0	0.00	0
	Pre-TM15	2	0.005 -- 0.01	0.007	0
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.001**	**-93%**
Plutonium-239/240	Background	194	-0.006 -- 0.22	0.004	0.02
	IHSS 115	26	0 -- 0.34	0.03	0.07
	IHSS 133	6	0 -- 0.02	0.00	0.01
	Pre-TM15	15	-0.003 -- 1.04	0.098	0.26
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.05**	**-51%**
Uranium-233/234	Background	35	0 -- 164	15.618	38.75
	IHSS 115	15	0 -- 28.72	7.33	7.91
	IHSS 133	4	0.69 -- 1.5	1.14	0.38
	Pre-TM15	14	0.506 -- 49	9.667	12.25
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**7.57**	**-22%**
Uranium-235	Background	35	-0.02 -- 6.29	0.617	1.38
	IHSS 115	15	0.02 -- 1.57	0.34	0.41
	IHSS 133	4	-0.01 -- 0.07	0.04	0.04
	Pre-TM15	14	0.055 -- 4	0.628	0.99
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.43**	**-32%**
Uranium-238	Background	22	0 -- 108	10.84	27.73
	IHSS 115	15	0 -- 30.74	7.53	9.79
	IHSS 133	4	0.38 -- 1.5	1.07	0.51
	Pre-TM15	14	0.399 -- 44	8.553	10.979
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**7.18**	**-16%**
Alpha	Background	23	0.351 -- 362	43.497	94.28
	IHSS 115	10	1.51 -- 73	24.52	23.18
	IHSS 133	3	29 -- 40	34.37	5.5
	Pre-TM15	14	8.1 -- 1,600	213.275	408.8
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**123.49**	**-42%**
Beta	Background	23	0.2 -- 220	24.945	53.34
	IHSS 115	10	1.25 -- 65	20.70	19.42
	IHSS 133	3	24 -- 45.04	32.35	11.18
	Pre-TM15	14	5.5 -- 1,300	158.102	332.38
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**93.24**	**-41%**
Cesium-137	Background	156	-0.594 -- 1.16	0.12	0.33
	IHSS 115	1	0.6 -- 0.6	0.60	N/A
	Pre-TM15	1	0.38	0.38	N/A
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.49**	**29%**

Table 2-7 (continued)

Constituent (COCs are ***Bold/Italic***)	OU 5* or Background Data	Number of Samples	Range of Activities (pCi/l)	Mean** Activity (pCi/l)	Standard Deviation**
Radium-226	Background	6	0.182 -- 0.52	0.355	0.13
	IHSS 115	3	1.62 -- 4.4	2.74	1.47
	IHSS 133	3	0.58 -- 1.7	1.13	0.56
	Pre-TM15	14	0.46 -- 4.4	2.462	1.63
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**2.30**	**-6%**
Strontium-89/90	Background	32	-0.286 -- 1.12	0.215	0.28
	IHSS 115	5	0.356 -- 1.2	0.819	0.40
	IHSS 133	3	0.02 -- 0.47	0.30	0.25
	Pre-TM15	8	-0.48 -- 1.5	0.567	0.62
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.60**	**5%**
Tritium	Background	84	-240 -- 39,030	624.852	4,246.75
	IHSS 115	9	39.3 -- 322.2	162.869	89.60
	IHSS 133	5	-56.4 -- 270.6	134.08	131.65
	Pre-TM15	5	-240 -- 557.69	-2.062	328.26
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**111.89**	**5526%**
Dissolved Activities					
Americium-241	Background	2	0.003 -- 0.02	0.011	0.011
	IHSS 115	3	0.0024	-0.002	0.004
	IHSS 133	3	0 -- 0.01	0.00	0
	Pre-TM15	9	-0.004 -- 0.02	0.004	0.006
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.002**	**-48%**
Plutonium-239/240	Background	1	0.011 -- 0.01	0.011	N/A
	IHSS 115	5	0.0093	0.002	0.004
	IHSS 133	3	0	0.00	0
	Pre-TM15	9	-0.004 -- 0	0	0.002
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.001**	**N/A**
Uranium-233/234	Background	207	-0.024 -- 199.5	6.914	25.439
	IHSS 115	30	0.015 -- 15.055	3.131	3.703
	IHSS 133	8	0.19 -- 1.39	0.60	0.47
	Pre-TM15	19	0.188 -- 11.5	2.701	2.928
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**2.63**	**-3%**
Uranium-235	Background	207	-0.037 -- 4.8	0.195	0.635
	IHSS 115	30	-0.0038 -- 0.846	0.151	0.177
	IHSS 133	8	-0.02 -- 0.28	0.08	0.11
	Pre-TM15	19	-0.006 -- 0.53	0.162	0.162
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.14**	**-11%**
Uranium-238	Background	177	-0.038 -- 135.6	4.832	17.673
	IHSS 115	30	0.011 -- 27.575	2.810	5.145
	IHSS 133	8	0.16 -- 3.59	1.04	1.14
	Pre-TM15	19	0.1412 -- 8.8	2.1087	2.154
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**2.33**	**10%**
Alpha	Background	213	-0.65 -- 312.7	8.354	32.315
	IHSS 115	25	0.061 -- 45.8	5.182	8.774
	IHSS 133	8	0.22 -- 1.36	0.87	0.44
	Pre-TM15	19	0 -- 27	5.162	6.023
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**4.51**	**-13%**

Table 2-7 (continued)

Constituent (COCs are ***Bold/Italic***)	OU 5* or Background Data	Number of Samples	Range of Activities (pCi/l)	Mean** Activity (pCi/l)	Standard Deviation**
Beta	Background	196	-1.5 -- 135.9	4.892	12.23
	IHSS 115	25	-0.0096 -- 19.45	4.972	3.99
	IHSS 133	8	0.35 -- 2.69	1.62	0.86
	Pre-TM15	19	1.41 -- 230	17.661	51.529
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**9.09**	**-49%**
Cesium-137	Background	38	-0.19 -- 2.6	0.42	0.525
	IHSS 115	15	-1.52 -- 0.95	0.11	0.58
	IHSS 133	4	0 -- 0.71	0.26	0.32
	Pre-TM15	2	0 -- 0.08	0.04	0.057
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.13**	**230%**
Radium-226	Background	36	0.055 -- 0.53	0.258	0.111
	IHSS 115	2	0.0245 -- 0.889	0.457	0.612
	Pre-TM15	7	0.2 -- 1.03	0.5	0.279
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.49**	**-2%**
Strontium-89/90	Background	180	-0.396 -- 1.8	0.338	0.306
	IHSS 115	21	0.1131 -- 2.2	0.717	0.491
	IHSS 133	8	-0.1 -- 0.55	0.21	0.22
	Pre-TM15	12	-0.201 -- 1.83	0.603	0.497
Mean of OU 5 Data and Percent Change from Pre-TM15 Mean -				**0.58**	**-3%**

Notes: * = OU 5 data where;
IHSS 115 refers to groundwater samples obtained at IHSS 115 for the groundwater monitoring program as detailed in TM15.
IHSS 133 refers to groundwater samples obtained at IHSS 133 for the groundwater monitoring program as detailed in TM15.
Pre-TM15 refers to samples collected within OU 5 prior to January 1994.
* * = Mean and Standard Deviation are calculated assuming data are normally distributed.
pCi/l = picocuries per liter. N/A = not applicable.

Table 2-8
Summary of Detected Organic Compounds in Groundwater Samples

TM15 Program Chemical (COCs are in ***Bold/Italics***)	Number of Samples	Range of Reporting Limits (ug/kg)	Percent of Samples Above Detection Limit TM15	*Pre-TM15*	Range of Nondetected Concentrations (ug/L)	Range of Detected Concentrations (ug/kg)	Maximum Concentration *Pre-TM15* (ug/kg)
115GW			**Volatile Organic Compounds**				
1,1,1-Trichloroethane	31	0.5 -- 10	6	*<5*	0.25 -- 5	0.3 -- 9	*40*
1,1,2,2-Tetrachloroethane	31	0.5 -- 10	3	*0*	0.25 -- 5	4	*<10*
1,1,2-Trichoroethane	31	0.5 -- 10	3	*0*	0.25 -- 5	2	*<10*
1,1-Dichoroethanel	31	0.5 -- 10	6	*0*	0.25 -- 5	0.4 -- 1	*<10*
1,1-Dichoroethanel	31	0.5 -- 10	10	*<5*	0.25 -- 5	2 -- 5	*32.5*
1,2-Dichoroethanel	26	5 -- 10	12	*<5*	2.5 -- 5	1 -- 3	*4*
Acetone	25	10	4	*<5*	5	8	*4.5*
Carbon Disulfide	26	5 -- 10	4	*0*	2.5 -- 5	1	*<10*
cis-1,2-Dichloroethene	5	0.5	40	*0*	0.25	3	*<0.2*
Mthylene Chloride	31	0.5 -- 10	16	*<5*	0.25 -- 5	2 -- 4	*6*
Tetrachloroethene	31	0.5 -- 10	16	*0*	0.25 -- 5	0.78 -- 24	*<10*
Toluene	31	0.5 -- 10	3	*0*	0.25 -- 5	0.3	*<10*
Trichloroethene	31	0.5 -- 10	16	*<5*	0.25 -- 5	2 -- 50.5	*150*
			Semi-Volatile Organic Compounds				
1,2,3-Trichlorobenzene	5	0.5	20	*0*	0.25	0.2	*<0.2*
2,4-Dimethylphenol	26	10 -- 14	4	*0*	5 -- 100	2	*<10*
2-Methylphenol	26	10 -- 14	4	*0*	5 -- 100	1	*<10*
4-Isopropyltoluene	5	0.5	20	*0*	0.25	0.2	*<0.2*
4-Methylphenol	26	10 -- 14	3.8	*0*	5 -- 100	3	*<10*
Aceaphthene	26	10 -- 14	11.5	*20*	5 -- 100	2 -- 4	*5*
Anthracene	26	10 -- 14	3.8	*0*	5 -- 100	0.5	*<10*
Bis(2-Ethylhexyl)Phthalate	26	10 -- 14	34.6	*20*	5 -- 100	1 -- 6	*3*
Butly Benzyl Phthalate	26	10 -- 14	3.8	*0*	5 -- 100	3	*<10*
Carbazole	22	10 -- 14	4.5	*0*	5 -- 100	4	*<10*
Di-n-Butly Phthalate	26	10 -- 14	15.4	*6.7*	5 -- 100	0.5 -- 3	*2*
Dibenzofuran	26	10 -- 14	3.8	*0*	5 -- 100	2	*<10*
Diethyl Phthalate	26	10 -- 14	23.1	*6.7*	5 -- 100	0.7 -- 5	*6*
Fluoranthene	26	10 -- 14	11.5	*20*	5 -- 100	1 -- 4	*4*
Fluorene	26	10 -- 14	7.7	*20*	5 -- 100	2 -- 3	*4*
Naphthalene	32	0.5 -- 14	9.4	*11.8*	0.25 -- 100	0.6 -- 16	*13*
Phenanthrene	26	10 -- 25	11.5	*20*	5 -- 100	1 -- 4	*6*
Pyrene	26	10 -- 14	11.5	*20*	5 -- 100	1 -- 3	*6.5*
133GW			**Volatile Organic Compounds**				
Methylene Chloride	13	5 -- 10	15	*<5*	2.5 -- 5	2 -- 4	*6*
Acetone	10	10	10	*0*	5	27	*4.5*
			Semi-Volatile Organic Compounds				
Bis(2-Ethylhexy)Phthalate	7	10	14	*20*	5	2	*3*
Butyl Benzyl Phthalate	7	10	14	*0*	5 -- 18	4	*<10*
Di-n-Butyl Phthalate	7	10	14	*6.7*	5	2	*2*
DI-n-Octyl Phthalate	7	10	14	*0*	5	3	*<10*

Notes: * = OU 5 data where;
115GW refers to groundwater samples obtained at IHSS 115 for the groundwater monitoring program as detailed in TM15.
133GW refers to groundwater samples obtained at IHSS 133 for the groundwater monitoring program as detailed in TM15.
** = Mean and Standard Deviation are calculated assuming data are normally distributed.
ug/l = micrograms per liter. N/A = not applicable.

Table 2-9
OU 5 Wind Resuspension Potential Study Results

Location	Aggregate Size Mode Estimate (mm)	Threshold Friction Velocity, u*t- Uncorrected (cm/s) (Figure 3-4) (1)	Bare Soil (m 2) (2)	Vegetation Coverage (m 2) (2,3)	Other Nonerodible Coverage (m 2) (2,3)	Vertical Fraction Embedded
115AQ1	4.00	115	0.30	0.35	0.65	0.35
115AQ2	3.00	100	0.60	0.15	0.25	0.50
115AQ3	4.00	155	0.40	0.35	0.25	0.50
115AQ4	4.00	115	0.20	0.05	0.80	0.50
115AQ5	1.50	75	0.15	0.80	0.25	0.50
115AQ6	0.50	50	0.10	0.90	0.10	0.75
115AQ7	0.75	58	0.55	0.40	0.15	0.50
115AQ8	4.00	115	0.10	0.90	0.65	0.50
115AQ9	1.50	75	0.05	0.95	0.15	0.50
115AQ10	0.75	58	0.05	0.95	0.03	0.80
115AQ11	3.00	100	0.05	0.95	0.25	0.50
115AQ12	1.50	75	0.00	1.00	0.05	0.50
115AQ13	1.00	65	0.25	0.75	0.10	0.50
115AQ14	4.00	115	0.00	1.00	0.70	0.50
115AQ15	0.75	58	0.00	1.00	0.30	0.80
SASH-AQ16	0.75	58	0.20	0.80	0.30	0.50
SASH-AQ17	0.30	40	0.03	0.97	0.30	0.50
209AQ18	4.00	115	0.25	0.40	0.40	0.50
209AQ19	4.00	115	0.20	0.30	0.50	0.50
209AQ20	4.00	115	0.10	0.50	0.65	0.80
W209AQ21	0.50	50	0.10	0.90	0.15	0.50
W209AQ22	0.75	58	0.10	0.90	0.03	0.50
OU3T-1AQ23	0.30	40	0.25	0.70	0.05	0.25
OU3T-2AQ25	0.50	50	0.35	0.60	0.15	0.20
OU3T-3AQ24	2.00	88	0.05	0.25	0.70	0.50
OU3T-4AQ26	0.50	50	0.85	0.10	0.10	0.50

Table 2-9 (continued)

Location	Equivalent Frontal Area of Nonerodible Elements (m 2) (Coverage *[1-emb.frac.])	Lc (Eq. Front. Area/Area of Bare Soil)	Correction Ration (Figure 3-5) (1,4)	Threshold Friction Velocity, u*t- Corrected (cm/s) ([u*t][Ratio])	Equivalent 10-m Wind Speed (mph) (5)
115AQ1	.4225	1.4	10.	1150	418
115AQ2	.125	.2	10.	1000	364
115AQ3	.125	.3	10.	1150	418
115AQ4	.4	2.	10.	1150	418
115AQ5	.125	.8	10.	750	273
115AQ6	.025	.3	10.	50	182
115AQ7	.075	.1	7.	406	148
115AQ8	.325	3.3	10.	1150	418
115AQ9	.075	1.5	10.	750	273
115AQ10	.015	.3	10.	580	211
115AQ11	.0625	1.3	10.	1000	364
115AQ12	.025	#Div/01	infinite	infinite	infinite
115AQ13	.05	.2	10.	650	236
115AQ14	.35	#Div/01	infinite	infinite	infinite
115AQ15	.06	#Div/01	infinite	infinite	infinite
SASH-AQ16	.15	.8	10.	580	211
SASH-AQ17	.15	5.	10.	400	145
209AQ18	.2	.8	10.	1150	418
209AQ19	.25	1.3	10.	1150	418
209AQ20	.13	1.3	10.	1150	418
W209AQ21	.075	.8	10.	500	182
W209AQ22	.0125	.1	7.	406	148
OU3T-1AQ23	.0375	.2	10.	400	145
OU3T-2AQ25	.12	.3	10.	500	182
OU3T-3AQ24	.35	7.	10.	880	320
OU3T-4AQ26	.05	.1	7.	350	127

Table 2-10
Evaluation of Intrinsic Air Permeability

SOIL BOREHOLES							SOIL GAS SURVEY RESULTS						
Location Code	State Plane Coordinates Northing	State Plane Coordinates Easting	Sample No.	Interval Top	Interval Bot.	Soil Description	RFEDS Location Code	Coordinates Northing	Coordinates Easting	Soil Gas Sample Number	Depth (ft)	Intrinsic Air Permeability k (darcy)	Corresponding Soil Type From Report
61293	747522.5	2081148	BH50509AS	3.35	3.6	Gravelly sand w/silt	504093	747595	2081130	SG 50040 AS	5.0	0.03	Clayey sands
			BH50510AS	5.25	5.5	Gravelly sand w/silt	503993	747595	2081170	SG 50039 AS	5.1	0.03	Clayey sands
No associated borehole.							501093	747595	2082250	SG 50010 AS	5.0		
							500993	747595	2082290	SG 50009 AS	5.1		
							500893	747595	2082330	SG 50008 AS	5.1		
							500893	747595	2082330	SG 50387 AS	5.0		
No associated borehole.							543393	747595	2082110	SG 50433 AS	4.8		
							501393	747595	2082130	SG 50013 AS	5.0	NA - Manual pump	
							501293	747595	2082170	SG 50012 AS	5.1		
59793	747552.6	2082128	BH50489AS	2.95	3.2	Sandy clay w/silt	543393	747595	2082110	SG 50433 AS	4.8		
			BH50490AS	6.25	6.5	Sandy clay w/silt	501393	747595	2082130	SG 50013 AS	5.0	NA - Manual pump	
							501293	747595	2082170	SG 50012 AS	5.1	0.03	Clayey sands
59393	747555.2	2081489	BH50466AS	2.75	3	Broken cobbles to clayey sand	515293	747530	2081450	SG 50152 AS	5.1	0.05	Clayey sands
			BH50467AS	5.15	5.4	Clayey sand	515193	747530	2081490	SG 50151 AS	3.1	0.12	Fine sands
							515093	747530	2081530	SG 50150 AS	3.5	0.12	Fine sands
No associated borehole.							542993	747595	2082030	SG 50429 AS	5.0		
							542993	747595	2082030	SG 50457 AS	5.0		
							501593	747595	2082050	SG 50015 AS	5.0	NA - Manual pump	
59193	747569.2	2081261	BH50462AS	0.05	0.3	Clayey sand	503793	747595	2081250	SG 50037 AS	5.1	0.02	Clayey sands
			BH50463AS	5.35	5.6	Clayey siltstone	503693	747595	2081290	SG 50036 AS	5.0	NA - Manual pump	
59593	747576.8	2081786	BH50541AS	4.75	5	Clayey sand w/gravel	502293	747595	2081770	SG 50022 AS	5.0	NA - Manual pump	
			BH50542AS	6.95	7.2	Gravelly sand w/clay	502193	747595	2081810	SG 50021 AS	5.1	NA - Manual pump	
59293	747583.9	2082143	BH50445AS	3.5	3.8	Sandy clay	501393	747595	2082130	SG 50013 AS	5.0	NA - Manual pump	
			BH50446AS	5	5.3	Clayey sand	501293	747595	2082170	SG 50012 AS	5.1	0.05	Clayey sands
No associated borehole.							503793	747595	2081250	SG 50037 AS	5.1		
							503693	747595	2081290	SG 50036 AS	5.0	NA - Manual pump	

Table 2-10 (continued)

SOIL BOREHOLES							SOIL GAS SURVEY RESULTS						
Location Code	State Plane Coordinates Northing	State Plane Coordinates Easting	Sample No.	Interval Top	Interval Bot.	Soil Description	RFEDS Location Code	Coordinates Northing	Coordinates Easting	Soil Gas Sample Number	Depth (ft)	Intrinsic Air Permeability k (darcy)	Corresponding Soil Type From Report
No associated borehole.							502093	747595	2081850	SG 50020 AS	5.0	NA - Manual pump	
							501993	747595	2081890	SG 50019 AS	5.2	NA - Manual pump	
							501993	747595	2081890	SG 50494 AS	5.2	NA - Duplicate	
No associated borehole.							508493	747664	2080970	SG 50084 AS	5.1		
No associated borehole.							514093	747699	2080870	SG 50140 AS	5.0		
							514193	747699	2080910	SG 50141 AS	3.5		
63193	747696.8	2082542	BH50621AS	?	4	Sandy clay w/silt	518993	747695	2082550	SG 50189 AS	5.0	NA - Manual pump	
			BH50622AS	?	6	Clay w/sand & gravel							
61093	747764.3	2081952	BH50607AS	?	4		532493	747770	2081900	SG 50324 AS	5.0	NA - Manual pump	
			BH50608AS	?	6		532393	747770	2082000	SG 50323 AS	5.0	NA - Manual pump	
51092	747768.8	2081497	BH50159AS	3	6	Silty clay w/sand and gravel	527093	747770	2081550	SG 50270 AS	5.1	NA - Manual pump	
60993	747816.5	2081948	BH50593AS	4	?	Claystone	540593	747815	2081950	SG 50405 AS	5.0	NA - Manual pump	
			BH50594AS	6	?	Claystone	540593	747815	2081950	SG 50434 AS	5.0	NA - Manual pump	
59493	747824.2	2081536	BH50524AS	0.75	1	Clayey sand	536693	747820	2081530	SG 50366 AS	3.0	0.05	Clayey sands
			BH50525AS	6.05	6.3	Gravelly sand w/silt	536693	747820	2081530	SG 50463 AS	3.0	NA - Duplicate	
							534793	747825	2081575	SG 50347 AS	5.0	NA - Manual pump	
50992	747842.8	2081536	BH50142AS	2	4.5	1 to 3': Sandy gravel w/cobbles, silt	536893	747840	2081550	SG 50368 AS	5.0	0.05	Clayey sands
			BH50143AS	4.5	6	Silty sand w/gravel and clay	534893	747845	2081555	SG 50348 AS	5.0	NA - Manual pump	
							534893	747845	2081555	SG 50444 AS	5.0	NA - Manual pump	
							526693	747845	2081575	SG 50266 AS	5.1		
							526693	747845	2081575	SG 50373 AS	5.0		
							534693	747845	2081595	SG 50346 AS	5.0	NA - Manual pump	
50892	747882.4	2082279	BH50127AS	2	4	Sandy clay w/silt and trace of gravel	528493	747870	2082250	SG 50284 AS	5.1	0.12	Fine sands
				4	6	Sandy clay w/silt and trace of gravel	522293	747895	2082250	SG 50222 AS	5.0	0.04	Clayey sands
							522393	747895	2082350	SG 50223 AS	5.0	0.01	Clayey sands
50792	747886.1	2082384	BH50110AS	2	4	Sandy gravel w/silt, cobbles	522393	747895	2082350	SG 50223 AS	5.0	0.01	Clayey sands
			BH50109AS	4	6	Sandy gravel w/silt, cobbles	522493	747895	2082450	SG 50224 AS	5.0	0.01	Clayey sands

Table 2-10 (continued)

SOIL BOREHOLES							SOIL GAS SURVEY RESULTS						
Location Code	State Plane Coordinates Northing	State Plane Coordinates Easting	Sample No.	Interval Top	Interval Bot.	Soil Description	RFEDS Location Code	Coordinates Northing	Coordinates Easting	Soil Gas Sample Number	Depth (ft)	Intrinsic Air Permeability k (darcy)	Corresponding Soil Type From Report
58693	747843.6	2081584	BH50373AS	2.8	3.1	Gravelly clay	519793	747795	2081550	SG 50197 AS	5.2	0.02	Clayey sands
				6.7	7	waste w/gravel	525993	747795	2081575	SG 50259 AS	5.0	NA - Manual pump	
							526093	747795	2081625	SG 50260 AS	3.4	NA - Manual pump	
							537293	747800	2081600	SG 50372 AS	5.0	NA - Manual pump	
							536493	747820	2081570	SG 50364 AS	5.0	NA - Manual pump	
							536493	747820	2081570	SG 50437 AS	5.0	NA - Manual pump	
							536793	747820	2081580	SG 50367 AS	5.0	NA - Manual pump	
							526393	747820	2081600	SG 50263 AS	4.9	0.06	Clayey sands
							534793	747825	2081575	SG 50347 AS	5.0	NA - Manual pump	
							537193	747840	2081600	SG 50371 AS	5.0	NA - Manual pump	
							526693	747845	2081575	SG 50266 AS	5.1	0.07	Clayey sands
							526693	747845	2081575	SG 50373 AS	5.0	0.13	Fine sands
							534693	747845	2081595	SG 50346 AS	5.0	NA - Manual pump	
							534593	747865	2081575	SG 50345 AS	5.0	NA - Manual pump	
							534593	747865	2081575	SG 50466 AS	5.0	NA - Duplicate	
58493	747895	2081653	BH50422AS	3.15	3.4	Gravelly sand w/clay, graphite	540393	747895	2081630	SG 50403 AS	5.0	0.04	Clayey sands
			BH50423AS	5.15	5.4	Graphite	521693	747895	2081650	SG 50216 AS	5.0	0.06	Clayey sands
							521693	747895	2081650	SG 50480 AS	5.0	NA - Duplicate	
58593	747912.3	2081632	BH50428AS	3.15	3.4	Sandy Clay	540393	747895	2081630	SG 50403 AS	5.0	0.04	Clayey sands
			BH50429AS	4.65	4.9	Sandy Clay	521693	747895	2081650	SG 50216 AS	5.0	0.06	Clayey sands
							521693	747895	2081650	SG 50480 AS	5.0	NA - Duplicate	
							535593	747915	2081610	SG 50355 AS	5.0	0.08	Clayey sands
							535593	747915	2081610	SG 50465 AS	5.0	NA - Duplicate	
							534993	747915	2081630	SG 50349 AS	5.0	NA - Manual pump	
							534993	747915	2081630	SG 50435 AS	5.0	NA - Manual pump	
							540293	747915	2081650	SG 50402 AS	5.0	0.10	Fine sands
50692	747914.4	2082505	BH50093AS	4	6	Clayey sand w/silt and gravel, trace	523993	747995	2082450	SG 50239 AS	5.0	0.13	Fine sands
						of cobbles	524093	747995	2082550	SG 50240 AS	5.1	0.02	Clayey sands
			BH50094AS	6	8	Clayey sand w/silt and gravel, trace	522493	747895	2082450	SG 50224 AS	5.0	0.01	Clayey sands
						of cobbles	522593	747895	2082550	SG 50225 AS	5.3	0.01	Clayey sands

Table 2-10 (continued)

SOIL BOREHOLES							SOIL GAS SURVEY RESULTS						
Location Code	State Plane Coordinates Northing	State Plane Coordinates Easting	Sample No.	Interval Top	Interval Bot.	Soil Description	RFEDS Location Code	Coordinates Northing	Coordinates Easting	Soil Gas Sample Number	Depth (ft)	Intrinsic Air Permeability k (darcy)	Corresponding Soil Type From Report
58393	747929.2	2081652	BH50418AS	0	1.5	Clayey sand to 1.0; waste,sand	533293	747920	2081650	SG 50332 AS	5.0	NA - Manual pump	
			BH50419AS	3.25	3.5	Waste,sand, metal	533293	747920	2081650	SG 50376 AS	5.0	0.17	Fine sands
			BH50420AS	6.45	6.7	waste, dried paint	533193	747920	2081700	SG 50331 AS	5.0	NA - Manual pump	
							535093	747935	2081650	SG 50350 AS	4.8	NA - Manual pump	
							535093	747935	2081650	SG 50436 AS	5.0	NA - Manual pump	
							535793	747935	2081670	SG 50357 AS	5.0	NA - Manual pump	
							535793	747935	2081670	SG 50464 AS	5.0	NA - Duplicate	
							535693	747935	2081630	SG 50356 AS	5.0	0.10	Fine sands
No associated borehole.							522693	747895	2082650	SG 50226 AS	5.0		
							522793	747895	2082750	SG 50227 AS	5.1		
							524193	747995	2082650	SG 50241 AS	5.0		
							524193	747995	2082650	SG 50478 AS	5.0	NA - Duplicate	
							524293	747995	2082750	SG 50242 AS	5.1		
50592	748051	2082358	BH50069AS	2	4	Sandy gravel w/cobbles and silt	528993	748020	2082375	SG 50289 AS	4.6	NA - Manual pump	
			BH50070AS	4	6	Sandy gravel w/cobbles and silt	528893	748020	2082400	SG 50288 AS	5.0	NA - Manual pump	
			BH50071AS	6	8	Sandy gravel w/cobbles and silt	528693	748045	2082375	SG 50286 AS	4.5	0.06	Clayey sands
							528793	748045	2082400	SG 50287 AS	4.6	0.06	Clayey sands
							528593	748070	2082375	SG 50285 AS	5.0	0.07	Clayey sands
							524493	748095	2082450	SG 50244 AS	3.4	0.03	Clayey sands
50492	748077.2	2082461	BH50044AS	2	4	Gravelly sand w/clay and silt	523993	747995	2082450	SG 50239 AS	5.0	0.13	Fine sands
			BH50045AS	4	6	Gravelly sand w/clay and silt	524093	747995	2082550	SG 50240 AS	5.1	0.02	Clayey sands
							524493	748095	2082450	SG 50244 AS	3.4	0.03	Clayey sands
							524593	748095	2082550	SG 50245 AS	3.6	0.06	Clayey sands
50392	748088.3	2082630	BH50019AS	3	4.5	Sand and silt	524093	747995	2082550	SG 50240 AS	5.1	0.02	Clayey sands
			BH50020AS	4.5	5.8	Sand and silt	524193	747995	2082650	SG 50241 AS	5.0	0.02	Clayey sands
							524193	747995	2082650	SG 50478 AS	5.0	NA - Duplicate	
							524593	748095	2082550	SG 50245 AS	3.6	0.06	Clayey sands
							524693	748095	2082650	SG 50246 AS	5.0	0.05	Clayey sands

Table 2-11
Summary of Boreholes and Wells Installed Under TM 15

Location	TM15 Program	Type	Measuring Point (ft. MSL)	Ground Surface Elevation (ft. MSL)	Screen Interval (ft)	Total Depth (ft)	Depth to Bedrock (ft)	IHSS/Site	Bedrock Type
56794	Geotech	Borehole		5,995.20		25	14	115/196	Claystone with Some Silt
56894	Geotech	Borehole		5,994.20		33	7.5	115/196	Sandy Siltstone
56994	Geotech	Monitoring Well	6,021.63	6,019.80	14.5-24.5	29	24.45	115/196	Claystone
57094	Geotech	Monitoring Well	5,972.12	5,970.20	24-34	37.5	34	115/196	Claystone with Some Silt
57194	Geotech	Monitoring Well	6,000.02	5,998.10	119-129	150	5.3	115/196	Claystone with Some Silt
57394	Geotech	Borehole		5,938.20		23	7.4	115/196	Claystone with Trace Silt
57494	Geotech	Borehole		5,971.40		36.5	10.5	115/196	Claystone
57694	Geotech	Borehole		5,946.20		36.5	4	115/196	Claystone
57794	Geotech	Borehole		5,985.90		29	6.4	115/196	Claystone with Trace Silt
58394	Geotech	Monitoring Well	5,999.54	5,997.60	3.4-5.4	9.5	5.3	115/196	Claystone
58994	Geotech	Borehole		5,952.10		19.3	4.5	115/196	Claystone
59094	Geotech	Borehole		5,951.80		17	11.5	115/196	Claystone with Some Silt
59194	Geotech	Monitoring Well	6,039.74	6,037.70	24-34	46	33.4	115/196	Claystone
59294	Geotech	Monitoring Well	5,982.73	5,980.80	12-17	32	14	115/196	Sandy Claystone
59594	Geotech	Monitoring Well	6,048.91	6,046.70	27.6-37.6	41	37.5	115/196	Claystone
59694	Geotech	Monitoring Well	5,999.00	5,997.00	6-16	20	16.1	115/196	Claystone
59794	Geotech	Monitoring Well	6,008.88	6,006.40	11-21	25.2	15.5	115/196	Claystone with Trace Silt
71194	Geotech	Monitoring Well	6,008.67	6,006.20	87.5-97.5	150	16	115/196	Claystone
71294	Geotech	Borehole		5,934.40		34.3	7.2	115/196	Claystone
71494	Geotech	Monitoring Well	5,999.80	5,997.70	34-40	48.1	5.3	115/196	Claystone with Some Silt
55394	Groundwater	Small Diameter Well	6,023.55	6,021.60	3.5-8.5	12	6.8	Woman Creek	Claystone with Some Silt
55794	Groundwater	Small Diameter Well	6,010.56	6,007.80	3-8	8	Not Encountered	133.4	Not Encountered
56294	Groundwater	Small Diameter Well	6,018.49	6,017.30	6-16	16	8.9	133.3	Sandy Claystone
56394	Groundwater	Borehole		5,983.60		6	Not Encountered	Woman Creek	Not Encountered
56494	Groundwater	Small Diameter Well	6,012.69	6,011.70	4-14	14	10	133.2	Claystone with Some Silt
56594	Groundwater	Small Diameter Well	5,970.85	5,969.60	3-8	10	6.8	Woman Creek	Silty Claystone
56694	Groundwater	Borehole		5,962.90		150.7	14	115/196	Claystone with Trace Silt
57594	Groundwater	Monitoring Well	5,948.43	5,946.20	79.9-89.9	104.9	16.5	115/196	Claystone
57894	Groundwater	Small Diameter Well	5,950.01	5,949.90	5-10	10	Not Encountered	115/196	Not Encountered
57994	Groundwater	Small Diameter Well	5,941.27	5,939.80	2-7	11	7	115/196	Claystone

Table 2-11 (continued)

Location	TM15 Program	Type	Measuring Point (ft. MSL)	Ground Surface Elevation (ft. MSL)	Screen Interval (ft)	Total Depth (ft)	Depth to Bedrock (ft)	IHSS/Site	Bedrock Type
58094	Groundwater	Small Diameter Well	5,930.91	5,929.60	3-8	12	10	115/196	Claystone with Some Silt
58194	Groundwater	Small Diameter Well	5,930.63	5,928.60	3-8	8	6.6	115/196	Claystone with Trace Silt
58294	Groundwater	Small Diameter Well	5,948.81	5,947.10	2.5	9	3	115/196	Claystone
58494	Groundwater	Small Diameter Well	5,996.38	5,994.80	5-10	13	12	115/196	Claystone
58594	Groundwater	Small Diameter Well	5,920.14	5,917.90	1-6	8	5.4	115/196	Claystone with Some Silt
58694	Groundwater	Small Diameter Well	5,959.96	5,958.50	2-5	9	2.2	115/196	Claystone
58794	Groundwater	Small Diameter Well	5,958.91	5,957.60	2-5	9	1.95	115/196	Claystone
59394	Groundwater	Monitoring Well	5,966.96	5,965.30	77.5-87.5	88.3	14	115/196	Claystone
59494	Groundwater	Borehole		6,026.20		19.9	11.9	115/196	Sandy Siltstone
59894	Groundwater	Monitoring Well	6,028.34	6,025.70	105.1-120.1	132.5	11.9	115/196	Claystone with Some Silt
71394	Groundwater	Monitoring Well	5,985.89	5,983.80	5.6-10.6	13.6	10.5	Woman Creek	Claystone with Trace Silt
55194	TDEM	Small Diameter Well	6,048.69	6,046.10	9-19	19	16.1	TDEM-1	Claystone with Trace Silt
55294	TDEM	Borehole		6,045.30		20	15.25	TDEM-1	Claystone with Trace Silt
55494	TDEM	Small Diameter Well	6,026.88	6,026.00		14	Not Encountered	133.4	Not Encountered
55594	TDEM	Small Diameter Well	6,033.80	6,032.40	3-8	8	4	133.4	Claystone
55694	TDEM	Borehole		6,037.40		16	10.6	133.4	Claystone
55894	TDEM	Borehole		6,040.70		12	6.4	TDEM-2	Claystone
55994	TDEM	Borehole		6,040.30		16	Not Encountered	TDEM-2	Not Encountered
56094	TDEM	Borehole		6,038.70		22	Not Encountered	TDEM-2	Not Encountered
56194	TDEM	Borehole		6,074.70		30	28	Concrete Pad	Claystone with Some Silt
58894	TDEM	Borehole		6,044.00		8	2.7	TDEM-W133	Claystone
59994	TDEM	Borehole		6,043.20		12	Not Encountered	TDEM-1	Not Encountered
60094	TDEM	Borehole		6,042.80		10	Not Encountered	TDEM-1	Not Encountered
57294	Treat	Borehole		6,027.20		8	Not Encountered	133.1	Not Encountered

Table 2-12
Comparison of Concentrations of Organic Chemicals in TM15 Subsurface-Soil Samples with Risk-Based Concentrations (RBCs)

Chemical	Residential Soil RBC (mg/kg)*	Maximum Detected Concentration (mg/kg)	Maximum Detect Concentration Exceeds RBC?	Maximum Nondetected Concentration (mg/kg)	Maximum Nondetected Concentration Exceeds RBC?
Bis(2-ethylhexyl)phthalate	4.57E+01	5.4E-01	No	5.3E-01	No
Bromoform	8.11E+01	2.0E-03	No	1.4E-02	No
Butylbenzyl phthalate	5.4E+04	2.1E+00	No	1.14E+00	No
Cholorform	1.05E+02	3.6E-02	No	1.3E-02	No
Diethyl phthalate	2.2E+05	8.9E-01	No	1.0E+00	No
Di-n-octyl phthalate	5.49E+03	5.0E-02	No	8.9E-01	No
Methylene chloride	8.54E+01	1.5E-01	No	3.0E-02	No

* Source - DOE (1995d)

Table 2-13
Comparison of Concentrations of Organic Chemicals in TM15 Groundwater with Risk-Based Concentrations (RBCs)

Chemical	Residential Groundwater RBC (mg/l)*	Maximum Detected Concentration (mg/l)	Maximum Detect Concentration Exceeds RBC?	Maximum Nondetected Concentration (mg/l)	Maximum Nondetected Concentration Exceeds RBC?
Compoiunds Not Detected in Samples Prior to TM15					
Anthracene	1.9E+01	5.0E-04	No	0.1	No
Butyl benzyl phthalate	7.3E+00	4.0E-03	No	1.0E-01	No
Carbazole	NA	4.0E-03	NA	1.0E-01	NA
Carbon Disulfide	2.76E-02	1.0E-03	No	5.0E-03	No
Dibenzofuran	NA	2.0E-03	NA	1.0E-01	NA
1,1-Dichloroethane	1.01E+00	1.0E-03	No	5.0E-03	No
Cis-1,2-dichloroethene	3.28E-01	3.0E-03	No	2.5E-04	No
2,4-Dimethylphenol	7.3E-01	2.0E-03	No	1.0E-01	No
4-Isopropyltoluene	NA	2.0E-04	NA	2.5E-04	NA
2-Methylphenol	1.83E+00	1.0E-03	No	1.0E-01	No
Di-n-octyl phthalate	7.3E-01	3.0E-03	No	5.0E-03	No
1,1,2,2-Tetrachloroethane	8.95E-05	4.0E-03	Yes**	5.0E-03	Yes**
Tetrachloroethene	1.43E-03	2.4E-02	Yes**	5.0E-03	Yes**
Toluene	9.65E-01	3.0E-04	No	5.0E-03	No
1,2,3-Trichlorobenzene	NA	2.0E-04	NA	2.5E-04	NA
1,1,2-Trichloroethane	3.18E-04	2.0E-03	Yes**	5.0E-03	Yes**
Compoiunds Detected at Lower Concentrations in Samples Collected Prior to TM15					
Acetone	3.65E+00	2.7E-02	NO	5.0E-03	No
Bis(2-ethylhexyl)phthalate	6.07E-03	6.0E-03	NO	1.0E-01	Yes**
Di-n-butyl phthalate	3.65E+00	3.0E-03	NO	1.0E-01	No
Naphthalene	1.46E+00	1.6E-02	NO	1.0E-01	No

* Source - DOE (1995d) ** These concentrations are less than 1,000 times the RBC.

Table 2-14
Comparison of Results of 1993 Wind Tunnel Study and 1995 Rapid Assessment Method

OU 3 Location	Threshold Friction Velocity (cm/s)	
	1993 Wind Tunnel Study (1)	1995 Rapid Assessment Method
T-1	>280	400
T-2	>170	500
T-3	>180	880
T-4	>160	350

Note: (1) Source: DOE, 1994c

Table 2-15
TCLP Extraction Results IHSS 133.2 (Location 57294)

	Total (mg/Kg)	TCLP #1 (mg/L)	TCLP #2 (mg/L)	TCLP #3 (mg/L)	TCLP #4 (mg/L)	TCLP #5 (mg/L)
Aluminum	1,486.6B	0.35B	0.66B	0.3U	0.3U	0.3U
Antimony	29.3	0.3U	0.3U	0.3U	0.3U	0.3U
Arsenic	24.3	0.2U	0.2U	0.2U	0.2U	0.2U
Barium	337.9B	1.18B	1.36B	1.27B	1.52B	1.37B
Beryllium	82.4B	0.09B	0.12B	0.06B	0.13B	0.06B
Cadmium	64.8	0.68B	0.63B	0.67B	0.79B	0.82B
Calcium	1 ,438.7B	227.34B	309.97B	437.5B	387.61B	331.34B
Chromium	140.3	0.05U	0.05U	0.05U	0.05U	0.05U
Cobalt	16.7B	0.05U	0.07U	0.05U	0.05B	0.05U
Copper	1,394.3B	3.77B	9.07B	4.64B	4.67B	2.69B
Iron	62,263.7B	0.2U	0.28B	0.2U	0.2U	0.22B
Lead	825	0.22B	0.51B	0.26B	18.5	0.87B
Magnesium	3,376.3B	26.76B	30.9B	33.71B	35.04B	28.66B
Manganese	525.1B	1.63B	2.39B	1.68B	1.5B	1.17B
Molybdenum	14.3B	0.1U	0.1U	0.1U	0.1U	0.1U
Nickel	195B	0.29B	0.22B	0.27B	0.21B	0.22B
Phosphorus	974.6B	0.5U	0.5U	0.5U	0.5U	0.5U
Selenium	80.8	0.5U	0.5U	0.5U	0.5U	0.51B
Silver	89.9B	0.03U	0.03U	0.03U	0.03U	0.03U
Strontium	54.1B	0.97B	1.11B	1.29B	1.29B	1.08B
Thallium	29.U	0.3U	0.35B	0.31B	0.54B	0.3U
Titanium	282.7B	0.02U	0.02U	0.02U	0.02U	0.02U
Vanadium	61.3B	0.5U	0.5U	0.5U	0.5U	0.5U
Zinc	1,428.3B	7.34B	10.55B	7.7B	8.05B	8.21B

Qualifiers: B=appears in blank
U=Contract detection limit

Table 2-16

Summary of Radionuclide Data for Surface Soils from IHSS 209 and Other Surface Disturbances

Location	Sample Number	Chemical	Results	Units	Error	Qualifier	Validation
SS133194	SS00001AS	Americium-241	0.182	PCI/G	0.061		V
SS133294	SS00002AS	Americium-242	0.042	PCI/G	0.020		V
SS133394	SS00003AS	Americium-243	0.619	PCI/G	0.098		V
SS133494	SS00004AS	Americium-244	0.582	PCI/G	0.107		V
SS133594	SS00005AS	Americium-245	0.432	PCI/G	0.088		V
SS133694	SS00006AS	Americium-246	0.456	PCI/G	0.091		V
SS133794	SS00007AS	Americium-247	0.071	PCI/G	0.032		V
SS133894	SS00008AS	Americium-248	0.045	PCI/G	0.032		V
SS133894	SS00009AS*	Americium-249	0.018	PCI/G	0.018		V
SS133194	SS00001AS	Plutonium-239/240	0.771	PCI/G	0.141		V
SS133294	SS00002AS	Plutonium-239/241	0.206	PCI/G	0.052		V
SS133394	SS00003AS	Plutonium-239/242	3.252	PCI/G	0.376		V
SS133494	SS00004AS	Plutonium-239/243	3.253	PCI/G	0.390		V
SS133594	SS00005AS	Plutonium-239/244	2.119	PCI/G	0.413		V
SS133694	SS00006AS	Plutonium-239/245	2.452	PCI/G	0.307		V
SS133794	SS00007AS	Plutonium-239/246	0.199	PCI/G	0.050		V
SS133894	SS00008AS	Plutonium-239/247	0.064	PCI/G	0.042		V
SS133894	SS00009AS*	Plutonium-239/248	0.052	PCI/G	0.028		V

* SS00009AS is a field duplicate of SS00008AS.
Refer to Figures 2-16 and 2-17 for sample locations.

3.0 PHYSICAL CHARACTERISTICS OF OU 5

This section provides a broad picture of the physical setting of and around OU 5. More specifically, this section discusses the physiographic features within and surrounding OU 5, the demography and land use of both OU 5 and the surrounding areas, as well as the climate, hydrology, geology and hydrogeology of the area encompassing OU 5 (Figure 3-1).

3.1 PHYSIOGRAPHIC FEATURES

3.1.1 Regional

The RFETS is located on the western margin of the Colorado Piedmont section of the Great Plains Physiographic Province, at an elevation of approximately 6,000 ft above mean sea level (MSL), on a broad eastward-sloping plain of coalescing alluvial fans. The Colorado Piedmont terminates abruptly on the west at the Front Range section of the Southern Rocky Mountain Province (EG&G, 1995a).

The Colorado Piedmont is characterized as an area of dissected topography and denudation, representing an old erosional surface along the eastern margin of the Rocky Mountains. The piedmont surface is broadly rolling and slopes gently to the east with a topographic relief of only several hundred ft. Drainages have been incised and portions of the alluvial cover have been removed by more recent erosional processes (Scott, 1963). The RFETS occupies an area on the eastern edge of the piedmont. In the eastern portions of the Rocky Flats Alluvium pediment, the nearly flat-lying surface gives way to lower, gently rolling terrain of the High Plains section of the Great Plains Physiographic Province (EG&G, 1995a).

The eastern margin of the Front Range, from approximately 4 miles west of RFETS, is characterized by a narrow zone of hogback ridges formed by steeply east-dipping Paleozoic and Mesozoic-aged strata (the Fountain formation and the Dakota Group, respectively). Less resistant sedimentary strata were removed by erosion. Approximately 15 miles west of RFETS, the Front Range reaches elevations of 12,000 to 14,000 ft above MSL. A Precambrian-age basement comprised of igneous and metamorphic rock assemblages make up the core of the Front Range.

Several pediments were developed across both hard and soft bedrock in the area of RFETS during the Quaternary period (Scott 1963). The Rocky Flats pediment is the most extensive of these, forming a broad flat surface east of Coal Creek. The broad pediments and narrow terraces are covered by thin alluvial deposits of ancient streams that once drained eastward into the Great Plains. The sequence of pediments reflects repetitive physical processes associated with cyclic changes in climate. Each erosional surface and stratigraphic sequence deposited on it probably represents a single glacial cycle. The oldest and highest pediment, the Subsummit Surface (Scott 1960), truncates the hogback ridges of the Front Range. Three successively younger pediments, veneered by alluvial gravels (including the Rocky Flats Alluvium), extend eastward from the mountain front. Erosion of valleys into the pediments followed each depositional cycle so that near the mountain fronts, stratigraphically younger geologic units occur at topographically lower elevations as narrow terrace deposits along the streams. These alluvial deposits in the OU 5 area are described in Section 3.6.1.

The industrial area of RFETS is located on a relatively flat surface of Rocky Flats Alluvium (Figure 3-1). The pediment surface has been eroded by Walnut Creek on the north and Woman Creek on the south; subsequently, terraces along these streams range in height from 50 ft to 150 ft. The grade of the gently eastward-sloping surface of the Rocky Flats Alluvium varies from 0.7 percent in the industrial area of RFETS to approximately 2 percent just east of the industrial area.

Surface water that flows from the northern portion of RFETS is drained by Rock Creek, which is a northeast-trending tributary of Coal Creek. The central and southern portions of the site are drained by Walnut Creek, South Walnut Creek, and Woman Creek. These drainages are all ephemeral tributaries of Big Dry Creek that flow eastward. Coal Creek separates all of the streams on the Rocky Flats Alluvium pediment from the Front Range foothills. Small drainage basins and low recharge from snowmelt or rainfall at higher elevations account for the ephemeral nature of the creeks (EG&G, 1995a).

3.1.2 OU 5 Area

The OU 5 study area consists of 11 IHSSs located along the Woman Creek Drainage including the Original Landfill (IHSS 115), the Water Treatment Plant Filter Backwash Pond (IHSS 196), the Ash Pits (IHSSs 133.1 through 133.4, and two previously unidentified ash pits), the Incinerator (IHSS 133.5), the Concrete Wash Pad (IHSS 133.6), Detention Ponds C-1 and C-2 (IHSSs 142.10 and

142.11, respectively), and Surface Disturbance (IHSS 209). Also included are two additional areas of surface disturbances, the Surface Disturbance South of the Ash Pits and the Surface Disturbance West of IHSS 209 (Figure 3-1).

The near-surface geologic materials at OU 5 consist of alluvium, colluvium, valley-fill alluvium, and artificial fill that unconformably overlay bedrock. Artificial fill and disturbed ground occur in localized areas, including the landfill, the ash pits, and the C-1 and C-2 dams.

3.2 DEMOGRAPHY AND LAND USE

Based on information provided by the Population, Economic, and Land Use Database for RFETS (DOE, 1995c), there are no residents within 2 miles of the industrial area of RFETS, and there are no predicted changes in population density through the year 2015. Exact numbers concerning current and future population trends of RFETS are not available. The plant was the largest manufacturing employer in the Denver Metro Area in 1994, employing approximately 6,500 people. However, as the mission changes from production to environmental restoration, employment numbers may continue to decrease until environmental work is complete (DOE, 1995c).

Land use in the vicinity of RFETS consists of residential and limited commercial development, parks, open space, agricultural land, and vacant land. Increased residential development has occurred within 5 miles of RFETS within the last 5 years. Within 5 miles of Rocky Flats, most residential land use, including changes from other land-use categories to residential land use, occurs immediately north, east, and south of Standley Lake. Small parcels of unincorporated residential land are located to the west, northwest, and north of Rocky Flats (DOE, 1995c).

There is limited commercial development within five miles of the plant. The primary exception is the commercial activity servicing the Jefferson County Airport. Industrial land uses within five miles of Rocky Flats are limited to quarrying and mining operations (DOE, 1995c). Other land uses within approximately 5 miles of RFETS include parks and open space, agricultural land, and vacant land (DOE, 1995c). Land uses more specific to OU 5 are discussed below.

Current activities within OU 5 consist of environmental investigations, monitoring, cleanup, and routine security surveillance. Operations and maintenance activities at RFETS are not conducted within OU 5 according to TM12, Exposure Assessment HHRA (DOE, 1995b). OU 5 is currently occupied for the most part by wildlife, and will most likely be preserved as open space or as an ecological reserve.

Ecological surveys of the buffer zone, performed in compliance with the Threatened and Endangered Species Act, have identified the presence of several listed species at RFETS. Because the RFETS buffer zone, including OU 5, has not been impacted by commercial development for many years, thus allowing progressive re-establishment of quality native habitats, the future use of this area as an ecological reserve is reasonable. The Jefferson County Board of Commissioners has also adopted a resolution stating its support of maintaining, in perpetuity, the undeveloped buffer zone of open space around RFETS for environmental, safety, and health reasons (DOE, 1995b). However, portions of OU 5 with suitable topography will be evaluated further for construction of, and subsequent use, as an office complex (DOE, 1995b).

3.3 METEOROLOGY AND CLIMATOLOGY

Meteorology at RFETS is influenced by its proximity to the Front Range. The RFETS is 4 miles east of the Front Range, and the ground elevation rises along the Front Range from 6,000 ft to more than 10,000 ft at a distance of only 20 miles to the west. The RFETS operates a 200-ft meteorological tower that is positioned approximately 1.2 miles northwest of OU 5. This tower provides meteorological data that are representative of the general conditions at RFETS. It gives the nearest, and therefore the most useful, meteorological information applicable to OU 5.

The predominant wind direction at RFETS is from the west and northwest. These winds tend to have greater speeds than winds out of the east and south (EG&G, 1991b). The average annual wind speed in 1991 was 8.7 miles per hour (mph) (EG&G, 1991b). Wind speeds greater than 20 mph occur between 500 and 600 hours per year at RFETS (DOE, 1980). During the winter and spring months, these strong winds, called chinooks, are associated with continental air masses moving over the Rocky Mountains. These winds have been recorded exceeding 120 mph at RFETS (DOE, 1980). During the summer months, localized thunderstorms account for strong wind conditions, which are typically less intense than winter wind phenomena. However, the more characteristic, if not so dramatic, airflow pattern at RFETS is the daily cycle of mountain and valley breezes. During the night, relatively cooler air flows off the east slope of the mountains and displaces warmer air at lower elevations. The windrose for night hours in Figure 3-2 shows this strong westerly component (EG&G, 1991b). Canyons, creek drainages, and ridges tend to channel these downslope winds as they move onto the plains. The downslope flows converge with the South Platte River Valley air flow moving to the north-northeast. During the daytime hours, solar insolation heats up the air along the slopes of the mountains more quickly than the air over the plains and valleys. This warming causes breezes to move upslope out of the valleys toward the mountains. Upslope conditions tend to be less pronounced and less channelized than downslope conditions (EG&G, 1991b). There are spatial and temporal distinctions in the shift from downslope to upslope conditions along the Front Range. The change typically occurs an hour or two earlier in the morning in the vicinity of RFETS than at locations on the east side of the Denver Basin (DOE, 1980).

According to the Pasquill classification, atmospheric stability is most frequently neutral (Class D) at RFETS. During 1991, Class D cases occurred 46.2 percent of the time. Stable conditions, Pasquill Classes E and F, occurred 42.6 percent of the time. Unstable cases, Classes A, B, and C, occurred only 11.2 percent (EG&G, 1991b). Unstable atmospheric conditions enhance vertical pollutant mixing; whereas stable conditions oppose atmospheric turbulence.

The climate at RFETS is characterized as semiarid. Annual climate summaries during 1993 indicated that the 1993 mean temperature of 45.7°F was more than 2°F below the average annual temperature. The annual temperature extremes ranged from a high of 91°F on July 10 and 29 to a low of -10°F on February 16 and November 25. The 1993 peak wind gust of 82 mph occurred on December 31. Precipitation during the year was more than 3 in. below normal, totaling 12.07 in. The largest daily precipitation fell on June 7, when 1.15 in. of rain was recorded. The largest 15-minute rainfall of 0.15 in. was recorded on March 28. Monthly precipitation ranged from 1.79 in. in June to 0.13 in. in January (EG&G, 1993b). Approximately 40 percent of the annual precipitation falls during the spring season, much of it as snow. Thunderstorms during the summer months provide another 30 percent of the annual precipitation (EG&G, 1993b). These thunderstorm events can be intense. On August 6, 1991, for example, 1.15 in. of rain fell within two hours (EG&G, 1991b).

3.4 SOILS

Soils within the OU 5 area have been classified by the Soil Conservation Service Department of Agriculture (Price and Amen, 1980). The location and lateral extent of these soil types within the

OU 5 area were digitized from Digital Line Graph (DLG) data from the Soil Conservation Service (Digital ARC/Info Coverage provided by EG&G RFETSSOIL Coverage) and are presented in Figure 3-6. Table 3-1 lists the major soil units within the OU 5 area, with their classifications and properties.

Most of the soil series shown on Table 3-1 are classified within the Argiustoll great group. Argiustolls are generally characterized as well-drained with dark-colored, humus-rich surface "A" horizons, argillic "B" horizons, and calcic "C" horizons. They exit in aridic and ustic (limited moisture) regimes, which are adequate for plant growth during the growing season. The two predominant subgroups are Torretic and Aridic. Torretic Argiustolls typically have a higher shrink-swell potential than Aridic Argiustolls (Price and Amen, 1980).

The predominant soil type within OU 5 are clay loams of the Denver-Kutch-Midway group (Price and Amen, 1980). These soils occur along the Woman Creek drainage (Figure 3-6). Slope gradients for these soils range from 9 to 25 percent, with the Denver and Kutch soils typically located on the hillslopes of the drainages, while the Midway soils are found on the ridge crests. The Denver clay loams consist of deep, well-drained calcareous clay, silty clay, and sandy clay material derived primarily from claystones, siltstones, and sandstones. The Kutch soils are moderately deep, well-drained, calcarious clayey alluvium and colluvium derived from claystones, siltstones, and sandstones; and from Rocky Flats Alluvium and terrace alluviums. The Midway clay loams are shallow, well-drained, calcarious clayey material derived form Rocky Flats Alluvium. These soils have low permeability and infiltration rates which result in a severe water erosion hazard.

The Woman Creek drainage is covered by the Haverson loam (0-3 percent slopes) (Figure 3-6). This soil type is also present downgradient of Antelope Spring and at IHSS 209. The Haverson loam is a deep, well-drained, stratified alluvium derived from Rocky Flats Alluvium and terrace alluviums; and bedrock claystones, siltstones, and sandstones (Price and Amen, 1980). The infiltration rate and permeablilty for this soil is slow and moderate/slow, respectively. This soil type is associated with slight water erosion hazards and low shrink-swell potential.

The Leyden-Primen-Standley cobbly clay loams (15 to 50 percent slopes) have limited areal extent east of Pond C-2 and north of the Woman Creek Drainage (Figure 3-6). The Leyden-Primen-Standley series is derived from the Rocky Flats Alluvium, terrace alluvium, and bedrock claystones. The soil mesic Aridic Argiustolls. This series displays a slow infiltration and a slow permeability, severe water erosion hazard, and moderate to high potential for shrinkage-swelling. Leyden soils are moderately deep and well-drained, consisting of calcareous, cobbly and clayey material. The Primen soils are shallow and well-drained. Standley soils are deep and well-drained (Price and Amen, 1980).

The Flatirons very cobbly sandy loams (0 to 3 percent slopes) are only found on ridge tops that consist predominately of Rocky Flats Alluvium. The Surface Disturbance South of the Ash Pits, IHSS 133.5, and the north side of IHSS 115 are all characterized by this soil type (Figure 3-6). The Flatirons soil is deep and well-drained, and is formed in noncalcareous, cobbly, stony, gravelly, and loamy material of the Rocky Flats Alluvium. Slow infiltration rate, slow permeability, slight water erosion hazard, and a moderate shrink-swell potential are associated with this soil type (Price and Amen, 1980).

The Nederland soil skirts the Flatiron soils along the ridges and hillsides of the OU 5 area and consists of very cobbly sandy loam which forms slopes of 15 to 50 percent (Figure 3-6). This soil is deep and well-drained, and formed in cobbly, gravelly and loam alluvium derived from the Rocky Flats Alluvium and terrace alluviums. This soil has moderate permeability and infiltration rate, a severe water erosion hazard, and low shrink-swell potential (Price and Amen, 1980).

3.5 HYDROLOGY

Appendix A (Hydrologic Data Summary Report) provides detailed information regarding the hydrology of OU 5. OU 5 is located within the Woman Creek drainage basin (Figure 3-1), in which water generally flows from west to east. The Woman Creek drainage basin extends eastward from the base of the foothills near the mouth of Coal Creek Canyon to Standley Lake. The portion of the basin that lies within the study area (headwaters to Indiana Street) consists of approximately 2,884 acres. The long-term average annual yield generated by this basin is 32.1 acre ft, with significant average storms producing surface flows of 4 to 7 cubic ft per second (cfs). During extreme precipitation events (greater than 15-year return occurrence based on precipitation) surface flows up to 40 cfs have been generated. Although seasonal flows can be low, Woman Creek receives continuous flow from Antelope Springs Creek. Woman Creek drains OU 5 and discharges, via Mower Ditch, into Mower Reservoir and Standley Lake. During periods of high flow, Woman Creek may discharge directly to Standley Lake (DOE, 1994b).

Detention Ponds C-1 and C-2 are located within the eastern reach of the Woman Creek basin. Pond C-1 is located on the Woman Creek channel; Pond C-2 is located off the Woman Creek channel. Pond C-2 receives relatively minor local flow from its surrounding drainage basin, while receiving the bulk of its flow from the SID, which lies on the northern flank of the Woman Creek basin (Figure 3-1) and crosses under the Woman Creek Diversion Ditch before emptying into the pond. The South Interceptor Ditch collects runoff from the southern side of industrial area and diverts it to Pond C-2. Pond C-2 water is not discharged to Woman Creek, but is pumped to the Broomfield Diversion Ditch (around Great Western Reservoir) approximately semiannually (DOE, 1994b).

The morphology of both Ponds C-1 and C-2 is related to sediment accumulations, which have reduced their storage capacity (DOE, 1993b). Pond C-1 had an estimated storage capacity at the spillway/outlet crest of approximately 6.1 ac-ft at the time of construction. By 1992, this spillway/outlet-crest storage capacity had decreased to approximately 5.2 ac-ft, or a volume reduction of approximately 15 percent (EG&G, 1992e). At the time of construction, Pond C-2 had a principal-spillway storage capacity of approximately 71 ac-ft. By 1992, this capacity had decreased to 70 ac-ft, or a reduction of approximately 1.4 percent (Merrick Engineering, 1992). The relatively small storage reduction from sedimentation in Pond C-2 appears reasonable, because the pond is off-channel and only 15 years old.

It is anticipated that these alterations to pond morphology will continue into the future, especially if additional development takes place onsite or in the upper Woman Creek drainage basin (Appendix A). Minor impacts on pond morphology (primarily affecting Pond C-1, but perhaps also Pond C-2 during larger storms) also could occur if development takes place in the Coal Creek basin and irrigation water continues to discharge into Woman Creek from the Kinnear and Smart 2 Ditches. This would mean that additional sediment might enter either of these ponds. Water/sediment interactions occur as precipitation and runoff erode surface soils as the water flows in open channels, streams, and within ponds (Appendix A).

The Woman Creek drainage basin has several artificial water controls, including the SID, which intercepts runoff and routes this runoff to Pond C-2. This runoff would normally flow into Woman Creek or would percolate into the underlying subsurface materials of the basin. Ponds C-1 and C-2 themselves are artificial water-control structures that temporarily store water and, in the case of Pond

C-2, may export water from the Woman Creek basin to the Walnut Creek basin. The Woman Creek diversion dam routes all Woman Creek flows less than about the 100-year flood peak around Pond C-2. Irrigation inputs to Woman Creek from the Kinnear Ditch and Smart 2 Ditch are artificial water controls that divert water from the Coal Creek basin into the Woman Creek basin (ASI, 1990). The French drain on the 881 Hillside also may be classified as an artificial water control structure that changes the groundwater flow from the 881 Hillside to Woman Creek (Appendix A).

Stream-reach gain/loss studies along Woman Creek, Mower Ditch, and selected tributaries, have been done by Colorado State University (Fedors et al., 1993), and interim study results were discussed in Section 4.1 of TM1 (DOE, 1993b). In addition, EG&G has continued the gain/loss measurements since December 1991. In March 1993, 36 wellpoints were installed along Woman Creek, as described in TM1 (DOE, 1993b). These wellpoints were installed to assess which reaches of Woman Creek are gaining water (flowing from the shallow groundwater system into Woman Creek) and which reaches of Woman Creek are losing water (flowing from Woman Creek into the shallow groundwater system). Locations of these wellpoints are shown on Figure 3-3.

For the wellpoint/stream-water surface elevation monitoring, a reach was assumed to be gaining if the upstream and downstream difference between the average groundwater elevation and surface-water elevation was positive (that is, flow was from the shallow groundwater system into Woman Creek). Conversely, a reach was assumed to be losing if the upstream and downstream difference between the average groundwater elevation and surface-water elevation was negative (flow was from Woman Creek into the shallow groundwater system). For the stream gain/loss study, a reach was assumed to be gaining if the difference between the downstream flow and the upstream flow was positive. Reaches were considered to be losing if the downstream flow and upstream flow difference was negative.

In general, four reaches of Woman Creek and its tributaries can be identified as generally gaining water from the shallow groundwater system on nearly a year-round basis. These include reaches 7-6 and 6-5 on the southwestern tributary flowing into Woman Creek, and reaches 9-10 and 18-19 on Woman Creek (Figure 3-3) (Appendix A). Gaining reach 9-10 is adjacent to IHSS 115; however, this gain is more likely due to inflows from the south bank (i.e., the opposite bank from the Original Landfill location), and seepage input from an old orchard area. (Reach 18-19 lies downgradient from the Old Firing Range.)

Other reaches downstream from Pond C-1 (reach C1-18) and both upstream and downstream from Pond C-2 (reach 20-24) have been identified, based upon existing data, as losing year round. It is uncertain why the reach downstream from Pond C-1 is losing year round. The reach in the vicinity of Pond C-2 most likely loses year round, because it is a manmade channel that is part of the Woman Creek diversion around Pond C-2.

The other Woman Creek reaches range from gaining during the winter and spring months and losing during the rest of the year (reaches 1-2, 2-3, 3-4, 4+5-8, 8-9, 11-12, 17-C1, and 19-20, to gaining for two months or less and losing the rest of the year (reaches 10-11, 12+13-16, 16-17). The gain/loss data is based upon historical data collected by Fedors (1993b). The data presented support the conclusions of Fedors et al., and the additional EG&G gain/loss data on Woman Creek.

3.6 GEOLOGY AND HYDROGEOLOGY

A comprehensive geologic and hydrogeologic framework for RFETS is presented in the Geologic Characterization Report for RFETS (EG&G, 1995a), and the Hydrogeologic Characterization Report (EG&G, 1995b). The Section 3.6.1 summarizes the geologic history, setting, and deposits. Section 3.6.2 presents a discussion of the inferred faults within the OU 5 area. Section 3.6.3 summarizes the OU 5 hydrogeologic setting.

3.6.1 Geologic History, Settings, and Deposits

During the late Cretaceous period, sediments east of the Front Range underwent initial orogenic uplift. As the Cretaceous sea gradually regressed from the west to the east, the Fox Hills beach-front sands, the Laramie delta-plain deposits, and the Arapahoe fluvial deposits prograded eastward over the Pierre Shale prodelta muds. This marine regression was occasionally interrupted by small-scale marine transgressions, which may have been caused by variations in the rate of uplift along the Front Range. During transgressive pulses, thin intervals of Pierre Shale prodelta muds were deposited above the Fox Hills Sandstone. As a result, the Fox Hills Sandstone intertongues with the underlying Pierre Shale (DOE, 1991). During the Pleistocene age the Rocky Flats Alluvium was deposited as an alluvial fan at the base of Coal Creek Canyon. Holocene age uplift has dissected the Rocky Flats Alluvium and deposited the unconsolidated terrace and valley fill sediments along the drainages. Geologic units observed in OU 5 are the Laramie Formation, the Arapahoe Formation, Rocky Flats Alluvium, valley-fill alluvium, colluvium, land slide and artificial fill or manmade deposits. Piney Creek Alluvium and valley-fill alluvium are the same, and are summarized the characteristics of each of the geologic units present in the OU 5 area.

The bedrock that is present in the OU 5 area is predominantly the Laramie Formation (Figure 3-4). Figure 3-5 shows the most recent interpretation of the bedrock elevation in the OU 5 area. The Upper Cretaceous-aged Laramie Formation is approximately 600- to 800-ft thick. It has been informally subdivided into lower and upper members. The Upper Laramie Formation is generally distinguished from the Lower Laramie Formation where the Upper Laramie Formation becomes dominantly composed of fine-grained sedimentary rocks (primarily claystone with no thick sandstone beds). The upper part of the Laramie Formation is approximately 300- to 500-ft thick and consists primarily of olive-gray and yellowish-orange claystones with large ironstone nodules. A few thin coal beds occur in the Upper Laramie Formation, but they are discontinuous. Lenticular beds of platey laminated or friable, calcareous, fine-grained, light olive-gray sandstones are also present and occur with greater frequency at higher levels in the section.

The Upper Cretaceous-aged Arapahoe Formation lies stratigraphically above the Laramie Formation, was deposited by a fluvial system, and is absent or as much as 50-ft thick within the vicinity of RFETS (EG&G, 1995a). The Arapahoe Formation is composed primarily of sandstones and claystones that are very similar to those in the underlying Laramie Formation. This similarity between the upper Laramie and Arapahoe Formations has resulted in confusion distinguishing these two units (EG&G, 1992f and 1995a). Previous works (Van Horn, 1957 and EG&G, 1992f) have described the base of the Arapahoe Formation as a thick, discontinuous conglomerate with clasts composed principally of chert with some granite, gneiss, and schist. As shown on Figure 3-4, only a small amount of Arapahoe Formation is present within the OU 5 area, with most of it located in the southeast portion of the OU and very little in the area of IHSS 133 or IHSS 115.

The sandstone units appear to be composed of channel, point bar, and overbank deposits from meandering and braided streams (Figure 3-7). It has been a point of controversy as to whether these sandstone units are part of the Laramie Formation or part of the Arapahoe Formation. Arapahoe Formation sandstones were previously classified as the No. 1 through No. 5 sandstones (DOE, 1991). However, the most recent study indicates that the No. 1 Sandstone belongs to the Arapahoe Formation, and Sandstones Nos. 2 through 5 belong to the Laramie Formation (EG&G, 1995a). More data have been collected from the No. 1 Sandstone than any of the other sandstone intervals because of its shallow subsurface depth and its hydraulic connection with other units of the UHSU in the eastern portion of the industrialized area, underlying OU 2.

In this report, sandstones and siltstones encountered in drill core collected during the OU 5 investigation are classified as undifferentiated Laramie Formation/Arapahoe Formation due to the inability to differentiate between the Laramie Formation or Arapahoe Formations at RFETS (Figure 3-8). According to Plate 5-9 of the Geologic Characterization Report (EG&G, 1995a), the Arapahoe Formation No. 1 sandstone or equivalent sandstones are interpreted to be present in OU 5, on the east side of IHSS 133, on the northeast side of IHSS 115, and in an area east of the Surface Disturbance South of the Ash Pits (Figure 3-7).

On the basis of the OU 5 investigation, the bedrock encountered in the area of IHSS 115 and IHSS 133 are composed predominantly of claystone with some thin interbeds and laminae of siltstone and sandstone (Appendix B). The claystone was observed to be massive-to-thinly laminated, containing trace ironstone nodules, trace to some organics in the form of leaf imprints, disseminated carbon and trace lignite interbeds, with some thin interbeds and laminae of siltstone and sandstone. Sandstone and siltstone interbeds, from 0.5- to 10-ft thick (Figure 3-8), consisted of very fine-to fine-grained clayey to silty sandstones and sandy to clayey siltstones, slightly friable to well cemented, trace ironstone nodules, cross bedded to laminated with some soft sediment deformation structures and trace fossils, with trace to some disseminated carbon. The environment of deposition appears to be a low-energy fluvial environment.

Unconsolidated material within OU 5 consists predominantly of landslide deposits and Rocky Flats Alluvium. Lesser amounts of artificial fill including waste fill, Piney Creek Alluvium, colluvium, and terrace alluvium exist within the OU 5 boundaries (Figures 3-9 and 3-10). The overall thickness of the unconsolidated material throughout OU 5 ranges from about 2 to approximately 30 ft.

Rocky Flats Alluvium - The Rocky Flats Alluvium was deposited by a system of coalescing alluvial fans aggraded by debris flows and braided streams along the base of the Front Range at the mouth of Coal Creek Canyon (EG&G, 1995a). This unit forms a large (approximately 10 square miles) fan-shaped deposit with bar-and-channel morphology on the Rocky Flats pediment. Eastward-flowing streams have dissected the pediment in several locations, and have exposed Cretaceous-age bedrock in some areas.

According to the Preliminary Surficial Geologic Map of the Rocky Flats Plant and Vicinity (Shroba and Carrera, 1994), the Rocky Flats Alluvium commonly consists of beds and lenses of poorly sorted, clast- and matrix-supported, white to pink, sandy cobbly gravel, gravelly sand, and silty sand. Clasts are commonly subangular quartzite that were derived from Coal Creek Canyon. Clasts of claystone and sandstone are locally present in the lower 20 in. of the unit. Generally, the thickness of this unit is about 3- to 30-ft where pediment deposits overlie Upper Cretaceous-aged bedrock, and about 30 to greater than 100 ft where these deposits overlie valley-fill deposits (Shroba and Carrera, 1994).

Terrace alluvium - This alluvium, as described in the Geologic Characterization Report (EG&G, 1995a), consists predominantly of a slightly cobbly, gravelly, light-grayish-brown to light-reddish-brown, silty sand to clayey silt. Clasts are mostly subangular quartzite. The unit forms small terraces and terrace remnants, about 8 to 33 ft above current stream levels, that lack bar-and-channel morphology and are locally mantled by a thin layer of colluvium. The terrace deposits within OU 5 are probably composed mostly of Broadway and Louviers Alluviums. The thickness of these deposits ranges from about 10 to 20 ft.

Piney Creek Alluvium - The Piney Creek Alluvium and post-Piney Creek Alluvium, undifferentiated, are commonly referred to as valley-fill alluvium in this report. These units consist of channel and terrace deposits in and along most of the ephemeral streams across RFETS. Areas in which Piney Creek Alluvium have been identified (Figure 3-10), consist of materials that are commonly slightly cobbly, grayish-brown, silty sand to sandy, clayey silt in the upper part, and poorly sorted, clast supported, slightly cobbly, gravel in a light-yellowish-brown, clayey, silty sand matrix in the lower part. Clasts are mostly subangular quartzite, with a minor amount of subrounded sandstone that was derived from older Quaternary-aged deposits. Thickness of this unit is about 3 to 15 ft; with an average of about 10 ft (Shroba and Carrera, 1994). The Piney Creek Alluvium contains stage I (Gile et al., 1966) carbonate veinlets and, locally, one or more buried soil "A" horizons about 2- to 3-in. thick, and also may contain expansive clays. The Piney Creek Alluvium forms low terraces approximately 3 to 6 ft above stream level that locally have poorly preserved bar-and-channel morphology.

Colluvium - The colluvial deposits at RFETS are middle Pleistocene to Recent in age and occur along valley slopes. The colluvial material commonly consists of dark-gray to light-reddish-brown, silty sand, sandy silt, clayey silt, and silty clay that contain minor amounts of boulders and cobbles. The unit locally includes clast- and matrix-supported, boulders and cobbles and to coarse to fine to gravel in a silty-clay matrix. These materials are typically wellgraded to poorly graded and unstratified to poorly stratified. Clasts are typically subangular to subrounded; their sedimentologic composition reflects that of the bedrock and surficial deposits from which they were derived. The thickness of these deposits is probably about 3 to 15 ft (Shroba and Carrera, 1994). The colluvium occurs as thin, discontinuous deposits in the western portion of RFETS, and as more broad and laterally extensive deposits in the eastern portion of RFETS (EG&G, 1995a).

Landslide Deposits - Landslide deposits include a wide variety of mass-movement deposits resulting from the downslope transport of unconsolidated-surficial and bedrock material along slip planes. Landslide deposits are common along modern drainage slopes throughout the site and can occur as laterally extensive deposits, as shown in Figure 3-9 (EG&G, 1995a). These deposits consist of materials that are commonly a dark-gray to light-reddish-brown, heterogeneous mixture of unsorted and unstratified surficial material and rock fragments in a wide range of sizes (including clasts that are of the same composition of the bedrock from which they were derived). Generally, the thickness of these units is probably 10 to 30 ft (Shroba and Carrera, 1994).

Artificial Fill - According to the Surficial Geologic Map of the Rocky Flats Environmental Technology Site and Vicinity (EG&G, 1995a), the artificial fill consists of compacted and uncompacted fill material composed of varying amounts of sand and finer material, heterogeneous cobbles and boulders, and refuse. Artificial fill which contains refuse will be referred to as waste fill. The unit locally includes small areas of Rocky Flats Alluvium, claystone, and other unconsolidated deposits. Generally, the thickness of this unit is less than 10 ft, however some of the earthen dams are greater than 30-ft thick.

3.6.2 Inferred Faulting

Inferred bedrock structures within the OU 5 area predominantly consists of three faults that are referred to in the Geologic Characterization Report (EG&G, 1995a). These inferred faults trend north-

northeast and are assumed to be high-angle reverse faults in conformance with the regional structural framework, as shown in Figure 3-11 (EG&G, 1995a). The dip of the fault planes is not known.

The longest inferred fault is a northeast-trending reverse fault that extends from Woman Creek to Colorado Highway 128, across the western part of the industrial area and the Landfill Pond (Figure 3-1). It is assumed that the fault plane dips to the west. This fault was confirmed during the past year by a series of boreholes drilled to the north of the Landfill Pond, as part of the Systematic Evaluation Program (SEP) (EG&G, 1995d), and by boreholes drilled in OU 5. This data provided the best control for the location and displacement of the fault. Displacement of the "A" claystone was determined to be about 60 ft at both locations.

Fault 4 is an inferred northeast-trending fault that extends from Woman Creek to South Walnut Creek across OU 2 and into OU 5 (Figure 3-11). It is assumed that the Fault 4 is a reverse fault that dips to the northwest. Displacement in the "A" claystone has been observed to be approximately 70 ft within OU 2. The location of this fault is similar to that of the OU 2 "bedrock step", which was identified using shallow seismic-reflection and borehole data (EG&G, 1995a).

Inferred Fault 5 also extends through OU 5, and is located along the southeastern edge of the Industrial Area (Figure 3-11). Displacement of the "A" claystone across this fault is estimated to be approximately 30 ft (EG&G, 1995a).

Evaluation of geologic and topographic features indicates a lack of recent movement along faults at RFETS. This lack of movement was recently confirmed in the SEP trench, where extensive fracturing was exposed in the bedrock across Fault 2 but was not present in the alluvium and did not offset the unconformity between the Laramie Formation and the overlying Rocky Flats Alluvium (EG&G, 1995a and 1995d). The fault is reported as not capable according to Nuclear Regulatory Commission guidelines and, therefore, does not pose a seismic risk for the site (EG&G, 1995d).

3.6.3 Hydrogeology

The regional hydrogeology and OU 5 hydrogeology are summarized in the following sections.

3.6.3.1 Regional Hydrogeology

The Denver Groundwater Basin underlies a 6,700-square-mile area in Colorado, extending from the Front Range on the west to near Limon on the east, and from Greeley on the north to Colorado Springs on the south. The center of the basin is located south of Bennett, Colorado, in western Arapahoe and Elbert Counties. Alluvial aquifers, 20- to 100-ft thick, commonly occur in the valleys of large streams in the basin.

The four major bedrock aquifers occurring in the Denver Basin, from deepest to shallowest, are the Laramie-Fox Hills Aquifer, the Arapahoe Aquifer, the Denver Aquifer, and the Dawson Aquifer. The Pierre Shale underlies these units and, because of its great thickness (up to 8,000 ft) and low permeability (Robson et al., 1981a and 1981b) is considered to be the base of the four bedrock aquifers listed above. Descriptions of the Denver Basin bedrock aquifers that exist beneath RFETS, the Laramie-Fox Hills Aquifer and the Arapahoe Aquifer, are presented below. The Denver and Dawson Aquifers do not underlie RFETS.

Laramie-Fox Hills Aquifer - The Laramie-Fox Hills Aquifer is composed of the sandstone and siltstone units of the Fox Hills Formation and the lower sandstone units of the Laramie Formation (Figure 3-3). The thickness of the aquifer ranges from 200 to 300 ft near the center of the Denver Basin (Robson et al., 1981b). The RFETS is located near the western boundary of the aquifer. The base of the aquifer dips steeply to the east in the area west of RFETS and then 2 to 3 degrees to the east beneath the site. The upper Laramie Formation, which separates the unconsolidated water-bearing UHSU in OU 5 (Section 3.6.3.2) from the underlying Laramie-Fox Hills Aquifer, consists of several hundred ft of claystones, siltstones, and some clayey or silty sandstones with occasional coal layers (EG&G, 1995a and 1995b).

In outcrop and shallow subcrop areas, recharge to the Laramie-Fox Hills Aquifer occurs as infiltration of incident precipitation and as infiltration of groundwater from shallow alluvial aquifers, respectively. Outcrops of the Laramie and Fox Hills Formations, in clay pits west of RFETS, are believed to be recharge areas for the aquifer (Rockwell, 1987). Toward the interior of the basin, downward leakage may also occur through the upper Laramie Formation from the overlying Arapahoe Aquifer (Robson et al., 198lb). Recharge to the Laramie-Fox Hills Aquifer from vertical leakage through the upper

Laramie Formation is expected to be minimal at RFETS because of the substantial thickness of claystones and siltstones of the upper Laramie Formation.

On a regional scale, groundwater in the Laramie-Fox Hills Aquifer flows from outcrop recharge areas toward the center of the basin. In the vicinity of RFETS, groundwater flow is generally from west to east (Hurr, 1976).

Arapahoe Aquifer - In the central part of the Denver groundwater basin, the Arapahoe Formation consists of a 400- to 700 ft-thick sequence of interbedded claystones, siltstones, sandstones, and conglomerates, with claystones and shale being more prominent in the northern third of the basin (Robson et al. 1981a). Individual sandstone beds are commonly lenticular and range from a few in. to 30- to 40-ft thick (Robson et al., 1981a). Beneath RFETS, the majority of groundwater flow in the Arapahoe Formation occurs in the lenticular sandstones within the claystones. The portion of Arapahoe Aquifer present beneath RFETS at OU 5 is not significant from a regional aquifer perspective because it is truncated by drainages on RFETS and does not extend laterally from RFETS to offsite areas.

Recharge to the Arapahoe Aquifer occurs by the same mechanisms described for the Laramie-Fox Hills Aquifer. In outcrop and subcrop areas, recharge occurs from infiltration of incident precipitation and as infiltration of groundwater from shallow alluvial aquifers, respectively. At RFETS, the Arapahoe Formation sandstones are recharged from infiltration of groundwater from overlying, unconsolidated surface deposits. On a regional scale, the primary recharge mechanism for the Arapahoe Aquifer occurs through leakage from the overlying Denver Aquifer (Robson et al., 1981a).

Groundwater in the Arapahoe Aquifer flows from recharge areas at the edge of the basin toward discharge areas along incised stream valleys. Groundwater also discharges from pumping wells (Robson et al., 1981a).

3.6.3.2 OU 5 Hydrogeology

Saturated, unconsolidated surface deposits and weathered bedrock units of the Arapahoe and/or upper Laramie Formations (Figures 3-4, 3-9, and 3-10) are considered the UHSU. The UHSU is the hydrogeologic unit of concern at RFETS because of the potential for contamination and contaminant migration. The vast majority of site impact has occurred in the UHSU. The unweathered undifferentiated Arapahoe Formation and Laramie Formation are considered the LHSU at RFETS. Contaminant concentrations in the unweathered upper Laramie Formation at RFETS are typically very low, and the Laramie-Fox Hills Aquifer exists at a substantial depth below RFETS with a substantial thickness of unweathered intervening claystones and siltstones separating it from the shallow UHSU (EG&G, 1995b). Therefore, the Laramie Formation and the Laramie-Fox Hills Aquifer are not addressed in the context of OU 5 hydrogeology because the potential for contamination of these units from site-related activities appears to be minimal.

Hydrogeologic conditions in the shallow surface units at OU 5 are influenced by local conditions, local recharge, and interactions with the SID, the 881 Hillside French Drain, and Woman Creek. The earthen dams of Ponds C-1 and C-2 also influence groundwater flow. The SID and Ponds C-1 and C-2 were constructed to contain surface water. The French Drain was constructed south of OU 1 to intercept groundwater flow.

In general, groundwater in the shallow unconsolidated geologic units of OU 5 flows from topographically higher pediment areas (recharge) toward the drainages (i.e., creeks) (discharge) that divide the pediment areas. Groundwater is then transmitted into and through the valley-fill alluvium that underlies the creeks, ultimately discharging to the creeks. The shape of the top of bedrock surface strongly influences groundwater flow by concentrating flow within erosional lows on the bedrock surface. Groundwater recharge to the shallow unconsolidated units occurs primarily as a result of local infiltration of snowmelt, rainfall, and surface water within the OU 5 area. Groundwater recharge also occurs as inflow to OU 5 from upgradient areas to the west and from the industrial area to the north. Artificial sources of recharge from the industrial area occurs from building footing drains, storm drains, and storm surface-water diversion ditches. Standing surface water with marsh-type vegetation observed along the SID suggests that it captures surface and groundwater, and locally affects the recharge to the groundwater system. Antelope Springs, located on the southwest corner of OU 5, receives recharge from Rocky Flats Lake (Figure 3-1).

Upper Hydrostratigraphic Unit - The shallow, saturated hydrogeologic units at OU 5 comprise the UHSU, which consists of unconsolidated surface deposits (Rocky Flats Alluvium, valley-fill alluvium, landslide, artificial fill, and colluvium) and weathered bedrock (claystone, sandstone, siltstone) of the

Arapahoe/Laramie Formations that are in hydraulic communication with the saturated surface materials. The Arapahoe/Laramie Formation sandstones, where they appear to be in hydraulic communication with saturated surface materials, are also considered to be part of the UHSU. The UHSU within OU 5 is believed to exist predominantly under unconfined conditions; however, partially confining conditions may exist in the bedrock sandstones that are part of the UHSU.

Groundwater in the UHSU flows generally eastward, with secondary flow patterns along slopes toward drainages. Groundwater flow in OU 5 is strongly affected by the topographic relief, the thin, relatively permeable surficial deposits, and the underlying impermeable claystone bedrock surface topography. Sitewide, the geometric means of the hydraulic conductivities are 2.54E-03 centimeters per second (cm/sec) for the valley-fill alluvium, 2.1E-04 cm/sec for the Rocky Flats Alluvium, and 9.33E-05 cm/sec for the colluvium, 3.89E-05 cm/sec for the weathered sandstone, 2.88E-05 cm/sec for the weathered siltstone, and 8.82E-07 cm/sec for the weathered claystone (EG&G, 1995b). The colluvium and landslide deposits are similar in textural and hydraulic properties ((Shroba and Carrera, 1994). Hydraulic characteristics of the artificial fill vary depending on the purpose of the fill. Generally, the fill ranges from low hydraulic conductivity, such as the Pond C-2 dam, to relatively high hydraulic conductivity associated with waste-fill materials. Many areas of artificial fill are superficial (road base) and the base of the fill is above the water table.

Groundwater elevations in the UHSU vary seasonally, with the highest elevations recorded during the late winter-spring time period and the lowest elevations recorded during the late summer-fall time period. Seasonal variations in groundwater elevations ranged from less than 1 ft to over 6 ft. The OU 5 area exhibits localized flow from seeps and springs on the slopes of the Woman Creek drainage (EG&G, 1995b). Some of the groundwater emerging at seeps and springs is lost to evaporation; however, some flows along the surface and discharges into Woman Creek. Woman Creek is both a gaining and a losing stream. In the western half of the drainage, Woman Creek is generally gaining, whereas in the eastern half, it is generally losing. The extent of gaining and losing reaches varies seasonally (Fedors and Warner, 1993) as described previously in Section 3.5.

Groundwater level data used for the evaluation of the UHSU were collected from historical and Phase I monitoring wells within the OU 5 area. These data were obtained from RFEDS and are presented in detail in Section 5.8 for the individual IHSSs. Groundwater-level data were used to create UHSU groundwater hydrographs (Section 5.8), and the UHSU potentiometric maps

(Section 5.7 and Figures 3-24, 3-25, 3-35, and 3-36). The potentiometric surface maps were prepared using all available groundwater elevation data. Physical parameter data, used for the evaluation of the hydraulic properties of the UHSU (Appendices A and C, were obtained from aquifer test results [Appendix D]). Descriptions of alluvial and bedrock materials were obtained from lithologic logs (Appendix B).

Lower Hydrostratigraphic Unit - The LHSU underlies the UHSU and is composed of unweathered upper Laramie Formation or Arapahoe Formation clayey to silty sandstones, claystones, and clayey to sandy siltstones. Unweathered bedrock sandstone, siltstone, and claystone geometric mean hydraulic conductivities are 5.77E-07 cm/sec, 1.59E-07 cm/sec, and 2.48E-07 cm/sec, respectively (EG&G, 1995b). The relatively low hydraulic conductivity of the unweathered bedrock suggests that the unweathered bedrock acts as a barrier to downward groundwater flow and effectively minimizes groundwater interaction between units above and below the base of weathering. Hydrograph data indicate unweathered bedrock and UHSU deposits are not hydraulically connected (EG&G, 1995b). Six bedrock wells were installed as part of the scope of TM15 to evaluate possible hydraulic interaction between the UHSU and the LHSU in OU 5, specifically in and around the Original Landfill (IHSS 115/196). Because of the lack of hydraulic connection between the UHSU and the LHSU, the vast majority of contamination occurs in the UHSU. A discussion of the LHSU in the area of the Original Landfill is presented in Section 3.8.1.

3.7 ECOLOGY

3.7.1 Terrestrial Ecosystems

The RFETS is located just below the elevation at which plains grasslands grade abruptly into lower montane (foothills) forests (Marr, 1964). The vegetation of RFETS and adjacent areas is dominated by mixed-grass prairie interspersed with various upland and lowland community types.

Wildlife communities at RFETS have been greatly influenced by the increase in human use and disturbance over the past 100 years. Most notable has been the reduction in the number and diversity of ungulates and predators. The relative isolation and habitat diversity of RFETS have resulted in a rich animal community when compared to nearby rangeland, cropland, and commercial or industrial development. The absence of domestic livestock and the proximity to large areas of open space have contributed significantly to the ecological resources at RFETS.

More information on ecological receptors and potential ecological risk in OU 5 can be found in the ERA for the Woman Creek watershed presented in Section 7.0.

3.7.1.1 Vegetation

Plant communities within OU 5 are influenced primarily by moisture and prior disturbance. Topographic position is the major factor influencing soil moisture. Areas along Woman Creek are persistently moist (mesic) because of subsurface flows within the valley floor alluvium, in addition to runoff and interflow from adjacent hillsides. The stream channel is wet (hydric) for much of the year, although duration of surface flow is variable. North-facing slopes within the drainage are relatively mesic because of the low angle of insolation and the retention of snow. South-facing slopes and ridgetops are not as dry (xeric) as might be expected, probably because of shallow subsurface flow through the Rocky Flats Alluvium that caps the drainage divides.

A complete list of plant species documented at RFETS is supplied in Appendix B of the *Baseline Biological Characterization of Terrestrial and Aquatic Habitats at the Rocky Flats Plant* (DOE, 1992c).

Mesic mixed grassland is the predominant habitat type associated with OU 5, occurring both as large communities and small inclusions in other habitats.. It dominates the north-facing and south-facing hillsides along the upper reaches of Woman Creek and the broad valley floor south and east of the OU 5 IHSSs (Figure 3-12). This habitat tends to be dominated by sod-forming (rhizomatous) grasses. Western wheatgrass *(Agropyron smithii)* is typically the dominant species. Other prevalent graminoids include blue grama *(Bouteloua gracilis)*, side-oats grama *(Bouteloua curtipendula)*, prairie junegrass *(Koeleria pyramidata)*, big bluestem *(Adropogon gerardii)*, little bluestem *(A. scoparium)*, Canada bluegrass *(Poa compressa)*, Kentucky bluegrass *(Poa pratensis)*, needle-and-thread *(Stipa comata)*, green needlegrass *(Stipa viridula)*, sleepygrass *(Stipa robusta)*, switchgrass *(Panicum virgatum)*, and narrowleaf sedge *(Carex stenophylla)*. Fringed sagebrush *(Artemisia frigida)*, prairie sage *(A. ludoviciana)*, and broom snakeweed *(Gutierrizia sarothrae)* are common throughout this habitat. Nonnative species such as knapweed *(Centaurea diffusa)*, cheatgrass *(Bromus tectorum)*, smooth brome *(Bromus inermis)*, and Russian thistle *(Salsola iberica)* also exist. The prevalence of taller and more sod-forming grasses, a generally higher diversity of native forbs, and an increased abundance of low shrubs or subshrubs influences small birds and mammals use.

Xeric-mixed grassland occupies the broad uplands both north of the OU 5 IHSSs and south of Woman Creek (Figure 3-12). This habitat is relatively dry as a result of greater exposure to sun and wind and well-drained soils, but persistent moisture is available at relatively shallow depths in the Rocky Flats Alluvium capping the ridges. As a result, some mesophytic species such as big bluestem and little bluestem are present. Prevalent native species include prairie junegrass, red three-awn *(Aristida purpurea)*, and mountain muhly *(Muhlenbergia montana)*, with varying amounts of blue grama, side-oats grama, and sand dropseed *(Sporobolus cryptandrus)*. Other common species include needle-and-thread, Canada bluegrass, bottlebrush squirreltail *(Sitanion hystrix)*, and narrowleaf sedge. Yucca and cacti are locally common in areas of shallow soil.

Annual grass/forb habitat is located in the surface disturbance south east of Pond C-1 and is dominated by weedy species (Figure 3-12). Prevalent species are usually aggressive, nonnative annual or biennial plants. Weedy mustards, weedy composites, field bindweed *(Convolvulus arvensis)*, and great mullein *(Verbascum thapsus)* dominate these areas, along with cheatgrass and Japanese brome *(Bromus japonicus)*. Cover, height, and seed production may support some wildlife use, but relatively low diversity, extreme seasonality, and short-lived productivity are limiting factors.

Reclaimed grassland generally occurs as distinct plantings north of Woman Creek up to and including patches in the industrial area of RFETS (Figure 3-12). This habitat consists of introduced range or pasture grasses, particularly smooth brome *(Bromopsis inermis)* and intermediate wheatgrass *(Agropyron intermedium)*, with minor amounts of crested wheatgrass *(A. cristatum)*. Many of the stands are nearly a monoculture of the planted species. The low plant diversity and structure of these coarse grasses are important limiting factors on wildlife use.

Riparian woodland habitats are associated with the hydric soils located along a narrow corridor on either side of Woman Creek and along the margins of Ponds C-1 and C-2 (Figure 3-12). This habitat consists of mature plains cottonwoods *(Populus deltoides)* and peachleaf willows *(Salix amygdaloides)*, occurring either as small clumps or individual trees along the drainages, ponds, and seeps. Associated species often include those listed below for riparian shrubland, as well as wild rose

(Rosa spp.*)*, golden currant *(Ribes aureum)*, snowberry *(Symphoricarpos* spp.*)*, and a variety of grasses and forbs. The presence of large trees and seasonal availability of surface water attract wildlife not otherwise associated with the prairie ecosystems that dominate RFETS.

Riparian shrubland also occurs along the Woman Creek corridor, often in association with riparian woodland. Dominant species include coyote willows *(Salix exigua)*, peachleaf willows, and leadplant *(Amorpha fruticosa)*. The shrubby species that dominate this habitat support use by some wetland or riparian wildlife species, but diversity and density are typically lower.

Short marsh habitats occur along Woman Creek and the SID and in groundwater seep areas to the south. It requires seasonally wet (saturated) sites such as hillside seeps (Figure 3-13). They are dominated by sedges, rushes, and hydrophytic forbs. Low plant height, low plant species diversity, dense cover, and wet soil limit the variety of wildlife using this habitat type.

Ponderosa pine woodland occurs as sparse stands on rocky uplands, such as those found in the surface disturbance located south of the south fork of Woman Creek (Figure 3-12). The understory beneath the open pine canopy is typically dominated by native species characteristic of the foothills a few miles west of RFETS. Shrubs in the understory include wax currant *(Ribes cereum)*, skunkbrush *(Rhus trilobata)*, and snowberry. Ponderosa pine *(Pinus ponderosa)* attract wildlife not otherwise present in prairie ecosystems, including a number of species that are eastward extensions of the nearby foothills fauna.

Disturbed communities and/or barren lands occur as small inclusions of other habitat types usually associated with IHSSs. Some IHSSs, such as the old landfill, are essentially devoid of vegetation. Most of the disturbed land has been invaded by annual weeds, such as tumble mustard *(Sisymbrium altissimum)*, tansy mustard *(Descurainia pinnata)*, alyssum *(Alyssum minus)*, prickly lettuce *(Lactuca serriola)*, diffuse knapweed *(Centaria diffusa)*, Russian thistle *(Salsola iberica)*, kochia *(Kochia scoparia)*, and bracted vervain *(Verbena bracteata)*. The lack of cover and food limit wildlife use of this habitat.

3.7.1.2 Wildlife

Large Mammals - Wildlife species within OU 5 are typical of RFETS and similar habitats throughout the Front Range foothills. This semblance is due to a lack of barriers within RFETS and between the western plains and the surrounding foothills. Larger mammals observed within OU 5 include the coyote *(Canis latrans)* and mule deer *(Odocoileus hemionus)*. Both of these species are wide ranging, and the mosaic of habitats within OU 5 is suitable for their use. Raccoons *(Procyon lotor)*, long-tailed weasels *(Mustela frenata)*, striped skunks *(Mephitis mephitis)*, and red foxes *(Vulpes vulpes)* also occur at RFETS in habitats such as those in OU 5.

Small Mammals - The most common and widespread small mammal within OU 5 is the deer mouse *(Peromyscus maniculatus)*, which has been captured in nearly every habitat type. Additional small mammal captures include the meadow vole *(Microtus pennsylvanicus)*, prairie vole *(M. ochrogaster)*, plains harvest mouse *(Reithrodontomys montanus)*, western harvest mouse *(R. megalotus)*, and hispid pocket mouse *(Chaetodipus hispidus)*. Less widely distributed species include the silky pocket mouse *(Perognathus flavus)*, plains pocket mouse *(P. flavescens)*, olive-backed pocket mouse *(P. fasciatus)*, and meadow jumping mouse *(Zapus hudsonius)*.

The meadow jumping mouse is of special interest because the subspecies that occurs at RFETS, Preble's Meadow Jumping Mouse *(Z.h. preblei)*, is a candidate for federal listing as threatened or endangered (Figure 3-14). The Preble's Meadow Jumping Mouse has been captured at OU 5, and a significant amount of suitable habitat occurs there (Figure 3-14). Animals were captured in riparian areas with well-developed shrub canopies and a relatively lush understory of grasses and forbs. This is typical of habitats occupied by the subspecies throughout its range. Quantitative descriptions of small mammal distribution and abundance can be found in the Ecological Monitoring Program 1995 Annual Report (EG&G, 1995f).

Birds - A variety of birds of prey occur at RFETS. The most common species are the red-tailed hawk *(Buteo jamaicensis)* and great horned owl *(Bubo virginianus)*, both are present on the site throughout the year and nest in mature cottonwoods or conifers such as those found in the Woman Creek valley. Other species that breed onsite include the Swainson's hawk *(Buteo swainsonii)*, American kestrel *(Falco sparverius)*, and long-eared owl *(Asio otus)*.

The C-ponds, constructed at RFETS for control of surface-water runoff, support seasonal use by a number of wading birds, shorebirds, waterfowl, and related species. The largest water bird observed at the site is the great blue heron *(Ardea herodias)*, which preys on fish, amphibians, and large macroinvertebrates. Herons are prevalent at Pond C-2 because of its abundant fathead minnow population. The smaller black-crowned night-heron *(Nycticorax nycticorax)* also feeds along the ponds, although less commonly. Neither of these species is known to nest in OU 5, although they use the site during the breeding season.

The most common waterfowl on Ponds C-1 and C-2 are the Canada goose *(Branta canadensis)*, mallard *(Anas platyrhynchos)*, gadwall *(A. strepera)*, green-winged teal *(A. crecca)*, blue-winged teal *(A. discors)*, and pied-billed grebe *(Podilymbus podiceps)*. All of the species listed above nest in wetland vegetation along the margins of the ponds.

The most extensive small bird communities in OU 5 are dominated by ground-nesting species typical of prairie ecosystems in the region. Ridgetops and hillsides support species such as western meadowlark *(Sturnella neglecta)*, vesper sparrow *(Pooecetes gramineus)*, and grasshopper sparrow *(Ammodramus savannarum)*, plus the horned lark *(Eremophila alpestris)* in more xeric habitats.

The presence of mature deciduous trees along Woman Creek riparian corridors attract sarboreal (tree-nesting) species such as the northern flicker *(Colaptes auratus)*, eastern and western kingirds *(Tyrannus tyrannus* and *T. verticalis)*, black-billed magpie *(Pica pica)*, American robin *(Turdus migratorius)*, warbling vireo *(Vireo gilvus)*, yellow warbler *(Dendroica petechia)*, northern oriole *(Icterus galbula)*, blue grosbeak *(Guiraca cyanea)*, and American and lesser goldfinches *(Carduelis tristis* and *C. psaltria)*.

Wetland shrubs and cattails support a songbird community dominated by the red-winged blackbird *(Agelaius phoeniceus)*, common yellowthroat *(Geothlypis trichas)*, song sparrow *(Melospiza melodia)* and less commonly, the yellow-headed blackbird *(Xanthocephalus xanthocephalus)*.

Reptiles and Amphibians - As is typical for the region, reptile and amphibian species are not as numerous as other invertebrates in OU 5. The most common species are the bullsnake *(Pituophis melanoleucus)*, yellow-bellied racer *(Coluber constrictor)*, garter snakes *(Thamnophis* spp.), and prairie rattlesnake *(Crotalus viridis).* All of these species occur in the open grassland habitats that dominate OU 5, although the garter snakes are frequently found in or near water.

By far the most abundant and widespread amphibian at RFETS and within OU 5 is the boreal chorus frog *(Pseudacris triseriata).* This small, wetland-dwelling member of the tree-frog family occurs in virtually every stream, pond, ditch, or other area where surface water persists through the spring and early summer. A true frog, the northern leopard frog *(Rana pipiens)* is completely aquatic and requires permanent water such as is found in the C-ponds.

The Woodhouse's toad *(Bufo woodhousei)* breeds in ponds and streams at the site but may wander considerable distances from water in search of insect prey. The plains spadefoot *(Scaphiopus bombifrons)* requires the least persistent water of any of the amphibians at the site; like true toads such as the Woodhouse's toad, spadefoots spend most of the year in the mud beneath seasonally wet sites.

Arthropods - Four classes of arthropods have been captured during sweep-netting, pitfall-trapping, or opportunistic netting of invertebrates within OU 5: the millipedes (Diplopoda), isopods or pill bugs (Crustacea), spiders and allies (Arachnida), and insects (Insecta) (DOE, 1992c). Of these, the insects were the most abundant and taxonomically diverse group.

The arthropod community in OU 5 provides a prey base for insectivores. Grasshoppers and leafhoppers are probably the most important prey groups because of their abundance, size, and tendency to occur on the foliage of plants, where they are easily detected and captured. Large grasshoppers are also consumed by predators such as kestrels and coyotes.

3.7.2 Aquatic Ecosystems

Aquatic habitats within OU 5 are restricted to the head waters of Woman Creek and its tributaries. Intermittent stream flow with areas of persistent flow typifies Woman Creek in OU 5. Intermittent segments contain isolated pools that provide important habitat for many aquatic species during the late summer and early fall when flow ceases. Persistent flows originate from seeps and springs around SW104, a surface-water sampling site south of the OU 5 area; from Rocky Flats Lake, an abandoned gravel pit southwest of RFETS; and dispersed groundwater seeps along Woman Creek. Pond C-1 is the only impoundment of Woman Creek on RFETS, as Pond C-2 receives flow from the SID.

OU 5 IHSSs do not appear to impact the water quality at Woman Creek. Water quality throughout the upper reaches of Woman Creek is good, and heterogeneous substrate in the stream channels provides habitat for species adaptable to variable flow (DOE, 1992a, 1992c).

Benthic Communities - The benthic macroinvertebrate community within Woman Creek is relatively rich and diverse (DOE, 1992c). The most abundant and widespread groups overall in stream communities are the larvae of true flies (Diptera) and mayflies (Ephemeroptera). The most common dipteran taxa are blackflies (Simulidae) and midges (Chironomidae). Both caenid and baetid mayflies are also common. Other aquatic invertebrates include caddisflies (Trichoptera), craneflies (Diptera: Tipulidae), predatory damselfly larvae (Odonata), and two noninsect taxa, the amphipod (sideswimmer) *(Hyalella azteca)* and the snail *(Physella* sp*)*. Species richness for mayflies and caddisflies increases from headwater segments to SW026 (east of Pond C-2) where flow in Woman Creek decreases, apparently due to loss to groundwater (DOE, 1992c).

The OU 5 pond habitats provide a more reliable water source than the intermittent stream channels. However, as is typical of lentic (pond) water bodies, the more homogenous substrate and lack of flow limits the macroinvertebrate communities. Most of the communities are strongly dominated by midges and aquatic earthworms (Oligochaeta). Pond C-1, with a more developed aquatic plant community along the edges, supports a more diverse assemblage of nektonic forms, including water striders (Hemiptera: Gerridae) and water boatmen (Hemiptera: Corixidae). Predatory dragonfly nymphs (Odonata) are present in the C-ponds, as are crayfish (Astacidae).

Fish - As with macroinvertebrates, low and intermittent flow along most stream reaches within OU 5 greatly limits the ichthyofauna of the site. Species captured in the streams include the creek chub *(Semotilus atromaculatus)*, stoneroller *(Campostoma anomalum)*, fathead minnow *(Pimephales promelas)*, and green sunfish *(Lepomis cyanellus)*. Of these species, the creek chub is the most tolerant of poor water conditions. McClane (1978) reported that within its range, "the creek chub may be found in almost any stream capable of supporting fish life."

Fish communities in the C-ponds are highly influenced by the presence of suitable substrates, aquatic vegetation, and persistence of water. The most common species include the golden shiner *(Notemigonus crysoleucus)*, white sucker *(Catostomus commersoni)*, and largemouth bass *(Micropterus salmoides)*. Golden shiners feed on a variety of small prey and algae and may themselves be important prey for larger fish or piscivorous birds because of the large populations they attain and their relatively large size. White suckers are "tolerant of large amounts of pollution, siltation, and turbidity and ... able to survive in waters low in oxygen" (McClane, 1978). This widespread species feeds on insect larvae and algae. Largemouth bass caught in Pond C-1 include large individuals that undoubtedly are at the top of the aquatic food web, aside from large terrestrial piscivores such as cormorants or great blue herons.

3.7.3 Species and Habitats of Special Concern

Candidate endangered-animal species of interest include the Preble's Meadow Jumping Mouse and ferruginous hawk *(Buteo regalis)*. Both have been documented at RFETS during field investigations in 1991 and 1992. Specimens of Preble's Meadow Jumping Mouse were collected in moist habitats along Woman Creek in both 1991 and 1992 (EG&G, 1992g). Swainson's hawks nest at RFETS and the tall cottonwoods along Woman Creek represent suitable nest sites. Ferruginous hawks are present in the region primarily during the winter, but an unmated juvenile male spent considerable time in the Woman Creek drainage during the summer of 1991.

Only one endangered plant species, the Ute (or Diluvium) ladies'-tresses orchid, is potentially on or near RFETS. It has been observed on Boulder County open space 10 miles to the north and along Clear Creek to the south. However, it has not been observed during intensive field investigations in OU 5 and other reaches of Woman Creek in 1991 or during a sitewide endangered species survey in 1992 (EG&G, 1992h).

3.8 PHYSICAL CHARACTERISTICS OF EACH IHSS

This section provides discussions of physical characteristics as they pertain specifically to the geology and hydrogeology of each IHSS within OU 5. The physical setting of each IHSS is also described within each of the following sections.

3.8.1 IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Pond)

This section discusses the geology, hydrogeology, and physical setting of IHSSs 115 and 196. Because IHSS 196 is located within the boundaries of IHSS 115, these IHSSs are discussed together, and reference Appendix C of TM15 (DOE, 1994a).

The Original Landfill (IHSS 115) and the Filter Backwash Pond (IHSS 196) are located within the south buffer zone just south of RFETS industrial area (Figure 3-15). IHSS 115/196 are located north of Woman Creek on a moderately to steeply sloping south-facing hillside, as shown in Photos 39, 40, and 42. The northern portion of the Original Landfill lies just south of the buffer zone access road and forms a flat bench that drops off to the south (DOE, 1994a), as shown in Photo 14. In the western section of the Original Landfill, as shown in Photo 47, an erosional swale exists. The original landfill extends beneath the SID and the SID road, and along the south sloping hillside down to Woman Creek. Three seeps have been identified along the eastern edge of the surface disturbance east of the Original Landfill (Figure 3-15). A sewer outfall pipe daylights in the top central portion of the original landfill, as shown in Photos 51 and 54. Waste debris can be found along the surface of the original landfill and sticking out of sloped areas, as shown in Photos 19, 20, 44, 52, and 53.

IHSS 196 lies near the bottom of the above-mentioned swale, north of the SID, within IHSS 115 (Figure 3-15). IHSS 196 lies within a flat section of the swale and is surrounded by steeping sloping sidewalls to the north, west and east. Two seeps have also been identified in the area and west of IHSS 196 (Figure 3-15).

The physical characteristics of the IHSS 115/196 area were based on information from the Phase I and TM15 field investigations (DOE, 1992a and 1994a), the Geologic Characterization Report (EG&G, 1995a), the Hydrogeologic Characterization Report (EG&G, 1995b), and the Preliminary RFETS OU 5 Geotechnical Investigation (EG&G, 1995e).

3.8.1.1 Geology IHSS 115/196

Geologic deposits present in IHSS 115/196 consist of unconsolidated artificial fill, waste fill, landslide, colluvium, valley-fill alluvium (Piney Creek Alluvium), Rocky Flats Alluvium, and consolidated bedrock of the undifferentiated Arapahoe/Laramie Formations. Borehole and monitoring well locations are presented in Figures 2-4 and 3-16. The preliminary geotechnical map of the area shows the surficial geology and is presented in Figure 3-16. Geologic cross sections through the area are presented in Figures 3-17 through 3-20B. Figure 3-21 presents the thickness of unconsolidated materials in IHSS 115/196 which range from 2 ft up to approximately 37 ft. The thickest sections of unconsolidated material is apparently Rocky Flats Alluvium in the northwest (boring 59594), waste fill in the central (boring 58693), and artificial fill and landslide material in the southeast center (57094) of the Original Landfill.

Artificial Fill - Artificial fill was encountered along the eastern portion of IHSS 115 and consisted primarily of sandy gravely clay and lacked plant production waste. The artificial fill was placed along the south side of the SID during its construction and consisted of excavated material and clean-imported road base/fill.

Waste Fill - Waste fill encountered in IHSS 115/196 consisted predominantly of sandy clayey gravels and cobbles, derived from the Rocky Flats Alluvium, mixed with varying amounts and types of waste from previous production at the site. Types of waste observed during this investigation included sheet metal, wood, broken glass, glass bottles, plastic, rubber, metal shavings, ceramic, shingles, nails, solid blocks of graphite, fine graphite silt and sand, concrete, asphalt, and 55-gallon steel drums. The consistency of the waste fill ranged from loose and unconsolidated to moderately dense and consolidated. The thickest deposits of the waste fill ranged from 9 ft (boring 56994), 12 ft (59194), and 15.5 ft (boring 56893) in the central area of IHSS 115/196 to approximately 12 to 20 ft on the west side of IHSS 115 (Figure 3-17).

Landslide - Landslide deposits were not differentiated from the other geologic deposits presented in Figure 3-16 because the other geologic units were incorporated into the landslides during the landsliding. Figures 3-18 through 3-20B show a symbol for landslide deposits, however, this unit may contain material from several discrete units and possibly different landslide events. A discussion of the landsliding in IHSS 115/196 is presented in Section 3.8.1.2.

Colluvium - Colluvium is exposed in small undisturbed areas south of the Rocky Flats pediment terrace (Figure 3-16) where the deposit was developed on the gently sloping bedrock surface. Colluvium consisted primarily of sandy clayey gravel and cobbles and sandy clay. In cross section, the colluvium appears to be mixed with and apparently mobilized into the landslide deposits. The thickness of colluvium ranged from 1 ft up to 13 ft.

Valley-Fill Alluvium/ Piney Creek Alluvium - Valley-fill alluvium (Piney Creek Alluvium of Figure 3-9) was encountered along Woman Creek and consisted primarily of sandy to silty-clayey gravel with cobbles. The maximum thickness of valley-fill alluvium was 5 to 7 ft.

Rocky Flats Alluvium - Rocky Flats Alluvium was encountered on the north side of IHSS 115/196 and consisted primarily of gravelly sand with some clay to sandy clay and clayey sand with some to trace gravel. In addition, there was a paleo-stream channel encountered in boring 59594 where a medium- to fine-grained sand was observed from 32 ft to 37.45 ft immediately above the underlying bedrock. Thickness of the Rocky Flats Alluvium ranged from approximately 15 ft (boring 56994 where 9 ft of overlying waste fill was observed) to 37.45 ft (boring 59594).

Arapahoe/Laramie Formations - The undifferentiated Arapahoe/Laramie Formation in IHSS 115/196 consisted predominantly of claystone with some thin interbeds and laminae of siltstone and sandstone. The claystone was observed to be massive to thinly laminated, containing trace ironstone nodules, trace to some organics in the form of leaf imprints, disseminated carbon and trace lignite interbeds, with some thin interbeds and laminae of siltstone and sandstone. Sandstone and siltstone interbeds, from 0.5- to 10-ft thick, consisted of very fine to fine grained clayey to silty sandstones and sandy to clayey siltstones, slightly friable to well cemented, trace ironstone nodules, cross bedded to laminated with some soft sediment deformation structures and trace fossils, with trace to some disseminated carbon.

As part of the groundwater investigation to evaluate possible hydraulic interaction between the UHSU and the LHSU and to evaluate the inferred Fault 2 (Figure 3-11), five bedrock boreholes (56694, 57194, 57594, 59894, and 71194) were drilled in and around the IHSS 115/196 area (Figures 2-4 and 3-16). Monitoring wells were installed in the borehole and screened where potential water-bearing sandstones or siltstones (Figure 3-8) were encountered on the basis of the geologic and geophysical logs (Appendix B). Boring 56694 was abandoned because of a borehole collapse during well installation and boring/well 59394 was installed as an offset. A sixth well (71494) was located on the basis of the upper siltstone interval observed at location 57194. The inferred Fault 2 apparently intersects the Old Landfill between locations 71194 and 57194, striking north-northeast. Vertical displacement of the "A" claystone along Fault 2 was estimated at 60 ft.

As part of the geotechnical investigation of the Original Landfill (EG&G, 1995e), the claystone bedrock, presented in cross sections A-A' through D-D' (Figures 3-17 through 3-20B), was differentiated based on the degree of weathering. Classifications are: severely weathered claystone; moderately weathered claystone; and fresh claystone. Severely weathered claystone ranged in thickness from 0.5 ft to 4 ft and is weathered to the extent that little to no original rock texture or structure are recognizable. Moderately weathered claystone ranged in thickness from 2 ft to 23 ft and is highly weathered (showing some discernible bedding structure, with heavy iron-oxide staining of both the groundmass and fractures and/or bedding planes), to moderately weathered (easily discernible bedding structures, with variable amounts of iron-oxide staining), to slightly weathered (occasional iron-oxide staining along fractures and bedding). Fresh unweathered bedrock is characterized by the absence of iron-oxide staining.

3.8.1.2 Landsliding IHSS 115/196

As shown on Figure 3-16, several discrete landslides, as well as general areas of land sliding within the IHSS 115/196 area were defined during the geotechnical investigation. Other areas of land sliding may possibly exist within the study area, although these areas are not readily evident because of their lack of indicative surface morphology. Such areas would involve slides that are obscured by fill and that are not apparent on pre-landfill airphotos, or that are very old with completely eroded surface features (EG&G, 1995e).

Three types of slope failure were noted within the IHSS 115/196 area during this geotechnical study. These failure types involve different geologic materials underlying the landfill slope, and are presented below.

The first type of slope failure involved waste-fill land sliding on severely weathered claystone. Evidence for this type of failure was encountered in borehole 57194, which was located approximately 20 ft downslope of the upper, concave landslide scarp in the central portion of the upper landfill slope, as shown in Figure 3-21 (EG&G, 1995e). Approximately 3 ft of waste fill, on disturbed, moderately weathered claystone, overlies in-place, severely weathered claystone. The contact of disturbed and in-place claystone at 4 ft lies along a nearly horizontal (10 degree), slick-slide surface. The disturbed material from 3.2 to 4 ft may represent a block of claystone worked in with the waste during fill placement, or bedrock incorporated within the sliding fill (EG&G, 1995e).

The second type of slope failure involved colluvium sliding on severely weathered claystone. Evidence of this type of land sliding was found in borehole 71294, located within the recent slide mass at the southeast corner of the study area. The colluvium at this location appears to have failed on, or with, underlying, severely weathered claystone (EG&G, 1995e).

The third type of slope failure involved landsliding within moderately weathered claystone. Direct evidence of this type of slope failure was found in boring 57694 and in deep bedrock monitoring-well 57594. These boreholes were drilled in the lower slope south of the SID, in the east portion of IHSS 115 (Figure 3-21) (EG&G, 1995e). At borehole 57694 (drilled into a relatively recent land slide), 3 ft of colluvium and 11.5 ft of underlying, moderately to severely weathered claystone overlie in place, severely weathered claystone at 14.5 ft. At borehole 57594, a similar sequence, with 6 ft of colluvium and about 10.5 ft of claystone, overlies in place, moderately weathered claystone at a depth of 16.5 ft (EG&G, 1995e). The landslide encountered in borehole 57694 is shown in cross-section C-C'.

The occurrence of colluvium or landslide debris underlain by moderately weathered claystone, without an intermediate zone of severely weathered bedrock, presents indirect evidence of sliding within the moderately weathered claystone. This relation was encountered in several boreholes, including 59694, 58693, 57094, and possibly 56994 (EG&G, 1995e). The land slides as interpreted in these boreholes, located along the slope above the SID, are shown in cross-sections A-A' and B-B' and Figure 3-21.

Based on a 1951 airphoto, boreholes 59794, 71194, 58693, 59294, and 59094 are located within the limits of what appears to be a large landslide (Figure 3-21). No apparent slide debris was encountered in borings 59794/71194, however, the alluvial bedrock contact is approximately 14 ft deeper than the elevation of the contact observed in borings 43392 and 59194, suggesting some movement downslope at this location has occurred. At 58693, roughly 12 ft of wet colluvium/slide material underlies approximately 15 ft of waste fill, and overlies fresh claystone at about 27 ft. Boreholes 59294 and 59094 are located on the lower slope, south of the SID; 59294 shows landslide materials that overlie severely weathered claystone, and 59094 shows similar landslide debris overlying valley-fill alluvium along Woman Creek (EG&G, 1995e).

The geologic interpretation presented on Section B-B (Figure 3-18) suggests a thick landslide deposit, or complex of land slides, through borehole 57094. This interpretation is based on the appearance of colluvium/slide material in the deeper portion of the core from 57094, the low top-of-bedrock elevation, the relatively thin, moderately weathered zone underlying colluvium/slide, and the base elevation of the nearby land slide evidenced in core from borehole 57594. Along the upper portion of Section B-B, sliding at the location of grouped boreholes 57194, 58394, and 71494 (located between prominent scarps on the upper landfill slope) involves waste fill slipping on weathered claystone. The conceptual landslide model presented on Section B-B shows waste fill, below the lower scarp, failing on the older slide material encountered in 57094. The actual depth of this upper waste-fill slide, below the lowed scarp, is uncertain (EG&G, 1995e).

No compelling evidence for deep-seated sliding within the fresh claystone was encountered during the geotechnical investigation (EG&G, 1995e).

3.8.1.3 Hydrogeology IHSS 115/196

The UHSU hydrogeology of the IHSS 115\196 area is characterized by the southerly slope toward Woman Creek, manmade drainages (the SID and building drains), and groundwater flow through the unconsolidated surface deposits (artificial fill, waste fill, landslide deposits, colluvium, and valley-fill alluvium) and the weathered bedrock of the Arapahoe/Laramie Formations). As described in Section 3.6.3.2, the LHSU consists of unweathered bedrock of the Arapahoe/Laramie Formations. A total of 61 wells or piezometers (wellpoints using teflon tubing, mini-wells using 1-in. PVC pipe, and monitoring wells using 2-in. PVC pipe) were installed in the IHSS 115/196 area as part of the OU 5 RFI/RI investigation. The UHSU potentiometric surface for May 1995 and October 1994 are presented in Figures 3-24 and 3-25 which represent the lowest and highest water-level elevations, respectively, recorded during the period August 1994 to July 1995. Only four UHSU wells were dry during the May 1995 water-level monitoring event and these locations were south of the SID on bedrock topographic highs. Well 62893, which was constructed in an area of a seep, was observed to be flowing at the surface during May 1995.

Groundwater generally flows from the upgradient Rocky Flats Alluvium through the laterally continuous and intertonguing unconsolidated surficial materials in a south-southeasterly direction until reaching the apex of Woman Creek (Figures 3-17 to 3-19). Along Woman Creek the groundwater flow direction changes to an easterly direction parallel to surface-water flow. The average groundwater gradient is 0.13 feet/foot during September 1994 and 0.16 feet/foot during May 1995. Groundwater flow is downgradient along the contact between the overlying unconsolidated deposits and the low permeability claystone bedrock.

Recharge of the IHSS 115/196 area is primarily from upgradient, precipitation infiltration (ground surface and along the SID), and possibly from building drains. Groundwater discharges to the surface in places of shallow bedrock as diffuse flow (seeps) and concentrated flow (springs) (Figures 3-15 and 3-16). Below the SID, Woman Creek is a losing stream for most of the year except for the wettest months. Seasonal variations in recharge strongly affect the UHSU potentiometric surface (Figures 3-24 and 3-25). Figures 3-22 and 3-23 present hydrographs of wells located in the IHSS 115/196 area. Note the cyclic nature of the hydrographs for wells 59493 and 59593 which were monitored over a two-year period (Figure 3-22). Seasonal fluctuations of 6 ft were observed in the wells located in IHSS 196 (wells 59493, 63893, 63993, and 64093) and over 9 ft in well 60593 southwest of IHSS 115/196.

Hydraulic characteristics of the waste fill in IHSS 115/196 were estimated during aquifer tests performed in 1993 (DOE, 1994a). Results of the test on well 59493 revealed hydraulic conductivities ranged from 1.37E-03 to 1.73E-02 cm/sec. Hydraulic conductivities in this range are indicative of permeable well-sorted sands and gravels. The log of 59493 indicates the waste fill is underlain by approximately 1 ft of colluvium that is underlain by fresh to moderately weathered claystone bedrock.

Hydraulic conductivities of the valley-fill alluvium/Piney Creek Alluvium in IHSS 115/196 were estimated in well 7086 during aquifer test evaluations for RFETS Hydrogeologic Characterization Report which ranged from 1.5E-04 to 6.8E-04 cm/sec (EG&G, 1995b).

Hydraulic characteristics of the Rocky Flats Alluvium in IHSS 115/196 were estimated during aquifer tests performed in 1995 by the Aquifer Testing Program (EG&G, 1995i). Hydraulic conductivities in well 56994 ranged from 1.0E-05 to 1.2E-06 cm/sec using the falling head and rising head methods, respectively, and well 59594 was estimated at 7.7E-03 cm/sec using both the rising and falling head methods.

Hydraulic characteristics of the colluvium/landslide material in IHSS 115/196 were estimated during aquifer tests performed in 1995 by the Aquifer Testing Program (EG&G, 1995i). Hydraulic conductivities in well 59694 were estimated at 6.8E-07 cm/sec using the rising head method.

As described in Section 3.6.3.2, the LHSU consists of unweathered bedrock of the Arapahoe/Laramie Formations. To evaluate the potential for hydraulic interaction between the UHSU and LHSU six bedrock monitoring wells were installed during the implementation of TM15 (DOE, 1994a). One of the six monitoring wells (well 57594) displayed artesian conditions (a water-level elevation higher than the top of the confined aquifer it is screened in) during May 1995. Well 57594 had a hydraulic head measured at 5940.5 ft above MSL and two adjacent UHSU wells with lower water-table elevations; wells 59993 and 57994 at 5937 ft and 5936 ft above MSL, respectively. Thus, the vertical gradient in this area near Woman Creek is upward at 1.0 feet/foot.

Of the six LHSU wells, three developed sufficient groundwater to be sampled for water-quality parameters (57594, 59894, and 71494) the remaining three wells have developed very slowly and have not been fully developed or sampled (57194, 59394, and 71194. Water-level measurements from wells 57194, 59394, and 71194 have not stabilized since installation which is consistent with the textural properties and low permeabilities of the LHSU. Water-level measurements in wells 57194, 59394, 59894, 71194, and 71494 indicate downward vertical gradients reflecting areas of recharge.

Hydraulic characteristics of the LHSU in IHSS 115/196 were estimated during aquifer tests performed in 1995 by the Aquifer Testing Program (EG&G, 1995i). Hydraulic conductivities of the upward fining clayey sandstone to sandy claystone in well 57594 ranged from 1.1E-06 to 7.0E-07 cm/sec. Hydraulic conductivities of the sandy siltstone in well 59894 ranged from 2.5E-06 to 9.7E-07. Hydraulic conductivities of the siltstone in well 71494 ranged from 3.8E-06 to 6.2E-06. The hydraulic conductivities of the LHSU lithologies screened in IHSS 115/196 are comparable to the geometric means for unweathered bedrock sandstone, siltstone, and claystone (5.77E-07 cm/sec, 1.59E-07 cm/sec, and 2.48E-07 cm/sec, respectively [EG&G, 1995b]) reported in Section 3.5.3.2.

In summary, on the basis of the contrasts in hydraulic conductivities observed in IHSS 115/196, the UHSU groundwater flow is along the contact between the fresh to moderately weathered bedrock and the overlying unconsolidated surficial materials. Because of the downward vertical gradient created by the two to three orders of magnitude difference in hydraulic conductivities between waste fill/Rocky Flats Alluvium and the bedrock in IHSS 115/196, very little possibility exists for downwind migration of contaminants.

3.8.2 IHSS 133 (Ash Pits, Incinerator, and Concrete Wash Pad)

This section discusses the geology, hydrogeology, and physical setting of IHSS 133. The IHSS incorporates four original ash pits and two new ash pits (TDEM-1 and TDEM-2) that were used to dispose of incinerator ashes, the former incinerator area, and a concrete wash pad. The concrete wash pad was used to wash out cement trucks that were being used to construct RFETS facilities.

The IHSS 133 area is located within the south buffer zone just southwest of RFETS industrial area, south of the west access road, and north of Woman Creek (Figure 3-15). Six IHSSs, one pit, and a disturbed area east of the IHSSs were identified. Two additional ash pits (TDEM-1 and TDEM-2) were identified from aerial photographs, results of the TDEM survey, and the soil-boring investigation. IHSSs 133.1 through 133.4 (the four original ash pits), IHSS 133.6 (concrete wash and disposal area), and the two TDEM anomalies lie south of a steep south-facing slope, on a fairly flat-lying surface that slopes gently, toward Woman Creek (DOE, 1994a), as shown in Photos 31 and 32. Photographs 18 and 36 show IHSS 133.2 (an ash pit delineated by two signs shown at the right side of photo 18) located just below the above-mentioned steep slope. The terrain is hummocky, as shown in Photos 31 and 32, and the individual ash pits can, to some extent, be identified as a hump on the ground surface. IHSS 133.5, as shown in Photo 17, occupies a portion of the above-mentioned steep, south-facing slope and a portion of a flat bench above the sloped area. IHSS 133.5 is the where the old incinerator was located and an area that was subsequently used for washing concrete trucks. It was common practice for concrete trucks with unused, partial loads of concrete to have their remaining loads-poured, and their interiors washed prior to being returned to their respective concrete plants.

The overall area is predominantly covered with prairie grasses and cacti. A dirt access road, an underground abandoned gasline, and an overhead powerline pass east to west through the IHSS 133 area.

The physical characteristics of the IHSS 133 area were based on information from the Phase I and TM15 field investigations (DOE, 1992a and 1994a), the Geologic Characterization Report (EG&G, 1995a), and the Hydrogeologic Characterization Report (EG&G, 1995b).

3.8.2.1 Geology IHSS 133

Geologic deposits present in IHSS 133 consist of unconsolidated artificial fill, waste fill, landslide, colluvium, valley-fill alluvium (Piney Creek Alluvium), Rocky Flats Alluvium, and consolidated bedrock of the Arapahoe/Laramie Formations are discussed below. The surficial geology and bedrock geologic map are presented in Figures 3-4 and 3-9. Borehole and monitoring well locations are presented in Figures 2-12 and 3-26. Geologic cross sections through the area are presented in Figures 3-27 through 3-32. Figure 3-33 presents the thickness of unconsolidated materials in IHSS 133 which range from 2.5 ft up to approximately 34 ft. The thickest sections of unconsolidated material appears to be the Rocky Flats Alluvium along the north side (55493) of IHSS 133.5 and the colluvium/landslide material in the east side (57093) in IHSS 133.2. A moderately thick section of colluvium/landslide material is present along the west side of IHSS 133.4. The thick sections of unconsolidated material on the east side of IHSS 133.2 and west side of IHSS 133.4 may represent paleo-landslide deposits.

Artificial Fill - Artificial fill encountered along the west-central portion of IHSS 133 consisted primarily of gravelly to clayey sand and clay, concrete, and lacks incinerated waste ash. The artificial fill was placed in and around IHSS 133.5, the former incinerator area and IHSS 133.6 the concrete washout area (Figure 3-9). Artificial fill was also placed as thin lifts for daily cover during disposal of the incinerator ash.

Waste Fill - Waste fill encountered in IHSS 133 consisted predominantly of incinerated types of waste mixed with sandy silt from previous production at RFETS. Types of waste observed during this investigation included small pieces of rusted metal, sand to silt size metal, broken glass, asbestos, ceramic, and nails. The consistency of the waste fill was loose with some evidence of differential compaction which created void spaces above the ash and the overlying cover of artificial fill. Waste fill from the incinerator was apparently placed into the ash pits in thin lifts which ranged in thickness from less than 0.5 ft up to approximately 3 ft (Appendix B). Waste fill was encountered to depths of up to 18 ft (boring 56094) but predominantly limited to depths less than 8 ft. Waste fill/ash material was encountered in IHSSs 133.1, 133.2 (northern half was confirmed to be an ash pit), 133.4, and in the two previously unidentified ash pits TDEM-1 and TDEM-2 (Figures 3-26, 3-27, 3-29 and 3-30). Waste ash material was also encountered in borehole 58093 between IHSSs 133.1 and 133.4 (Figure 3-26). The lateral extent of waste fill correlates well with the TDEM anomaly map in Figure 2-11.

Landslide - Landslide deposits were differentiated from the other geologic deposits presented in Figure 3-9 on the basis of the hummocky topography present. Because the colluvium was incorporated into the landslide deposits during the landsliding and colluvium closely resembles the textural characteristics observed in IHSS 115/196, landslide deposits will be referred to as colluvium.

Colluvium - Colluvium is exposed south of the Rocky Flats pediment terrace (Figure 3-9) where the deposit was developed on the gently sloping bedrock surface. Colluvium consisted primarily of sandy clayey gravel and cobbles and sandy clay. The colluvium appears to be mixed with and apparently mobilized into the landslide deposits on the eastern portion of IHSS 133. The thickness of colluvium ranged from 2.5 ft up to 34 ft.

Valley-Fill Alluvium/ Piney Creek Alluvium - Valley-fill alluvium (Piney Creek Alluvium of Figure 3-9) was encountered along Woman Creek and consisted primarily of sandy to silty-clayey gravel with cobbles. The maximum thickness of valley-fill alluvium was 5 to 10 ft.

Rocky Flats Alluvium - Rocky Flats Alluvium was encountered on the north side of IHSS 133 and consisted primarily of gravelly sand with some clay to sandy clay and clayey sand with a trace gravel. Thickness of the Rocky Flats Alluvium ranged from 27 ft (boring 55393) to 32.8 ft (boring 55493)

Arapahoe/Laramie Formations - The undifferentiated Arapahoe/Laramie Formation in IHSS 133 is assumed to be the same as the bedrock encountered in IHSS 115/196. Bedrock lithology observed in boring 59894, northeast of IHSS 133.2, consisted predominantly of claystone with some thin interbeds and laminae of siltstone and sandstone. The claystone was observed to be massive to thinly laminated, containing trace ironstone nodules, trace to some organics in the form of leaf imprints, disseminated carbon and trace lignite interbeds, with some thin interbeds and laminae of siltstone and sandstone. Sandstone and siltstone interbeds (Figure 3-8), from 0.5- to 10-ft thick, consisted of very fine to fine grained clayey to silty sandstones and sandy to clayey siltstones, slightly friable to well cemented, trace ironstone nodules, cross bedded to laminated with some soft sediment deformation structures and trace fossils, with trace to some disseminated carbon.

Sandy claystone and clayey sandstone was encountered in boreholes east of IHSS 733.2 (boreholes 57493, 57593, and 59494/59894) on the east side of IHSS 133.2 (boreholes 57093 and 57393). Sandy claystone was also encountered between IHSSs 133.3 and 133.4 (borehole 63093) and clayey siltstone was encountered on the west side of the north ash pit in IHSS 133.4 (55893).

3.8.2.2 Hydrogeology IHSS 133

The UHSU hydrogeology of the IHSS 133 area is characterized by the southerly slope toward Woman Creek and groundwater flow through saturated unconsolidated surface deposits (artificial fill, waste fill, colluvium/landslide deposits, and valley-fill alluvium) and the weathered bedrock of the Arapahoe/Laramie Formations). As described in Section 3.6.3.2, the LHSU consists of unweathered bedrock of the Arapahoe/Laramie Formations. A total of 29 wells or piezometers (wellpoints using teflon tubing, mini-wells using 1-in. PVC pipe, and monitoring wells using 2-in. PVC pipe) were installed in the IHSS 133 area as part of the OU 5 RFI/RI investigation. The UHSU potentiometric surface for October 1994 and May 1995 are presented in Figures 3-34 and 3-35 which represent the lowest and highest water-level elevations, respectively, recorded during the period August 1994 to July 1995. Only two UHSU wells were dry during the May 1995 water-level monitoring event and these wells were 51593 and 55794. Well 51593 is south of IHSS 133.3 and well 55794 is southwest of IHSS 133.3. These wells are dry and do not fully penetrate the surficial materials because of refusal during drilling. Well 62693, which was constructed in an area of a seep, was observed to be flowing at the surface during May 1995.

Groundwater generally flows from the upgradient Rocky Flats Alluvium through the laterally continuous and intertonguing unconsolidated surficial materials in a south-southeasterly direction until reaching the apex of Woman Creek (Figures 3-34 and 3-35). Along Woman Creek the groundwater flow direction changes to an easterly direction parallel to surface-water flow. The groundwater gradient appears to be strongly affected by seasonal fluctuations and from west to east across IHSS 133. For October 1994 the gradient is 0.09 feet/foot on the west side, zero or unsaturated through the center, and 0.07 feet/foot on the east side. For May 1995 the gradient is 0.1 feet/foot on the west side, 0.18 feet/foot through the center and 0.1 feet/foot on the east side. Groundwater flow is downgradient along the contact between the overlying unconsolidated deposits and the low permeability claystone bedrock where there appears to be bedrock topographic lows.

Recharge of the IHSS 115/196 area is primarily from upgradient precipitation infiltration. Groundwater discharges to the surface in places of shallow bedrock as diffuse flow (seeps) and concentrated flow (springs), as shown in Figures 3-15 and 3-16. Woman Creek is a losing stream for most of the year except for the wettest spring months (December-March or April). Seasonal variations in recharge strongly affect the UHSU potentiometric surface (Figures 3-34 and 3-35). Figure 3-36 presents hydrographs of wells located in the IHSS 133 area. Note the cyclic nature of the hydrographs for wells 58793 and 63093 which were monitored over a two-year and one-year period, respectively. Seasonal fluctuations of 9 ft were observed in several of the wells located in IHSS 133 (wells 58793, 63593, 63693, and 56494) and over 15 ft in well 56294 southwest of IHSS 133.3.

Hydraulic characteristics of the colluvium/landslide material in well 58793 in IHSS 133 were estimated during aquifer tests performed in 1993 (DOE, 1994a). However, the results of the test on well 58793 were inconclusive. The well dewatered at a low pumping rate and no drawdown was observed in the observation wells (DOE, 1994a).

Hydraulic conductivities of the valley-fill alluvium/Piney Creek Alluvium in IHSS 133 were estimated in well 5686 during aquifer test evaluations from the Hydrogeologic Characterization Report which ranged from 1.0E-04 to 5.0E-05 cm/sec (EG&G, 1995b).

3.8.3 IHSS 142 (C-Series Ponds)

This section discusses the physical setting, geology, and hydrogeology of IHSSs 142.10 and 142.11. Also, because these IHSSs are actually ponds, a section describing their hydrology is included that references Appendix C of TM15 (DOE, 1994a).

Ponds C-1 (IHSS 142.10) as shown in Photo 68, and C-2 (IHSS 142.11), as shown in Photo 74, are located along Woman Creek within the southeast section of the south buffer zone on the eastern reach of Woman Creek (Figure 3-15). These ponds are approximately 2,000 ft apart, with Pond C-1 to the west, or upstream of Pond C-2 along Woman Creek. According to Merrick Engineering (1992) the maximum storage capacity of Pond C-1 is 5.2 ac-ft and Pond C-2 is 69.4 ac-ft. The estimated average retention in Pond C-1 is 29 percent or 1.5 ac-ft and Pond C-2 is 20 percent or 14 ac-ft (Patton, 1995). Sediment from erosional processes has been deposited into these ponds since construction, thereby decreasing their storage capacities (see Section 3.4).

3.8.3.1 Geology IHSS 142

The geology of IHSSs 142.10 and 142.11 has been characterized from information obtained from monitoring-well boreholes and the Geologic Characterization Report (EG&G, 1995a). The surficial geology within the area of IHSSs 142.10 and 142.11 is for the most part nonexistent because these IHSSs primarily encompass Ponds C-1 and C-2. However, the surficial material surrounding the ponds consists mainly of artificial fill. Small areas along the north and west shores of both ponds and a larger area east of Pond C-1 and north of Pond C-2 consist of Piney Creek Alluvium, as shown in Figure 3-10 (EG&G, 1995a). Descriptions of these units, as well as an IHSS-specific description of the alluvial thickness, are provided in the following paragraphs.

Other surficial materials surrounding these IHSSs are primarily landslide deposits and colluvium, as shown in Figure 3-10, both of which have been previously described.

The valley-fill alluvium that was encountered in the wells east of IHSSs 142.10 and 142.11 ranged in thickness from 4 to 10 ft. The thickness of the valley-fill alluvium encountered in wells 50092 and 50192 (east of IHSS 142.10), and 50292 (east of IHSS 142.11) was approximately 10 ft and consisted predominantly of a sandy or silty gravel and silty sands, overlain with a silty clay/clayey silt (Figures 3-37 and 3-38). The thickness of the valley-fill alluvium encountered in well 51193 (east of IHSS 142.10) was approximately 7.1 ft (Figure 3-38) and the thickness of the valley-fill alluvium in the small-diameter wells (drilled for aquifer testing) surrounding well 51193 was 5.5 ft in well 63293, 4 ft in well 63393, and 9.5 ft in borehole 63493. The valley-fill alluvium encountered at these locations is assumed to be the same as described above.

Valley-fill alluvium may not be present beneath the detention ponds because the top 5 to 10 ft of the surficial materials was removed during construction. The base of Pond C-2 is keyed into the bedrock of the Laramie Formation but Pond C-1 is not keyed into bedrock. The sediment that has been deposited in the ponds since their construction is unconsolidated and consists of fine-grained organic silts and clays (DOE, 1992a).

Based on borehole data, the bedrock underlying the areas adjacent to IHSSs 142.10 and 142.11 consists of claystone. Claystone bedrock provides a relatively impermeable layer. As shown in Figure 3-4 (EG&G, 1995a), the bedrock beneath these ponds appears to be the Laramie Formation.

3.8.3.2 Hydrogeology IHSS 142

The hydrogeology of Ponds C-1 and C-2 is controlled primarily by surface water, as both ponds are located along Woman Creek (Figure 1-2). Both ponds were created by dams. Pond C-1 is within the channel of Woman Creek and is recharged by stream flow, and possibly by groundwater inflow during the wetter months. Woman Creek upgradient of Pond C-1 is gaining during the wet months of December through March or April, but losing the rest of the year. Immediately downgradient of Pond C-1,Woman Creek is losing year round. During the drier months, Pond C-1 may act as a source of recharge to the groundwater system. The water level in Pond C-1 is controlled by a gate. Two wells (50092 and 51193) located at the base and east of Dam C-1, perennially contain groundwater (Figure 2-13). Dam C-1 is not keyed to bedrock and groundwater appears to flow beneath the dam. Dam C-1 has a hydraulic height of 15 ft and is classified as a small-sized dam (Army Corps of Engineers, 1984).

Pond C-2 is located farther east along a losing reach of the original Woman Creek stream channel. Woman Creek has been diverted around Pond C-2 and surface water from Woman Creek flows into the pond only during periods of high flow. The SID drains into Pond C-2 and, therefore, accepts surface-water drainage from the industrialized area upgradient of the SID. The dam at Pond C-2 is keyed into bedrock and effectively stops groundwater flow from moving out of the pond and cutting off flow to the natural stream channel east of the dam (Figure 2-13). This is evidenced by wells 50192 and 50292 east of the base of the dam, which are perennially dry. Dam C-2 has a hydraulic height of 35.5 ft and is classified as a small-sized dam (Army Corp of Engineers, 1984). Pond C-2 is a terminal pond and the water level in the pond is controlled by pumping and transferring the water to the Broomfield Diversion Ditch.

3.8.4 IHSS 209 and Other Surface Disturbances

This section discusses the physical setting, geology, and hydrogeology specific to IHSS 209, the Surface Disturbance West of IHSS 209, and the Surface Disturbance South of the Ash Pits.

Three separate surface disturbances are described in this section. These areas include IHSS 209, the Surface Disturbance West of IHSS 209, and the Surface Disturbance South of the Ash Pits. IHSS 209 is located approximately 1,000 ft southeast of Pond C-1 (Figure 3-15). This area was included as an IHSS because unknown activities took place in this area of shallow excavations and surface disturbances. This IHSS covers approximately 5.2 acres and is located along a long narrow plateau bounded to the north, east, and south by a uniform slope leading into the Woman Creek drainage. A dirt road transects this IHSS and circles near the eastern boundary of the IHSS. Three excavations are located within the boundary of this IHSS (Figure 1-5). Two depressions, which periodically retain water, are present near the northern and southwestern boundary of this unit, as shown in Figure 1-5 (DOE, 1992a). Photo 82 in Appendix C of TM15, shows the depression at the southwestern end of the IHSS. The depth of this depression is about 5 ft.

A second surface disturbance, the Surface Disturbance West of IHSS 209, is located approximately 1,500 ft west of IHSS 209 (Figures 1-5 and 3-15) and consists of several small disturbed areas. This disturbance covers an area of about 62,500 square ft (DOE, 1992a) and is located on a fairly shallow slope that faces north toward Woman Creek.

A third surface disturbance area, the Surface Disturbance South of the Ash Pits, is located approximately 1,200 ft south of the IHSS 133 area and south of Woman Creek (Figure 3-15). This area consists of four excavations and a disturbed area that is covered with boulders, as shown in Photo 89, on the western side of the disturbed area (Figure 1-6). Two excavations trend along northeast-southwest axes, each approximately 30-ft wide and 400-ft long. Photos 83 and 84 in Appendix C of TM15, show one of the excavated trenches looking southwest and northeast, respectively. These photos show this trench to be approximately 5 to 8-ft wide and about 2-ft deep. A horseshoe-shaped area is located northeast of the parallel excavations and a third excavation is located to the southwest (DOE, 1992a). This surface disturbance is located on top of a high plateau that is situated along the southern portion of the OU. It is sloped on the north and southeast. Two ephemeral streams drain this area. These streams flow into Woman Creek from the north and southeast sides of the disturbed area.

3.8.4.1 Geology

The geology of IHSS 209 and the other surface disturbances have been characterized from information obtained from boreholes and the Geologic Characterization Report (EG&G, 1995a). There are a number of geologic units present at IHSS 209 and the other surface disturbances, including artificial fill, landslide deposits, Rocky Flats Alluvium, colluvium, and the Arapahoe/Laramie Formations. Descriptions of these units, as well as an IHSS-specific description of the alluvial thickness, are provided in the following paragraphs.

IHSS 209 - The surficial geology of IHSS 209 consists primarily of Rocky Flats Alluvium with three small pockets of artificial fill (Figure 3-10). The surface materials surrounding the IHSS have been identified as landslide deposits (EG&G, 1995a).

Artificial fill, landslide deposits, colluvium, and the Rocky Flats Alluvium present in IHSS 209 have been described in previous sections. The only subsurface data available are from borehole 41191 (Figure 3-36). These data indicate that the alluvial material is approximately 31-ft thick on top of this knoll. Also, based on data from borehole 41191, the bedrock underlying IHSS 209 consists of claystone. This claystone most likely belongs to the Arapahoe Formation, as inferred from Plate 2-1 of the Geologic Characterization Report (EG&G, 1995a), and as shown in Figure 3-3 of this report. A discussion of the Arapahoe Formation is provided in Section 3.6.

Surface Disturbance West of IHSS 209 - The surficial geology of the Surface Disturbance West of IHSS 209 has recently been mapped. According to Figure 3-4 (EG&G, 1995a), the area is covered with landslide deposits (Figure 3-10). A description of landslide deposits was previously provided in Section 3.6. According to data from borehole 57693, there is no alluvial material at this location. The geological material encountered in borehole 57693 consisted of highly to slightly weathered claystone to a depth of 6 ft. Figure 3-4 shows that both the Arapahoe and Laramie Formations underlie this IHSS. Descriptions of these two formations were presented in Section 3.6.

Surface Disturbance South of the Ash Pits - Surficial geology of the Surface Disturbance South of the Ash Pits consists mostly of Rocky Flats Alluvium with about one-third of the area covered with colluvium (Figure 3-9). The surface materials surrounding the IHSS have been identified as landslide deposits, as shown in Figure 3-9 (EG&G, 1995a). Summary descriptions of these landslide deposits were provided in Section 3.6.

Based on borehole data, the Rocky Flats Alluvium on top of the knoll is approximately 30-ft thick, and off to the side of the knoll, the thickness decreases to approximately 24 ft in borehole 57893, as presented in Figure 3-39. The Rocky Flats Alluvium consisted predominantly of a gravelly sand with some interbedded silty or clayey sands (Figure 3-39).

Bedrock data from the IHSS are from boreholes 57793 and 57893 (borehole 57993 did not reach bedrock). The bedrock encountered in borehole 57793 consisted of claystone. However, the bedrock encountered in borehole 57893 consisted of clayey sandstone at 24.4 ft and grading to a sandstone at 30.4 ft. Two other boreholes that are nearest to the surface disturbance include borehole 41391 and well 0590/borehole 590 and borehole 5386. Borehole 41391 and well 0590 encountered a claystone, and borehole 5386 was not logged. Borehole 41391, southeast of the IHSS, encountered 38 ft of Rocky Flats Alluvium, 4 ft silty claystone, 4.5 ft of silty sandstone to clayey siltstone, claystone to a depth of 130 ft, 0.5 ft of siltstone, 14 ft of claystone, 1 ft of silty sandstone, then claystone to a total depth of 202 ft.

Three boreholes located in the area of the Surface Disturbance South of the Ash Pits encountered sandstone. Two sandstone units were encountered in borehole B402189 at depths of 6 ft and 20.5 ft below the top of bedrock. Because each of these three boreholes encountered sandstone at depths of 24.4, 28, and 33 ft, it may be possible that they have penetrated the same lithologic unit. According to Plate 5-9 of the Geologic Characterization Report (EG&G, 1995a), these boreholes are all interpreted to have penetrated the Arapahoe No. 1 sandstone. The thickness of these sandstones ranges from 5.5 ft (borehole 57893) to 16 ft (second sandstone encountered in borehole B402189). Both boreholes B402189 and B405889 encountered a sandstone that was 12-ft thick.

3.8.4.2 Hydrogeology

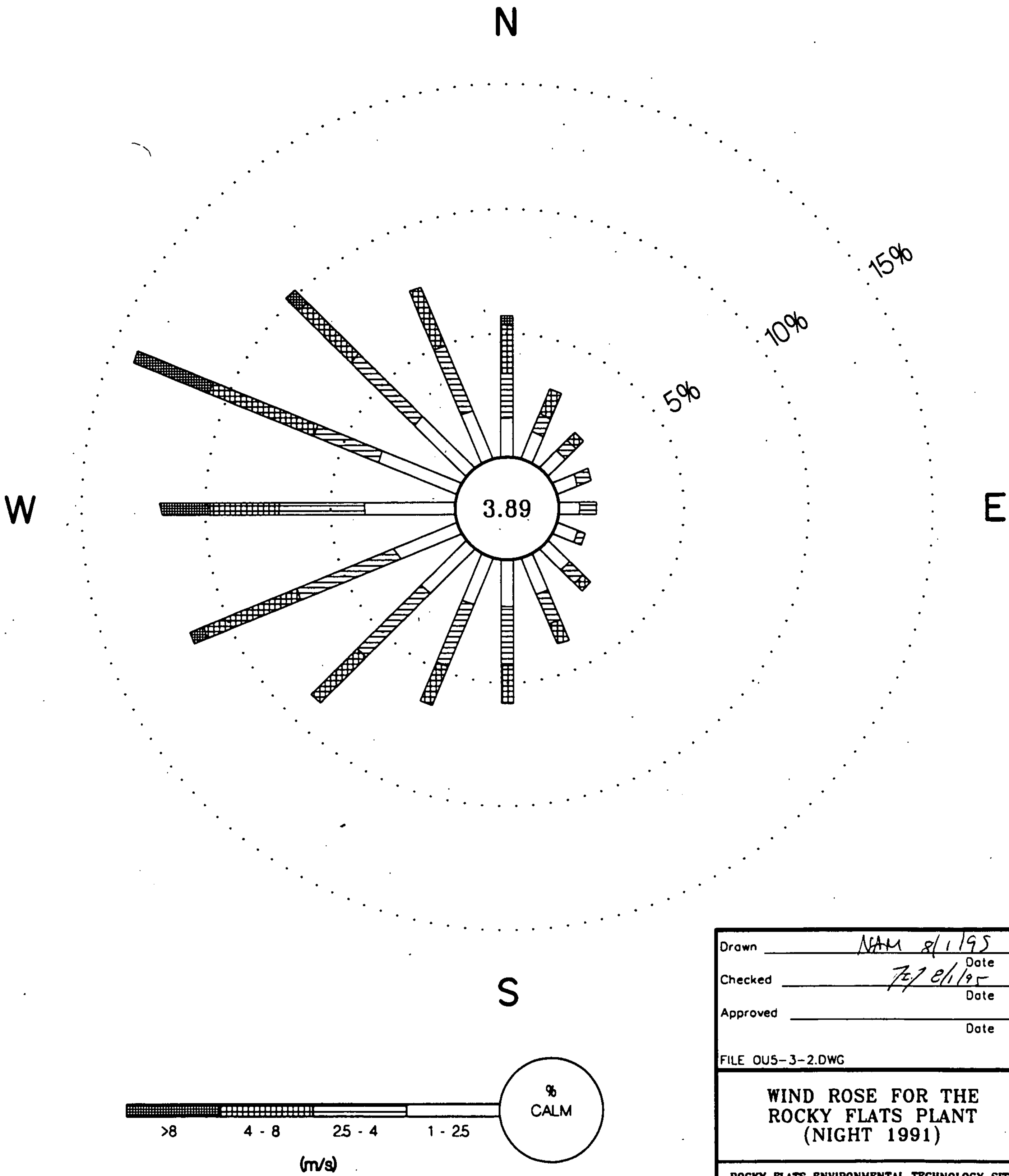
The hydrogeology of IHSS 209 and the other surface disturbances on the south side of Woman Creek were not characterized for hydrogeology with the installation of wells during RFI/RI activities. Generally, groundwater flows into these areas from areas upgradient and then downslope toward the north to the apex of Woman Creek. All are located on or at the edge of the Rocky Flats Alluvium pediment. The UHSU water table south of Woman Creek was not included in the potentiometric map of OU 5 (Figure 5-15) but is sufficiently described and presented in the Geological and Hydrogeologic Characterization Reports (EG&G, 1995a and 1995b).

IHSS 209 was dry when investigated during the summer of 1992. It is located on the Rocky Flats Alluvium pediment, and contains small areas of artificial fill (Figure 3-10). Recharge is from infiltration of precipitation. Because the site is on the drainage divide between Woman Creek and Smart Ditch, groundwater is expected to flow north, east, and south, toward both drainage basins. No seeps were observed in this area (EG&G, 1994a).

The Surface Disturbance West of IHSS 209 occurs on the top of the slope adjacent to the Rocky Flats Alluvium pediment outcrop, within landslide material (EG&G, 1992e). Bedrock is essentially at the surface, and the area was dry when drilled during the summer months of 1992. The area is within the Woman Creek drainage basin, and when saturated conditions exist, groundwater flows to the east and north. Recharge is from infiltration of precipitation. Discharge is through evapotranspiration and downgradient groundwater and surface water flow. Figure 3-15 shows the location of an ephemeral seep present to the west of the IHSS (EG&G, 1994a).

The Surface Disturbance South of the Ash Pits is located on the Rocky Flats Alluvium pediment with some colluvium (EG&G, 1992e). It lies on a minor groundwater divide within the Woman Creek drainage basin. Groundwater recharge is primarily from precipitation infiltration. A small tributary of Woman Creek bounds the southeastern edge of the disturbance, and a number of perennial and ephemeral seeps bound the northwestern edge (EG&G, 1994a). Groundwater discharges to the seeps, and the tributary to the southeast, and flows to the north through unconsolidated surficial materials toward Woman Creek. Discharge also occurs through evapotranspiration.

NIGHT 1991



Source: EG&G Rocky Flats, n.d., Crocker pers. comm. 1993

Drawn NAM 8/1/95 Date	
Checked 7E7 8/1/95 Date	
Approved Date	
FILE OU5-3-2.DWG	

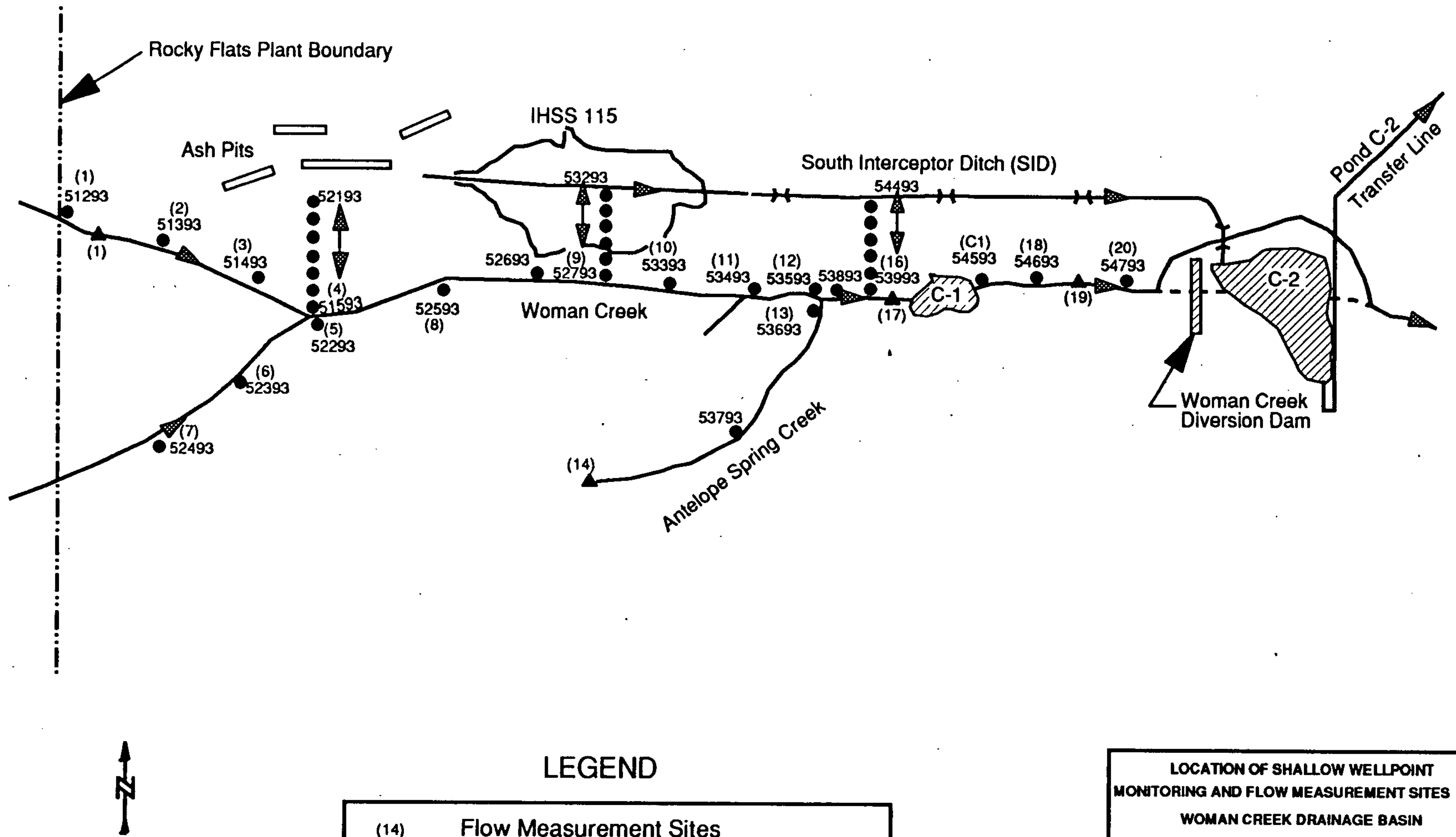
WIND ROSE FOR THE ROCKY FLATS PLANT (NIGHT 1991)

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-2



LEGEND

(14)	Flow Measurement Sites
52593 ●	Wellpoint Monitoring Sites
(14) ▲	Gain/Loss Location if Different from Wellpoint Location
→	Direction of Surface Water Flow
)(	Culvert

DRAWN NAM 8/1/95 DATE

CHECKED [illegible] 8/1/95 DATE

APPROVED ________ DATE

FILE OU5-3-3.DRW

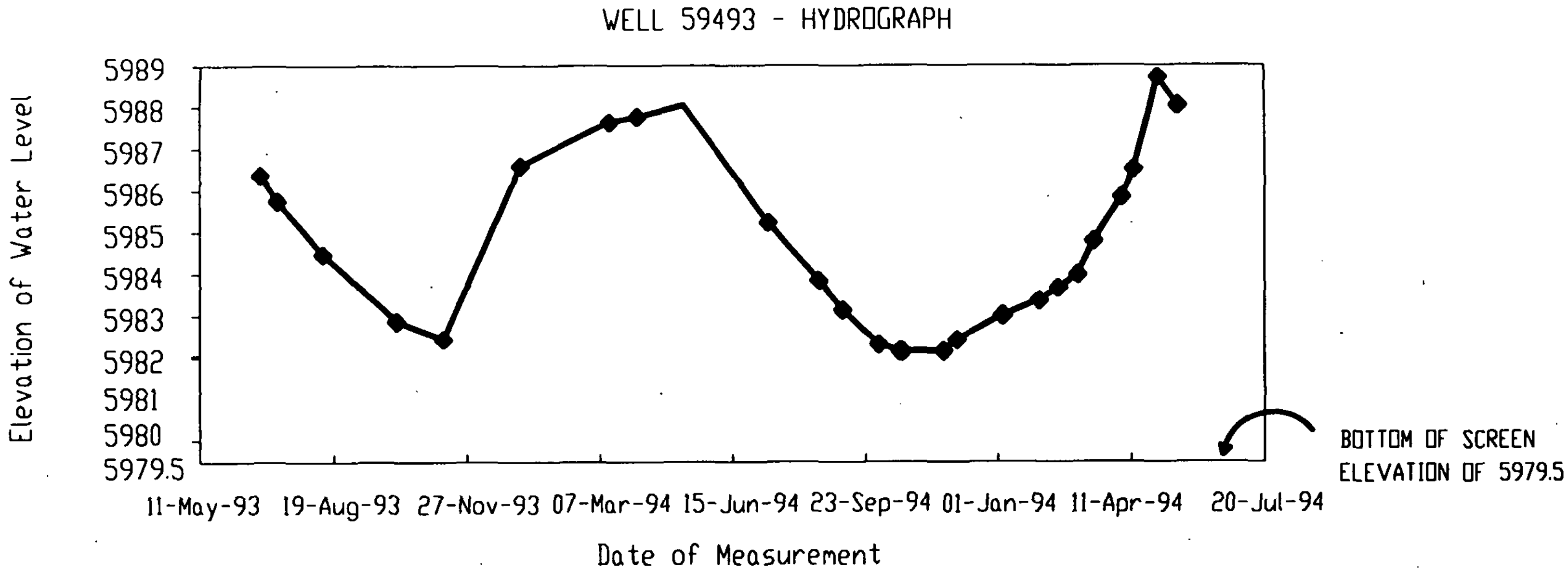
LOCATION OF SHALLOW WELLPOINT MONITORING AND FLOW MEASUREMENT SITES
WOMAN CREEK DRAINAGE BASIN

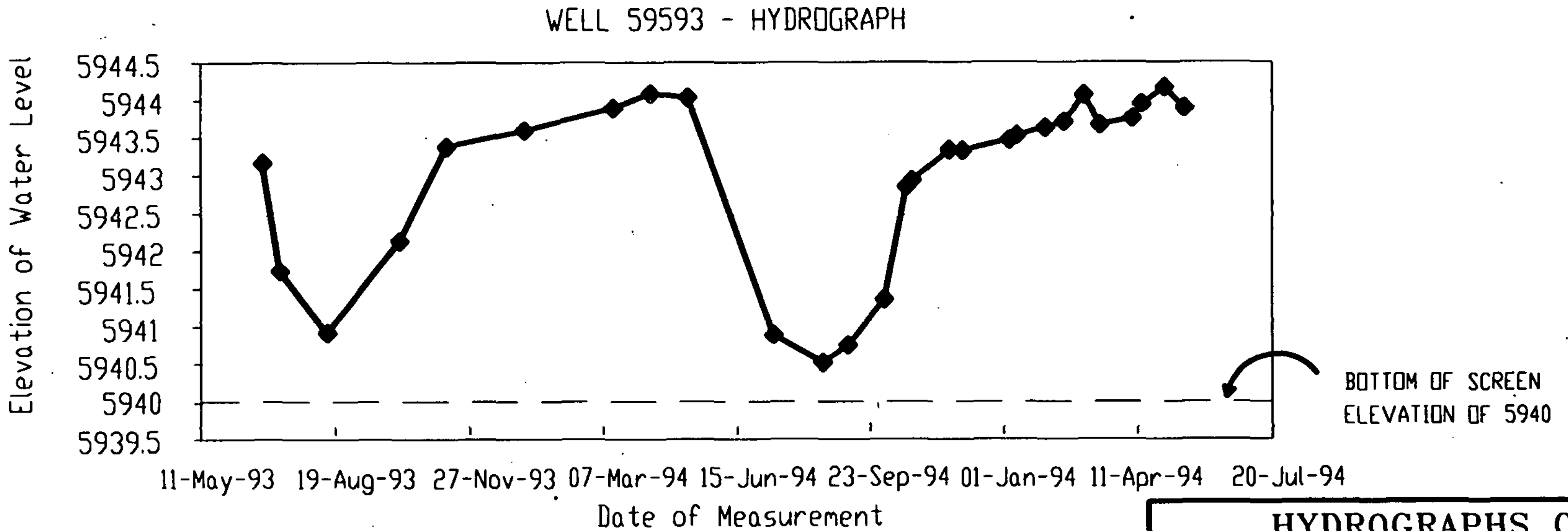
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

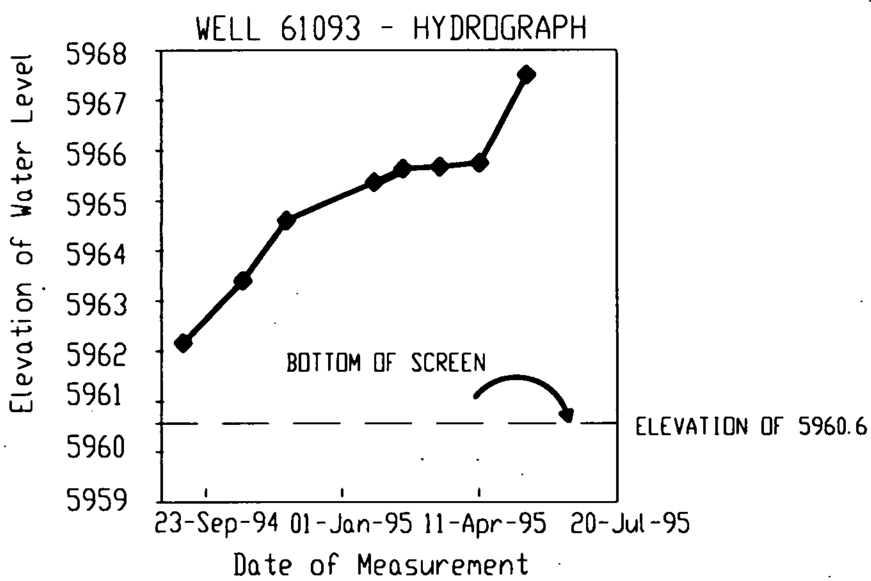
RFI/RI REPORT

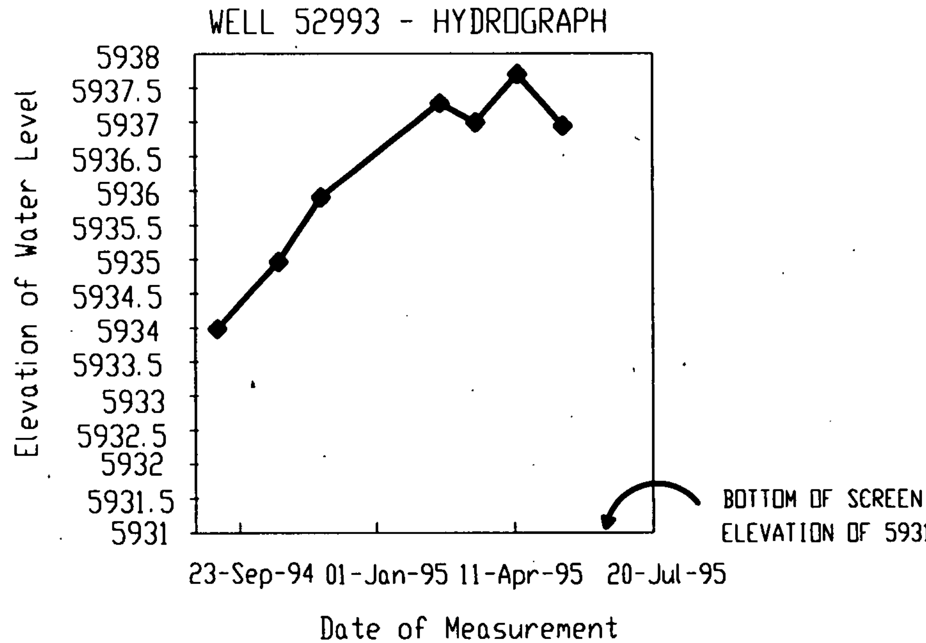
FIGURE 3 - 3





Drawn NAM 8/9/95 Date	**HYDROGRAPHS OF WELLS 59493 & 59593**
Checked [illegible] 8/9/95 Date	**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**
Approved ______ Date	**OU5 - WOMAN CREEK PRIORITY DRAINAGE**
	RFI/RI REPORT
FILE OU5-3-22.DWG	**FIGURE 3-22**





Source of Data - RFEDS

Drawn NAM 9/28/95 Date

Checked 9/28/95 Date

Approved Date

FILE OU5-3-23.DWG

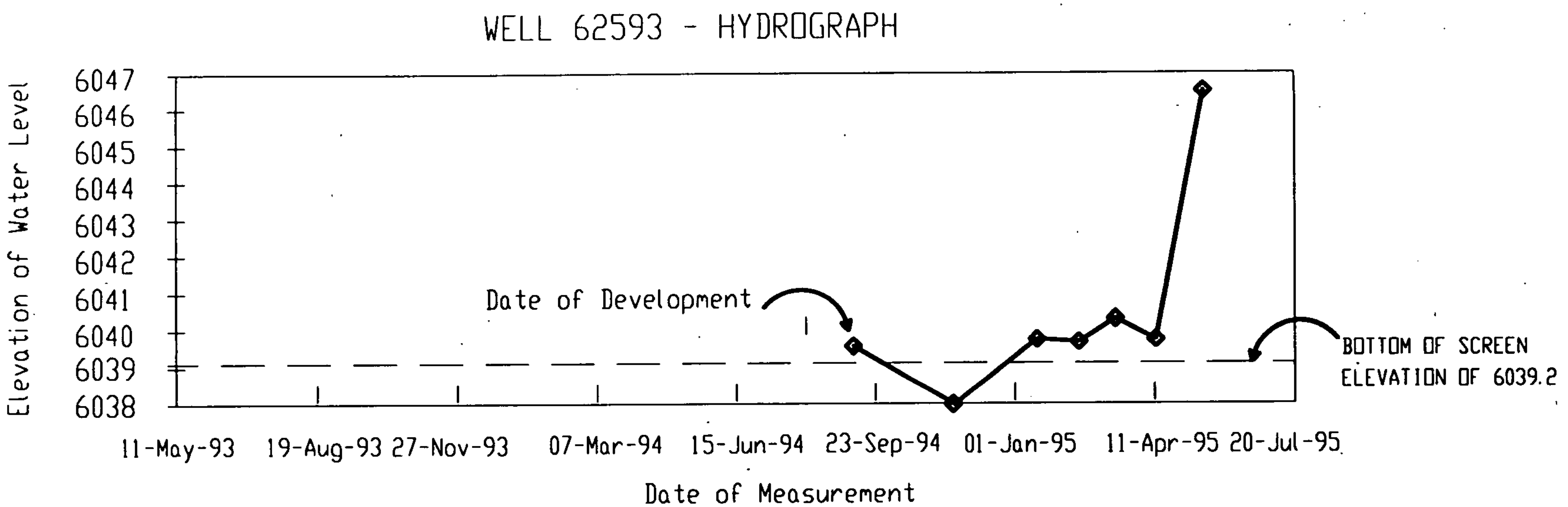
HYDROGRAPHS OF WELLS 52993 & 61093

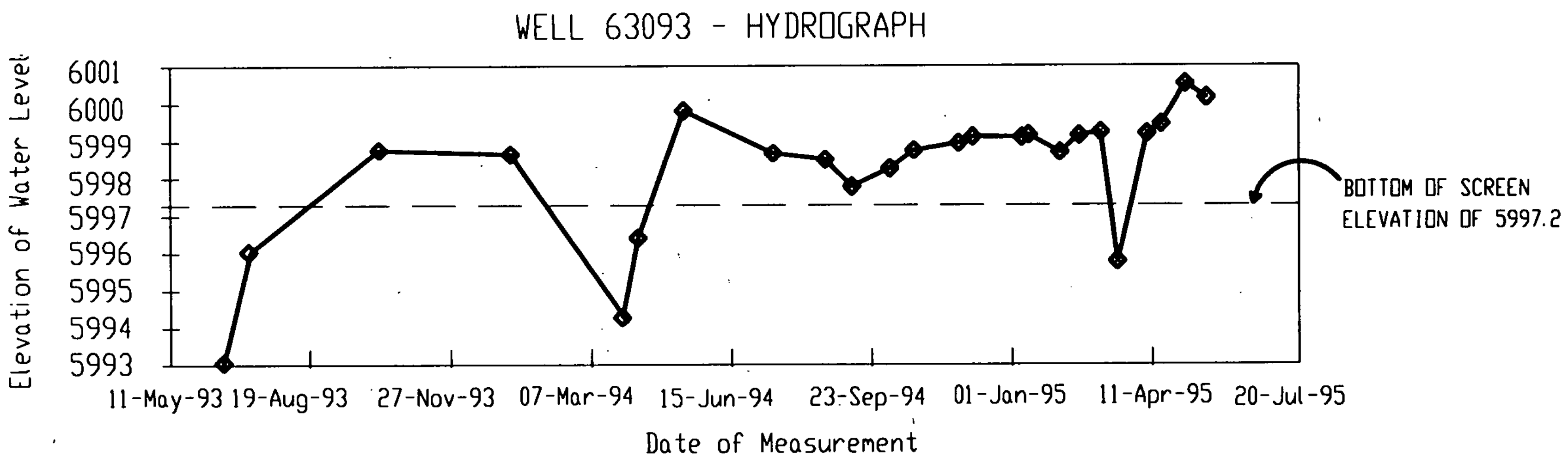
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-23





Source of Data - RFEDS

Drawn NAM 10/2/95 Date
Checked JEA 10/2/95 Date
Approved MRW 10/10/95 Date

FILE OU5-3-36.DWG

HYDROGRAPHS OF WELLS 62593 & 63093

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-36

Table 3-1

1 page

Table 3-1
Soil Units Within the OU 5 Area

Series	Family	Phase	Mimimum-Maximum Slope (%)	Location (ie. hillside, ridge, etc.)	Infiltration Rate	Permeability	Water Capacity	Water Erosion Hazard	Shrink-Swell Potential
Denver-Kutch-Midway	Torretic Argiustolls	clay loam	9-25	hillsides, ridge	slow	slow	high/low	severe	high
Flatirons	Aridic Paleustolls	very cobbly sandy loam	0-3	ridges	slow	slow	low	slight	moderate
Denver	Torretic Argiustolls	clay loam	5-9	hillside	slow	slow	high	severe	high
Nederland	Aridic Argiustolls	very cobbly sandy loam	15-50	ridges, hillsides	moderate	moderate	moderate	severe	low
Haverson	Ustic Torrifluventis	loam	0-3	flood plain	slow	moderate/ slow	high	slight	low
Leyden-Primen-Standley	Aridic Argiustolls	cobbly clay loam	15-50	hillsides	slow	slow	low/high	severe	moderate to high

Source: Department of Agriculture (1980)

4.0 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of COCs within OU 5 were evaluated for various media, including surface soil, subsurface soil, groundwater, surface water, seep water, pond sediment, seep sediment, and stream sediment. These evaluations were performed in accordance with Section 3.4.1.3 of *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988c). Section 4.1 presents a discussion of data used in the evaluation of the nature and extent of contamination, as well as an assessment of the quality of those data. Section 4.2 presents a summary of the comparison of these data to background values. The distributions of those analytes identified as COCs, based on the methodology described in Section 4.2, are discussed in Section 4.3. Section 4.4 presents a summary of the contaminant assessment.

4.1 DESCRIPTION OF DATA USED FOR CONTAMINANT ASSESSMENT

4.1.1 Description of Data

Data used for preparation of this report were collected during the OU 5 Phase I field program, which was conducted in two stages. The first stage began in August 1992 and continued through November 1993. The second stage began in August 1994, after TM15 was finalized, and ended in June 1995. First-stage data, that were used for identifying constituents as COC, are documented in TM15 (DOE, 1994a). Data from both stages have been used to evaluate the nature and extent of contamination. All data were obtained from the Rocky Flats Environmental Database System (RFEDS).

Data obtained from RFEDS were carefully reviewed, and unusable data were removed from the working data sets prior to being used in any analysis. These steps are documented in Appendix A of TM11 (1995a) DOE.

4.1.2 Evaluation of Data Usability

The OU 5 Work Plan (DOE, 1992a) established the data quality objectives (DQOs) for each analyte group and medium sampled. DQOs are expressed in quantitative and qualitative terms of precision, accuracy, representativeness, completeness, and comparability. These parameters are routinely referred to as the PARCC parameters.

Appendix O presents a data quality and usability summary for the OU 5 RFI/RI. The data usability summary evaluates how data quality supports or limits the achievement of the prescribed DQOs, and how it affects data usability for the RFI/RI. The discussion presented in Appendix O indicates that the data collected for the OU 5 RFI/RI generally meet or exceed the DQOs established in the OU 5 Work Plan (DOE, 1992a).

4.2 COMPARISON TO THE SITE BACKGROUND DATA

Data collected prior to implementation of TM15 (DOE, 1994a) were compared quantitatively to background data. As described in TM15, constituents found in samples of surface soil, subsurface soil, groundwater, surface water, and stream sediments were compared to the corresponding $UTL_{99/99}$, as provided in the 1993 Background Geochemical Characterization Report (DOE, 1993a). For those analytes where a $UTL_{99/99}$ was not provided by the Background Geochemical Characterization Report, the maximum background concentration was used for this comparison. Because the background concentrations of organic compounds are assumed to be zero, any detected organic compound was considered to be an indication of possible contamination. The data documented in TM15 provided initial indications of contamination, based on data from field investigations completed in August 1993 and groundwater samples collected through November 1993.

In Section 2.0, Tables 2-7 through 2-9, show a comparison of concentrations from the combined stage-one and stage-two data sets to both background data and the OU 5 data collected prior to implementation of TM15. These comparisons show the statistical effects to the data set after integrating the data collected during the implementation of TM15.

The COCs described in TM11 (DOE, 1995a) were derived from the same data set reported in TM15 (DOE, 1994a). The COCs were selected based on the results of statistical comparison to background concentrations, assessments of toxicity, evaluation of detection frequencies, and review of the spatial/temporal distribution of analyte concentrations. The resulting COCs are listed in Table 6-25. During selection of COCs, the concentrations of each analyte were compared to those of the same analyte in the corresponding background medium. However, data for pond sediment in OU 5 were compared to background data for seep sediments, because of the lack of background pond data, and because flow conditions for ponds and seeps are similar (both have relatively long residence time), (DOE, 1995a). Background comparisons for inorganic analytes were performed according to the procedures given in the "Guidance Document, Statistical Comparisons of Site-Background Data in Support of RFI/RI Investigations" (EG&G, 1994a), which was primarily based on the methodology proposed by Gilbert (1993). The formal statistical tests include the Gehan test, Slippage test, Quantile test, and t-test. Comparisons of the analytical results to the background $UTL_{99/99}$ for each analyte in each medium were performed to ensure that isolated areas of contamination (i.e., hot spots) were not overlooked. Appendix A of the COC in TM11 presents a detailed description of the conditions for applying each of these tests (DOE, 1995a).

4.3 THE EXTENT OF COCs IN AND AROUND OU 5 IHSSs

The nature of the wastes in the OU 5 IHSSs have been discussed in Section 1.0 and in TM15 (DOE, 1994a) for the field investigation outlined in the OU 5 Work Plan (DOE, 1992a). Section 6.2 discusses the identification of COCs for each medium. These COCs are summarized in Table 6-25 and listed below.

- Surface Soils: Aroclor-1254, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, copper, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, mercury, pyrene, silver, uranium-233/234, uranium-235, and uranium-238.

- Subsurface Soils: antimony, Aroclor-1254, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, beryllium, cadmium, copper, molybdenum, nickel, silver, uranium-233/234, uranium-235, and uranium-238.

- Groundwater: aluminum, barium, beryllium, manganese, vanadium, americium-241, plutonium-239/240, radium-226, uranium-233/234, uranium-235, and uranium-238.

- Surface Water: barium, lithium, strontium, americium-24, uranium-233/234, and uranium-238.

- Seep Water: acetone, 1,1-dichloroethene (1,1-DCE), 1,2-dichloroethene (1,2-DCE), PCE, and TCE..

- <u>Pond Sediment</u>: mercury, zinc, americium-241, plutonium-239/240, uranium-233/234, uranium-235, and uranium-238.

- <u>Seep Sediment</u>: antimony, beryllium, zinc, uranium-233/234, uranium-235, and uranium-238.

- <u>Stream Sediment</u>: copper, mercury, zinc, americium-241, and plutonium-239/240.

The extent and variation of concentration of the COCs are graphically displayed as symbols on Figures 4-1A through 4-12. Data used to develop these figures represent a combined data set that includes the pre-TM15 data and data collected during implementation of activities specified in TM15 (DOE, 1994a).

For metal and radionuclide COCs, the following concentration intervals (levels) were used to characterize and display concentrations:

- Level-5: concentrations/activities that are less than or equal to the arithmetic mean background concentration/activity

- Level-4: concentrations/activities that exceed the background mean but are less than or equal to the background mean plus one standard deviation

- Level-3: concentrations/activities that exceed the background mean plus one standard deviation but are less than or equal to the background mean plus two standard deviations

- Level-2: concentrations/activities that exceed the background mean plus two standard deviations but are less than or equal to the background mean plus three standard deviations; and

- Level-1: concentrations/activities that exceed the background mean plus three standard deviations

As part of the COC-selection process, as discussed in the COC TM (DOE, 1995a) and in Section 6.0, concentrations/activities were compared to the corresponding background $UTLs_{99/99}$. The $UTL_{99/99}$, in most cases, is comparable to the background mean plus three standard deviations. Therefore, four of the five symbols on Figures 4-1A through 4-12 indicate concentrations that are not above the $UTLs_{99/99}$ for metals and radionuclides.

For organic COCs, the following concentration intervals (levels) were used to characterize concentrations:

- Level-4: concentrations that were detected at levels less than the reporting limit
- Level-3: concentrations that exceed the reporting limit but are less than or equal to ten times the reporting limit
- Level-2: concentrations that exceed ten times the reporting limit but are less than or equal to 100 times the reporting limit
- Level-1: concentrations that exceed 100 times the reporting limit

The symbol at each sample location in Figures 4-1A through 4-12 indicates the greatest concentration level for one or more COCs. The symbols show the general distribution of the COCs and the general deviation from background mean concentrations. Boxes associated with the symbols list the individual COCs that show concentrations greater than the background mean. The upper panel in each box corresponds to the level-1 concentration intervals described above; that is, the box contains a list of inorganic COCs found at concentrations/activities exceeding three standard deviations above the background mean. For organic chemicals, the box contains a list of those compounds found at concentrations exceeding 100 times the reporting limit. The lower panel lists COCs in the level-2 concentration interval. All metal and radionuclide COCs not listed anywhere in the box are less than two standard deviations above the background mean. All organic COCs not listed anywhere in the box were found only at levels less than ten times the reporting limit. Tables 4-A1 through 4-11 present data used to create Figures 4-1A through 4-12.

The following subsections describe the nature and extent of contamination associated with each IHSS in OU 5. However, all surface-water and sediment data are presented under IHSS 142, in order to be consistent with the AOCs presented in Section 6.0 of this RFI/RI report.

4.3.1 IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Pond)

4.3.1.1 Surface Soil

Data used to determine the extent of metal COCs for IHSS 115/196 surface soil (copper, mercury, and silver) are presented in Table 4-1. Figures 4-1A, B, C, and D show the extent of these COCs. The central area of IHSS 115 contains the greatest number of locations that have COCs at level-1 concentrations; copper, mercury, and silver are all found at level-1 concentrations in this area. Construction of the outfall pipe (Section 1.2.2.1) and slumping of surficial materials may have brought contaminated landfill material to the surface in the central area of IHSS 115. Three sampling locations (Figure 4-1C) are just south of this area and outside the IHSS boundary; of these, location SS509693 is the only one that has a COC concentration at level-1 (mercury, 0.26 milligrams per kilogram [mg/kg]).

Data used to plot the extent of radionuclide COCs for surface soil (the three isotopes of uranium) are presented in Table 4-2. These data are illustrated on Figures 4-2A, B, C, and D. The center of IHSS 115 contains the greatest number of locations that have radionuclide COCs that exceed the background mean plus three standard deviations (level-1). All three uranium isotopes are found in the level-1 concentration interval there. As indicated above, construction of the outfall pipe and slumping of surficial materials may have brought contaminated landfill material to the surface in this area. Three locations (SS509693, SS510293, and SS505893), as shown in Figure 4-2D, that contain uranium isotopes at level-1 concentrations, are located south of this area, and just outside of the IHSS boundary.

Data used to plot the extent of organic COCs for surface soil are presented in Table 4-3. These data are shown on Figures 4-3A, B, and C. All of the locations where organic COCs were detected are in the IHSS 115/196 area. Locations of detected organic COCs correspond with the location of the soil gas anomalies (Section 2.2.1.2). The highest concentrations were detected at location SS510593 (Figure 4-3C), where all of the organic COCs were found at concentrations greater than 100 times the reporting limit. No concentrations greater than the reporting limit were found outside of the boundary of IHSS 115, although two locations immediately south of IHSS 115 showed detected concentrations that were greater than the instrument detection limit, but less than the contract-required detection limit.

4.3.1.2 Subsurface Soil

Data used to plot the extent of metal COCs for IHSS 115/196 subsurface soil (antimony, beryllium, cadmium, copper, molybdenum, nickel, and silver) are presented in Table 4-4. Figures 4-4A, B, C, and D show the general extent of these COCs. The location symbols in this figure show the maximum concentration level of any metal COC in each borehole, without regard to the depth sampled. As discussed previously, the boxes show metal COCs that were detected at level-1 and level-2 concentrations. A metal may appear in both panels of a box because of its depth-related variability in concentration.

In IHSS 115, copper and nickel were found at several locations in level-1 concentrations. Antimony, cadmium, molybdenum, and silver were also detected at this concentration level. All but one of these samples with metals in the highest concentration interval were from depths of less than 13 ft in an area where waste was identified in boreholes. Moreover, with only one exception, those boreholes in which waste was not identified, contained lower concentrations of metals. The exception was the nickel concentration at location 63193 (Figure 4-4C), where the composited interval from 12 to 20 ft contained 84.9 mg/kg nickel. However, this concentration only marginally exceeds the background mean plus three standard deviations. Although waste was not identified in this borehole, the borehole is in an area where landfill materials were relocated during construction of the SID. Cadmium, copper and nickel were also detected at level-2 concentrations within the area where boreholes did not contain the waste material. One borehole (57994, Figure 4-4C) south of the central area of the landfill and the IHSS boundary contains copper and nickel in the upper 6 ft at level-2 concentrations. These observations indicate that the greatest concentrations of metal COCs are within IHSS 115 and have about the same vertical distribution as the wastes. Downslope from the IHSS, metal COCs were detected at lower concentrations.

Data used to plot the extent of radionuclide COCs for subsurface soil (the three isotopes of uranium) are presented in Table 4-5. These data are summarized on Figure 4-5A and B.

The distribution of radionuclides in subsurface soil at IHSS 115/196 is similar to that of metal COCs; samples containing radionuclide COCs at level-1 and level-2 activities were collected within the IHSS boundary from the upper 13 ft of subsurface soil (Table 4-5). An exception to this observation on the vertical distribution is for a sample collected from below 19.5 ft in borehole 58693 (Figure 4-5D) that contained uranium-238 at 1.7 picocuries per gram (pCi/g) (level-2). The radionuclides tend to be associated with waste material, and more than 15 ft of waste was identified in borehole 58693. Waste material was identified in all IHSS 115/196 boreholes with level-1 and level-2 activities, with the exception of samples BH50087AS from borehole 50692 and BH50603AS from borehole 61093 (Figure 4-5D). These two boreholes contained no identified waste. Borehole 50692 is located in the surface disturbance at the east end of IHSS 115. Sample BH50087AS was collected from a composited interval from 0 to 6 ft and may, therefore, be influenced by surface-soil contamination. Borehole 61093 is located in the central portion of the landfill within a slump that is surrounded by waste. Therefore, the radionuclides in the sample from 61093 are likely to be associated with waste. The only borehole outside the IHSS boundary that contained a radionuclide COC at an activity exceeding the background mean plus two standard deviations was 61293 (Figure 4-5C), where uranium-238 was detected with an activity of 0.3395 pCi/g in the sample collected from 6 to 10.6 ft deep. These observations indicate that elevated activities of radionuclide COCs are essentially contained within the waste material area, although the occurrence of uranium-325 at an elevated concentration in borehole 61293 is unexplained.

Data used to plot the extent of organic COCs in subsurface soil are presented in Table 4-6. These data are summarized on Figures 4-6A and B. The greatest number of locations that have organic COCs are located in the vicinity of IHSS 196, where the thickest section of waste was penetrated. Organic COCs were also detected at the soil-gas anomaly in the central portion of IHSS 115 (Section 2.2.1.2). The two, level-3 concentrations of COCs at locations 56694 and 57594 (Figure 4-6A) outside of IHSS 115 are composited samples of drilling cuttings from deep boreholes. These samples contained benzo(a)pyrene. Evaluation of the spatial distribution of these COC concentrations indicates that organic COCs are restricted to areas within the waste material of IHSS 115/196.

4.3.1.3 Groundwater

Data used to plot the extent of metal COCs (aluminum, barium, beryllium, manganese, and vanadium) dissolved in IHSS 115/196 groundwater are presented in Table 4-7. These data are summarized on

Figures 4-7A and B. The extent of dissolved metals, rather than total metals, is presented to provide a meaningful interpretation of groundwater chemistry (EG&G, 1995c). The concentrations of total metals includes those metals contained in or absorbed onto suspended sediments, which may be affected by factors unrelated to the extent or degree of groundwater contamination. Dissolved manganese and barium are present at level-1 and level-2 concentrations within the landfill. Only two sampling locations downgradient from IHSS 115 (61293 and 58094; Figure 4-7A) yielded samples with concentrations of dissolved metals at level 1 or level 2. Dissolved barium and manganese were detected at levels 1 and 2 in the sample obtained in January 1995 from monitoring well 61293 (Figure 4-7A). In addition, dissolved manganese was detected at a level-3 concentration at location 59594 upgradient from the landfill (Figure 4-7A). These observations indicate that manganese and barium are the dominant metal COCs associated with IHSS 115, although their distribution does not seem to be well correlated with waste materials.

Data used to plot radionuclide COCs (americium-241, plutonium-239/240, radium-226, and the three isotopes of uranium) in groundwater are presented in Table 4-8. These data are summarized on Figure 4-8A. Dissolved radium-226 was detected with level-1 or level-2 activities at three locations in IHSS 115. No level-1 or level-2 activities of dissolved radium-226 have been detected downgradient of IHSS 115. Radium-226 seems to be the only radionuclide present at elevated activities in the groundwater of IHSS 115.

4.3.1.4 Surface Water

Distribution of COCs in IHSS 115/196 surface water is discussed in Section 4.3.3.1.

4.3.1.5 Seep Water

Seep water was only sampled at two locations (62793 and 62893) in IHSS 115/196. Only location 62893 at the northeast edge of the landfill contained any of the COCs. All detected values were trace detections of organic compounds. Seep water location 62893 is actually a wellpoint with the screened interval between 10 to 15 ft below ground surface. This wellpoint was installed just downgradient of the seep and was to be used to help characterize the seep water.

4.3.1.6 Seep Sediments

Seep sediment samples were only collected at the two IHSS 115/196 locations where seeps occur (Figure 2-12). TM15 (DOE, 1994a) contains a detailed discussion of results for these samples. The sediment sample collected adjacent to seep-water sampling location 62893 contained antimony at a concentration exceeding the $UTL_{99/99}$. Neither of the two sediment samples contained radionuclide COCs exceeding the corresponding UTLs.

4.3.2 IHSS 133 (Ash Pits)

4.3.2.1 Surface Soil

Data used to plot metal COCs in IHSS 133 surface soil (copper, mercury, and silver) are presented in Table 4-1. Figure 4-1D summarizes the extent of these COCs. Two locations (SS513693 and SS514493; Figure 4-1A) contain copper at level-2 concentrations. One location (SS513893) contains copper at a level-1 concentration (26.8 mg/kg), but its concentration is only 0.73 mg/kg above the base of the level-1 concentration interval. Metal COCs in surface soils are not greatly elevated in the IHSS 133 area.

Data used to plot radionuclide COCs in surface soil (the three isotopes of uranium) are presented in Table 4-2. Figure 4-2D summarizes the extent of these COCs. Fifteen surface-soil sampling locations contain radionuclide COCs at level-1 activities. Results from one location (SS515493, Figure 4-2D) are the only ones that exceed the $UTLs_{99/99}$ listed in TM11 (DOE, 1995a). This location was sampled at the position of an elevated HPGe measurement (Section 2.2.2.3). With the exception of this sample, data indicate that these constituents are fairly evenly distributed throughout the surface soil in the vicinity of IHSS 133.

No organic COCs were detected in surface soils in the IHSS 133 area.

4.3.2.2 Subsurface Soil

Data used to plot metal COCs in IHSS 133 subsurface soil (antimony, beryllium, cadmium, copper, molybdenum, nickel, and silver) are presented in Table 4-4. These data are summarized on

Figure 4-4D, which shows the location of the boreholes. Most boreholes that contain metals at level-1 concentrations contain waste materials, as may be seen by inspection of borehole logs in Appendix B, or they are near locations with waste materials in the subsurface. Exceptions are boreholes 55193, 58793, 59093, and 55294 (Figure 4-4D). The presence of level-1 concentrations of metals at these locations is unexplained. In borehole 55193 the concentration of copper exceeds level-1 in a sample taken at 6 to 8 ft in claystone just below the top of bedrock. Borehole 58793 is near the southern trench of IHSS 133.2 where no waste was found in the subsurface. This borehole contained a level-1 concentration of antimony in gravelly sand just above bedrock at 18 to 24 ft. Borehole 59093 contained antimony at a level-1 concentration in a sample from 0 to 6 ft in clayey sand. Borehole 55294 is located at the position designated as TDEM-1, approximately 25 ft north of IHSS 133.6. A sample from gravelly sand at 12 to 15.2 ft immediately above bedrock contained a level-1 concentration of nickel; with the exception of the four unexplained occurrences, it appears that the lateral extent of level-1 concentrations of COC metal detects is consistent with the extent of waste material.

The vertical extent of explained occurrences of level-1 concentrations in IHSS 133 are consistent with the depth of waste materials. However, cadmium and copper were detected in borehole 56094 at 18 to 22 ft. This borehole contained waste material, but the depth of the waste was not recorded because of the radioactivity hazard. A sample from borehole 58093 contained cadmium at a level-1 concentration from a depth of 10 to 12 ft, that was in the top of bedrock immediately beneath a waste interval. All other occurrences of level-1 metals concentrations were from sample intervals that extended to shallower depths, consistent with known depths of waste materials.

Data used to plot radionuclide COCs in subsurface soil are presented in Table 4-5 and are summarized on Figure 4-5D. These data indicate lateral and vertical extent similar to that of the metal COCs. One difference is the level-1 activity of uranium-235 detected in borehole 64493, which lies within the magnetic anomaly west of IHSS 133 (Section 2.2.2.2). The presence of a level-1 activity of uranium-235 at this location is unexplained.

Data used to plot organic COCs in subsurface soil are summarized in Table 4-6. These data are shown on Figure 4-6A. No organic COCs were detected at IHSS 133, although only a very limited number of subsurface-soil samples were collected for analysis of organic chemicals at IHSS 133.

4.3.2.3 Groundwater

Data used to plot metal COCs (aluminum, barium, beryllium manganese, and vanadium) dissolved in IHSS 133 groundwater are presented in Table 4-7 and are summarized on Figure 4-7A. As shown on Figure 4-7A, only manganese was detected at level-1 concentrations in the IHSS 133 area. Wells 58793 and 63793 are downgradient from the IHSS 133.2 ash pit. If the manganese in these wells is from waste in the ash pit to the north, sampling data are insufficient to define the downgradient and lateral extent of the possible plume, because no monitoring wells are located in downgradient and lateral positions; however, a plume may not exist. Manganese in the IHSS 133 area is not closely associated with subsurface occurrences of waste, and its occurrence at level-1 concentrations is unexplained. It is noteworthy that manganese staining is described in samples from several boreholes in OU 5, including those in the IHSS 133 area, and manganese will coprecipitate with barium (Hem, 1985). Results throughout OU 5, as summarized in Figure 4-7A, suggest that barium is associated with manganese.

Data used to plot radionuclide COCs dissolved in groundwater are presented in Table 4-8 and are summarized on Figure 4-8A. No level-1 activities of radionuclides were detected in the IHSS 133 area. Radium was detected at a level-2 activities in well 58793 and may come from the IHSS 133.2 ash pit to the north.

4.3.2.4 Surface Water

Distribution of COCs in IHSS 133 surface water is discussed in Section 4.3.3.1.

4.3.2.5 Seep Water

Seep water was only sampled at two locations (wellpoints 62593 and 62693) in IHSS 133 (Figure 2-12). Neither location contained any of the COCs for seep water. TM15 (DOE, 1994a) contains a detailed discussion of results of these samples.

4.3.2.6 Seep Sediments

Seep sediment samples were only sampled at the two IHSS 133 seep locations (Figure 2-12). TM15 (DOE, 1994a) contains a detailed discussion of results of these samples. Both locations contained zinc at a concentration exceeding the background $UTL_{99/99}$. Antimony exceeded the background $UTL_{99/99}$ in the sample from the seep near wellpoint 62693. The sample from the sampling location near wellpoint 62593 contained uranium-238 exceeding the background $UTL_{99/99}$.

4.3.2.7 Stream Sediments

Distribution of COCs in IHSS 133 stream sediments is discussed in Section 4.3.3.3.

4.3.3 IHSS 142 (C-Series Ponds)

4.3.3.1 Surface Water

Pond water sampling, as part of the OU 5 RFI/RI, was excluded from the Field Sampling Plan by TM1, Revised Network Design. A large database was already in existence from information collected in support of the NPDES permit, as well as weekly, monthly, and quarterly surveillance sampling programs that were in place during the remedial investigation. The data from these programs were used to characterize the C-series pond water, and is presented in Appendix A as part of the discussion of historical surface-water data for the ponds.

Figure 4-9 shows that metal COCs for surface water (barium, lithium, and strontium) were not detected within OU 5 at concentrations exceeding the background mean; however, statistical analyses indicated that the distribution of these metals was sufficiently different from background to warrant their inclusion as COCs (DOE, 1995a).

Data used to plot radionuclide COCs (americium-241, uranium-233/234, and uranium-238) in surface water are presented in Table 4-9 and are summarized on Figure 4-10. Americium-241 and uranium-238 were detected at a level-1 activities in the SID at SW027 north of Pond C-2.

The sample from location SW50293 (Figure 4-10), flowing seep water, contained americium-241, uranium-233/234, and uranium-238 at level-1 activities. Americium-241, uranium-233-234, and uranium-238 were also detected at level-1 activities in the SID (SW507).

4.3.3.2 Pond Sediments

The nature and extent of COCs in C-Series pond sediments are discussed in Appendix A and TM15 (DOE, 1994a). A summary for each pond is presented below.

IHSS 142.10 (Pond C-1) - Mercury was detected in samples from the three locations (inlet, mid-point, and deepest) at concentrations exceeding the background $UTL_{99/99}$. One sample had an activity of uranium-238 that exceeded the background $UTL_{99/99}$. This sample was obtained from the midpoint of Pond C-1.

IHSS 142.11 (Pond C-2) - Zinc was detected at concentrations exceeding the background $UTL_{99/99}$ in the samples from the midpoint and the deepest portion of Pond C-2. Radionuclide COCs were not detected at activities exceeding the background $UTL_{99/99}$.

4.3.3.3 Stream Sediments

Data used to plot metal COCs (copper, mercury, and zinc) in stream sediments from Woman Creek and the SID are presented in Table 4-10. These data are summarized on Figure 4-11. No metal COCs were detected at level-1 or level-2 concentrations for samples collected along Woman Creek or its tributaries.

Copper, mercury, and zinc were detected at level-1 concentrations in the sediment sample from the location in the SID at the southeast corner of IHSS 115.

Data used to plot radionuclide COCs (americium-241 and plutonium-239/240) in stream sediments are presented in Table 4-11 and are summarized on Figure 4-12. There are no radionuclide COCs that were detected at activities exceeding even the background mean for samples collected along Woman Creek or its tributaries. There are no radionuclide COCs that were detected at activities exceeding the background mean plus one standard deviation.

4.3.3.4 Subsurface Soil

IHSS 142.10 (Pond C-1) - In subsurface soils downgradient of Pond C-1, COCs were not detected at concentrations exceeding the background mean plus one standard deviation (Figure 4-4B).

IHSS 142.11 (Pond C-2) - Cadmium was detected at a level-1 concentration in borehole 50292 east of Pond C-2 (Figure 4-4B). No other metal COCs were detected exceeding level-4 concentrations, for samples collected near Pond C-2. Radionuclide COCs were not detected exceeding level-4 activities. Organic COCs were not detected in subsurface-soil samples at Pond C-2.

4.3.3.5 Groundwater

Data used to plot metal COCs (aluminum, barium, beryllium, manganese, and vanadium) dissolved in groundwater from Woman Creek are presented in Table 4-7 and are summarized on Figure 4-7B. Data used to plot radionuclide COCs (americium-241, plutonium-239/240, radium-226, and the three isotopes of uranium) in groundwater from Woman Creek are presented in Table 4-8 and summarized on Figure 4-8B.

Pond C-1 - Downgradient of Pond C-1, no metal COCs dissolved were detected in groundwater at level-1 concentrations (Figure 4-7B). Dissolved barium and manganese were found at level-2 concentrations.

Dissolved radium-226 in groundwater is the only radionuclide COC that has been detected exceeding level-3 activities in the wells downgradient of Pond C-1. No radionuclides were detected at level-1 activities.

Pond C-2 - Both wells below Pond C-2 have been dry since they were constructed, therefore, no groundwater samples have been collected from these wells.

4.3.4 IHSS 209 and Other Surface Disturbances

Data used to plot COCs for the various media for IHSS 209 and the other surface disturbances are presented in Tables 4-1 through 4-6 and summarized on Figures 4-1A through 4-6B.

Of the media sampled at IHSS 209 and the other surface disturbances (surface soil and subsurface soil), the following is a short list of the COCs detected at level-1 and level-2 concentrations.

- A surface-soil sample from location SS512493 in IHSS 209 (Figure 4-1B) contained mercury at a level-1 concentration.
- A subsurface-soil sample obtained from 24 to 28.9 ft in borehole 57793 (Figure 4-4A) in the Surface Disturbance South of the Ash Pits contained a level-2 concentration of antimony.
- A subsurface-soil sample obtained from the surface to 2 ft in borehole 57793 (Figure 4-5A) contained a level-2 activity of uranium-235.

These data suggest that COCs exceeding background are not present within IHSS 209 and the other surface disturbances, with the possible exception of mercury in one surface-soil sample at IHSS 209.

4.3.5 Summary of COCs In and Around OU 5 IHSSs

4.3.5.1 Summary of IHSS 115/196

At IHSS 155/196, elevated concentrations of the COCs in all media (surface soils, subsurface soils, and groundwater) tend to be located in areas where buried wastes are present, and elevated concentrations in the subsurface soil tend to be limited to the same depths as waste materials. However, one surface-soil sample located outside of the IHSS 115 boundary, south of the central part of the landfill, contained elevated mercury, which was also detected at elevated concentrations in surface soil within IHSS 115 directly upslope. Elevated activities of uranium in surface soil follow the same pattern, with downslope occurrences between the IHSS boundary and Woman Creek. The distribution of organic chemicals in surface soils is also similar, but more restricted areally, with all of the detects greater than the contract-required reporting limits occurring within the boundary of the IHSS, where concentrations are generally less than 100 times these reporting limits.

The greatest concentrations of COCs in subsurface soil are within the IHSS 115 boundary and most of the greater concentrations are near IHSS 196, where much waste is buried. A few occurrences of nickel and uranium-238 and -235 that are not closely associated with the wastes may be related to construction of the SID, and other unknown causes.

The metal COCs dissolved in groundwater are primarily manganese and barium, which may be naturally occurring, because considerable manganese staining is found on subsurface materials and barium tends to be associated with manganese. No elevated metal COCs are unequivocally associated with the wastes. However, radium-226 dissolved in groundwater appears to be associated with the waste in the central part of the landfill and to have migrated downgradient at low activities toward Woman Creek.

4.3.5.2 Summary of IHSS 133

The occurrence of COCs in the IHSS 133 area is similar to that in IHSS 155/196, in that elevated concentrations tend to be in areas where buried wastes are present and tend to be limited to depths of wastes. Metals in the surface soils are at lower concentrations than in IHSS 115, with copper dominating. Again the uranium COCs in the surface soils tend to be elevated near waste sites and downslope from them. No organic COCs were detected in the IHSS 133 area. Elevated levels of metal and radionuclide COCs in subsurface soils are closely associated with the buried wastes. However, as in IHSS 115, copper and nickel, in addition to uranium isotopes, are more widely distributed than the waste. Also in IHSS 115, manganese and barium are at elevated concentrations in groundwater, though these two metals may be naturally occurring. Radium-226 was detected at greater than two standard deviations above the background mean in a well downgradient from the ash pit in IHSS 133.2, suggesting the presence of a plume containing low activities of radium-226.

4.3.5.3 Summary of IHSS 142

Elevated levels of COCs in Pond C-1 and Pond C-2 appear to be confined to the pond sediments. Mercury and uranium-238 concentrations were detected in Pond C-1 sediments and zinc concentrations exceeding the $UTL_{99/99}$ were found in Pond C-2. Dissolved radium-226 was detected in a monitoring well downgradient from Pond C-1 at levels greater than two standard deviations above the background mean. Wells immediately downslope from Pond C-2 are dry.

Elevated levels of COCs have been detected in surface water and sediments at a few locations in OU 5. In a sediment sample from the SID at the southeast corner of IHSS 115, copper, mercury, and zinc were detected at concentrations greater than three standard deviations above the background mean. In Woman Creek north of Pond C-2, americium-241 and uranium-238 were detected at greater than three standard deviations above the background mean. Other measurable concentrations and activities of COCs in surface water and stream sediments have been at relatively low levels.

4.3.5.4 Summary of IHSS 209 and Surface Disturbances

The only detect of a COC at a concentration greater than three standard deviations above the background mean is for mercury in surface soil at a location in IHSS 209.

Tables 4-1 through 4-11

34 pages

[illegible]

[illegible]
[illegible]

[illegible]
[illegible]

[illegible]
[illegible]

[illegible]
[illegible]

[illegible]

Table 4-1
Summary of Metal COCs Exceeding Background Mean in Surface Soil

IHSS	Sequence ID	Location	Sample No.	Constituent	Result in mg/kg	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
Exceeds the Background Mean but is less than Background Mean plus one Standard Deviation												
115/196	2161124	SS510593	SS50056AS	COPPER	16.1		5	V	13.41	17.63	21.85	26.07
	2206001	SS507993	SS50030AS	COPPER	15.75		5	V	13.41	17.63	21.85	26.07
	2160900	SS507293	SS50023AS	COPPER	15.7		5	V	13.41	17.63	21.85	26.07
	2224988	SS510393	SS50054AS	COPPER	15.6		5	JA	13.41	17.63	21.85	26.07
	2160984	SS507593	SS50026AS	COPPER	15.5		5	V	13.41	17.63	21.85	26.07
	2161208	SS510893	SS50059AS	COPPER	15.5		5	V	13.41	17.63	21.85	26.07
	2223606	SS509293	SS50043AS	COPPER	15.4		5	V	13.41	17.63	21.85	26.07
	2075525	SS506893	SS50019AS	COPPER	14.9		5	V	13.41	17.63	21.85	26.07
	2227179	SS508093	SS50031AS	COPPER	14.7		5	JA	13.41	17.63	21.85	26.07
	2160872	SS507193	SS50022AS	COPPER	14.5		5	V	13.41	17.63	21.85	26.07
	2161096	SS510193	SS50052AS	COPPER	14.5		5	V	13.41	17.63	21.85	26.07
	2160816	SS506993	SS50020AS	COPPER	14.1		5	V	13.41	17.63	21.85	26.07
	2224966	SS509793	SS50048AS	COPPER	13.8		5	JA	13.41	17.63	21.85	26.07
	2225309	SS509793	SS50048AS	MERCURY	0.1	B	0.1	V	0.08	0.11	0.14	0.17
	2225315	SS510393	SS50054AS	MERCURY	0.1	B	0.1	V	0.08	0.11	0.14	0.17
	2223807	SS509993	SS50050AS	MERCURY	0.09	B	0.1	V	0.08	0.11	0.14	0.17
	2123597	SS506493	SS50015ASU5	SILVER	3.3		2	V	2.8	4.84	6.88	8.92
133.2	2746484	SS514993	SS50112AS	COPPER	15.6		5	V	13.41	17.63	21.85	26.07
	2650897	SS514893	SS50111AS	COPPER	14.75		5	V	13.41	17.63	21.85	26.07
	2746462	SS515193	SS50114AS	COPPER	14.3		5	V	13.41	17.63	21.85	26.07
	2746073	SS514993	SS50112AS	MERCURY	0.1	B	0.1	V	0.08	0.11	0.14	0.17
133.4	2746116	SS514093	SS50102AS	COPPER	15.9		5	V	13.41	17.63	21.85	26.07
133.5	2744014	SS513493	SS50096AS	COPPER	13.8		5	V	13.41	17.63	21.85	26.07
	2746204	SS514393	SS50106AS	COPPER	13.6		5	V	13.41	17.63	21.85	26.07
209	2666874	SS512493	SS50083AS	COPPER	14.2		5	V	13.41	17.63	21.85	26.07
S133	2569821	SS513393	SS50092AS	MERCURY	0.1	B	0.1	V	0.08	0.11	0.14	0.17
W209	2569263	SS511793	SS50076AS	COPPER	17.3		5	V	13.41	17.63	21.85	26.07
	2569329	SS512193	SS50080AS	COPPER	17		5	V	13.41	17.63	21.85	26.07
	2569307	SS511993	SS50078AS	COPPER	16.4		5	V	13.41	17.63	21.85	26.07
	2569219	SS511593	SS50074AS	COPPER	16.2		5	V	13.41	17.63	21.85	26.07
	2569285	SS511893	SS50077AS	COPPER	16		5	V	13.41	17.63	21.85	26.07
	2569241	SS511693	SS50075AS	COPPER	14.9		5	V	13.41	17.63	21.85	26.07
	2666818	SS512293	SS50081AS	COPPER	13.7		5	V	13.41	17.63	21.85	26.07
	2569743	SS512193	SS50080AS	MERCURY	0.09	B	0.1	V	0.08	0.11	0.14	0.17
Exceeds the Background Mean plus one Standard Deviation but is less than Background Mean plus two Standard Deviations												
115/196	2160844	SS507093	SS50021AS	COPPER	20.3		5	V	13.41	17.63	21.85	26.07
	2223628	SS509893	SS50049AS	COPPER	20.3		5	V	13.41	17.63	21.85	26.07
	2161068	SS509593	SS50046AS	COPPER	20.1		5	V	13.41	17.63	21.85	26.07
	2703339	SS510293	SS50053AS	COPPER	19.1		5	V	13.41	17.63	21.85	26.07
	2206029	SS508293	SS50033AS	COPPER	18.3		5	V	13.41	17.63	21.85	26.07
	2206253	SS511293	SS50063AS	COPPER	17.7		5	V	13.41	17.63	21.85	26.07
	2225297	SS508693	SS50037AS	MERCURY	0.12		0.1	V	0.08	0.11	0.14	0.17
	2225303	SS509193	SS50042AS	MERCURY	0.12		0.1	V	0.08	0.11	0.14	0.17
	2703561	SS510293	SS50053AS	MERCURY	0.12	B	0.1	V	0.08	0.11	0.14	0.17
133.3	2746006	SS514493	SS50107AS	MERCURY	0.12		0.1	JA	0.08	0.11	0.14	0.17
	2746254	SS514493	SS50107AS	SILVER	6.3		2	JA	2.8	4.84	6.88	8.92
133.5	2744036	SS513793	SS50099AS	COPPER	18.1		5	V	13.41	17.63	21.85	26.07
W209	2666790	SS512093	SS50079AS	COPPER	18.1		5	V	13.41	17.63	21.85	26.07
Exceeds the Background Mean plus two Standard Deviations but is less than Background Mean plus three Standard Deviations												
115/196	2223825	SS509893	SS50049AS	MERCURY	0.17		0.1	V	0.08	0.11	0.14	0.17
	2161157	SS510693	SS50057AS	MERCURY	0.16		0.1	V	0.08	0.11	0.14	0.17
133.3	2746248	SS514493	SS50107AS	COPPER	24.4		5	V	13.41	17.63	21.85	26.07
	2743970	SS513693	SS50098AS	COPPER	23.9		5	V	13.41	17.63	21.85	26.07
Exceeds the Background Mean plus three Standard Deviations												
115/196	2224922	SS508693	SS50037AS	COPPER	184		5	JA	13.41	17.63	21.85	26.07
	2223562	SS509993	SS50050AS	COPPER	139		5	V	13.41	17.63	21.85	26.07
	2227223	SS510093	SS50051AS	COPPER	112		5	JA	13.41	17.63	21.85	26.07

Table 4-1
Summary of Metal COCs Exceeding Background Mean in Surface Soil

IHSS	Sequence ID	Location	Sample No.	Constituent	Result in mg/kg	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background: Mean	X = 1	X=2	X=3
	2161152	SS510693	SS50057AS	COPPER	78.2		5	V	13.41	17.63	21.85	26.07
	2223540	SS509393	SS50044AS	COPPER	71.9		5	V	13.41	17.63	21.85	26.07
	2205973	SS507893	SS50029AS	COPPER	68.3		5	V	13.41	17.63	21.85	26.07
	2227075	SS508993	SS50040AS	COPPER	60.45		5	JA	13.41	17.63	21.85	26.07
	2206113	SS508893	SS50039AS	COPPER	58.8		5	V	13.41	17.63	21.85	26.07
	2227201	SS509493	SS50045AS	COPPER	55.7		5	JA	13.41	17.63	21.85	26.07
	2206085	SS508493	SS50035AS	COPPER	45.2		5	V	13.41	17.63	21.85	26.07
	2224944	SS509193	SS50042AS	COPPER	35.4		5	JA	13.41	17.63	21.85	26.07
	2223584	SS508793	SS50038AS	COPPER	33.5		5	V	13.41	17.63	21.85	26.07
	2223650	SS510493	SS50055AS	COPPER	30.4		5	V	13.41	17.63	21.85	26.07
	2205945	SS507793	SS50028AS	COPPER	27.6		5	V	13.41	17.63	21.85	26.07
	2205978	SS507893	SS50029AS	MERCURY	0.38		0.1	V	0.08	0.11	0.14	0.17
	2227372	SS508093	SS50031AS	MERCURY	0.37		0.1	JA	0.08	0.11	0.14	0.17
	2227384	SS510093	SS50051AS	MERCURY	0.34		0.1	JA	0.08	0.11	0.14	0.17
	2227378	SS509493	SS50045AS	MERCURY	0.28		0.1	JA	0.08	0.11	0.14	0.17
	2703567	SS509693	SS50047AS	MERCURY	0.26		0.1	V	0.08	0.11	0.14	0.17
	2227342	SS508993	SS50040AS	MERCURY	0.255		0.1	JA	0.08	0.11	0.14	0.17
	2205950	SS507793	SS50028AS	MERCURY	0.23		0.1	V	0.08	0.11	0.14	0.17
	2206118	SS508893	SS50039AS	MERCURY	0.21		0.1	V	0.08	0.11	0.14	0.17
	2223801	SS509393	SS50044AS	MERCURY	0.21		0.1	V	0.08	0.11	0.14	0.17
	2223813	SS508793	SS50038AS	MERCURY	0.195		0.1	V	0.08	0.11	0.14	0.17
	2205982	SS507893	SS50029AS	SILVER	94.3	N	2	JA	2.8	4.84	6.88	8.92
	2206038	SS508293	SS50033AS	SILVER	12.6	N	2	JA	2.8	4.84	6.88	8.92
133.5	2744058	SS513893	SS50100AS	COPPER	26.8		5	V	13.41	17.63	21.85	26.07
209	2666879	SS512493	SS50083AS	MERCURY	0.66		0.1	V	0.08	0.11	0.14	0.17

These data are graphically displayed on Figures 4-7a and 7b.

Table 4-2 Summary of Radionuclide COCs Exceeding Background Mean in Surface Soil

IHSS	Sequence ID	Location	Sample No.	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean	X = 1	X=2	X=3
									Mean + (X * STD DEV) of background			
Exceeds the Background Mean but is less than Background Mean plus one Standard Deviation												
115/196	3671442	SS505193	SS50002AS	U233234	1.139		0.0364	Y	0.822	1.202	1.582	1.962
	3670873	SS505593	SS50006AS	U233234	1.126		0.0287	Y	0.822	1.202	1.582	1.962
	3671441	SS505793	SS50008AS	U233234	1.1005		0.0247	Y	0.822	1.202	1.582	1.962
	2269934	SS510893	SS50059AS	U233234	1.0919		0.0341	A	0.822	1.202	1.582	1.962
	2269942	SS509893	SS50049AS	U233234	1.0697		0.0316	A	0.822	1.202	1.582	1.962
	2330946	SS508593	SS50036AS	U233234	1.04		0.027	A	0.822	1.202	1.582	1.962
	2425847	SS506293	SS50013AS	U233234	1		0.1	A	0.822	1.202	1.582	1.962
	2425879	SS507393	SS50024AS	U233234	0.96		0.2	A	0.822	1.202	1.582	1.962
	2330938	SS508493	SS50035AS	U233234	0.941		0.016	A	0.822	1.202	1.582	1.962
	2405921	SS507093	SS50021AS	U233234	0.934		0.023	A	0.822	1.202	1.582	1.962
	2405918	SS507593	SS50026AS	U233234	0.929		0	A	0.822	1.202	1.582	1.962
	2330932	SS507993	SS50030AS	U233234	0.914		0.019	A	0.822	1.202	1.582	1.962
	2330940	SS508293	SS50033AS	U233234	0.912		0.017	A	0.822	1.202	1.582	1.962
	3670874	SS505693	SS50007AS	U233234	0.905		0.0178	Y	0.822	1.202	1.582	1.962
	2330930	SS508993	SS50040AS	U233234	0.896		0.032	A	0.822	1.202	1.582	1.962
	2425839	SS506193	SS50012AS	U233234	0.89		0.1	A	0.822	1.202	1.582	1.962
	2405909	SS508693	SS50037AS	U233234	0.873		0.031	A	0.822	1.202	1.582	1.962
	2330944	SS509493	SS50045AS	U233234	0.856		0.019	A	0.822	1.202	1.582	1.962
	2425871	SS506893	SS50019AS	U233234	0.83		0.1	A	0.822	1.202	1.582	1.962
	2425895	SS506993	SS50020AS	U233234	0.83		0.1	A	0.822	1.202	1.582	1.962
	3670894	SS510293	SS50053AS	U235	0.085		0.0251	Y	0.039	0.091	0.143	0.195
	3670895	SS509693	SS50047AS	U235	0.0826		0.0265	Y	0.039	0.091	0.143	0.195
	2330909	SS508893	SS50039AS	U235	0.0759		0	A	0.039	0.091	0.143	0.195
	2425856	SS506493	SS50015AS	U235	0.074	U	0.2	A	0.039	0.091	0.143	0.195
	2405868	SS507193	SS50022AS	U235	0.0739		0	A	0.039	0.091	0.143	0.195
	3671464	SS505893	SS50009AS	U235	0.0724		0.0205	Y	0.039	0.091	0.143	0.195
	2425888	SS507693	SS50027AS	U235	0.072	U	0.2	A	0.039	0.091	0.143	0.195
	2330900	SS509493	SS50045AS	U235	0.0652		0	A	0.039	0.091	0.143	0.195
	2269969	SS511393	SS50064AS	U235	0.0623		0.0459	A	0.039	0.091	0.143	0.195
	3670903	SS515293	SS50126AS	U235	0.0557		0.0273	Y	0.039	0.091	0.143	0.195
	2405884	SS507093	SS50021AS	U235	0.0556		0	A	0.039	0.091	0.143	0.195
	2269960	SS508793	SS50038AS	U235	0.05524		0.0379	A	0.039	0.091	0.143	0.195
	2425872	SS506893	SS50019AS	U235	0.052	U	0.1	A	0.039	0.091	0.143	0.195
	2270050	SS509093	SS50041AS	U235	0.0503		0.0618		0.039	0.091	0.143	0.195
	2681789	SS509093	SS50041AS	U235	0.05		0.06	A	0.039	0.091	0.143	0.195
	2330903	SS508293	SS50033AS	U235	0.0493		0.017	A	0.039	0.091	0.143	0.195
	2269958	SS509393	SS50044AS	U235	0.0482		0.0973	A	0.039	0.091	0.143	0.195
	2425880	SS507393	SS50024AS	U235	0.048	U	0.2	A	0.039	0.091	0.143	0.195
	3671462	SS505993	SS50010AS	U235	0.04705		0.0297	Y	0.039	0.091	0.143	0.195
	2425848	SS506293	SS50013AS	U235	0.047	U	0.2	A	0.039	0.091	0.143	0.195
	2330896	SS508993	SS50040AS	U235	0.0459		0.023	A	0.039	0.091	0.143	0.195
	2425832	SS506093	SS50011AS	U235	0.045	U	0.1	A	0.039	0.091	0.143	0.195
	2330902	SS507993	SS50030AS	U235	0.0448		0	A	0.039	0.091	0.143	0.195
	2330905	SS508393	SS50034AS	U235	0.0442		0	A	0.039	0.091	0.143	0.195
	2405870	SS507493	SS50025AS	U235	0.0413		0	A	0.039	0.091	0.143	0.195
	2425840	SS506193	SS50012AS	U235	0.04	U	0.2	A	0.039	0.091	0.143	0.195
	3670897	SS505593	SS50006AS	U235	0.0399		0.0196	Y	0.039	0.091	0.143	0.195
	3670901	SS515293	SS50124AS	U235	0.0391		0.0222	Y	0.039	0.091	0.143	0.195
	3671479	SS505793	SS50008AS	U238	1.0632		0.0196	Y	0.733	1.146	1.559	1.972
	2330966	SS508593	SS50036AS	U238	1.02		0.027	A	0.733	1.146	1.559	1.972
	3670922	SS505693	SS50007AS	U238	0.9608		0.0179	Y	0.733	1.146	1.559	1.972
	2330951	SS508393	SS50034AS	U238	0.954		0.018	A	0.733	1.146	1.559	1.972
	2405935	SS507593	SS50026AS	U238	0.95		0.021	A	0.733	1.146	1.559	1.972
	2425889	SS507693	SS50027AS	U238	0.93		0.2	A	0.733	1.146	1.559	1.972
	2269978	SS510593	SS50056AS	U238	0.9198		0.0315	A	0.733	1.146	1.559	1.972
	2425857	SS506493	SS50015AS	U238	0.9		0.2	A	0.733	1.146	1.559	1.972
	2405937	SS509193	SS50042AS	U238	0.874		0.02	A	0.733	1.146	1.559	1.972
	2425849	SS506293	SS50013AS	U238	0.87		0.1	A	0.733	1.146	1.559	1.972
	2269976	SS510893	SS50059AS	U238	0.8699		0.0341	A	0.733	1.146	1.559	1.972
	2425873	SS506893	SS50019AS	U238	0.85		0.1	A	0.733	1.146	1.559	1.972
	2330954	SS507993	SS50030AS	U238	0.843		0	A	0.733	1.146	1.559	1.972
	2425897	SS506993	SS50020AS	U238	0.84		0.1	A	0.733	1.146	1.559	1.972
	2330952	SS508293	SS50033AS	U238	0.821		0.017	A	0.733	1.146	1.559	1.972
	2425841	SS506193	SS50012AS	U238	0.82		0.1	A	0.733	1.146	1.559	1.972
	2405936	SS509793	SS50048AS	U238	0.798		0.033	A	0.733	1.146	1.559	1.972
	2425881	SS507393	SS50024AS	U238	0.79		0.2	A	0.733	1.146	1.559	1.972
	2269985	SS510493	SS50055AS	U238	0.7779		0.0425	A	0.733	1.146	1.559	1.972
	2405922	SS507193	SS50022AS	U238	0.76		0.022	A	0.733	1.146	1.559	1.972
	2425833	SS506093	SS50011AS	U238	0.76		0.1	A	0.733	1.146	1.559	1.972
	2405925	SS510393	SS50054AS	U238	0.749		0.019	A	0.733	1.146	1.559	1.972
	2330955	SS507793	SS50028AS	U238	0.744		0.022	A	0.733	1.146	1.559	1.972
	2269989	SS511293	SS50063AS	U238	0.7402		0.0359	A	0.733	1.146	1.559	1.972
133.1	2689692	SS514193	SS50103AS	U235	0.062	BJ	0.01	A	0.039	0.091	0.143	0.195
133.2	2689762	SS514993	SS50112AS	U235	0.089	BJ	0.012	A	0.039	0.091	0.143	0.195
	3670899	SS514893	SS50111AS	U235	0.04895		0.0274	Y	0.039	0.091	0.143	0.195

Table 4-2 Summary of Radionuclide COCs Exceeding Background Mean in Surface Soil'

IHSS	Sequence ID	Location	Sample No.	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
133.3	2689720	SS514493	SS50107AS	U235	0.087	BJ	0.025	A	0.039	0.091	0.143	0.195
133.4	2642367	SS513993	SS50101AS	U235	0.045	J	0.013	A	0.039	0.091	0.143	0.195
133.5	2642339	SS513493	SS50096AS	U235	0.054	J	0.011	A	0.039	0.091	0.143	0.195
	2642346	SS513793	SS50099AS	U235	0.048	J	0.038	A	0.039	0.091	0.143	0.195
133.6	2642332	SS513593	SS50097AS	U235	0.044	J	0.021	A	0.039	0.091	0.143	0.195
209	2732828	SS512493	SS50083AS	U233234	1.07		0.037	A	0.822	1.202	1.582	1.962
	2732799	SS512493	SS50083AS	U235	0.0494		0.013	A	0.039	0.091	0.143	0.195
	2732851	SS512493	SS50083AS	U238	1.08		0.031	A	0.733	1.146	1.559	1.972
S133	2725184	SS513093	SS50089AS	U233234	0.836		0.035	A	0.822	1.202	1.582	1.962
	2725149	SS512993	SS50093AS	U235	0.05255		0.036	A	0.039	0.091	0.143	0.195
	2725198	SS513093	SS50089AS	U238	0.873		0.035	A	0.733	1.146	1.559	1.972
W209	2732824	SS511993	SS50078AS	U233234	0.965		0.032	A	0.822	1.202	1.582	1.962
	2725180	SS512193	SS50080AS	U233234	0.926		0.034	A	0.822	1.202	1.582	1.962
	2732831	SS512093	SS50079AS	U233234	0.892		0.046	A	0.822	1.202	1.582	1.962
	2732805	SS511993	SS50078AS	U235	0.0573		0.016	A	0.039	0.091	0.143	0.195
	2732804	SS512093	SS50079AS	U235	0.0563		0.037	A	0.039	0.091	0.143	0.195
	2732794	SS511593	SS50074AS	U235	0.046		0.016	A	0.039	0.091	0.143	0.195
	2732795	SS511693	SS50075AS	U235	0.046		0.015	A	0.039	0.091	0.143	0.195
	2732841	SS511993	SS50078AS	U238	1.03		0.026	A	0.733	1.146	1.559	1.972
	2732845	SS511593	SS50074AS	U238	0.913		0.013	A	0.733	1.146	1.559	1.972
	2732842	SS511893	SS50077AS	U238	0.875		0.031	A	0.733	1.146	1.559	1.972
	2725205	SS512193	SS50080AS	U238	0.869		0.03	A	0.733	1.146	1.559	1.972
	2732843	SS511793	SS50076AS	U238	0.842		0.011	A	0.733	1.146	1.559	1.972
	2732854	SS512093	SS50079AS	U238	0.827		0.041	A	0.733	1.146	1.559	1.972
	2732853	SS512293	SS50081AS	U238	0.807		0.03	A	0.733	1.146	1.559	1.972
Exceeds the Background Mean plus one Standard Deviation but is less than Background Mean plus two Standard Deviations												
115/196	2330943	SS510093	SS50051AS	U233234	1.55		0.023	A	0.822	1.202	1.582	1.962
	2330945	SS508093	SS50031AS	U233234	1.46		0.026	A	0.822	1.202	1.582	1.962
	3670878	SS515293	SS50125AS	U233234	1.3237		0.0302	Y	0.822	1.202	1.582	1.962
	3670879	SS515293	SS50126AS	U233234	1.2839		0.04	Y	0.822	1.202	1.582	1.962
	3670877	SS515293	SS50124AS	U233234	1.2634		0.0361	Y	0.822	1.202	1.582	1.962
	3671443	SS505993	SS50010AS	U233234	1.21295		0.0342	Y	0.822	1.202	1.582	1.962
	2330912	SS510093	SS50051AS	U235	0.124		0	A	0.039	0.091	0.143	0.195
	2330904	SS508493	SS50035AS	U235	0.11		0.016	A	0.039	0.091	0.143	0.195
	2425912	SS508193	SS50032AS	U235	0.11	U	0.2	A	0.039	0.091	0.143	0.195
	3670925	SS515293	SS50124AS	U238	1.5522		0.0222	Y	0.733	1.146	1.559	1.972
	2330965	SS508093	SS50031AS	U238	1.54		0.019	A	0.733	1.146	1.559	1.972
	2330964	SS508493	SS50035AS	U238	1.35		0.016	A	0.733	1.146	1.559	1.972
	2405931	SS507493	SS50025AS	U238	1.31		0.029	A	0.733	1.146	1.559	1.972
	3671481	SS505993	SS50010AS	U238	1.24775		0.0234	Y	0.733	1.146	1.559	1.972
	3670927	SS515293	SS50126AS	U238	1.2394		0.0273	Y	0.733	1.146	1.559	1.972
	2405941	SS507093	SS50021AS	U238	1.18		0	A	0.733	1.146	1.559	1.972
	2269982	SS509293	SS50043AS	U238	1.1761		0.0323	A	0.733	1.146	1.559	1.972
133.2	2689763	SS514993	SS50112AS	U233234	1.5	B	0.012	A	0.822	1.202	1.582	1.962
	2689748	SS515093	SS50113AS	U235	0.13	BJ	0.023	A	0.039	0.091	0.143	0.195
	2689755	SS515193	SS50114AS	U235	0.099	BJ	0.021	A	0.039	0.091	0.143	0.195
133.3	2689742	SS514793	SS50110AS	U233234	1.4	B	0.049	A	0.822	1.202	1.582	1.962
133.4	2642361	SS514093	SS50102AS	U233234	1.5	B	0.033	A	0.822	1.202	1.582	1.962
	2642368	SS513993	SS50101AS	U233234	1.5	B	0.033	A	0.822	1.202	1.582	1.962
133.5	2642353	SS513893	SS50100AS	U235	0.11	J	0.022	A	0.039	0.091	0.143	0.195
	2642338	SS513493	SS50096AS	U238	1.3	B	0.03	A	0.733	1.146	1.559	1.972
133.6	2642325	SS513693	SS50098AS	U235	0.11	J	0.031	A	0.039	0.091	0.143	0.195
Exceeds the Background Mean plus two Standard Deviations but is less than Background Mean plus three Standard Deviations												
115/196	2269937	SS509393	SS50044AS	U233234	1.7913		0.1149	A	0.822	1.202	1.582	1.962
	2330963	SS508893	SS50039AS	U238	1.92		0.014	A	0.733	1.146	1.559	1.972
	2330947	SS508993	SS50040AS	U238	1.77		0.032	A	0.733	1.146	1.559	1.972
	3671480	SS505193	SS50002AS	U238	1.5753		0.0223	Y	0.733	1.146	1.559	1.972
	3670926	SS515293	SS50125AS	U238	1.5696		0.0302	Y	0.733	1.146	1.559	1.972
133.1	2689728	SS514593	SS50108AS	U233234	1.8	B	0.019	A	0.822	1.202	1.582	1.962
	2689693	SS514193	SS50103AS	U233234	1.7	B	0.01	A	0.822	1.202	1.582	1.962
	2689691	SS514193	SS50103AS	U238	1.6	B	0.017	A	0.733	1.146	1.559	1.972
133.2	3670875	SS514893	SS50111AS	U233234	1.6469		0.0273	Y	0.822	1.202	1.582	1.962
	2689749	SS515093	SS50113AS	U233234	1.6	B	0.014	A	0.822	1.202	1.582	1.962
	3670923	SS514893	SS50111AS	U238	1.96495		0.0274	Y	0.733	1.146	1.559	1.972
133.3	2689735	SS514693	SS50109AS	U233234	1.6	B	0.036	A	0.822	1.202	1.582	1.962
	2689741	SS514793	SS50110AS	U235	0.19	BJ	0.027	A	0.039	0.091	0.143	0.195
	2689734	SS514693	SS50109AS	U235	0.17	BJ	0.014	A	0.039	0.091	0.143	0.195
	2689740	SS514793	SS50110AS	U238	1.8	B	0.049	A	0.733	1.146	1.559	1.972
133.4	2642360	SS514093	SS50102AS	U235	0.15	J	0.021	A	0.039	0.091	0.143	0.195
133.5	2642354	SS513893	SS50100AS	U233234	1.8	B	0.052	A	0.822	1.202	1.582	1.962
	2689700	SS514293	SS50104AS	U233234	1.7	B	0.011	A	0.822	1.202	1.582	1.962
	2689706	SS514393	SS50106AS	U235	0.1635	BJ	0.012	A	0.039	0.091	0.143	0.195
	2689699	SS514293	SS50104AS	U235	0.15	BJ	0.011	A	0.039	0.091	0.143	0.195
133.6	2642326	SS513693	SS50098AS	U233234	1.6	B	0.041	A	0.822	1.202	1.582	1.962

Table 4-2 Summary of Radionuclide COCs Exceeding Background Mean in Surface Soil

IHSS	Sequence ID	Location	Sample No.	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
Exceeds the Background Mean plus three Standard Deviations												
115/196	3419245	SS505493	SS50005AS	U233234	2800		70	V	0.822	1.202	1.582	1.962
	3419233	SS505093	SS50001AS	U233234	200		9	V	0.822	1.202	1.582	1.962
	3419239	SS505293	SS50003AS	U233234	97		5	V	0.822	1.202	1.582	1.962
	3419251	SS515593	SS50127AS	U233234	94		6	V	0.822	1.202	1.582	1.962
	3419257	SS515693	SS50128AS	U233234	13		0.8	V	0.822	1.202	1.582	1.962
	3670870	SS510293	SS50053AS	U233234	3.637		0.0446	Y	0.822	1.202	1.582	1.962
	3670872	SS505393	SS50004AS	U233234	2.7079		0.0175	Y	0.822	1.202	1.582	1.962
	2269938	SS509993	SS50050AS	U233234	2.6707		0.049	A	0.822	1.202	1.582	1.962
	3670871	SS509693	SS50047AS	U233234	2.4392		0.0432	Y	0.822	1.202	1.582	1.962
	3671445	SS505893	SS50009AS	U233234	2.3131		0.0258	Y	0.822	1.202	1.582	1.962
	2269939	SS508793	SS50038AS	U233234	2.26115		0.0619	A	0.822	1.202	1.582	1.962
	3419246	SS505493	SS50005AS	U235	670		30	V	0.039	0.091	0.143	0.195
	3419234	SS505093	SS50001AS	U235	46		6	V	0.039	0.091	0.143	0.195
	3419240	SS505293	SS50003AS	U235	23		3	V	0.039	0.091	0.143	0.195
	3419252	SS515593	SS50127AS	U235	19		4	V	0.039	0.091	0.143	0.195
	3419258	SS515693	SS50128AS	U235	2.1		0.5	V	0.039	0.091	0.143	0.195
	3670896	SS505393	SS50004AS	U235	0.2739		0.0176	Y	0.039	0.091	0.143	0.195
	2269959	SS509993	SS50050AS	U235	0.2283		0.0301	A	0.039	0.091	0.143	0.195
	3419247	SS505493	SS50005AS	U238	38000		70	V	0.733	1.146	1.559	1.972
	3419235	SS505093	SS50001AS	U238	2000		9	V	0.733	1.146	1.559	1.972
	3419241	SS505293	SS50003AS	U238	1000		4	V	0.733	1.146	1.559	1.972
	3419253	SS515593	SS50127AS	U238	780		5	V	0.733	1.146	1.559	1.972
	3419259	SS515693	SS50128AS	U238	86		0.6	V	0.733	1.146	1.559	1.972
	2269980	SS509993	SS50050AS	U238	17.7287		0.0576	A	0.733	1.146	1.559	1.972
	3670920	SS505393	SS50004AS	U238	10.0269		0.0222	Y	0.733	1.146	1.559	1.972
	2269979	SS509393	SS50044AS	U238	7.7302		0.0829	A	0.733	1.146	1.559	1.972
	2330957	SS510093	SS50051AS	U238	5.43		0	A	0.733	1.146	1.559	1.972
	2269981	SS508793	SS50038AS	U238	3.6463		0.0379	A	0.733	1.146	1.559	1.972
	3670918	SS510293	SS50053AS	U238	3.3073		0.0251	Y	0.733	1.146	1.559	1.972
	2269984	SS509893	SS50049AS	U238	2.3629		0.0317	A	0.733	1.146	1.559	1.972
	3670919	SS509693	SS50047AS	U238	2.2344		0.0265	Y	0.733	1.146	1.559	1.972
	2330958	SS509493	SS50045AS	U238	2.17		0.019	A	0.733	1.146	1.559	1.972
	2269977	SS510693	SS50057AS	U238	2.0374		0.0399	A	0.733	1.146	1.559	1.972
	3670921	SS505593	SS50006AS	U238	2.0258		0.0196	Y	0.733	1.146	1.559	1.972
	3671483	SS505893	SS50009AS	U238	1.9819		0.0205	Y	0.733	1.146	1.559	1.972
133.1	2689726	SS514593	SS50108AS	U238	2	B	0.05	A	0.733	1.146	1.559	1.972
133.2	2689756	SS515193	SS50114AS	U233234	2.2	B	0.021	A	0.822	1.202	1.582	1.962
	2689754	SS515193	SS50114AS	U238	2.6	B	0.021	A	0.733	1.146	1.559	1.972
	2689761	SS514993	SS50112AS	U238	2.3	B	0.021	A	0.733	1.146	1.559	1.972
	2689747	SS515093	SS50113AS	U238	2.1	B	0.023	A	0.733	1.146	1.559	1.972
133.3	2689721	SS514493	SS50107AS	U233234	3.3	B	0.015	A	0.822	1.202	1.582	1.962
	2689719	SS514493	SS50107AS	U238	5.2	B	0.039	A	0.733	1.146	1.559	1.972
	2689733	SS514693	SS50109AS	U238	2.8	B	0.036	A	0.733	1.146	1.559	1.972
133.4	3670881	SS515493	SS50121AS	U233234	47.4833		0.073	Y	0.822	1.202	1.582	1.962
	3670882	SS515493	SS50122AS	U233234	44.9751		0.0933	Y	0.822	1.202	1.582	1.962
	3670883	SS515493	SS50123AS	U233234	43.2646		0.1066	Y	0.822	1.202	1.582	1.962
	3670906	SS515493	SS50122AS	U235	2.8877		0.1366	Y	0.039	0.091	0.143	0.195
	3670905	SS515493	SS50121AS	U235	2.2385		0.073	Y	0.039	0.091	0.143	0.195
	3670907	SS515493	SS50123AS	U235	2.1994		0.1066	Y	0.039	0.091	0.143	0.195
	3670929	SS515493	SS50121AS	U238	209.2773		0.0921	Y	0.733	1.146	1.559	1.972
	3670930	SS515493	SS50122AS	U238	203.0783		0.0933	Y	0.733	1.146	1.559	1.972
	3670931	SS515493	SS50123AS	U238	190.321		0.1066	Y	0.733	1.146	1.559	1.972
	2642359	SS514093	SS50102AS	U238	2.6	B	0.038	A	0.733	1.146	1.559	1.972
	2642366	SS513993	SS50101AS	U238	2.2	B	0.033	A	0.733	1.146	1.559	1.972
133.5	2689707	SS514393	SS50106AS	U233234	2.6	B	0.012	A	0.822	1.202	1.582	1.962
	2642347	SS513793	SS50099AS	U233234	2.4	B	0.014	A	0.822	1.202	1.582	1.962
	2689705	SS514393	SS50106AS	U238	4.1	B	0.012	A	0.733	1.146	1.559	1.972
	2642345	SS513793	SS50099AS	U238	3.5	B	0.014	A	0.733	1.146	1.559	1.972
	2642352	SS513893	SS50100AS	U238	3.1	B	0.068	A	0.733	1.146	1.559	1.972
	2689698	SS514293	SS50104AS	U238	2.5	B	0.019	A	0.733	1.146	1.559	1.972
133.6	2642333	SS513593	SS50097AS	U233234	2.4	B	0.021	A	0.822	1.202	1.582	1.962
	2642331	SS513593	SS50097AS	U238	2.5	B	0.039	A	0.733	1.146	1.559	1.972
	2642324	SS513693	SS50098AS	U238	2.3	B	0.06	A	0.733	1.146	1.559	1.972

These data are graphically displayed on Figures 4-2a and 2b.

Table 4-3 Summary of Organic COCs in Surface Soil

IHSS	Sequence ID	Location	Sample No.	Test Group Code	Constituent	Result in ug/kg	Qualifier	Reporting Limit	Valid.
Dectected at concentration below Reporting Limit									
115/196	2264610	SS509993	SS50050AS	BNACLP	Benzo(a)anthracene	320	J	330	
	2203934	SS507993	SS50030AS	BNACLP	Benzo(a)anthracene	290	J	330	A
	2265850	SS509993	SS50050AS	BNACLP	Benzo(a)anthracene	280	J	330	A
	2231849	SS508693	SS50037AS	BNACLP	Benzo(a)anthracene	240	J	330	A
	2266034	SS509293	SS50043AS	BNACLP	Benzo(a)anthracene	210	J	330	A
	2247160	SS509493	SS50045AS	BNACLP	Benzo(a)anthracene	200	J	330	A
	2247252	SS510093	SS50051AS	BNACLP	Benzo(a)anthracene	200	J	330	V
	2158674	SS508193	SS50032AS	BNACLP	Benzo(a)anthracene	170	J	330	A
	2204081	SS508493	SS50035AS	BNACLP	Benzo(a)anthracene	170	J	330	A
	2204473	SS511393	SS50064AS	BNACLP	Benzo(a)anthracene	160	J	330	A
	2266218	SS510493	SS50055AS	BNACLP	Benzo(a)anthracene	160	J	330	A
	2158331	SS507193	SS50022AS	BNCLP	Benzo(a)anthracene	150	J	330	A
	2204326	SS511093	SS50061AS	BNACLP	Benzo(a)anthracene	120	JX	330	A
	2204228	SS509093	SS50041AS	BNACLP	Benzo(a)anthracene	83	J	330	A
	2701641	SS509693	SS50047AS	BNACLP	Benzo(a)anthracene	66	J	330	A
	2247068	SS508093	SS50031AS	BNACLP	Benzo(a)anthracene	64	J	330	A
	2247166	SS509493	SS50045AS	BNACLP	Benzo(a)Pyrene	240	J	330	A
	2247258	SS510093	SS50051AS	BNACLP	Benzo(a)Pyrene	240	J	330	A
	2266040	SS509293	SS50043AS	BNACLP	Benzo(a)Pyrene	240	J	330	A
	2158680	SS508193	SS50032AS	BNACLP	Benzo(a)Pyrene	180	J	330	A
	2231855	SS508693	SS50037AS	BNACLP	Benzo(a)Pyrene	160	J	330	A
	2204479	SS511393	SS50064AS	BNACLP	Benzo(a)Pyrene	150	J	330	A
	2266224	SS510493	SS50055AS	BNACLP	Benzo(a)Pyrene	150	J	330	A
	2246656	SS508993	SS50040AS	BNACLP	Benzo(a)Pyrene	102	J	330	A
	2247074	SS508093	SS50031AS	BNACLP	Benzo(a)Pyrene	73	J	330	A
	2158678	SS508193	SS50032AS	BNACLP	Benzo(b)Fluoranthene	320	J	330	A
	2231853	SS508693	SS50037AS	BNACLP	Benzo(b)Fluoranthene	320	J	330	A
	2247164	SS509493	SS50045AS	BNACLP	Benzo(b)Fluoranthene	320	J	330	A
	2266222	SS510493	SS50055AS	BNACLP	Benzo(b)Fluoranthene	300	J	330	A
	2204477	SS511393	SS50064AS	BNACLP	Benzo(b)Fluoranthene	220	JX	330	A
	2204085	SS508493	SS50035AS	BNACLP	Benzo(b)Fluoranthene	200	J	330	A
	2247256	SS510093	SS50051AS	BNACLP	Benzo(b)Fluoranthene	130	J	330	A
	2247072	SS508093	SS50031AS	BNACLP	Benzo(b)Fluoranthene	110	J	330	A
	2246654	SS508993	SS50040AS	BNACLP	Benzo(b)Fluoranthene	103.5	J	330	A
	2158433	SS507393	SS50024AS	BNACLP	Benzo(b)Fluoranthene	87	J	330	A
	2265950	SS508793	SS50038AS	BNACLP	Dibenzo(a,h)anthracene	135	J	330	A
	2265766	SS509393	SS50044AS	BNACLP	Dibenzo(a,h)anthracene	69	J	330	A
	2265858	SS509993	SS50050AS	BNACLP	Dibenzo(a,h)anthracene	60		330	A
	2246646	SS508993	SS50040AS	BNACLP	Fluoranthene	250	J	330	A
	2204322	SS511093	SS50061AS	BNACLP	Fluoranthene	230	J	330	A
	2247064	SS508093	SS50031AS	BNACLP	Fluoranthene	210	J	330	A
	2204224	SS509093	SS50041AS	BNACLP	Fluoranthene	180	J	330	A
	2701637	SS509693	SS50047AS	BNACLP	Fluoranthene	180	J	330	A
	2158278	SS507093	SS50021AS	BNCLP	Fluoranthene	150	J	330	A
	2204518	SS511493	SS50065AS	BNACLP	Fluoranthene	150	J	330	A
	2158180	SS506693	SS50017AS	BNCLP	Fluoranthene	130	J	330	A
	2158229	SS506993	SS50020AS	BNACLP	Fluoranthene	130	J	330	A
	2158425	SS507393	SS50024AS	BNACLP	Fluoranthene	120	J	330	A
	2701546	SS510293	SS50053AS	BNACLP	Fluoranthene	120	J	330	A
	2158621	SS507693	SS50027AS	BNACLP	Fluoranthene	110	J	330	A
	2246972	SS508593	SS50036AS	BNACLP	Fluoranthene	110	J	330	A
	2158572	SS507593	SS50026AS	BNCLP	Fluoranthene	97	J	330	A
	2232209	SS510393	SS50054AS	BNACLP	Fluoranthene	83	J	330	A
	2122170	SS506193	SS50012ASU5	BNACLP	Fluoranthene	68	J	330	A
	2265857	SS509993	SS50050AS	BNACLP	Indeno(1,2,3-cd)Pyrene	250	J	330	A
	2265765	SS509393	SS50044AS	BNACLP	Indeno(1,2,3-cd)Pyrene	240	J	330	A
	2264617	SS509993	SS50050AS	BNACLP	Indeno(1,2,3-cd)Pyrene	230	J	330	
	2266133	SS509893	SS50049AS	BNACLP	Indeno(1,2,3-cd)Pyrene	210	J	330	A
	2122365	SS506493	SS50015ASU5	BNACLP	Indeno(1,2,3-cd)Pyrene	170	J	330	A
	2247167	SS509493	SS50045AS	BNACLP	Indeno(1,2,3-cd)Pyrene	140	J	330	A

Table 4-3 Summary of Organic COCs in Surface Soil

IHSS	Sequence ID	Location	Sample No.	Test Group Code	Constituent	Result in ug/kg	Qualifier	Reporting Limit	Valid.
	2266041	SS509293	SS50043AS	BNACLP	Indeno(1,2,3-cd)Pyrene	130	J	330	A
	2247259	SS510093	SS50051AS	BNACLP	Indeno(1,2,3-cd)Pyrene	120	J	330	A
	2266225	SS510493	SS50055AS	BNACLP	Indeno(1,2,3-cd)Pyrene	82	J	330	A
	2246657	SS508993	SS50040AS	BNACLP	Indeno(1,2,3-cd)Pyrene	59.5	J	330	A
	2247075	SS508093	SS50031AS	BNACLP	Indeno(1,2,3-cd)Pyrene	52	J	330	A
	2158328	SS507193	SS50022AS	BNCLP	Pyrene	280	J	330	A
	2158720	SS509593	SS50046AS	BNCLP	Pyrene	280	J	330	A
	2204078	SS508493	SS50035AS	BNACLP	Pyrene	270	J	330	A
	2204323	SS511093	SS50061AS	BNACLP	Pyrene	200	J	330	A
	2246647	SS508993	SS50040AS	BNACLP	Pyrene	175	J	330	A
	2204225	SS509093	SS50041AS	BNACLP	Pyrene	170	J	330	A
	2701638	SS509693	SS50047AS	BNACLP	Pyrene	170	J	330	A
	2158279	SS507093	SS50021AS	BNCLP	Pyrene	150	J	330	A
	2247065	SS508093	SS50031AS	BNACLP	Pyrene	140	J	330	A
	2204519	SS511493	SS50065AS	BNACLP	Pyrene	130	J	330	A
	2158230	SS506993	SS50020AS	BNACLP	Pyrene	115	J	330	A
	2158181	SS506693	SS50017AS	BNCLP	Pyrene	110	J	330	A
	2158573	SS507593	SS50026AS	BNCLP	Pyrene	110	J	330	A
	2232210	SS510393	SS50054AS	BNACLP	Pyrene	100	J	330	A
	2158622	SS507693	SS50027AS	BNACLP	Pyrene	90	J	330	A
	2701547	SS510293	SS50053AS	BNACLP	Pyrene	83	J	330	A
	2158426	SS507393	SS50024AS	BNACLP	Pyrene	81	J	330	A
	2122171	SS506193	SS50012ASU5	BNACLP	Pyrene	63	BJ	330	A
	2246973	SS508593	SS50036AS	BNACLP	Pyrene	59	J	330	A
Exceeds Reporting Limit but is less than ten times the Reporting Limit									
115/196	2232031	SS509193	SS50042AS	BNACLP	Benzo(a)anthracene	3000	D	330	Z
	2231939	SS509193	SS50042AS	BNACLP	Benzo(a)anthracene	2900		330	[illegible]
	2232121	SS509793	SS50048AS	BNACLP	Benzo(a)anthracene	1500		330	V
	2203836	SS507793	SS50028AS	BNACLP	Benzo(a)anthracene	1300		330	V
	2203885	SS507893	SS50029AS	BNACLP	Benzo(a)anthracene	800		330	V
	2265942	SS508793	SS50038AS	BNACLP	Benzo(a)anthracene	800		330	V
	2158870	SS510693	SS50057AS	BNCLP	Benzo(a)anthracene	780	J	330	A
	2122358	SS506493	SS50015ASU5	BNACLP	Benzo(a)anthracene	460		330	V
	2204277	SS510993	SS50060AS	BNACLP	Benzo(a)anthracene	440	J	330	A
	2265758	SS509393	SS50044AS	BNACLP	Benzo(a)anthracene	410		330	V
	2203983	SS508293	SS50033AS	BNACLP	Benzo(a)anthracene	380	J	330	A
	2266126	SS509893	SS50049AS	BNACLP	Benzo(a)anthracene	360	J	330	A
	2232037	SS509193	SS50042AS	BNACLP	Benzo(a)Pyrene	1400	D	330	Z
	2203842	SS507793	SS50028AS	BNACLP	Benzo(a)Pyrene	1300		330	V
	2231945	SS509193	SS50042AS	BNACLP	Benzo(a)Pyrene	1300		330	V
	2232127	SS509793	SS50048AS	BNACLP	Benzo(a)Pyrene	1200		330	V
	2203891	SS507893	SS50029AS	BNACLP	Benzo(a)Pyrene	930		330	V
	2265948	SS508793	SS50038AS	BNACLP	Benzo(a)Pyrene	840		330	V
	2158876	SS510693	SS50057AS	BNCLP	Benzo(a)Pyrene	790	J	330	A
	2203940	SS507993	SS50030AS	BNACLP	Benzo(a)Pyrene	615	J	330	A
	2203989	SS508293	SS50033AS	BNACLP	Benzo(a)Pyrene	470	J	330	A
	2265764	SS509393	SS50044AS	BNACLP	Benzo(a)Pyrene	460		330	V
	2122364	SS506493	SS50015ASU5	BNACLP	Benzo(a)Pyrene	400		330	V
	2264616	SS509993	SS50050AS	BNACLP	Benzo(a)Pyrene	400		330	
	2266132	SS509893	SS50049AS	BNACLP	Benzo(a)Pyrene	390		330	V
	2265856	SS509993	SS50050AS	BNACLP	Benzo(a)Pyrene	370		330	JA
	2231943	SS509193	SS50042AS	BNACLP	Benzo(b)Fluoranthene	2600		330	V
	2232035	SS509193	SS50042AS	BNACLP	Benzo(b)Fluoranthene	2500	D	330	Z
	2232125	SS509793	SS50048AS	BNACLP	Benzo(b)Fluoranthene	2000		330	V
	2203840	SS507793	SS50028AS	BNACLP	Benzo(b)Fluoranthene	1700		330	V
	2203889	SS507893	SS50029AS	BNACLP	Benzo(b)Fluoranthene	1700		330	V
	2265946	SS508793	SS50038AS	BNACLP	Benzo(b)Fluoranthene	1350		330	[illegible]
	2158874	SS510693	SS50057AS	BNCLP	Benzo(b)Fluoranthene	1300		330	V
	2266130	SS509893	SS50049AS	BNACLP	Benzo(b)Fluoranthene	740		330	V
	2265762	SS509393	SS50044AS	BNACLP	Benzo(b)Fluoranthene	730		330	V
	2203938	SS507993	SS50030AS	BNACLP	Benzo(b)Fluoranthene	645	J	330	A

Table 4-3 Summary of Organic COCs in Surface Soil

IHSS	Sequence ID	Location	Sample No.	Test Group Code	Constituent	Result in ug/kg	Qualifier	Reporting Limit	Valid.
	2264614	SS509993	SS50050AS	BNACLP	Benzo(b)Fluoranthene	640		330	
	2203987	SS508293	SS50033AS	BNACLP	Benzo(b)Fluoranthene	620	JX	330	A
	2122362	SS506493	SS50015ASU5	BNACLP	Benzo(b)Fluoranthene	530		330	V
	2266038	SS509293	SS50043AS	BNACLP	Benzo(b)Fluoranthene	410		330	V
	2204138	SS508893	SS50039AS	BNACLP	Dibenzo(a,h)anthracene	1100		330	V
	2204187	SS508893	SS50039AS	BNACLP	Dibenzo(a,h)anthracene	960	DJ	330	
	2232117	SS509793	SS50048AS	BNACLP	Fluoranthene	2500		330	V
	2158866	SS510693	SS50057AS	BNCLP	Fluoranthene	2100		330	V
	2203881	SS507893	SS50029AS	BNACLP	Fluoranthene	2000		330	V
	2265938	SS508793	SS50038AS	BNACLP	Fluoranthene	1700		330	V
	2122354	SS506493	SS50015ASU5	BNACLP	Fluoranthene	1000		330	V
	2265754	SS509393	SS50044AS	BNACLP	Fluoranthene	940		330	V
	2266122	SS509893	SS50049AS	BNACLP	Fluoranthene	910		330	V
	2264606	SS509993	SS50050AS	BNACLP	Fluoranthene	900		330	
	2203979	SS508293	SS50033AS	BNACLP	Fluoranthene	810		330	V
	2265846	SS509993	SS50050AS	BNACLP	Fluoranthene	760		330	V
	2203930	SS507993	SS50030AS	BNACLP	Fluoranthene	730		330	V
	2266030	SS509293	SS50043AS	BNACLP	Fluoranthene	640		330	V
	2247156	SS509493	SS50045AS	BNACLP	Fluoranthene	580		330	V
	2231845	SS508693	SS50037AS	BNACLP	Fluoranthene	570		330	V
	2247248	SS510093	SS50051AS	BNACLP	Fluoranthene	570		330	V
	2266214	SS510493	SS50055AS	BNACLP	Fluoranthene	520		330	V
	2204273	SS510993	SS50060AS	BNACLP	Fluoranthene	505	J	330	A
	2158670	SS508193	SS50032AS	BNACLP	Fluoranthene	440	J	330	A
	2158719	SS509593	SS50046AS	BNCLP	Fluoranthene	380	J	330	A
	2158327	SS507193	SS50022AS	BNCLP	Fluoranthene	370	J	330	A
	2204469	SS511393	SS50064AS	BNACLP	Fluoranthene	360	J	330	A
	2204077	SS508493	SS50035AS	BNACLP	Fluoranthene	350	J	330	A
	2204137	SS508893	SS50039AS	BNACLP	Indeno(1,2,3-cd)Pyrene	3100		330	JA
	2204186	SS508893	SS50039AS	BNACLP	Indeno(1,2,3-cd)Pyrene	3100	D	330	
	2203843	SS507793	SS50028AS	BNACLP	Indeno(1,2,3-cd)Pyrene	1100		330	JA
	2232038	SS509193	SS50042AS	BNACLP	Indeno(1,2,3-cd)Pyrene	600	DJ	330	Z
	2265949	SS508793	SS50038AS	BNACLP	Indeno(1,2,3-cd)Pyrene	470		330	V
	2232128	SS509793	SS50048AS	BNACLP	Indeno(1,2,3-cd)Pyrene	420		330	V
	2231946	SS509193	SS50042AS	BNACLP	Indeno(1,2,3-cd)Pyrene	410		330	V
	2263773	SS509393	SS50044AS	PESTCLP	PCB-1254	1100		160	V
	2263913	SS510493	SS50055AS	PESTCLP	PCB-1254	1100		160	V
	2246200	SS508993	SS50040AS	PESTCLP	PCB-1254	1065		160	V
	2205407	SS508893	SS50039AS	PESTCLP	PCB-1254	900	X	160	V
	2205245	SS507793	SS50028AS	PESTCLP	PCB-1254	850	X	160	V
	2263829	SS508793	SS50038AS	PESTCLP	PCB-1254	630		160	V
	2205380	SS508493	SS50035AS	PESTCLP	PCB-1254	560	X	160	V
	2263885	SS509893	SS50049AS	PESTCLP	PCB-1254	430		160	V
	2263857	SS509293	SS50043AS	PESTCLP	PCB-1254	220		160	V
	2203833	SS507793	SS50028AS	BNACLP	Pyrene	2600		330	V
	2232118	SS509793	SS50048AS	BNACLP	Pyrene	2600		330	V
	2203882	SS507893	SS50029AS	BNACLP	Pyrene	1700		330	V
	2158867	SS510693	SS50057AS	BNCLP	Pyrene	1600		330	V
	2265939	SS508793	SS50038AS	BNACLP	Pyrene	1500		330	V
	2122355	SS506493	SS50015ASU5	BNACLP	Pyrene	1000	BX	330	JA
	2264607	SS509993	SS50050AS	BNACLP	Pyrene	730		330	
	2265755	SS509393	SS50044AS	BNACLP	Pyrene	730		330	V
	2265847	SS509993	SS50050AS	BNACLP	Pyrene	710		330	V
	2203980	SS508293	SS50033AS	BNACLP	Pyrene	700	J	330	A
	2266123	SS509893	SS50049AS	BNACLP	Pyrene	670		330	V
	2203931	SS507993	SS50030AS	BNACLP	Pyrene	635		330	V
	2204274	SS510993	SS50060AS	BNACLP	Pyrene	490	J	330	A
	2266031	SS509293	SS50043AS	BNACLP	Pyrene	470		330	V
	2247249	SS510093	SS50051AS	BNACLP	Pyrene	440		330	V
	2231846	SS508693	SS50037AS	BNACLP	Pyrene	430		330	V
	2247157	SS509493	SS50045AS	BNACLP	Pyrene	430		330	V

Table 4-3 Summary of Organic COCs in Surface Soil

IHSS	Sequence ID	Location	Sample No.	Test Group Code	Constituent	Result in ug/kg	Qualifier	Reporting Limit	Valid.
	2158671	SS508193	SS50032AS	BNACLP	Pyrene	410	J	330	A
	2204470	SS511393	SS50064AS	BNACLP	Pyrene	340	J	330	A
	2266215	SS510493	SS50055AS	BNACLP	Pyrene	340	J	330	A
Exceeds ten times the Reporting Limit but less than one hundred times the Reporting Limit									
115/196	2204130	SS508893	SS50039AS	BNACLP	Benzo(a)anthracene	4400		330	V
	2204179	SS508893	SS50039AS	BNACLP	Benzo(a)anthracene	3500	D	330	
	2204136	SS508893	SS50039AS	BNACLP	Benzo(a)Pyrene	4500		330	V
	2204185	SS508893	SS50039AS	BNACLP	Benzo(a)Pyrene	3900	D	330	
	2204134	SS508893	SS50039AS	BNACLP	Benzo(b)Fluoranthene	5500		330	V
	2204183	SS508893	SS50039AS	BNACLP	Benzo(b)Fluoranthene	4600	D	330	
	2158829	SS510593	SS50056AS	BNACLP	Dibenzo(a,h)anthracene	9200	DJ	330	
	2158780	SS510593	SS50056AS	BNACLP	Dibenzo(a,h)anthracene	7000		330	V
	2204126	SS508893	SS50039AS	BNACLP	Fluoranthene	12000		330	V
	2204175	SS508893	SS50039AS	BNACLP	Fluoranthene	9900	D	330	
	2232027	SS509193	SS50042AS	BNACLP	Fluoranthene	6200	D	330	V
	2231935	SS509193	SS50042AS	BNACLP	Fluoranthene	4200		330	Z
	2203832	SS507793	SS50028AS	BNACLP	Fluoranthene	3400		330	V
	2158828	SS510593	SS50056AS	BNACLP	Indeno(1,2,3-cd)Pyrene	32000	D	330	JA
	2158779	SS510593	SS50056AS	BNACLP	Indeno(1,2,3-cd)Pyrene	28000	E	330	
	2246396	SS510093	SS50051AS	PESTCLP	PCB-1254	3900		160	V
	2246368	SS509493	SS50045AS	PESTCLP	PCB-1254	2400		160	V
	2263801	SS509993	SS50050AS	PESTCLP	PCB-1254	2300	C	160	V
	2160260	SS510693	SS50057AS	PESTCLP	PCB-1254	2200	X	160	V
	2204127	SS508893	SS50039AS	BNACLP	Pyrene	9500		330	V
	2204176	SS508893	SS50039AS	BNACLP	Pyrene	8400	D	330	
	2232028	SS509193	SS50042AS	BNACLP	Pyrene	6100	D	330	V
	2231936	SS509193	SS50042AS	BNACLP	Pyrene	5100		330	[illegible]
Exceeds one hundred times the Reporting Limit									
115/196	2158821	SS510593	SS50056AS	BNACLP	Benzo(a)anthracene	45000	D	330	V
	2158772	SS510593	SS50056AS	BNACLP	Benzo(a)anthracene	40000	E	330	
	2158778	SS510593	SS50056AS	BNACLP	Benzo(a)Pyrene	43000	E	330	
	2158827	SS510593	SS50056AS	BNACLP	Benzo(a)Pyrene	41000	D	330	V
	2158825	SS510593	SS50056AS	BNACLP	Benzo(b)Fluoranthene	49000	XD	330	V
	2158776	SS510593	SS50056AS	BNACLP	Benzo(b)Fluoranthene	48000	E	330	
	2158817	SS510593	SS50056AS	BNACLP	Fluoranthene	140000	D	330	V
	2158768	SS510593	SS50056AS	BNACLP	Fluoranthene	73000	E	330	
	2158818	SS510593	SS50056AS	BNACLP	Pyrene	120000	D	330	V
	2158769	SS510593	SS50056AS	BNACLP	Pyrene	59000	E	330	

These data are graphically displayed on Figures 4-3a and 3b.

Table 4-4
Summary of Metal COCs Exceeding Background Mean in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in mg/kg	Qualifier	Reporting Limit	Valid.	Mean	Mean + (X * STD DEV) of background X = 1	X=2	X=3
Exceeds the Background Mean but is less than Background Mean plus one Standard Deviation													
115/196	3335198	59593	BH50540AS	0'-2'	ANTIMONY	8.5	B	12	JA	6.56	9.4	12.24	15.08
	3334952	59793	BH50488AS	0'-2'	ANTIMONY	7.1	B	12	JA	6.56	9.4	12.24	15.08
	4981949	56694	BH00122AS	43.0-150.0	COPPER	25.2		25	JA	12.59	25.36	38.13	50.9
	5105493	59894	BH00164AS	19.9-31.9	COPPER	23.3		25	V	12.59	25.36	38.13	50.9
	2700368	59593	BH50552AS	0'-6'	COPPER	22.85		5	V	12.59	25.36	38.13	50.9
	5009789	58794	BH00054AS	0.0-2.4	COPPER	22.6		5	JA	12.59	25.36	38.13	50.9
	2633713	58593	BH50404AS	12.5'-18.1'	COPPER	22.5		5	V	12.59	25.36	38.13	50.9
	4929377	57594	BH00082AS	6.0-12.0	COPPER	22.4		25	V	12.59	25.36	38.13	50.9
	5105437	59494	BH00160AS	11.9-17.9	COPPER	22.4		25	V	12.59	25.36	38.13	50.9
	4929349	57594	BH00078AS	0.0-6.0	COPPER	22.2		25	V	12.59	25.36	38.13	50.9
	2686964	59293	BH50441AS	12'-18.9'	COPPER	21.7		5	V	12.59	25.36	38.13	50.9
	2700126	59793	BH50486AS	13.3'-15.3'	COPPER	21.6		5	V	12.59	25.36	38.13	50.9
	2700434	59593	BH50554AS	14.4'-16.4'	COPPER	21.3		5	V	12.59	25.36	38.13	50.9
	4932915	57594	BH00085AS	18.0-23.0	COPPER	21		25	V	12.59	25.36	38.13	50.9
	2700500	59493	BH50522AS	12.9'-17.8'	COPPER	20.7		5	V	12.59	25.36	38.13	50.9
	2091481	50792	BH50105AS	0'-10'	COPPER	20.5		5	V	12.59	25.36	38.13	50.9
	4981921	56694	BH00113AS	43.0-150.0	COPPER	20.4		25	V	12.59	25.36	38.13	50.9
	4880286	58494	BH00068AS	0.0-6.0	COPPER	20.3		25	V	12.59	25.36	38.13	50.9
	5105297	57094	BH00147AS	0.0-40.0	COPPER	19.9		25	V	12.59	25.36	38.13	50.9
	4961693	56694	BH00112AS	0.0-41.0	COPPER	19.6		25	V	12.59	25.36	38.13	50.9
	4880314	58494	BH00071AS	6.0-9.5	COPPER	19.5		25	V	12.59	25.36	38.13	50.9
	2133994	51092	BH50153AS	0'-6'	COPPER	19.1		5	V	12.59	25.36	38.13	50.9
	4961553	56694	BH00096AS	0.0-6.0	COPPER	18.4		25	V	12.59	25.36	38.13	50.9
	5105325	57094	BH00148AS	0.0-40.0	COPPER	17.9		25	V	12.59	25.36	38.13	50.9
	5009761	58694	BH00052AS	0.0-2.9	COPPER	17.3		5	JA	12.59	25.36	38.13	50.9
	2700802	63193	BH50616AS	0'-6'	COPPER	17.3		5	JA	12.59	25.36	38.13	50.9
	2700044	59793	BH50484AS	0'-7.3'	COPPER	17.2		5	V	12.59	25.36	38.13	50.9
	2120433	50892	BH50121AS	0'-6'	COPPER	17.1		5	V	12.59	25.36	38.13	50.9
	2686942	59293	BH50440AS	6'-12'	COPPER	16.9		5	V	12.59	25.36	38.13	50.9
	2700692	61293	BH50505AS	6'-10.6'	COPPER	16.9		5	JA	12.59	25.36	38.13	50.9
	2120477	50892	BH50123AS	8'-16'	COPPER	16.7		5	V	12.59	25.36	38.13	50.9
	4961525	56694	BH00095AS	0.0-6.0	COPPER	16.7		25	V	12.59	25.36	38.13	50.9
	2686882	59293	BH50439AS	0'-6'	COPPER	16.7		5	V	12.59	25.36	38.13	50.9
	2700890	61093	BH50603AS	6'-13'	COPPER	16.7		5	JA	12.59	25.36	38.13	50.9
	2120389	50592	BH50064AS	12'-18'	COPPER	16.6		5	V	12.59	25.36	38.13	50.9
	2700192	59193	BH50457AS	2'-8'	COPPER	16.55		5	V	12.59	25.36	38.13	50.9
	3334959	59793	BH50488AS	0'-2'	COPPER	16.5		5	V	12.59	25.36	38.13	50.9
	2060864	50692	BH50089AS	0'-14'	COPPER	15.9		5	V	12.59	25.36	38.13	50.9
	2005309	50392	BH50015AS	18'-24'	COPPER	15.8		5	V	12.59	25.36	38.13	50.9
	2746550	58693	BH50349AS	12'-19.5'	COPPER	15.55		5	V	12.59	25.36	38.13	50.9
	2120455	50892	BH50122AS	6'-12'	COPPER	15.3		5	V	12.59	25.36	38.13	50.9
	2700824	63193	BH50617AS	6'-12'	COPPER	15.3		5	JA	12.59	25.36	38.13	50.9
	2005272	50392	BH50016AS	25'-30'	COPPER	14.8		5	V	12.59	25.36	38.13	50.9
	2060820	50692	BH50087AS	0'-6'	COPPER	14.8		5	V	12.59	25.36	38.13	50.9
	2650787	58693	BH50405AS	25.5'-29.5'	COPPER	14.7		5	V	12.59	25.36	38.13	50.9
	3334995	59293	BH50444AS	0'-2'	COPPER	14.7		5	V	12.59	25.36	38.13	50.9
	4961581	56694	BH00098AS	6.0-10.0	COPPER	14.5		25	V	12.59	25.36	38.13	50.9
	5105353	59494	BH00152AS	0.0-5.9	COPPER	14.5		25	V	12.59	25.36	38.13	50.9
	2037352	50492	BH50039AS	12'-18'	COPPER	13.9		5	V	12.59	25.36	38.13	50.9
	2060842	50692	BH50088AS	6'-12'	COPPER	13.2		5	V	12.59	25.36	38.13	50.9
	2700632	61293	BH50504AS	0'-6'	COPPER	12.8		5	JA	12.59	25.36	38.13	50.9
	5105465	59894	BH00162AS	17.9-19.9	COPPER	12.7		25	V	12.59	25.36	38.13	50.9
	4880295	58494	BH00068AS	0.0-6.0	NICKEL	33.2		40	JA	19.81	40.37	60.93	81.49
	2633635	58593	BH50347AS	0'-6'	NICKEL	33.05		8	V	19.81	40.37	60.93	81.49
	2700872	60993	BH50588AS	0'-6'	NICKEL	28.6		8	V	19.81	40.37	60.93	81.49
	4961674	56694	BH00111AS	0.0-35.0	NICKEL	27.1		40	V	19.81	40.37	60.93	81.49
	2700438	59593	BH50554AS	14.4'-16.4'	NICKEL	25.5		8	V	19.81	40.37	60.93	81.49
	5105502	59894	BH00164AS	19.9-31.9	NICKEL	23.7		40	V	19.81	40.37	60.93	81.49
	2120393	50592	BH50064AS	12'-18'	NICKEL	23.6		8	V	19.81	40.37	60.93	81.49
	3335189	59593	BH50540AS	0'-2'	NICKEL	23.5		8	V	19.81	40.37	60.93	81.49
	2133976	50992	BH50140AS	0'-16'	NICKEL	23.4		8	V	19.81	40.37	60.93	81.49
	4981958	56694	BH00122AS	43.0-150.0	NICKEL	23.4		40	V	19.81	40.37	60.93	81.49
	5105306	57094	BH00147AS	0.0-40.0	NICKEL	22.6		40	V	19.81	40.37	60.93	81.49
	5105334	57094	BH00148AS	0.0-40.0	NICKEL	22		40	V	19.81	40.37	60.93	81.49
	5105446	59494	BH00160AS	11.9-17.9	NICKEL	21.3		40	V	19.81	40.37	60.93	81.49
	2746340	58393	BH50343AS	0'-6'	NICKEL	21		8	V	19.81	40.37	60.93	81.49

Table 4-4
Summary of Metal COCs Exceeding Background Mean in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in mg/kg	Qualifier	Reporting Limit	Valid.	Mean	Mean + (X * STD DEV) of background X = 1	X=2	X=3
	2133932	50992	BH50138AS	0'-6'	NICKEL	20.9		8	V	19.81	40.37	60.93	81.49
	2700048	59793	BH50484AS	0'-7.3'	NICKEL	20.4		8	V	19.81	40.37	60.93	81.49
	2700372	59593	BH50552AS	0'-6'	NICKEL	20.15		8	V	19.81	40.37	60.93	81.49
	2746534	58493	BH50346AS	6'-12'	SILVER	13.7		2	V	5.7	15.1	24.5	33.9
	2133934	50992	BH50138AS	0'-6'	SILVER	11.3		2	V	5.7	15.1	24.5	33.9
	2746512	58493	BH50345AS	0'-6'	SILVER	11.2		2	V	5.7	15.1	24.5	33.9
	3335055	59493	BH50524AS	.4'-2'	SILVER	8.2		2	V	5.7	15.1	24.5	33.9
	2133978	50992	BH50140AS	0'-16'	SILVER	6.5		2	V	5.7	15.1	24.5	33.9
133.1	2700280	58893	BH50458AS	0'-6'	COPPER	23.1		5	V	12.59	25.36	38.13	50.9
	2453018	56493	BH50219AS	0'-6'	COPPER	21		5	V	12.59	25.36	38.13	50.9
	2700302	58893	BH50459AS	6'-12'	COPPER	20.1		5	V	12.59	25.36	38.13	50.9
	2452294	56293	BH50206AS	0'-6'	COPPER	15.9		5	V	12.59	25.36	38.13	50.9
	3334885	58893	BH50646AS	0'-2'	COPPER	14.1		5	V	12.59	25.36	38.13	50.9
	2700284	58893	BH50458AS	0'-6'	NICKEL	23.1		8	V	19.81	40.37	60.93	81.49
	2743652	56393	BH50211AS	0'-2'	SILVER	9.8		2	V	5.7	15.1	24.5	33.9
133.2	2687052	58793	BH50409AS	18'-24'	COPPER	24.7		5	V	12.59	25.36	38.13	50.9
	2453410	57593	BH50301AS	12'-14'	COPPER	19.4		5	V	12.59	25.36	38.13	50.9
	2452630	57393	BH50256AS	0'-2'	COPPER	19.3		5	V	12.59	25.36	38.13	50.9
	2452686	57393	BH50258AS	4.6'-12.1'	COPPER	19.1		5	V	12.59	25.36	38.13	50.9
	2452658	57393	BH50257AS	0'-6.6'	COPPER	18.9		5	V	12.59	25.36	38.13	50.9
	2515255	57293	BH50252AS	0'-6'	COPPER	17.6		5	V	12.59	25.36	38.13	50.9
	2425182	56993	BH50202AS	8.1'-14'	COPPER	17.5		5	V	12.59	25.36	38.13	50.9
	2425322	57093	BH50241AS	0'-2'	COPPER	17.5		5	V	12.59	25.36	38.13	50.9
	2452714	57393	BH50259AS	10.2'-18.1'	COPPER	17.4		5	V	12.59	25.36	38.13	50.9
	2452546	57193	BH50246AS	0'-2'	COPPER	17.1		5	V	12.59	25.36	38.13	50.9
	2686986	58793	BH50406AS	0'-6.1'	COPPER	16.9		5	V	12.59	25.36	38.13	50.9
	2425350	57093	BH50242AS	0'-6'	COPPER	16.1		5	V	12.59	25.36	38.13	50.9
	2452574	57193	BH50247AS	0'-5.5'	COPPER	15		5	V	12.59	25.36	38.13	50.9
	2462699	56993	BH50199AS	0'-4'	COPPER	14.5		5	V	12.59	25.36	38.13	[illegible]
	2453158	57493	BH50261AS	0'-2'	COPPER	14.5		5	V	12.59	25.36	38.13	[illegible]
	2425266	56893	BH50239AS	8.3'-14.3'	COPPER	14.3		5	V	12.59	25.36	38.13	50.9
	2453270	57493	BH50265AS	18'-20'	COPPER	14.3		5	V	12.59	25.36	38.13	50.9
	2425406	57093	BH50244AS	12.3'-18.6'	COPPER	14		5	V	12.59	25.36	38.13	50.9
	2687008	58793	BH50407AS	6.1'-12'	COPPER	13.95		5	V	12.59	25.36	38.13	50.9
	2515284	57293	BH50253AS	6'-12'	COPPER	13.7		5	V	12.59	25.36	38.13	50.9
	2515422	57293	BH50292AS	26'-30'	COPPER	13.6		5	V	12.59	25.36	38.13	50.9
	2462677	56993	BH50198AS	0'-2'	COPPER	13.1		5	V	12.59	25.36	38.13	50.9
	2515226	57293	BH50251AS	0'-2'	COPPER	12.9		5	V	12.59	25.36	38.13	50.9
	2515313	57293	BH50254AS	12'-18'	COPPER	12.7		5	V	12.59	25.36	38.13	50.9
	2452664	57393	BH50257AS	0'-6.6'	NICKEL	30.6		8	V	19.81	40.37	60.93	81.49
	2425356	57093	BH50242AS	0'-6'	NICKEL	27.7		8	V	19.81	40.37	60.93	81.49
	2687056	58793	BH50409AS	18'-24'	NICKEL	25.7		8	V	19.81	40.37	60.93	81.49
	2515259	57293	BH50252AS	0'-6'	NICKEL	25.4		8	JA	19.81	40.37	60.93	81.49
	2687078	58793	BH50410AS	24'-28.4'	NICKEL	24.8		8	V	19.81	40.37	60.93	81.49
	2425412	57093	BH50244AS	12.3'-18.6'	NICKEL	22.5		8	V	19.81	40.37	60.93	81.49
	2452636	57393	BH50256AS	0'-2'	NICKEL	20.8		8	V	19.81	40.37	60.93	81.49
133.3	3335136	61193	BH50649AS	0'-2'	ANTIMONY	6.7	B	12	JA	6.56	9.4	12.24	15.08
	2700588	61493	BH50585AS	8.5'-15.9'	COPPER	25.3		5	V	12.59	25.36	38.13	50.9
	2700736	61393	BH50570AS	0'-6'	COPPER	24.55		5	V	12.59	25.36	38.13	50.9
	2452462	56593	BH50224AS	13'-17'	COPPER	23.9		5	V	12.59	25.36	38.13	50.9
	2701000	63093	BH50559AS	15'-20'.	COPPER	20.55		5	JA	12.59	25.36	38.13	50.9
	2700758	61393	BH50576AS	0'-10'	COPPER	20.1		5	V	12.59	25.36	38.13	50.9
	2452518	56693	BH50227AS	0'-6'	COPPER	20		5	V	12.59	25.36	38.13	50.9
	2700566	61493	BH50583AS	0'-8.5'	COPPER	19.8		5	JA	12.59	25.36	38.13	50.9
	2700978	59693	BH50558AS	12'-15.5'	COPPER	18.15		5	V	12.59	25.36	38.13	50.9
	2453074	56793	BH50232AS	0'-6'	COPPER	18		5	V	12.59	25.36	38.13	50.9
	2452434	56593	BH50223AS	6'-12'	COPPER	17		5	V	12.59	25.36	38.13	50.9
	2700912	59693	BH50556AS	0'-6'	COPPER	16.5		5	JA	12.59	25.36	38.13	50.9
	3335123	61193	BH50649AS	0'-2'	COPPER	15		5	V	12.59	25.36	38.13	50.9
	2452490	56693	BH50226AS	0'-2'	COPPER	14.5		5	V	12.59	25.36	38.13	50.9
	2453130	56793	BH50234AS	10'-12'	COPPER	14.5		5	V	12.59	25.36	38.13	50.9
	2452378	56593	BH50221AS	0'-2'	COPPER	13.6		5	V	12.59	25.36	38.13	50.9
	2453102	56793	BH50233AS	6'-12'	COPPER	13.4		5	V	12.59	25.36	38.13	50.9
	2700610	61493	BH50584AS	5.5'-13.5'	COPPER	13.4		5	JA	12.59	25.36	38.13	[illegible]
	2453046	56793	BH50231AS	0'-2'	COPPER	13.3		5	V	12.59	25.36	38.13	[illegible]
	3334793	61493	BH50651AS	0'-2'	COPPER	13.3		5	V	12.59	25.36	38.13	50.9
	2452406	56593	BH50222AS	0'-6'	COPPER	13.1		5	V	12.59	25.36	38.13	50.9

Table 4-4
Summary of Metal COCs Exceeding Background Mean in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in mg/kg	Qualifier	Reporting Limit	Valid.	Mean	Mean + (X * STD DEV) of background X = 1	X=2	X=3
	2700350	61193	BH50503AS	6'-10'	NICKEL	34.65		8	V	19.81	40.37	60.93	81.49
	2700916	59693	BH50556AS	0'-6'	NICKEL	21.3		8	V	19.81	40.37	60.93	81.49
	2700762	61393	BH50576AS	0'-10'	NICKEL	20.9		8	V	19.81	40.37	60.93	81.49
133.4	2519064	55793	BH50307AS	0'-6'	CADMIUM	0.76	B	1	JA	0.64	0.88	1.12	1.36
	2519068	55793	BH50307AS	0'-6'	COPPER	24.9		5	V	12.59	25.36	38.13	50.9
	2519090	55793	BH50308AS	6'-12'	COPPER	23.9		5	V	12.59	25.36	38.13	50.9
	3335051	58993	BH50647AS	0'-2'	COPPER	23.4		5	V	12.59	25.36	38.13	50.9
	2358212	55593	BH50082AS	18'-24'	COPPER	23.1		5	V	12.59	25.36	38.13	50.9
	2463001	55993	BH50187AS	9.3'-15'	COPPER	22.7		5	V	12.59	25.36	38.13	50.9
	2519134	55793	BH50309AS	12.4'-18.4'	COPPER	21.7		5	V	12.59	25.36	38.13	50.9
	2358240	55593	BH50083AS	24'-26'	COPPER	21.1		5	V	12.59	25.36	38.13	50.9
	2358128	55593	BH50058AS	6'-12'	COPPER	20.4		5	V	12.59	25.36	38.13	50.9
	2700214	59093	BH50411AS	0'-6'	COPPER	19.65		5	V	12.59	25.36	38.13	50.9
	2743712	58093	BH50313AS	0'-2'	COPPER	19.5		5	V	12.59	25.36	38.13	50.9
	2358100	55593	BH50057AS	0'-6'	COPPER	19		5	V	12.59	25.36	38.13	50.9
	2703235	58993	BH50480AS	0'-6.4'	COPPER	17.75		5	V	12.59	25.36	38.13	50.9
	2703317	58993	BH50482AS	6.4'-12'	COPPER	16.3		5	V	12.59	25.36	38.13	50.9
	2462891	56093	BH50271AS	2'-8'	COPPER	15.5		5	V	12.59	25.36	38.13	50.9
	2425126	55893	BH50141AS	0'-2'	COPPER	15.2		5	V	12.59	25.36	38.13	50.9
	2700236	59093	BH50412AS	6'-12'	COPPER	14.3		5	V	12.59	25.36	38.13	50.9
	3335105	59093	BH50648AS	0'-2'	COPPER	13.2		5	V	12.59	25.36	38.13	50.9
	2743744	58093	BH50314AS	0'-8'	MOLYBDENUM	19.6	B	40	V	15.39	24.4	33.41	42.42
	2358218	55593	BH50082AS	18'-24'	NICKEL	30.3		8	V	19.81	40.37	60.93	81.49
	2519072	55793	BH50307AS	0'-6'	NICKEL	26.1		8	V	19.81	40.37	60.93	81.49
	2519094	55793	BH50308AS	6'-12'	NICKEL	25.3		8	V	19.81	40.37	60.93	81.49
	2358134	55593	BH50058AS	6'-12'	NICKEL	20.3		8	V	19.81	40.37	60.93	81.49
	2743716	58093	BH50313AS	0'-2'	NICKEL	20.1		8	JA	19.81	40.37	60.93	81.49
	3335037	58993	BH50647AS	0'-2'	SILVER	11.6		2	V	5.7	15.1	24.5	33.9
133.[illegible]	2358012	55493	BH50033AS	6'-12.4'	CADMIUM	0.7	B	1	V	0.64	0.88	1.12	1.36
	2358352	55293	BH50107AS	6'-10'	COPPER	19.9		5	V	12.59	25.36	38.13	50.9
	2358016	55493	BH50033AS	6'-12.4'	COPPER	19.9		5	V	12.59	25.36	38.13	50.9
	2358324	55293	BH50106AS	0'-6'	COPPER	18.2		5	V	12.59	25.36	38.13	50.9
	2357988	55493	BH50032AS	0'-6'	COPPER	17.6		5	V	12.59	25.36	38.13	50.9
	2331328	55493	BH50166AS	17.3'-24.3'	COPPER	13.9		5	V	12.59	25.36	38.13	50.9
	2331300	55393	BH50117AS	25.8'-33.3'	COPPER	13.7		5	V	12.59	25.36	38.13	50.9
	2358268	55193	BH50090AS	0'-6'	COPPER	13.6		5	V	12.59	25.36	38.13	50.9
	2432354	55393	BH50165AS	12'-17.2'	COPPER	13.35		5	V	12.59	25.36	38.13	50.9
	2358330	55293	BH50106AS	0'-6'	NICKEL	22.2		8	V	19.81	40.37	60.93	81.49
133.6	2357932	54893	BH50017AS	0'-6.5'	COPPER	24.1		5	V	12.59	25.36	38.13	50.9
	2358380	55093	BH50131AS	6'-13.2'	COPPER	19.5		5	V	12.59	25.36	38.13	50.9
	2358044	54993	BH50035AS	0'-6'	COPPER	19.4		5	V	12.59	25.36	38.13	50.9
	2358072	54993	BH50042AS	6'-10'	COPPER	15.1		5	V	12.59	25.36	38.13	50.9
	2358050	54993	BH50035AS	0'-6'	NICKEL	19.9		8	V	19.81	40.37	60.93	81.49
142.10	1882999	50092	BH50000AS	0'-14.8'	CADMIUM	0.82	B	1	V	0.64	0.88	1.12	1.36
	1883003	50092	BH50000AS	0'-14.8'	COPPER	20.5		5	V	12.59	25.36	38.13	50.9
	2075487	51193	BH50168AS	0'-10'	COPPER	16.8		5	V	12.59	25.36	38.13	50.9
142.11	1883227	50292	BH50008AS	0'-14.5'	COPPER	22.8		5	V	12.59	25.36	38.13	50.9
Magnetic Anomaly W. of 133	2860046	64493	BH50632AS	12'-14'	ANTIMONY	7.7	B	12	JA	6.56	9.4	12.24	15.08
	2859958	64593	BH50636AS	12'-18'	ANTIMONY	6.9	B	12	JA	6.56	9.4	12.24	15.08
	2860031	64493	BH50631AS	6'-12'	COPPER	18.6		5	V	12.59	25.36	38.13	50.9
	2859817	64693	BH50638AS	0'-6'	COPPER	18.4		5	V	12.59	25.36	38.13	50.9
	2860009	64493	BH50630AS	0'-6'	COPPER	17.9		5	V	12.59	25.36	38.13	50.9
	2859921	64593	BH50634AS	0'-6'	COPPER	17		5	V	12.59	25.36	38.13	50.9
	2860053	64493	BH50632AS	12'-14'	COPPER	16.5		5	V	12.59	25.36	38.13	50.9
	2859943	64593	BH50635AS	6'-12'	COPPER	16		5	V	12.59	25.36	38.13	50.9
	2859877	64693	BH50639AS	6'-12'	COPPER	15.6		5	V	12.59	25.36	38.13	50.9
	2859899	64693	BH50640AS	12'-16'	COPPER	14.5		5	V	12.59	25.36	38.13	50.9
	2859969	64593	BH50636AS	12'-18'	NICKEL	27		8	V	19.81	40.37	60.93	81.49
	2859821	64693	BH50638AS	0'-6'	NICKEL	24		8	V	19.81	40.37	60.93	81.49
	2860035	64493	BH50631AS	6'-12'	NICKEL	23.9		8	V	19.81	40.37	60.93	81.49
	2860013	64493	BH50630AS	0'-6'	NICKEL	23.3		8	V	19.81	40.37	60.93	81.49
	2859881	64693	BH50639AS	6'-12'	NICKEL	23		8	V	19.81	40.37	60.93	81.49
	2859947	64593	BH50635AS	6'-12'	NICKEL	22.5		8	V	19.81	40.37	60.93	81.49
	2859925	64593	BH50634AS	0'-6'	NICKEL	22.1		8	V	19.81	40.37	60.93	81.49
S133[illegible]	2569395	57993	BH50316AS	4.9'-8.1'	COPPER	19.55		5	V	12.59	25.36	38.13	50.9
	2519398	57793	BH50338AS	24'-28.9'	COPPER	16.8		5	V	12.59	25.36	38.13	50.9

Table 4-4
Summary of Metal COCs Exceeding Background Mean in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in mg/kg	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
	3348803	57893	BH50342AS	18.7'-26.4'	COPPER	14.7		5	V	12.59	25.36	38.13	50.9
TDEM-1	4933027	60094	BH00089AS	0.0-5.0	COPPER	19.6		25	V	12.59	25.36	38.13	50.9
	5209091	55194	BH00029AS	6.0-12.0	COPPER	16.4		25	V	12.59	25.36	38.13	50.9
	5209203	55294	BH00033AS	12.0-15.2	COPPER	15		25	V	12.59	25.36	38.13	50.9
	5209175	55294	BH00032AS	6.0-12.0	COPPER	13.5		25	V	12.59	25.36	38.13	50.9
	5209147	55294	BH00031AS	0.0-6.0	COPPER	13.4		25	V	12.59	25.36	38.13	50.9
	5209156	55294	BH00031AS	0.0-6.0	NICKEL	29.3		40	JA	19.81	40.37	60.93	81.49
	4933008	59994	BH00088AS	0.0-5.3	NICKEL	26.5		40	V	19.81	40.37	60.93	81.49
TDEM-2	4880230	55894	BH00036AS	0.0-6.0	COPPER	23		25	V	12.59	25.36	38.13	50.9
	5284212	56094	BH00038AS	6.0-12.0	NICKEL	32.6		40	Y	19.81	40.37	60.93	81.49
	5284268	56094	BH00040AS	18.0-22.0	NICKEL	30.6		40	Y	19.81	40.37	60.93	81.49
	5284240	56094	BH00039AS	12.0-18.0	NICKEL	24.6		40	Y	19.81	40.37	60.93	81.49
	5284249	56094	BH00040AS	18.0-22.0	SILVER	8.5		10	Y	5.7	15.1	24.5	33.9
TDEM-W133	4880258	58894	BH00064AS	0.0-2.7	COPPER	19.6		25	V	12.59	25.36	38.13	50.9
W209	2519178	57693	BH50319AS	0'-6'	COPPER	18.9		5	V	12.59	25.36	38.13	50.9
	3334903	57693	BH50642AS	0'-2'	COPPER	16.9		5	V	12.59	25.36	38.13	50.9
Exceeds the Background Mean plus one Standard Deviation but is less than Background Mean plus two Standard Deviations													
115/196	2746568	58693	BH50350AS	19.5'-25.5'	CADMIUM	1.1	B	1	V	0.64	0.88	1.12	1.36
	3335069	59493	BH50524AS	.4'-2'	COPPER	37		5	V	12.59	25.36	38.13	50.9
	3335013	58693	BH50644AS	0'-2'	COPPER	34.5		5	V	12.59	25.36	38.13	50.9
	3335185	59593	BH50540AS	0'-2'	COPPER	30.9		5	V	12.59	25.36	38.13	50.9
	2650809	58693	BH50348AS	0'-6'	COPPER	29.8		5	V	12.59	25.36	38.13	50.9
	4961665	56694	BH00111AS	0.0-35.0	COPPER	29.7		25	V	12.59	25.36	38.13	50.9
	2037296	50492	BH50037AS	0'-6'	COPPER	26.6		5	V	12.59	25.36	38.13	50.9
	2700868	60993	BH50588AS	0'-6'	COPPER	26		5	V	12.59	25.36	38.13	50.9
	2700828	63193	BH50617AS	6'-12'	NICKEL	46.6		8	V	19.81	40.37	60.93	81.49
133.1	2743678	56393	BH50212AS	2'-6'	MOLYBDENUM	24.5	B	40	V	15.39	24.4	33.41	42.42
	4961506	57294	BH00091AS	0.0-4.0	NICKEL	58		40	V	19.81	40.37	60.93	[illegible]
	2743628	56393	BH50213AS	6'-8'	NICKEL	45.3		8	V	19.81	40.37	60.93	[illegible]
133.2	2452770	57393	BH50291AS	22.1'-26.1'	COPPER	34.2		5	V	12.59	25.36	38.13	50.9
	2687074	58793	BH50410AS	24'-28.4'	COPPER	27		5	V	12.59	25.36	38.13	50.9
	2462725	56993	BH50201AS		NICKEL	51		8	V	19.81	40.37	60.93	81.49
133.3	2700346	61193	BH50503AS	6'-10'	COPPER	29.8		5	V	12.59	25.36	38.13	50.9
	2700956	59693	BH50557AS	6'-12'	COPPER	28.2		5	V	12.59	25.36	38.13	50.9
	3334867	61393	BH50650AS	0'-2'	COPPER	27.3		5	V	12.59	25.36	38.13	50.9
	2452471	56593	BH50224AS	13'-17'	SILVER	15.6		2	V	5.7	15.1	24.5	33.9
133.4	2743729	58093	BH50314AS	0'-8'	BERYLLIUM	12.2		1	V	4.66	9.43	14.2	18.97
	2462935	55993	BH50162AS	0'-2'	COPPER	27.9		5	V	12.59	25.36	38.13	50.9
	2519046	55793	BH50306AS	0'-2'	COPPER	26.4		5	V	12.59	25.36	38.13	50.9
	2700258	59093	BH50413AS	12'-16.3'	COPPER	26.3		5	V	12.59	25.36	38.13	50.9
	5422816	55694	BH00041AS	0.0-6.0	NICKEL	59.6		2.58	Y	19.81	40.37	60.93	81.49
	2462961	55993	BH50151AS	0'-6'	NICKEL	54.8		8	V	19.81	40.37	60.93	81.49
	2463007	55993	BH50187AS	9.3'-15'	SILVER	16.4		2	JA	5.7	15.1	24.5	33.9
Magnetic Anomaly W. of 133	2860002	64493	BH50630AS	0'-6'	ANTIMONY	11.1	B	12	JA	6.56	9.4	12.24	15.08
	2859914	64593	BH50634AS	0'-6'	ANTIMONY	9.5	B	12	JA	6.56	9.4	12.24	15.08
	2859810	64693	BH50638AS	0'-6'	ANTIMONY	9.5	B	12	JA	6.56	9.4	12.24	15.08
	2859991	64593	BH50637AS	18'-20'	NICKEL	58.8		8	V	19.81	40.37	60.93	81.49
	2859903	64693	BH50640AS	12'-16'	NICKEL	51.8		8	V	19.81	40.37	60.93	81.49
S133	2569391	57993	BH50316AS	4.9'-8.1'	CADMIUM	0.935		1	V	0.64	0.88	1.12	1.36
	2569399	57993	BH50316AS	4.9'-8.1'	NICKEL	45.4		8	V	19.81	40.37	60.93	81.49
TDEM-1	4932999	59994	BH00088AS	0.0-5.3	COPPER	37.9		25	V	12.59	25.36	38.13	50.9
TDEM-2	5284182	56094	BH00037AS	0.0-6.0	MOLYBDENUM	25		200	Y	15.39	24.4	33.41	42.42
	5372479	55994	BH00035AS	6.0-11.2	NICKEL	44.9	EN*	2.94	Y	19.81	40.37	60.93	81.49
	5284193	56094	BH00038AS	6.0-12.0	SILVER	23.1		10	Y	5.7	15.1	24.5	33.9
Exceeds the Background Mean plus two Standard Deviations but is less than Background Mean plus three Standard Deviations													
115/196	2746354	58393	BH50344AS	6'-12.7'	CADMIUM	1.3		1	V	0.64	0.88	1.12	1.36
	2650805	58693	BH50348AS	0'-6'	CADMIUM	1.2		1	V	0.64	0.88	1.12	1.36
	2633685	58593	BH50403AS	6'-12.5'	COPPER	50.8		5	V	12.59	25.36	38.13	50.9
	2633629	58593	BH50347AS	0'-6'	COPPER	49.85		5	V	12.59	25.36	38.13	50.9
	5009655	57994	BH00047AS	0.0-6.3	COPPER	42.4		5	JA	12.59	25.36	38.13	50.9
	2700894	61093	BH50603AS	6'-13'	NICKEL	73.8		8	V	19.81	40.37	60.93	[illegible]
	5009660	57994	BH00047AS	0.0-6.3	NICKEL	69.9		8	JA	19.81	40.37	60.93	[illegible]
133.1	2743672	56393	BH50212AS	2'-6'	NICKEL	66.3		8	V	19.81	40.37	60.93	[illegible]
	4961487	57294	BH00091AS	0.0-4.0	SILVER	26.9		10	V	5.7	15.1	24.5	33.9
133.2	2687023	58793	BH50408AS	12'-18'	ANTIMONY	14.2		12	JA	6.56	9.4	12.24	15.08

Table 4-4
Summary of Metal COCs Exceeding Background Mean in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in mg/kg	Qualifier	Reporting Limit	Valid.	Mean	Mean + (X * STD DEV) of background X = 1	X=2	X=3
	2462670	56993	BH50198AS	0'-2'	ANTIMONY	14.1	B	12	JA	6.56	9.4	12.24	15.08
	2515251	57293	BH50252AS	0'-6'	CADMIUM	1.3		1	JA	0.64	0.88	1.12	1.36
	2462695	56993	BH50199AS	0'-4'	CADMIUM	1.2		1	JA	0.64	0.88	1.12	1.36
133.4	2462884	56093	BH50271AS	2'-8'	ANTIMONY	15		12	JA	6.56	9.4	12.24	15.08
	2519042	55793	BH50306AS	0'-2'	CADMIUM	1.3		1	JA	0.64	0.88	1.12	1.36
	2743690	58093	BH50315AS	10'-12'	COPPER	40.2		5	V	12.59	25.36	38.13	50.9
Concrete Pad	5009822	56194	BH00043AS	0.0-6.0	NICKEL	75.9		8	JA	19.81	40.37	60.93	81.49
Mag. Anom.	2860057	64493	BH50632AS	12'-14'	NICKEL	72		8	V	19.81	40.37	60.93	81.49
S133	2519391	57793	BH50338AS	24'-28.9'	ANTIMONY	13.5	B	12	JA	6.56	9.4	12.24	15.08
Exceeds the Background Mean plus three Standard Deviations													
115/196	2700707	59493	BH50520AS	0'-6.3'	ANTIMONY	19.5		12	V	6.56	9.4	12.24	15.08
	2746351	58393	BH50344AS	6'-12.7'	ANTIMONY	15.8		12	JA	6.56	9.4	12.24	15.08
	2746521	58493	BH50346AS	6'-12'	ANTIMONY	15.6		12	JA	6.56	9.4	12.24	15.08
	2746524	58493	BH50346AS	6'-12'	CADMIUM	2.3		1	V	0.64	0.88	1.12	1.36
	2633625	58593	BH50347AS	0'-6'	CADMIUM	2.2		1	JA	0.64	0.88	1.12	1.36
	2700714	59493	BH50520AS	0'-6.3'	COPPER	6920		5	V	12.59	25.36	38.13	50.9
	2746528	58493	BH50346AS	6'-12'	COPPER	749		5	V	12.59	25.36	38.13	50.9
	2746358	58393	BH50344AS	6'-12.7'	COPPER	361		5	V	12.59	25.36	38.13	50.9
	2700456	59493	BH50521AS	6.9'-12.9'	COPPER	117.35		5	V	12.59	25.36	38.13	50.9
	2650831	58693	BH50417AS	6'-12'	COPPER	92		5	V	12.59	25.36	38.13	50.9
	2746336	58393	BH50343AS	0'-6'	COPPER	73.5		5	V	12.59	25.36	38.13	50.9
	2133927	50992	BH50138AS	0'-6'	COPPER	65.7		5	V	12.59	25.36	38.13	50.9
	2746506	58493	BH50345AS	0'-6'	COPPER	59.1		5	V	12.59	25.36	38.13	50.9
	2133972	50992	BH50140AS	0'-16'	COPPER	58		5	V	12.59	25.36	38.13	50.9
	2746538	58493	BH50346AS	6'-12'	MOLYBDENUM	190		40	V	15.39	24.4	33.41	42.42
	2746362	58393	BH50344AS	6'-12.7'	NICKEL	118		8	V	19.81	40.37	60.93	81.49
	4880323	58494	BH00071AS	6.0-9.5	NICKEL	102		40	JA	19.81	40.37	60.93	81.49
	2700718	59493	BH50520AS	0'-6.3'	NICKEL	91.7		8	V	19.81	40.37	60.93	81.49
	2746532	58493	BH50346AS	6'-12'	NICKEL	91.2		8	V	19.81	40.37	60.93	81.49
	2700850	63193	BH50618AS	12'-20'	NICKEL	84.9		8	V	19.81	40.37	60.93	81.49
	2700720	59493	BH50520AS	0'-6.3'	SILVER	36		2	V	5.7	15.1	24.5	33.9
133.1	2743661	56393	BH50212AS	2'-6'	ANTIMONY	33.2		12	JA	6.56	9.4	12.24	15.08
	2743617	56393	BH50213AS	6'-8'	ANTIMONY	19.8		12	JA	6.56	9.4	12.24	15.08
	4961491	57294	BH00091AS	0.0-4.0	BERYLLIUM	22.8		5	V	4.66	9.43	14.2	18.97
	2743664	56393	BH50212AS	2'-6'	CADMIUM	56.9		1	V	0.64	0.88	1.12	1.36
	4961493	57294	BH00091AS	0.0-4.0	CADMIUM	15.2		5	V	0.64	0.88	1.12	1.36
	2743620	56393	BH50213AS	6'-8'	CADMIUM	3.2		1	JA	0.64	0.88	1.12	1.36
	2743642	56393	BH50211AS	0'-2'	CADMIUM	2		1	JA	0.64	0.88	1.12	1.36
	2743668	56393	BH50212AS	2'-6'	COPPER	2920		5	V	12.59	25.36	38.13	50.9
	4961497	57294	BH00091AS	0.0-4.0	COPPER	365		25	V	12.59	25.36	38.13	50.9
	2743646	56393	BH50211AS	0'-2'	COPPER	158		5	V	12.59	25.36	38.13	50.9
	2743624	56393	BH50213AS	6'-8'	COPPER	83.6		5	V	12.59	25.36	38.13	50.9
	4961504	57294	BH00091AS	0.0-4.0	MOLYBDENUM	470		200	V	15.39	24.4	33.41	42.42
	2743674	56393	BH50212AS	2'-6'	SILVER	158		2	V	5.7	15.1	24.5	33.9
133.2	2463060	56893	BH50238AS	4'-8.3'	ANTIMONY	149		12	JA	6.56	9.4	12.24	15.08
	2686979	58793	BH50406AS	0'-6.1'	ANTIMONY	24.2		12	JA	6.56	9.4	12.24	15.08
	2687045	58793	BH50409AS	18'-24'	ANTIMONY	21		12	JA	6.56	9.4	12.24	15.08
	2463062	56893	BH50238AS	4'-8.3'	BERYLLIUM	131		1	V	4.66	9.43	14.2	18.97
	2462717	56993	BH50201AS	.	CADMIUM	24.9		1	V	0.64	0.88	1.12	1.36
	2463063	56893	BH50238AS	4'-8.3'	CADMIUM	17.6		1	JA	0.64	0.88	1.12	1.36
	2463041	56893	BH50237AS	2'-4'	CADMIUM	2.6		1	JA	0.64	0.88	1.12	1.36
	2425178	56993	BH50202AS	8.1'-14'	CADMIUM	1.6		1	V	0.64	0.88	1.12	1.36
	2463067	56893	BH50238AS	4'-8.3'	COPPER	1380		5	V	12.59	25.36	38.13	50.9
	2462721	56993	BH50201AS	.	COPPER	149		5	V	12.59	25.36	38.13	50.9
	2463045	56893	BH50237AS	2'-4'	COPPER	64.1		5	V	12.59	25.36	38.13	50.9
	2463077	56893	BH50238AS	4'-8.3'	MOLYBDENUM	129		40	V	15.39	24.4	33.41	42.42
	2463071	56893	BH50238AS	4'-8.3'	NICKEL	4750		8	V	19.81	40.37	60.93	81.49
	2463073	56893	BH50238AS	4'-8.3'	SILVER	190		2	V	5.7	15.1	24.5	33.9
	2462727	56993	BH50201AS	.	SILVER	41.2		2	V	5.7	15.1	24.5	33.9
133.3	2700342	61193	BH50503AS	6'-10'	CADMIUM	1.4		1	JA	0.64	0.88	1.12	1.36
133.4	2703228	58993	BH50480AS	0'-6.4'	ANTIMONY	51.5		12	JA	6.56	9.4	12.24	15.08
	2743727	58093	BH50314AS	0'-8'	ANTIMONY	50.5		12	JA	6.56	9.4	12.24	15.08
	3374234	59093	BH50667AS	0'-6'	ANTIMONY	33		12	JA	6.56	9.4	12.24	15.08
	2462972	55993	BH50161AS	4'-9.3'	ANTIMONY	28		12	JA	6.56	9.4	12.24	15.08
	2462950	55993	BH50151AS	0'-6'	ANTIMONY	19.6		12	JA	6.56	9.4	12.24	15.08
	2703310	58993	BH50482AS	6.4'-12'	ANTIMONY	19.45		12	JA	6.56	9.4	12.24	15.08

Table 4-4
Summary of Metal COCs Exceeding Background Mean in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in mg/kg	Qualifier	Reporting Limit	Valid.	Mean	Mean + (X * STD DEV) of background X = 1	X=2	X=3
	2519083	55793	BH50308AS	6'-12'	ANTIMONY	16.4		12	JA	6.56	9.4	12.24	15.08
	2462953	55993	BH50151AS	0'-6'	CADMIUM	42.3		1	V	0.64	0.88	1.12	1.36
	2462975	55993	BH50161AS	4'-9.3'	CADMIUM	39.9		1	V	0.64	0.88	1.12	1.36
	2743730	58093	BH50314AS	0'-8'	CADMIUM	26.7		1	V	0.64	0.88	1.12	1.36
	5422759	55694	BH00041AS	0.0-6.0	CADMIUM	11.2	N*	0.644	Y	0.64	0.88	1.12	1.36
	2743686	58093	BH50315AS	10'-12'	CADMIUM	2.1		1	JA	0.64	0.88	1.12	1.36
	2462931	55993	BH50162AS	0'-2'	CADMIUM	1.5		1	JA	0.64	0.88	1.12	1.36
	5422762	55694	BH00042AS	6.0-10.6	CADMIUM	1.4	N*	0.655	Y	0.64	0.88	1.12	1.36
	5422783	55694	BH00041AS	0.0-6.0	COPPER	2520		0.43	Y	12.59	25.36	38.13	50.9
	2462957	55993	BH50151AS	0'-6'	COPPER	957		5	V	12.59	25.36	38.13	50.9
	2743734	58093	BH50314AS	0'-8'	COPPER	880		5	V	12.59	25.36	38.13	50.9
	2462979	55993	BH50161AS	4'-9.3'	COPPER	755		5	V	12.59	25.36	38.13	50.9
	5422786	55694	BH00042AS	6.0-10.6	COPPER	66.4		0.437	Y	12.59	25.36	38.13	50.9
	2743738	58093	BH50314AS	0'-8'	NICKEL	115		8	V	19.81	40.37	60.93	81.49
	2462983	55993	BH50161AS	4'-9.3'	NICKEL	93.2		8	V	19.81	40.37	60.93	81.49
	2462985	55993	BH50161AS	4'-9.3'	SILVER	311		2	V	5.7	15.1	24.5	33.9
	2743740	58093	BH50314AS	0'-8'	SILVER	106		2	V	5.7	15.1	24.5	33.9
	2462963	55993	BH50151AS	0'-6'	SILVER	53.3		2	V	5.7	15.1	24.5	33.9
	5422835	55694	BH00041AS	0.0-6.0	SILVER	50.7		0.644	Y	5.7	15.1	24.5	33.9
133.5	2358296	55193	BH50099AS	6'-8'	COPPER	390		5	V	12.59	25.36	38.13	50.9
142.11	1883223	50292	BH50008AS	0'-14.5'	CADMIUM	1.8		1	JA	0.64	0.88	1.12	1.36
TDEM-1	5209212	55294	BH00033AS	12.0-15.2	NICKEL	355		40	JA	19.81	40.37	60.93	81.49
TDEM-2	5372394	55994	BH00034AS	0.0-6.0	ANTIMONY	16.3	N	0.497	Y	6.56	9.4	12.24	15.08
	5372409	55994	BH00034AS	0.0-6.0	BERYLLIUM	446		0.248	Y	4.66	9.43	14.2	18.97
	5372414	55994	BH00034AS	0.0-6.0	CADMIUM	71		0.745	Y	0.64	0.88	1.12	1.36
	5284171	56094	BH00037AS	0.0-6.0	CADMIUM	35.3		5	Y	0.64	0.88	1.12	1.36
	5284199	56094	BH00038AS	6.0-12.0	CADMIUM	8.8		5	Y	0.64	0.88	1.12	1.36
	5372417	55994	BH00035AS	6.0-11.2	CADMIUM	5.2		0.734	Y	0.64	0.88	1.12	1.36
	5284255	56094	BH00040AS	18.0-22.0	CADMIUM	2.1		5	Y	0.64	0.88	1.12	[illegible]
	5372438	55994	BH00034AS	0.0-6.0	COPPER	8850		0.745	Y	12.59	25.36	38.13	[illegible]
	5284175	56094	BH00037AS	0.0-6.0	COPPER	1150		25	Y	12.59	25.36	38.13	50.9
	5372441	55994	BH00035AS	6.0-11.2	COPPER	758		0.734	Y	12.59	25.36	38.13	50.9
	5284203	56094	BH00038AS	6.0-12.0	COPPER	309		25	Y	12.59	25.36	38.13	50.9
	5284259	56094	BH00040AS	18.0-22.0	COPPER	124		25	Y	12.59	25.36	38.13	50.9
	5284231	56094	BH00039AS	12.0-18.0	COPPER	85		25	Y	12.59	25.36	38.13	50.9
	5372471	55994	BH00034AS	0.0-6.0	MOLYBDENUM	65.1		3.72	Y	15.39	24.4	33.41	42.42
	5372476	55994	BH00034AS	0.0-6.0	NICKEL	255	EN*	2.98	Y	19.81	40.37	60.93	81.49
	5284184	56094	BH00037AS	0.0-6.0	NICKEL	93		40	Y	19.81	40.37	60.93	81.49
	5372495	55994	BH00034AS	0.0-6.0	SILVER	209	E	0.993	Y	5.7	15.1	24.5	33.9
	5372498	55994	BH00035AS	6.0-11.2	SILVER	51.3	E	0.979	Y	5.7	15.1	24.5	33.9

These data are graphically displayed on Figures 4-4a and 4b.

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background: Mean	X = 1	X=2	X=3
Exceeds the Background Mean but is less than Background Mean plus one Standard Deviation													
115/196	2262673	50992	BH50138AS	0'-6'	U233234	1.7	B	0.005	A	0.779	1.711	2.643	3.575
	2689770	58693	BH50349AS	12'-19.5'	U233234	1.645	B	0.021	A	0.779	1.711	2.643	3.575
	2695013	58593	BH50347AS	0'-6'	U233234	1.641		0.045962	V	0.779	1.711	2.643	3.575
	2262631	50892	BH50123AS	8'-16'	U233234	1.6	B	0.02	A	0.779	1.711	2.643	3.575
	5068976	57594	BH00082AS	6.0-12.0	U233234	1.51		0.03	Y	0.779	1.711	2.643	3.575
	2262638	50892	BH50121AS	0'-6'	U233234	1.5	B	0.016	A	0.779	1.711	2.643	3.575
	2689784	58693	BH50405AS	25.5'-29.5'	U233234	1.5	B	0.01	A	0.779	1.711	2.643	3.575
	3671054	59793	BH50486AS	13.3'-15.3'	U233234	1.4974		0.0304	Y	0.779	1.711	2.643	3.575
	3671058	61293	BH50505AS	6'-10.6'	U233234	1.4867		0.0544	Y	0.779	1.711	2.643	3.575
	2695034	58593	BH50404AS	12.5'-18.1'	U233234	1.434		0.058313	V	0.779	1.711	2.643	3.575
	3671536	61293	BH50508AS	0'-2'	U233234	1.4322		0.0261	Y	0.779	1.711	2.643	3.575
	2262659	50792	BH50105AS	0'-10'	U233234	1.4	B	0.02	A	0.779	1.711	2.643	3.575
	2642403	58393	BH50343AS	0'-6'	U233234	1.4	B	0.015	A	0.779	1.711	2.643	3.575
	3671214	59593	BH50554AS	14.4'-16.4'	U233234	1.3878		0.0177	Y	0.779	1.711	2.643	3.575
	3671527	59593	BH50540AS	0'-2'	U233234	1.3299		0.0209	Y	0.779	1.711	2.643	3.575
	5069652	56694	BH00096AS	0.0-6.0	U233234	1.322		0.0157	V	0.779	1.711	2.643	3.575
	5011953	56694	BH00122AS	43.0-150.0	U233234	1.32		0.0251	V	0.779	1.711	2.643	3.575
	2262694	50692	BH50087AS	0'-6'	U233234	1.3	B	0.016	A	0.779	1.711	2.643	3.575
	2253001	50692	BH50088AS	6'-12'	U233234	1.3		0.013	A	0.779	1.711	2.643	3.575
	2262687	50992	BH50140AS	0'-16'	U233234	1.3	B	0.044	A	0.779	1.711	2.643	3.575
	5069644	56694	BH00095AS	0.0-6.0	U233234	1.286		0.0179	V	0.779	1.711	2.643	3.575
	3671043	59293	BH50441AS	12'-18.9'	U233234	1.2769		0.0212	Y	0.779	1.711	2.643	3.575
	3671042	59293	BH50440AS	6'-12'	U233234	1.2688		0.0227	Y	0.779	1.711	2.643	3.575
	3671409	63193	BH50617AS	6'-12'	U233234	1.254		0.0391	Y	0.779	1.711	2.643	3.575
	2695027	58593	BH50403AS	6'-12.5'	U233234	1.252		0.084029	V	0.779	1.711	2.643	3.575
	3671406	60993	BH50588AS	0'-6'	U233234	1.2378		0.0216	Y	0.779	1.711	2.643	3.575
	2262680	50992	BH50139AS	6'-12'	U233234	1.2	B	0.027	A	0.779	1.711	2.643	3.575
	3671407	61093	BH50603AS	6'-13'	U233234	1.1888		0.0465	Y	0.779	1.711	2.643	3.575
	3671211	59593	BH50552AS	0'-6'	U233234	1.18155		0.022	Y	0.779	1.711	2.643	3.575
	3671533	58693	BH50644AS	0'-2'	U233234	1.1507		0.0243	Y	0.779	1.711	2.643	3.575
	3671210	59493	BH50522AS	12.9'-17.8'	U233234	1.1312		0.0222	Y	0.779	1.711	2.643	3.575
	5069636	56694	BH00111AS	0.0-35.0	U233234	1.118		0.0178	V	0.779	1.711	2.643	3.575
	5011945	56694	BH00113AS	43.0-150.0	U233234	1.108		0.0465	V	0.779	1.711	2.643	3.575
	2252994	50592	BH50066AS	0'-32'	U233234	1.1		0.015	A	0.779	1.711	2.643	3.575
	5017732	57594	BH00121AS	24.0-105.0	U233234	1.098		0.0164	V	0.779	1.711	2.643	3.575
	5186001	59494	BH00152AS	0.0-5.9	U233234	1.094		0.0241	V	0.779	1.711	2.643	3.575
	3671535	59293	BH50444AS	0'-2'	U233234	1.089		0.0363	Y	0.779	1.711	2.643	3.575
	3671041	59293	BH50439AS	0'-6'	U233234	1.0885		0.028	Y	0.779	1.711	2.643	3.575
	5012726	57594	BH00085AS	18.0-23.0	U233234	1.087		0.0143	V	0.779	1.711	2.643	3.575
	3671052	59793	BH50484AS	0'-7.3'	U233234	1.0815		0.0257	Y	0.779	1.711	2.643	3.575
	3671206	59193	BH50457AS	2'-8'	U233234	1.07715		0.0234	Y	0.779	1.711	2.643	3.575
	5186041	59894	BH00164AS	19.9-31.9	U233234	1.074		0.0166	V	0.779	1.711	2.643	3.575
	3671408	63193	BH50616AS	0'-6'	U233234	1.074		0.0221	Y	0.779	1.711	2.643	3.575
	5069668	56694	BH00112AS	0.0-41.0	U233234	1.073		0.0216	V	0.779	1.711	2.643	3.575
	3671047	59393	BH50477AS	6'-8'	U233234	1.0705		0.0179	Y	0.779	1.711	2.643	3.575
	3671053	59793	BH50485AS	5.3'-11.3'	U233234	1.0659		0.0257	Y	0.779	1.711	2.643	3.575
	5069660	56694	BH00098AS	6.0-10.0	U233234	1.063		0.0139	V	0.779	1.711	2.643	3.575
	3671537	59793	BH50488AS	0'-2'	U233234	1.0586		0.0569	Y	0.779	1.711	2.643	3.575
	3671410	63193	BH50618AS	12'-20'	U233234	1.0381		0.0352	Y	0.779	1.711	2.643	3.575
	3671525	58593	BH50427AS	0'-2'	U233234	1.0261		0.0543	Y	0.779	1.711	2.643	3.575
	3671531	59493	BH50524AS	.4'-2'	U233234	1.0234		0.022	Y	0.779	1.711	2.643	3.575
	3671046	59393	BH50476AS	0'-6'	U233234	1.0051		0.0233	Y	0.779	1.711	2.643	3.575
	5112058	58294	BH00050AS	0.0-4.0	U233234	1.005		0.0244	V	0.779	1.711	2.643	3.575
	2252987	50692	BH50089AS	0'-14'	U233234	1		0.046	A	0.779	1.711	2.643	3.575
	2262652	50792	BH50104AS	0'-6'	U233234	1	B	0.012	A	0.779	1.711	2.643	3.575
	4954843	58294	BH00050AS	0.0-4.0	U233234	0.9946		0.0452	V	0.779	1.711	2.643	3.575
	2253015	50392	BH50016AS	25'-30'	U233234	0.98		0.026	A	0.779	1.711	2.643	3.575
	5112050	57994	BH00047AS	0.0-6.3	U233234	0.9612		0.0174	V	0.779	1.711	2.643	3.575
	2642382	58693	BH50417AS	6'-12'	U233234	0.96	B	0.042	A	0.779	1.711	2.643	3.575
	3671524	59393	BH50465AS	0'-2'	U233234	0.9536		0.0262	Y	0.779	1.711	2.643	3.575
	2253022	50392	BH50015AS	18'-24'	U233234	0.91		0.015	A	0.779	1.711	2.643	3.575
	5185985	57094	BH00147AS	0.0-40.0	U233234	0.8814		0.0328	V	0.779	1.711	2.643	3.575
	5068968	58494	BH00071AS	6.0-9.5	U233234	0.87		0.02	Y	0.779	1.711	2.643	3.575
	2425815	51092	BH50153AS	0'-6'	U233234	0.84		0.1	A	0.779	1.711	2.643	3.575
	5068975	57594	BH00078AS	0.0-6.0	U233234	0.82		0.02	Y	0.779	1.711	2.643	3.575
	5112074	58794	BH00054AS	0.0-2.4	U233234	0.8117		0.0227	V	0.779	1.711	2.643	3.575
	2425823	51092	BH50154AS	0'-12'	U233234	0.81		0.04	A	0.779	1.711	2.643	3.575
	4954842	57994	BH00047AS	0.0-6.3	U233234	0.7816		0.0312	V	0.779	1.711	2.643	3.575
	2262602	50492	BH50037AS	0'-6'	U235	0.068	J	0.033	A	0.022	0.068	0.114	0.16
	3671543	58593	BH50427AS	0'-2'	U235	0.0662		0.0305	Y	0.022	0.068	0.114	0.16
	2642374	58693	BH50348AS	0'-6'	U235	0.066	J	0.039	A	0.022	0.068	0.114	0.16

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
	2262686	50992	BH50140AS	0'-16'	U235	0.064	J	0.028	A	0.022	0.068	0.114	0.16
	2695035	58593	BH50404AS	12.5'-18.1'	U235	0.0638		0.048526	V	0.022	0.068	0.114	0.16
	3671078	59793	BH50486AS	13.3'-15.3'	U235	0.0632		0.0186	Y	0.022	0.068	0.114	0.16
	3671551	58693	BH50644AS	0'-2'	U235	0.0627		0.0243	Y	0.022	0.068	0.114	0.16
	3671415	61093	BH50603AS	6'-13'	U235	0.0626		0.0243	Y	0.022	0.068	0.114	0.16
	3671234	59493	BH50522AS	12.9'-17.8'	U235	0.0622		0.0176	Y	0.022	0.068	0.114	0.16
	2253056	50592	BH50063AS	6'-12'	U235	0.061	J	0.022	A	0.022	0.068	0.114	0.16
	5068984	58494	BH00068AS	0.0-6.0	U235	0.06		0.01	Y	0.022	0.068	0.114	0.16
	2253035	50392	BH50013AS	6'-12'	U235	0.058	J	0.028	A	0.022	0.068	0.114	0.16
	5069653	56694	BH00096AS	0.0-6.0	U235	0.05681		0.0179	V	0.022	0.068	0.114	0.16
	2252993	50592	BH50066AS	0'-32'	U235	0.055	J	0.015	A	0.022	0.068	0.114	0.16
	3335594	58393	BH50418AS	19.5'-21.5'	U235	0.054	U	0.2	A	0.022	0.068	0.114	0.16
	5017733	57594	BH00121AS	24.0-105.0	U235	0.05395		0.0124	V	0.022	0.068	0.114	0.16
	5186042	59894	BH00164AS	19.9-31.9	U235	0.05001		0.0202	V	0.022	0.068	0.114	0.16
	2642402	58393	BH50343AS	0'-6'	U235	0.05	J	0.04	A	0.022	0.068	0.114	0.16
	3671416	63193	BH50616AS	0'-6'	U235	0.0499		0.0175	Y	0.022	0.068	0.114	0.16
	3671235	59593	BH50552AS	0'-6'	U235	0.04975		0.0174	Y	0.022	0.068	0.114	0.16
	5011954	56694	BH00122AS	43.0-150.0	U235	0.04971		0.0215	V	0.022	0.068	0.114	0.16
	5185994	57094	BH00148AS	0.0-40.0	U235	0.0494		0.0464	V	0.022	0.068	0.114	0.16
	5112075	58794	BH00054AS	0.0-2.4	U235	0.04938		0.0227	V	0.022	0.068	0.114	0.16
	4954855	58694	BH00052AS	0.0-2.9	U235	0.0491		0.0201	A	0.022	0.068	0.114	0.16
	3671555	59793	BH50488AS	0'-2'	U235	0.0477		0.032	Y	0.022	0.068	0.114	0.16
	2262644	50892	BH50122AS	6'-12'	U235	0.047	J	0.02	A	0.022	0.068	0.114	0.16
	3671067	59293	BH50441AS	12'-18.9'	U235	0.0462		0.0213	Y	0.022	0.068	0.114	0.16
	2253042	50392	BH50012AS	0'-4.5'	U235	0.046	J	0.013	A	0.022	0.068	0.114	0.16
	3671549	59493	BH50524AS	.4'-2'	U235	0.0449		0.0221	Y	0.022	0.068	0.114	0.16
	5069669	56694	BH00112AS	0.0-41.0	U235	0.0427		0.0175	V	0.022	0.068	0.114	0.16
	2642381	58693	BH50417AS	6'-12'	U235	0.041	J	0.02	A	0.022	0.068	0.114	0.16
	5012727	57594	BH00085AS	18.0-23.0	U235	0.04041		0.0186	V	0.022	0.068	0.114	0.16
	5068993	57594	BH00082AS	6.0-12.0	U235	0.04		0.02	Y	0.022	0.068	0.114	0.16
	5011946	56694	BH00113AS	43.0-150.0	U235	0.03948		0.0293	V	0.022	0.068	0.114	[illegible]
	4954856	58794	BH00054AS	0.0-2.4	U235	0.038		0.0349	A	0.022	0.068	0.114	[illegible]
	2425816	51092	BH50153AS	0'-6'	U235	0.037	U	0.1	A	0.022	0.068	0.114	0.16
	5186026	59494	BH00160AS	11.9-17.9	U235	0.03697		0.0119	V	0.022	0.068	0.114	0.16
	5112051	57994	BH00047AS	0.0-6.3	U235	0.0369		0.0226	V	0.022	0.068	0.114	0.16
	3671542	59393	BH50465AS	0'-2'	U235	0.0367		0.0208	Y	0.022	0.068	0.114	0.16
	3671071	59393	BH50477AS	6'-8'	U235	0.0365		0.0179	Y	0.022	0.068	0.114	0.16
	5069645	56694	BH00095AS	0.0-6.0	U235	0.03605		0.0251	V	0.022	0.068	0.114	0.16
	5185986	57094	BH00147AS	0.0-40.0	U235	0.03358	J	0.0383	V	0.022	0.068	0.114	0.16
	3671230	59193	BH50457AS	2'-8'	U235	0.0324		0.016	Y	0.022	0.068	0.114	0.16
	5069637	56694	BH00111AS	0.0-35.0	U235	0.03215		0.0178	V	0.022	0.068	0.114	0.16
	2262679	50992	BH50139AS	6'-12'	U235	0.032	J	0.027	A	0.022	0.068	0.114	0.16
	2262609	50492	BH50038AS	6'-12'	U235	0.031	J	0.024	A	0.022	0.068	0.114	0.16
	2425824	51092	BH50154AS	0'-12'	U235	0.029	J	0.02	A	0.022	0.068	0.114	0.16
	5186034	59894	BH00162AS	17.9-19.9	U235	0.02872		0.0203	V	0.022	0.068	0.114	0.16
	3671553	59293	BH50444AS	0'-2'	U235	0.0283		0.019	Y	0.022	0.068	0.114	0.16
	2253000	50692	BH50088AS	6'-12'	U235	0.028	J	0.021	A	0.022	0.068	0.114	0.16
	5012735	57594	BH00086AS	24.0-60.0	U235	0.02745		0.023	V	0.022	0.068	0.114	0.16
	2262616	50492	BH50039AS	12'-18'	U235	0.027	U	0.034	A	0.022	0.068	0.114	0.16
	4954854	58294	BH00050AS	0.0-4.0	U235	0.0264		0.0277	V	0.022	0.068	0.114	0.16
	5186018	59494	BH00159AS	11.9-17.9	U235	0.02591		0.00701	V	0.022	0.068	0.114	0.16
	2695028	58593	BH50403AS	6'-12.5'	U235	0.02501	J	0.062254	V	0.022	0.068	0.114	0.16
	3671066	59293	BH50440AS	6'-12'	U235	0.0247		0.0228	Y	0.022	0.068	0.114	0.16
	5069661	56694	BH00098AS	6.0-10.0	U235	0.02267		0.0169	V	0.022	0.068	0.114	0.16
	3671089	59293	BH50439AS	0'-6'	U238	1.1067		0.0242	Y	0.733	1.109	1.485	1.861
	2262650	50792	BH50104AS	0'-6'	U238	1.1	B	0.005	A	0.733	1.109	1.485	1.861
	2262678	50992	BH50139AS	6'-12'	U238	1.1	B	0.027	A	0.733	1.109	1.485	1.861
	3335595	58393	BH50418AS	19.5'-21.5'	U238	1.1		0.2	A	0.733	1.109	1.485	1.861
	3671254	59193	BH50457AS	2'-8'	U238	1.0743		0.016	Y	0.733	1.109	1.485	1.861
	5185995	57094	BH00148AS	0.0-40.0	U238	1.05		0.0464	V	0.733	1.109	1.485	1.861
	3671091	59293	BH50441AS	12'-18.9'	U238	1.0343		0.0213	Y	0.733	1.109	1.485	1.861
	4954865	58294	BH00050AS	0.0-4.0	U238	1.0285		0.0277	V	0.733	1.109	1.485	1.861
	5112060	58294	BH00050AS	0.0-4.0	U238	1.026		0.016	V	0.733	1.109	1.485	1.861
	5011947	56694	BH00113AS	43.0-150.0	U238	1.024		0.0357	V	0.733	1.109	1.485	1.861
	5017734	57594	BH00121AS	24.0-105.0	U238	1.006		0.00702	V	0.733	1.109	1.485	[illegible]
	5185987	57094	BH00147AS	0.0-40.0	U238	1.003		0.0328	V	0.733	1.109	1.485	[illegible]
	5186043	59894	BH00164AS	19.9-31.9	U238	1.003		0.0286	V	0.733	1.109	1.485	1.861
	2253013	50392	BH50016AS	25'-30'	U238	1	B	0.016	A	0.733	1.109	1.485	1.861
	2262615	50492	BH50039AS	12'-18'	U238	1	B	0.022	A	0.733	1.109	1.485	1.861
	3671101	59793	BH50485AS	5.3'-11.3'	U238	0.99695		0.0204	Y	0.733	1.109	1.485	1.861
	3671258	59493	BH50522AS	12.9'-17.8'	U238	0.9901		0.0176	Y	0.733	1.109	1.485	1.861
	3671426	63193	BH50618AS	12'-20'	U238	0.9872		0.0198	Y	0.733	1.109	1.485	1.861

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
	3671561	58593	BH50427AS	0'-2'	U238	0.9806		0.0305	Y	0.733	1.109	1.485	1.861
	3671560	59393	BH50465AS	0'-2'	U238	0.9621		0.0208	Y	0.733	1.109	1.485	1.861
	3671094	59393	BH50476AS	0'-6'	U238	0.9601		0.0185	Y	0.733	1.109	1.485	1.861
	2253048	50592	BH50062AS	0'-6'	U238	0.96	B	0.024	A	0.733	1.109	1.485	1.861
	2253062	50592	BH50064AS	12'-18'	U238	0.96	B	0.019	A	0.733	1.109	1.485	1.861
	5069662	56694	BH00098AS	6.0-10.0	U238	0.9555		0.0118	V	0.733	1.109	1.485	1.861
	2262622	50492	BH50040AS	18'-24'	U238	0.94	B	0.011	A	0.733	1.109	1.485	1.861
	5069000	58494	BH00071AS	6.0-9.5	U238	0.91		0.02	Y	0.733	1.109	1.485	1.861
	5112052	57994	BH00047AS	0.0-6.3	U238	0.8997		0.0174	V	0.733	1.109	1.485	1.861
	2425825	51092	BH50154AS	0'-12'	U238	0.87		0.02	A	0.733	1.109	1.485	1.861
	3671100	59793	BH50484AS	0'-7.3'	U238	0.868		0.0204	Y	0.733	1.109	1.485	1.861
	2253069	50592	BH50065AS	18'-24'	U238	0.86	B	0.009	A	0.733	1.109	1.485	1.861
	2425817	51092	BH50153AS	0'-6'	U238	0.86		0.1	A	0.733	1.109	1.485	1.861
	3671095	59393	BH50477AS	6'-8'	U238	0.854		0.0179	Y	0.733	1.109	1.485	1.861
	2253076	50492	BH50041AS	30'-38'	U238	0.84	B	0.013	A	0.733	1.109	1.485	1.861
	5112076	58794	BH00054AS	0.0-2.4	U238	0.8314		0.0195	V	0.733	1.109	1.485	1.861
	5186011	59494	BH00155AS	5.9-11.9	U238	0.8124		0.0187	V	0.733	1.109	1.485	1.861
	4954866	58694	BH00052AS	0.0-2.9	U238	0.8072		0.0201	A	0.733	1.109	1.485	1.861
	4954867	58794	BH00054AS	0.0-2.4	U238	0.8068		0.0349	A	0.733	1.109	1.485	1.861
	2262601	50492	BH50037AS	0'-6'	U238	0.8	B	0.033	A	0.733	1.109	1.485	1.861
	5069007	57594	BH00078AS	0.0-6.0	U238	0.8		0.01	Y	0.733	1.109	1.485	1.861
	2253041	50392	BH50012AS	0'-4.5'	U238	0.79	B	0.013	A	0.733	1.109	1.485	1.861
	5068999	58494	BH00068AS	0.0-6.0	U238	0.79		0.01	Y	0.733	1.109	1.485	1.861
	2262608	50492	BH50038AS	6'-12'	U238	0.76	B	0.014	A	0.733	1.109	1.485	1.861
	5112068	58694	BH00052AS	0.0-2.9	U238	0.7421		0.0265	V	0.733	1.109	1.485	1.861
	5186035	59894	BH00162AS	17.9-19.9	U238	0.7367		0.0309	V	0.733	1.109	1.485	1.861
133.1	2550476	56493	BH50219AS	0'-6'	U233234	1.5	B	0.017	A	0.779	1.711	2.643	3.575
	2525792	56293	BH50206AS	0'-6'	U233234	1.441		0.052	A	0.779	1.711	2.643	3.575
	2439080	56193	BH50176AS	0'-2'	U233234	1.1	B	0.011	A	0.779	1.711	2.643	3.575
	2439108	56193	BH50304AS	18'-25'	U233234	1	B	0.01	A	0.779	1.711	2.643	3.575
	2550469	56493	BH50220AS	0'-2'	U233234	0.95	B	0.019	A	0.779	1.711	2.643	3.575
	2525785	56293	BH50210AS	0'-2'	U233234	0.9302		0.037	A	0.779	1.711	2.643	3.575
	3671045	58893	BH50459AS	6'-12'	U233234	0.9009		0.024	Y	0.779	1.711	2.643	3.575
	2439087	56193	BH50177AS	0'-6'	U233234	0.89	B	0.021	A	0.779	1.711	2.643	3.575
	3335579	58893	BH50646AS	0'-2'	U233234	0.88		0.2	A	0.779	1.711	2.643	3.575
	2439094	56193	BH50178AS	6'-11.4'	U233234	0.8	B	0.013	A	0.779	1.711	2.643	3.575
	2439101	56193	BH50303AS	12'-18'	U233234	0.79	B	0.017	A	0.779	1.711	2.643	3.575
	2550468	56493	BH50220AS	0'-2'	U235	0.068	J	0.019	A	0.022	0.068	0.114	0.16
	2439079	56193	BH50176AS	0'-2'	U235	0.054	J	0.011	A	0.022	0.068	0.114	0.16
	3671068	58893	BH50458AS	0'-6'	U235	0.0366		0.0207	Y	0.022	0.068	0.114	0.16
	2525800	56293	BH50207AS	6'-10'	U235	0.03042	J	0.043	A	0.022	0.068	0.114	0.16
	3671069	58893	BH50459AS	6'-12'	U235	0.0223		0.0164	Y	0.022	0.068	0.114	0.16
	2525801	56293	BH50207AS	6'-10'	U238	1.1085		0.057	A	0.733	1.109	1.485	1.861
	2439085	56193	BH50177AS	0'-6'	U238	1.1	B	0.021	A	0.733	1.109	1.485	1.861
	2439106	56193	BH50304AS	18'-25'	U238	1.1	B	0.01	A	0.733	1.109	1.485	1.861
	2439092	56193	BH50178AS	6'-11.4'	U238	1.1	B	0.022	A	0.733	1.109	1.485	1.861
	3335581	58893	BH50646AS	0'-2'	U238	0.97		0.2	A	0.733	1.109	1.485	1.861
	2439099	56193	BH50303AS	12'-18'	U238	0.91	B	0.053	A	0.733	1.109	1.485	1.861
	2550460	56193	BH50305AS	23'-30'	U238	0.82	B	0.015	A	0.733	1.109	1.485	1.861
133.2	2625468	57193	BH50246AS	0'-2'	U233234	1.625		0.116367	A	0.779	1.711	2.643	3.575
	2522237	57293	BH50251AS	0'-2'	U233234	1.6	B	0.013	A	0.779	1.711	2.643	3.575
	2522258	57293	BH50254AS	12'-18'	U233234	1.6	B	0.017	A	0.779	1.711	2.643	3.575
	2550609	57493	BH50261AS	0'-2'	U233234	1.5	B	0.014	A	0.779	1.711	2.643	3.575
	2625475	57193	BH50247AS	0'-5.5'	U233234	1.499		0.066429	A	0.779	1.711	2.643	3.575
	2467547	56993	BH50202AS	8.1'-14'	U233234	1.48		0.033	V	0.779	1.711	2.643	3.575
	2522286	57393	BH50257AS	0'-6.6'	U233234	1.4	B	0.029	A	0.779	1.711	2.643	3.575
	2522307	57393	BH50260AS	16.1'-24.1'	U233234	1.4	B	0.012	A	0.779	1.711	2.643	3.575
	2522314	57393	BH50291AS	22.1'-26.1'	U233234	1.4	B	0.014	A	0.779	1.711	2.643	3.575
	2522293	57393	BH50258AS	4.6'-12.1'	U233234	1.4	B	0.013	A	0.779	1.711	2.643	3.575
	3670886	58793	BH50406AS	0'-6.1'	U233234	1.3926		0.0284	Y	0.779	1.711	2.643	3.575
	2465693	57593	BH50299AS	0'-6'	U233234	1.3	B	0.047	A	0.779	1.711	2.643	3.575
	2522265	57293	BH50255AS	20'-26'	U233234	1.2	B	0.022	A	0.779	1.711	2.643	3.575
	2550616	57493	BH50262AS	0'-6'	U233234	1.2	B	0.039	A	0.779	1.711	2.643	3.575
	2467542	57093	BH50242AS	0'-6'	U233234	1.18		0	V	0.779	1.711	2.643	3.575
	3671538	58793	BH50645AS	0'-2'	U233234	1.1409		0.0314	Y	0.779	1.711	2.643	3.575
	3670887	58793	BH50407AS	6.1'-12'	U233234	1.1229		0.0285	Y	0.779	1.711	2.643	3.575
	2467543	57093	BH50241AS	0'-2'	U233234	1.11		0.013	V	0.779	1.711	2.643	3.575
	2625489	57193	BH50250AS	7'-13'	U233234	1.107		0.096004	A	0.779	1.711	2.643	3.575
	2522300	57393	BH50259AS	10.2'-18.1'	U233234	1.1	B	0.014	A	0.779	1.711	2.643	3.575
	2550455	57493	BH50265AS	18'-20'	U233234	1.1	B	0.017	A	0.779	1.711	2.643	3.575
	2465686	57593	BH50298AS	0'-2'	U233234	1.1	B	0.041	A	0.779	1.711	2.643	3.575
	2465714	57593	BH50301AS	12'-14'	U233234	1.1	B	0.01	A	0.779	1.711	2.643	3.575

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
	2465700	57593	BH50300AS	6'-12'	U233234	1.1	B	0.014	A	0.779	1.711	2.643	3.575
	2624779	56893	BH50236AS	0'-2'	U233234	1.077		0.049377	A	0.779	1.711	2.643	3.575
	2525820	56893	BH50240AS	14.3'-20.3'	U233234	1.02595		0.044	A	0.779	1.711	2.643	3.575
	3670889	58793	BH50409AS	18'-24'	U233234	1.009		0.0285	Y	0.779	1.711	2.643	3.575
	2522279	57393	BH50256AS	0'-2'	U233234	1	B	0.012	A	0.779	1.711	2.643	3.575
	3670890	58793	BH50410AS	24'-28.4'	U233234	0.9837		0.0178	Y	0.779	1.711	2.643	3.575
	3670888	58793	BH50408AS	12'-18'	U233234	0.9751		0.0176	Y	0.779	1.711	2.643	3.575
	2465707	57593	BH50294AS	6'-12'	U233234	0.97	B	0.014	A	0.779	1.711	2.643	3.575
	2467541	57093	BH50243AS	6'-12.3'	U233234	0.956		0.014	V	0.779	1.711	2.643	3.575
	2467546	56993	BH50199AS	0'-4'	U233234	0.932		0.026	A	0.779	1.711	2.643	3.575
	2525813	56893	BH50239AS	8.3'-14.3'	U233234	0.9233		0.046	A	0.779	1.711	2.643	3.575
	2467537	57093	BH50276AS	30.7'-36.1'	U233234	0.803		0.013	V	0.779	1.711	2.643	3.575
	2467506	56993	BH50202AS	8.1'-14'	U235	0.0641		0.023	V	0.022	0.068	0.114	0.16
	2465706	57593	BH50294AS	6'-12'	U235	0.061	J	0.036	A	0.022	0.068	0.114	0.16
	2522236	57293	BH50251AS	0'-2'	U235	0.06	BJ	0.022	A	0.022	0.068	0.114	0.16
	2467514	57093	BH50245AS	18.6'-24'	U235	0.0524		0.013	V	0.022	0.068	0.114	0.16
	2467507	56993	BH50204AS	20.7'-26.7'	U235	0.0502		0	V	0.022	0.068	0.114	0.16
	2467515	57093	BH50243AS	6'-12.3'	U235	0.0481		0	V	0.022	0.068	0.114	0.16
	2525821	56893	BH50240AS	14.3'-20.3'	U235	0.046647		0.044	A	0.022	0.068	0.114	0.16
	2625476	57193	BH50247AS	0'-5.5'	U235	0.04503	J	0.068914	A	0.022	0.068	0.114	0.16
	3670913	58793	BH50409AS	18'-24'	U235	0.045		0.0195	Y	0.022	0.068	0.114	0.16
	2522250	57293	BH50253AS	6'-12'	U235	0.044	BJ	0.012	A	0.022	0.068	0.114	0.16
	3671556	58793	BH50645AS	0'-2'	U235	0.044		0.025	Y	0.022	0.068	0.114	0.16
	3670912	58793	BH50408AS	12'-18'	U235	0.0431		0.0177	Y	0.022	0.068	0.114	0.16
	2522264	57293	BH50255AS	20'-26'	U235	0.042	BJ	0.034	A	0.022	0.068	0.114	0.16
	3670911	58793	BH50407AS	6.1'-12'	U235	0.0389		0.0195	Y	0.022	0.068	0.114	0.16
	2467517	56993	BH50203AS	14.3'-20.7'	U235	0.0374		0	V	0.022	0.068	0.114	0.16
	2467504	56993	BH50198AS	0'-2'	U235	0.0367		0	V	0.022	0.068	0.114	0.16
	2522299	57393	BH50259AS	10.2'-18.1'	U235	0.034	BJ	0.014	A	0.022	0.068	0.114	0.16
	2550608	57493	BH50261AS	0'-2'	U235	0.034	J	0.014	A	0.022	0.068	0.114	[illegible]
	2467513	57093	BH50276AS	30.7'-36.1'	U235	0.0334		0.013	V	0.022	0.068	0.114	[illegible]
	3670910	58793	BH50406AS	0'-6.1'	U235	0.0317		0.0194	Y	0.022	0.068	0.114	[illegible]
	3670914	58793	BH50410AS	24'-28.4'	U235	0.0291		0.0179	Y	0.022	0.068	0.114	0.16
	2522278	57393	BH50256AS	0'-2'	U235	0.029	BJ	0.012	A	0.022	0.068	0.114	0.16
	2465699	57593	BH50300AS	6'-12'	U235	0.028	U	0.044	A	0.022	0.068	0.114	0.16
	2467510	57093	BH50275AS	24'-30.7'	U235	0.0279		0	V	0.022	0.068	0.114	0.16
	2550628	57493	BH50264AS	12'-18'	U238	1.1	B	0.016	A	0.733	1.109	1.485	1.861
	2467564	57093	BH50241AS	0'-2'	U238	1.03		0	V	0.733	1.109	1.485	1.861
	2550614	57493	BH50262AS	0'-6'	U238	1	B	0.071	A	0.733	1.109	1.485	1.861
	2465712	57593	BH50301AS	12'-14'	U238	1	B	0.01	A	0.733	1.109	1.485	1.861
	2465684	57593	BH50298AS	0'-2'	U238	0.98	B	0.016	A	0.733	1.109	1.485	1.861
	2522277	57393	BH50256AS	0'-2'	U238	0.97	B	0.012	A	0.733	1.109	1.485	1.861
	2525822	56893	BH50240AS	14.3'-20.3'	U238	0.96475		0.057	A	0.733	1.109	1.485	1.861
	3670936	58793	BH50408AS	12'-18'	U238	0.9464		0.0223	Y	0.733	1.109	1.485	1.861
	3670938	58793	BH50410AS	24'-28.4'	U238	0.9037		0.0179	Y	0.733	1.109	1.485	1.861
	2550621	57493	BH50263AS	6'-12'	U238	0.82	B	0.024	A	0.733	1.109	1.485	1.861
	2467549	56993	BH50198AS	0'-2'	U238	0.779		0.014	V	0.733	1.109	1.485	1.861
133.3	2439129	56593	BH50221AS	0'-2'	U233234	1.6	B	0.06	A	0.779	1.711	2.643	3.575
	3671220	63093	BH50559AS	15'-20'	U233234	1.5392		0.0478	Y	0.779	1.711	2.643	3.575
	2439115	56693	BH50226AS	0'-2'	U233234	1.4	B	0.011	A	0.779	1.711	2.643	3.575
	3671215	59693	BH50556AS	0'-6'	U233234	1.3268		0.0245	Y	0.779	1.711	2.643	3.575
	2550490	56793	BH50233AS	6'-12'	U233234	1.3	B	0.027	A	0.779	1.711	2.643	3.575
	3671218	59693	BH50557AS	6'-12'	U233234	1.2384		0.0282	Y	0.779	1.711	2.643	3.575
	2439143	56593	BH50223AS	6'-12'	U233234	1.2	B	0.11	A	0.779	1.711	2.643	3.575
	2439122	56693	BH50227AS	0'-6'	U233234	1.2	B	0.035	A	0.779	1.711	2.643	3.575
	2439136	56593	BH50222AS	0'-6'	U233234	1.1	B	0.011	A	0.779	1.711	2.643	3.575
	3335586	61393	BH50650AS	0'-2'	U233234	1		0.1	A	0.779	1.711	2.643	3.575
	3671224	61493	BH50583AS	0'-8.5'	U233234	0.9959		0.0291	Y	0.779	1.711	2.643	3.575
	2550504	56793	BH50232AS	0'-6'	U233234	0.99	B	0.016	A	0.779	1.711	2.643	3.575
	3671221	61393	BH50570AS	0'-6'	U233234	0.98865		0.0219	Y	0.779	1.711	2.643	3.575
	3671222	61393	BH50576AS	0'-10'	U233234	0.9853		0.0178	Y	0.779	1.711	2.643	3.575
	3335607	61493	BH50651AS	0'-2'	U233234	0.93		0.2	A	0.779	1.711	2.643	3.575
	3671056	61193	BH50503AS	6'-10'	U233234	0.89635		0.0165	Y	0.779	1.711	2.643	3.575
	2625482	56593	BH50224AS	13'-17'	U233234	0.8024		0.062641	A	0.779	1.711	2.643	[illegible]
	3671225	61493	BH50585AS	8.5'-15.9'	U233234	0.7885		0.0259	Y	0.779	1.711	2.643	[illegible]
	2550503	56793	BH50232AS	0'-6'	U235	0.058	J	0.016	A	0.022	0.068	0.114	[illegible]
	3671239	59693	BH50556AS	0'-6'	U235	0.0547		0.0195	Y	0.022	0.068	0.114	0.16
	3671249	61493	BH50585AS	8.5'-15.9'	U235	0.0529		0.0205	Y	0.022	0.068	0.114	0.16
	3671245	61393	BH50570AS	0'-6'	U235	0.0496		0.0174	Y	0.022	0.068	0.114	0.16
	3671248	61493	BH50583AS	0'-8.5'	U235	0.04935		0.0179	Y	0.022	0.068	0.114	0.16
	2439121	56693	BH50227AS	0'-6'	U235	0.048	J	0.013	A	0.022	0.068	0.114	0.16
	3671080	61193	BH50503AS	6'-10'	U235	0.0438		0.0165	Y	0.022	0.068	0.114	0.16

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
	3671250	61493	BH50584AS	5.5'-13.5'	U235	0.0399		0.0206	Y	0.022	0.068	0.114	0.16
	3671243	59693	BH50558AS	12'-15.5'	U235	0.0388		0.0226	Y	0.022	0.068	0.114	0.16
	3671244	63093	BH50559AS	15'-20'	U235	0.03265		0.0293	Y	0.022	0.068	0.114	0.16
	2550486	56793	BH50234AS	10'-12'	U235	0.03	J	0.023	A	0.022	0.068	0.114	0.16
	2625483	56593	BH50224AS	13'-17'	U235	0.02713	J	0.066717	A	0.022	0.068	0.114	0.16
	3335588	61393	BH50650AS	0'-2'	U238	1.1		0.1	A	0.733	1.109	1.485	1.861
	3335609	61493	BH50651AS	0'-2'	U238	1.1		0.1	A	0.733	1.109	1.485	1.861
	3671266	59693	BH50557AS	6'-12'	U238	1.0966		0.0283	Y	0.733	1.109	1.485	1.861
	3671270	61393	BH50576AS	0'-10'	U238	1.0892		0.0178	Y	0.733	1.109	1.485	1.861
	2625484	56593	BH50224AS	13'-17'	U238	1.034		0.043704	A	0.733	1.109	1.485	1.861
	3671104	61193	BH50503AS	6'-10'	U238	0.9435		0.0165	Y	0.733	1.109	1.485	1.861
	3671268	63093	BH50559AS	15'-20'	U238	0.922		0.0293	Y	0.733	1.109	1.485	1.861
	3671273	61493	BH50585AS	8.5'-15.9'	U238	0.9084		0.0205	Y	0.733	1.109	1.485	1.861
	3671267	59693	BH50558AS	12'-15.5'	U238	0.80475		0.0226	Y	0.733	1.109	1.485	1.861
	2550485	56793	BH50234AS	10'-12'	U238	0.79	B	0.023	A	0.733	1.109	1.485	1.861
133.4	2525869	55993	BH50162AS	0'-2'	U233234	1.6		0.032	A	0.779	1.711	2.643	3.575
	2439059	55593	BH50059AS	12'-18'	U233234	1.5	B	0.02	A	0.779	1.711	2.643	3.575
	2439073	55593	BH50083AS	24'-26'	U233234	1.5	B	0.018	A	0.779	1.711	2.643	3.575
	2653841	55793	BH50307AS	0'-6'	U233234	1.484		0.070402	A	0.779	1.711	2.643	3.575
	2522230	55593	BH50057AS	0'-6'	U233234	1.4	B	0.012	A	0.779	1.711	2.643	3.575
	2439052	55593	BH50058AS	6'-12'	U233234	1.4	B	0.048	A	0.779	1.711	2.643	3.575
	2439066	55593	BH50082AS	18'-24'	U233234	1.3	B	0.019	A	0.779	1.711	2.643	3.575
	3671529	59093	BH50648AS	0'-2'	U233234	1.2966		0.0292	Y	0.779	1.711	2.643	3.575
	2653774	55693	BH50101AS	6'-12'	U233234	1.246		0.068371	A	0.779	1.711	2.643	3.575
	2525771	55893	BH50141AS	0'-2'	U233234	1.242		0.045	A	0.779	1.711	2.643	3.575
	2653855	55693	BH50113AS	18'-24.5'	U233234	1.23		0.08605	A	0.779	1.711	2.643	3.575
	2525778	55893	BH50149AS	0'-6'	U233234	1.138		0.045	A	0.779	1.711	2.643	3.575
	2525764	55993	BH50187AS	9.3'-15'	U233234	1.12		0.029	A	0.779	1.711	2.643	3.575
	3671040	59093	BH50413AS	12'-16.3'	U233234	1.0768		0.0206	Y	0.779	1.711	2.643	3.575
	2653781	55693	BH50102AS	12'-18'	U233234	1.013		0.039622	A	0.779	1.711	2.643	3.575
	2695396	58093	BH50313AS	0'-2'	U233234	0.962		0.034	A	0.779	1.711	2.643	3.575
	2653862	55793	BH50310AS	18.4'-22.4'	U233234	0.9452		0.152185	A	0.779	1.711	2.643	3.575
	3671039	59093	BH50412AS	6'-12'	U233234	0.8874		0.0284	Y	0.779	1.711	2.643	3.575
	2653869	55793	BH50309AS	12.4'-18.4'	U233234	0.8694		0.134509	A	0.779	1.711	2.643	3.575
	2439065	55593	BH50082AS	18'-24'	U235	0.068	J	0.019	A	0.022	0.068	0.114	0.16
	2525856	56093	BH50271AS	2'-8'	U235	0.068		0.037	A	0.022	0.068	0.114	0.16
	3671062	59093	BH50411AS	0'-6'	U235	0.0679		0.0187	Y	0.022	0.068	0.114	0.16
	2653768	55693	BH50100AS	0'-6'	U235	0.06624	J	0.101381	A	0.022	0.068	0.114	0.16
	2653856	55693	BH50113AS	18'-24.5'	U235	0.05969	J	0.08605	A	0.022	0.068	0.114	0.16
	2439058	55593	BH50059AS	12'-18'	U235	0.057	J	0.012	A	0.022	0.068	0.114	0.16
	2695362	58093	BH50313AS	0'-2'	U235	0.0544		0.012	A	0.022	0.068	0.114	0.16
	2653842	55793	BH50307AS	0'-6'	U235	0.05322	J	0.0671	A	0.022	0.068	0.114	0.16
	2525779	55893	BH50149AS	0'-6'	U235	0.051		0.038	A	0.022	0.068	0.114	0.16
	2525772	55893	BH50141AS	0'-2'	U235	0.04773		0.047	A	0.022	0.068	0.114	0.16
	2525870	55993	BH50162AS	0'-2'	U235	0.04672		0.032	A	0.022	0.068	0.114	0.16
	2653782	55693	BH50102AS	12'-18'	U235	0.04228		0.039622	A	0.022	0.068	0.114	0.16
	2653775	55693	BH50101AS	6'-12'	U235	0.03611	J	0.062515	A	0.022	0.068	0.114	0.16
	3671064	59093	BH50413AS	12'-16.3'	U235	0.0355		0.0163	Y	0.022	0.068	0.114	0.16
	2525765	55993	BH50187AS	9.3'-15'	U235	0.03232		0.029	A	0.022	0.068	0.114	0.16
	2653870	55793	BH50309AS	12.4'-18.4'	U235	0.02892	J	0.115726	A	0.022	0.068	0.114	0.16
	2653863	55793	BH50310AS	18.4'-22.4'	U235	0.02519	J	0.122162	A	0.022	0.068	0.114	0.16
	2439072	55593	BH50083AS	24'-26'	U235	0.025	J	0.01	A	0.022	0.068	0.114	0.16
	2525780	55893	BH50149AS	0'-6'	U238	1.107		0.045	A	0.733	1.109	1.485	1.861
	2439064	55593	BH50082AS	18'-24'	U238	1.1	B	0.012	A	0.733	1.109	1.485	1.861
	3671088	59093	BH50413AS	12'-16.3'	U238	1.0812		0.0163	Y	0.733	1.109	1.485	1.861
	2653871	55793	BH50309AS	12.4'-18.4'	U238	1.041		0.13171	A	0.733	1.109	1.485	1.861
	2653864	55793	BH50310AS	18.4'-22.4'	U238	1.012		0.131379	A	0.733	1.109	1.485	1.861
	3671087	59093	BH50412AS	6'-12'	U238	0.8945		0.0174	Y	0.733	1.109	1.485	1.861
	3671086	59093	BH50411AS	0'-6'	U238	0.8053		0.0187	Y	0.733	1.109	1.485	1.861
133.5	2451950	55293	BH50106AS	0'-6'	U233234	1.7	B	0.017	A	0.779	1.711	2.643	3.575
	2451936	55193	BH50090AS	0'-6'	U233234	1.5	B	0.015	A	0.779	1.711	2.643	3.575
	2451943	55193	BH50099AS	6'-8'	U233234	1.3	B	0.029	A	0.779	1.711	2.643	3.575
	2420060	55493	BH50033AS	6'-12.4'	U233234	1.23		0.018	V	0.779	1.711	2.643	3.575
	2451957	55293	BH50107AS	6'-10'	U233234	1	B	0.01	A	0.779	1.711	2.643	3.575
	2451935	55193	BH50090AS	0'-6'	U235	0.053	J	0.035	A	0.022	0.068	0.114	0.16
	2420028	55493	BH50034AS	12.4'-19.3'	U235	0.0477		0.01	V	0.022	0.068	0.114	0.16
	2420026	55393	BH50164AS	6'-12'	U235	0.0382		0	V	0.022	0.068	0.114	0.16
	2420016	55393	BH50165AS	12'-17.2'	U235	0.03505		0	V	0.022	0.068	0.114	0.16
	2420027	55493	BH50169AS	22.3'-30.2'	U235	0.024		0.015	V	0.022	0.068	0.114	0.16
	2467511	55393	BH50116AS	18.2'-23.8'	U235	0.0236		0.018	V	0.022	0.068	0.114	0.16
	2451955	55293	BH50107AS	6'-10'	U238	0.97	B	0.01	A	0.733	1.109	1.485	1.861
133.6	2451999	54993	BH50042AS	6'-10'	U233234	1.5	B	0.011	A	0.779	1.711	2.643	3.575

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
	2451978	54893	BH50017AS	0'-6.5'	U233234	1.4	B	0.016	A	0.779	1.711	2.643	3.575
	2451985	54893	BH50031AS	4.4'-12'	U233234	1.4	B	0.012	A	0.779	1.711	2.643	3.575
	2451992	54993	BH50035AS	0'-6'	U233234	1.3	B	0.01	A	0.779	1.711	2.643	3.575
	2451971	55093	BH50131AS	6'-13.2'	U233234	1.1	B	0.02	A	0.779	1.711	2.643	3.575
	2451964	55093	BH50060AS	0'-6'	U233234	1	B	0.026	A	0.779	1.711	2.643	3.575
	2451970	55093	BH50131AS	6'-13.2'	U235	0.048	J	0.008	A	0.022	0.068	0.114	0.16
	2451963	55093	BH50060AS	0'-6'	U235	0.045	J	0.008	A	0.022	0.068	0.114	0.16
	2451998	54993	BH50042AS	6'-10'	U235	0.04	BJ	0.011	A	0.022	0.068	0.114	0.16
	2451962	55093	BH50060AS	0'-6'	U238	1.1	B	0.032	A	0.733	1.109	1.485	1.861
142.10	2262666	51193	BH50168AS	0'-10'	U233234	1	B	0.005	A	0.779	1.711	2.643	3.575
	2045287	50092	BH50000AS	0'-14.8'	U233234	0.8288		0	A	0.779	1.711	2.643	3.575
	2262665	51193	BH50168AS	0'-10'	U235	0.065	J	0.012	A	0.022	0.068	0.114	0.16
	2262664	51193	BH50168AS	0'-10'	U238	1.1	B	0.005	A	0.733	1.109	1.485	1.861
	2045289	50092	BH50000AS	0'-14.8'	U238	0.9557		0	A	0.733	1.109	1.485	1.861
142.11	2045303	50292	BH50008AS	0'-14.5'	U233234	0.8856		0	A	0.779	1.711	2.643	3.575
Concrete Pad	5112082	56194	BH00043AS	0.0-6.0	U233234	1.014		0.0171	V	0.779	1.711	2.643	3.575
	4954841	56194	BH00043AS	0.0-6.0	U233234	0.8961		0.0228	V	0.779	1.711	2.643	3.575
	5112083	56194	BH00043AS	0.0-6.0	U235	0.05152		0.0223	V	0.022	0.068	0.114	0.16
	4954852	56194	BH00043AS	0.0-6.0	U235	0.0465		0.0228	V	0.022	0.068	0.114	0.16
Magnetic Anomaly W. of 133	3671430	64693	BH50638AS	0'-6'	U233234	1.419		0.0254	Y	0.779	1.711	2.643	3.575
	3335628	64693	BH50654AS	0'-2'	U233234	1.4		0.2	A	0.779	1.711	2.643	3.575
	3671433	64593	BH50634AS	0'-6'	U233234	1.3243		0.0183	Y	0.779	1.711	2.643	3.575
	3335621	64593	BH50653AS	0'-2'	U233234	1.3		0.2	A	0.779	1.711	2.643	3.575
	3671435	64593	BH50636AS	12'-18'	U233234	1.2928		0.0218	Y	0.779	1.711	2.643	3.575
	3671431	64693	BH50639AS	6'-12'	U233234	1.2445		0.029	Y	0.779	1.711	2.643	3.575
	3671432	64693	BH50640AS	12'-16'	U233234	1.2145		0.026	Y	0.779	1.711	2.643	3.575
	3335614	64493	BH50652AS	0'-2'	U233234	1.2		0.2	A	0.779	1.711	2.643	3.575
	3671434	64593	BH50635AS	6'-12'	U233234	1.1822		0.0313	Y	0.779	1.711	2.643	3.575
	3671436	64593	BH50637AS	18'-20'	U233234	1.1003		0.0318	Y	0.779	1.711	2.643	3.575
	3671437	64493	BH50630AS	0'-6'	U233234	1.0744		0.0208	Y	0.779	1.711	2.643	[illegible]
	3671438	64493	BH50631AS	6'-12'	U233234	0.9867		0.0342	Y	0.779	1.711	2.643	[illegible]
	3335629	64693	BH50654AS	0'-2'	U235	0.067	U	0.1	A	0.022	0.068	0.114	[illegible]
	3671454	64593	BH50636AS	12'-18'	U235	0.0534		0.0219	Y	0.022	0.068	0.114	0.16
	3671452	64593	BH50634AS	0'-6'	U235	0.0499		0.0184	Y	0.022	0.068	0.114	0.16
	3671457	64493	BH50631AS	6'-12'	U235	0.0331		0.0271	Y	0.022	0.068	0.114	0.16
	3671456	64493	BH50630AS	0'-6'	U235	0.0311		0.0208	Y	0.022	0.068	0.114	0.16
	3671453	64593	BH50635AS	6'-12'	U235	0.0269		0.0248	Y	0.022	0.068	0.114	0.16
	3671450	64693	BH50639AS	6'-12'	U235	0.0269		0.0199	Y	0.022	0.068	0.114	0.16
	3335630	64693	BH50654AS	0'-2'	U238	1.1		0.1	A	0.733	1.109	1.485	1.861
	3671472	64593	BH50635AS	6'-12'	U238	1.034		0.0248	Y	0.733	1.109	1.485	1.861
S133	3335600	57793	BH50329AS	0'-2'	U233234	1.5		0.2	A	0.779	1.711	2.643	3.575
	3671526	57893	BH50355AS	0'-2'	U233234	1.2179		0.0443	Y	0.779	1.711	2.643	3.575
	2695402	57993	BH50320AS	0'-6'	U233234	0.866		0.047	A	0.779	1.711	2.643	3.575
	3671530	57993	BH50643AS	0'-2'	U233234	0.8516		0.0236	Y	0.779	1.711	2.643	3.575
	2695398	57793	BH50322AS	6.3'-12'	U233234	0.794		0.06	A	0.779	1.711	2.643	3.575
	3671548	57993	BH50643AS	0'-2'	U235	0.048		0.0236	Y	0.022	0.068	0.114	0.16
	2695358	57793	BH50321AS	0'-5.75'	U235	0.0427		0.012	A	0.022	0.068	0.114	0.16
	2695370	57793	BH50323AS	12.2'-18.2'	U235	0.0382		0.022	A	0.022	0.068	0.114	0.16
	3671544	57893	BH50355AS	0'-2'	U235	0.037		0.0303	Y	0.022	0.068	0.114	0.16
	2725144	57793	BH50338AS	24'-28.9'	U235	0.0353		0.019	A	0.022	0.068	0.114	0.16
	2695359	57993	BH50320AS	0'-6'	U235	0.035		0.03	A	0.022	0.068	0.114	0.16
	2725145	57893	BH50339AS	0'-6'	U235	0.0321		0.022	A	0.022	0.068	0.114	0.16
	2725147	57893	BH50341AS	12.4'-17.8'	U235	0.0309		0.021	A	0.022	0.068	0.114	0.16
	2725142	57793	BH50324AS	18.8'-24.4'	U235	0.02965		0.02	A	0.022	0.068	0.114	0.16
	2725157	57893	BH50342AS	18.7'-26.4'	U235	0.0288		0.026	A	0.022	0.068	0.114	0.16
	2725146	57893	BH50340AS	6'-12.4'	U235	0.0229		0.021	A	0.022	0.068	0.114	0.16
	2695418	57793	BH50322AS	6.3'-12'	U238	1.06		0.021	A	0.733	1.109	1.485	1.861
	3335602	57793	BH50329AS	0'-2'	U238	1		0.1	A	0.733	1.109	1.485	1.861
	3671566	57993	BH50643AS	0'-2'	U238	0.8516		0.0236	Y	0.733	1.109	1.485	1.861
	2695423	57993	BH50320AS	0'-6'	U238	0.845		0.024	A	0.733	1.109	1.485	1.861
TDEM-1	5362681	55194	BH00029AS	6.0-12.0	U233234	1.71		0.0252	Y	0.779	1.711	2.643	3.575
	5362713	55294	BH00033AS	12.0-15.2	U233234	1.457		0.0167	Y	0.779	1.711	2.643	3.575
	5362689	55194	BH00030AS	12.0-16.1	U233234	1.445		0.017	Y	0.779	1.711	2.643	3.575
	5362697	55294	BH00031AS	0.0-6.0	U233234	1.429		0.0127	Y	0.779	1.711	2.643	[illegible]
	5362705	55294	BH00032AS	6.0-12.0	U233234	1.25		0.0201	Y	0.779	1.711	2.643	[illegible]
	5012752	60094	BH00089AS	0.0-5.0	U233234	0.8786		0.0287	V	0.779	1.711	2.643	3.575
	5362714	55294	BH00033AS	12.0-15.2	U235	0.05756		0.0143	Y	0.022	0.068	0.114	0.16
	5362698	55294	BH00031AS	0.0-6.0	U235	0.05567		0.0114	Y	0.022	0.068	0.114	0.16
	5012753	60094	BH00089AS	0.0-5.0	U235	0.05098		0.0197	V	0.022	0.068	0.114	0.16
	5362706	55294	BH00032AS	6.0-12.0	U235	0.0491		0.0172	Y	0.022	0.068	0.114	0.16
	5362690	55194	BH00030AS	12.0-16.1	U235	0.0375		0.0159	Y	0.022	0.068	0.114	0.16

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
TDEM-2	5292586	56094	BH00039AS	12.0-18.0	U233234	1.23		0.0217	Y	0.779	1.711	2.643	3.575
	4954840	55894	BH00036AS	0.0-6.0	U233234	1.0095		0.0238	V	0.779	1.711	2.643	3.575
	5112042	55894	BH00036AS	0.0-6.0	U233234	0.8552		0.023	V	0.779	1.711	2.643	3.575
	4954851	55894	BH00036AS	0.0-6.0	U235	0.0584		0.0301	V	0.022	0.068	0.114	0.16
	5112043	55894	BH00036AS	0.0-6.0	U235	0.05301		0.0128	V	0.022	0.068	0.114	0.16
	5292587	56094	BH00039AS	12.0-18.0	U235	0.03363		0.0186	Y	0.022	0.068	0.114	0.16
TDEM-W133	5068966	58894	BH00064AS	0.0-2.7	U233234	1.11		0.01	Y	0.779	1.711	2.643	3.575
	5068998	58894	BH00064AS	0.0-2.7	U238	0.97		0.01	Y	0.733	1.109	1.485	1.861
W209	2695387	57693	BH50319AS	0'-6'	U233234	1.03		0.042	A	0.779	1.711	2.643	3.575
	3335572	57693	BH50642AS	0'-2'	U233234	0.86		0.2	A	0.779	1.711	2.643	3.575
	2695356	57693	BH50319AS	0'-6'	U235	0.0659		0.016	A	0.022	0.068	0.114	0.16
	3335573	57693	BH50642AS	0'-2'	U235	0.042	U	0.2	A	0.022	0.068	0.114	0.16
	3335574	57693	BH50642AS	0'-2'	U238	0.85		0.1	A	0.733	1.109	1.485	1.861
Exceeds the Background Mean plus one Standard Deviation but is less than Background Mean plus two Standard Deviations													
115/196	3671208	59493	BH50521AS	6.9'-12.9'	U233234	2.6248		0.0251	Y	0.779	1.711	2.643	3.441
	2642375	58693	BH50348AS	0'-6'	U233234	2	B	0.015	A	0.779	1.711	2.643	3.441
	3671213	59593	BH50553AS	6'-12'	U233234	1.9101		0.0306	Y	0.779	1.711	2.643	3.441
	2262645	50892	BH50122AS	6'-12'	U233234	1.8	B	0.02	A	0.779	1.711	2.643	3.441
	2689777	58693	BH50350AS	19.5'-25.5'	U233234	1.8	B	0.019	A	0.779	1.711	2.643	3.441
	3671057	61293	BH50504AS	0'-6'	U233234	1.7503		0.0283	Y	0.779	1.711	2.643	3.441
	2689776	58693	BH50350AS	19.5'-25.5'	U235	0.11	BJ	0.011	A	0.022	0.068	0.114	0.153
	3671081	61293	BH50504AS	0'-6'	U235	0.1051		0.0194	Y	0.022	0.068	0.114	0.153
	2262693	50692	BH50087AS	0'-6'	U235	0.096	J	0.016	A	0.022	0.068	0.114	0.153
	2262658	50792	BH50105AS	0'-10'	U235	0.091	J	0.006	A	0.022	0.068	0.114	0.153
	2253063	50592	BH50064AS	12'-18'	U235	0.09	J	0.029	A	0.022	0.068	0.114	0.153
	3671414	60993	BH50588AS	0'-6'	U235	0.088		0.0216	Y	0.022	0.068	0.114	0.153
	3671238	59593	BH50554AS	14.4'-16.4'	U235	0.0843		0.0178	Y	0.022	0.068	0.114	0.153
	3671237	59593	BH50553AS	6'-12'	U235	0.084		0.0188	Y	0.022	0.068	0.114	0.153
	3671076	59793	BH50484AS	0'-7.3'	U235	0.0832		0.0204	Y	0.022	0.068	0.114	0.153
	2689783	58693	BH50405AS	25.5'-29.5'	U235	0.081	BJ	0.01	A	0.022	0.068	0.114	0.153
	5068985	58494	BH00071AS	6.0-9.5	U235	0.08		0.02	Y	0.022	0.068	0.114	0.153
	2262637	50892	BH50121AS	0'-6'	U235	0.079	J	0.005	A	0.022	0.068	0.114	0.153
	2262623	50492	BH50040AS	18'-24'	U235	0.078	J	0.011	A	0.022	0.068	0.114	0.153
	2262651	50792	BH50104AS	0'-6'	U235	0.078	J	0.005	A	0.022	0.068	0.114	0.153
	2262672	50992	BH50138AS	0'-6'	U235	0.078	J	0.005	A	0.022	0.068	0.114	0.153
	3671545	59593	BH50540AS	0'-2'	U235	0.0769		0.021	Y	0.022	0.068	0.114	0.153
	2695014	58593	BH50347AS	0'-6'	U235	0.075495		0.04943	V	0.022	0.068	0.114	0.153
	2253021	50392	BH50015AS	18'-24'	U235	0.074	J	0.015	A	0.022	0.068	0.114	0.153
	3671554	61293	BH50508AS	0'-2'	U235	0.0732		0.0207	Y	0.022	0.068	0.114	0.153
	3671418	63193	BH50618AS	12'-20'	U235	0.0724		0.0198	Y	0.022	0.068	0.114	0.153
	2262630	50892	BH50123AS	8'-16'	U235	0.072	J	0.012	A	0.022	0.068	0.114	0.153
	5186002	59494	BH00152AS	0.0-5.9	U235	0.07051		0.0232	V	0.022	0.068	0.114	0.153
	3671070	59393	BH50476AS	0'-6'	U235	0.07		0.0185	Y	0.022	0.068	0.114	0.153
	3671417	63193	BH50617AS	6'-12'	U235	0.0685		0.022	Y	0.022	0.068	0.114	0.153
	3671077	59793	BH50485AS	5.3'-11.3'	U235	0.0683		0.0204	Y	0.022	0.068	0.114	0.153
	2689768	58693	BH50349AS	12'-19.5'	U238	1.45	B	0.021	A	0.733	1.109	1.485	1.807
	3671262	59593	BH50554AS	14.4'-16.4'	U238	1.448		0.0178	Y	0.733	1.109	1.485	1.807
	3671572	61293	BH50508AS	0'-2'	U238	1.4435		0.0207	Y	0.733	1.109	1.485	1.807
	2695036	58593	BH50404AS	12.5'-18.1'	U238	1.437		0.048526	V	0.733	1.109	1.485	1.807
	2253020	50392	BH50015AS	18'-24'	U238	1.4	B	0.015	A	0.733	1.109	1.485	1.807
	2642401	58393	BH50343AS	0'-6'	U238	1.4	B	0.015	A	0.733	1.109	1.485	1.807
	5069008	57594	BH00082AS	6.0-12.0	U238	1.39		0.02	Y	0.733	1.109	1.485	1.807
	3671102	59793	BH50486AS	13.3'-15.3'	U238	1.338		0.0186	Y	0.733	1.109	1.485	1.807
	3671425	63193	BH50617AS	6'-12'	U238	1.3345		0.022	Y	0.733	1.109	1.485	1.807
	5069646	56694	BH00095AS	0.0-6.0	U238	1.323		0.0224	V	0.733	1.109	1.485	1.807
	3671563	59593	BH50540AS	0'-2'	U238	1.3128		0.021	Y	0.733	1.109	1.485	1.807
	2252992	50592	BH50066AS	0'-32'	U238	1.3	B	0.015	A	0.733	1.109	1.485	1.807
	2262629	50892	BH50123AS	8'-16'	U238	1.3	B	0.012	A	0.733	1.109	1.485	1.807
	2262685	50992	BH50140AS	0'-16'	U238	1.3	B	0.024	A	0.733	1.109	1.485	1.807
	2695029	58593	BH50403AS	6'-12.5'	U238	1.262		0.057886	V	0.733	1.109	1.485	1.807
	3671573	59793	BH50488AS	0'-2'	U238	1.2495		0.032	Y	0.733	1.109	1.485	1.807
	3671106	61293	BH50505AS	6'-10.6'	U238	1.2409		0.0544	Y	0.733	1.109	1.485	1.807
	5069654	56694	BH00096AS	0.0-6.0	U238	1.236		0.0129	V	0.733	1.109	1.485	1.807
	5011955	56694	BH00122AS	43.0-150.0	U238	1.234		0.0272	V	0.733	1.109	1.485	1.807
	3671571	59293	BH50444AS	0'-2'	U238	1.2333		0.0239	Y	0.733	1.109	1.485	1.807
	3671424	63193	BH50616AS	0'-6'	U238	1.2261		0.0175	Y	0.733	1.109	1.485	1.807
	5069638	56694	BH00111AS	0.0-35.0	U238	1.214		0.0159	V	0.733	1.109	1.485	1.807
	5186003	59494	BH00152AS	0.0-5.9	U238	1.212		0.0164	V	0.733	1.109	1.485	1.807
	5012728	57594	BH00085AS	18.0-23.0	U238	1.209		0.0143	V	0.733	1.109	1.485	1.807
	3671259	59593	BH50552AS	0'-6'	U238	1.192		0.0174	Y	0.733	1.109	1.485	1.807
	3671090	59293	BH50440AS	6'-12'	U238	1.1855		0.0287	Y	0.733	1.109	1.485	1.807
	5069670	56694	BH00112AS	0.0-41.0	U238	1.171		0.0175	V	0.733	1.109	1.485	1.807

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
	3671567	59493	BH50524AS	.4'-2'	U238	1.1581		0.0221	Y	0.733	1.109	1.485	1.807
133.1	3671044	58893	BH50458AS	0'-6'	U233234	1.8486		0.0207	Y	0.779	1.711	2.643	3.441
	2525786	56293	BH50210AS	0'-2'	U235	0.08865		0.044	A	0.022	0.068	0.114	0.153
	3335580	58893	BH50646AS	0'-2'	U235	0.076	U	0.2	A	0.022	0.068	0.114	0.153
	2439086	56193	BH50177AS	0'-6'	U235	0.073	J	0.021	A	0.022	0.068	0.114	0.153
	2525793	56293	BH50206AS	0'-6'	U235	0.06913		0.048	A	0.022	0.068	0.114	0.153
	3671093	58893	BH50459AS	6'-12'	U238	1.2577		0.0207	Y	0.733	1.109	1.485	1.807
	2550474	56493	BH50219AS	0'-6'	U238	1.2	B	0.017	A	0.733	1.109	1.485	1.807
133.2	2522244	57293	BH50252AS	0'-6'	U233234	2.2	B	0.026	A	0.779	1.711	2.643	3.441
	2522272	57293	BH50292AS	26'-30'	U233234	1.8	B	0.047	A	0.779	1.711	2.643	3.441
	2522313	57393	BH50291AS	22.1'-26.1'	U235	0.11	BJ	0.014	A	0.022	0.068	0.114	0.153
	2625469	57193	BH50246AS	0'-2'	U235	0.09712		0.096297	A	0.022	0.068	0.114	0.153
	2465685	57593	BH50298AS	0'-2'	U235	0.092	J	0.026	A	0.022	0.068	0.114	0.153
	2625490	57193	BH50250AS	7'-13'	U235	0.09156		0.077064	A	0.022	0.068	0.114	0.153
	2467516	57093	BH50241AS	0'-2'	U235	0.0775		0	V	0.022	0.068	0.114	0.153
	2522285	57393	BH50257AS	0'-6.6'	U235	0.077	BJ	0.018	A	0.022	0.068	0.114	0.153
	2522292	57393	BH50258AS	4.6'-12.1'	U235	0.075	BJ	0.013	A	0.022	0.068	0.114	0.153
	2465713	57593	BH50301AS	12'-14'	U235	0.072	J	0.017	A	0.022	0.068	0.114	0.153
	2467508	57093	BH50242AS	0'-6'	U235	0.0705		0.015	V	0.022	0.068	0.114	0.153
	2625470	57193	BH50246AS	0'-2'	U238	1.478		0.150293	A	0.733	1.109	1.485	1.807
	2522298	57393	BH50259AS	10.2'-18.1'	U238	1.4	B	0.044	A	0.733	1.109	1.485	1.807
	2550607	57493	BH50261AS	0'-2'	U238	1.4	B	0.014	A	0.733	1.109	1.485	1.807
	2465691	57593	BH50299AS	0'-6'	U238	1.4	B	0.015	A	0.733	1.109	1.485	1.807
	3671574	58793	BH50645AS	0'-2'	U238	1.3915		0.025	Y	0.733	1.109	1.485	1.807
	3670934	58793	BH50406AS	0'-6.1'	U238	1.3452		0.0194	Y	0.733	1.109	1.485	1.807
	2525815	56893	BH50239AS	8.3'-14.3'	U238	1.324		0.026	A	0.733	1.109	1.485	1.807
	2522263	57293	BH50255AS	20'-26'	U238	1.3	B	0.013	A	0.733	1.109	1.485	1.807
	2522305	57393	BH50260AS	16.1'-24.1'	U238	1.3	B	0.012	A	0.733	1.109	1.485	1.807
	2465705	57593	BH50294AS	6'-12'	U238	1.3	B	0.023	A	0.733	1.109	1.485	1.807
	3670935	58793	BH50407AS	6.1'-12'	U238	1.2094		0.0195	Y	0.733	1.109	1.485	1.807
	2522312	57393	BH50291AS	22.1'-26.1'	U238	1.2	B	0.023	A	0.733	1.109	1.485	[illegible]
	2550453	57493	BH50265AS	18'-20'	U238	1.2	B	0.017	A	0.733	1.109	1.485	[illegible]
	2465698	57593	BH50300AS	6'-12'	U238	1.2	B	0.024	A	0.733	1.109	1.485	1.807
	2467559	57093	BH50242AS	0'-6'	U238	1.19		0.015	V	0.733	1.109	1.485	1.807
	3670937	58793	BH50409AS	18'-24'	U238	1.1706		0.0195	Y	0.733	1.109	1.485	1.807
	2467558	57093	BH50243AS	6'-12.3'	U238	1.16		0	V	0.733	1.109	1.485	1.807
	2467566	56993	BH50199AS	0'-4'	U238	1.11		0.026	A	0.733	1.109	1.485	1.807
	2625491	57193	BH50250AS	7'-13'	U238	1.11		0.087781	A	0.733	1.109	1.485	1.807
133.3	3671055	61193	BH50500AS	0'-6'	U233234	1.8225		0.0335	Y	0.779	1.711	2.643	3.441
	2550497	56793	BH50231AS	0'-2'	U233234	1.8	B	0.033	A	0.779	1.711	2.643	3.441
	3671246	61393	BH50576AS	0'-10'	U235	0.1087		0.0178	Y	0.022	0.068	0.114	0.153
	3671242	59693	BH50557AS	6'-12'	U235	0.1074		0.0283	Y	0.022	0.068	0.114	0.153
	2439128	56593	BH50221AS	0'-2'	U235	0.082	J	0.053	A	0.022	0.068	0.114	0.153
	3671079	61193	BH50500AS	0'-6'	U235	0.0809		0.0206	Y	0.022	0.068	0.114	0.153
	2439135	56593	BH50222AS	0'-6'	U235	0.08	J	0.011	A	0.022	0.068	0.114	0.153
	2439114	56693	BH50226AS	0'-2'	U235	0.069	J	0.011	A	0.022	0.068	0.114	0.153
	3671263	59693	BH50556AS	0'-6'	U238	1.48435		0.0246	Y	0.733	1.109	1.485	1.807
	2550495	56793	BH50231AS	0'-2'	U238	1.4	B	0.06	A	0.733	1.109	1.485	1.807
	2550502	56793	BH50232AS	0'-6'	U238	1.4	B	0.016	A	0.733	1.109	1.485	1.807
	2439134	56593	BH50222AS	0'-6'	U238	1.3	B	0.019	A	0.733	1.109	1.485	1.807
	2439120	56693	BH50227AS	0'-6'	U238	1.3	B	0.022	A	0.733	1.109	1.485	1.807
	2439141	56593	BH50223AS	6'-12'	U238	1.2	B	0.12	A	0.733	1.109	1.485	1.807
	3671269	61393	BH50570AS	0'-6'	U238	1.1674		0.0174	Y	0.733	1.109	1.485	1.807
	3671272	61493	BH50583AS	0'-8.5'	U238	1.13495		0.0179	Y	0.733	1.109	1.485	1.807
133.4	3671051	58993	BH50482AS	6.4'-12'	U233234	2.6331		0.0389	Y	0.779	1.711	2.643	3.441
	2695389	58093	BH50315AS	10'-12'	U233234	2.46		0.034	A	0.779	1.711	2.643	3.441
	2653767	55693	BH50100AS	0'-6'	U233234	2.058		0.12179	A	0.779	1.711	2.643	3.441
	2653834	55793	BH50306AS	0'-2'	U233234	1.958		0.099847	A	0.779	1.711	2.643	3.441
	2525855	56093	BH50271AS	2'-8'	U233234	1.735		0.044	A	0.779	1.711	2.643	3.441
	2439051	55593	BH50058AS	6'-12'	U235	0.11	J	0.015	A	0.022	0.068	0.114	0.153
	3671547	59093	BH50648AS	0'-2'	U235	0.0724		0.0232	Y	0.022	0.068	0.114	0.153
	2653776	55693	BH50101AS	6'-12'	U238	1.44		0.049486	A	0.733	1.109	1.485	1.807
	2439071	55593	BH50083AS	24'-26'	U238	1.4	B	0.018	A	0.733	1.109	1.485	1.807
	2525766	55993	BH50187AS	9.3'-15'	U238	1.367		0.04	A	0.733	1.109	1.485	[illegible]
	2522228	55593	BH50057AS	0'-6'	U238	1.3	B	0.012	A	0.733	1.109	1.485	[illegible]
	2439057	55593	BH50059AS	12'-18'	U238	1.2	B	0.012	A	0.733	1.109	1.485	[illegible]
	3671565	59093	BH50648AS	0'-2'	U238	1.1991		0.0232	Y	0.733	1.109	1.485	1.807
	2653857	55693	BH50113AS	18'-24.5'	U238	1.169		0.062282	A	0.733	1.109	1.485	1.807
133.5	2451942	55193	BH50099AS	6'-8'	U235	0.1	BJ	0.011	A	0.022	0.068	0.114	0.153
	2451956	55293	BH50107AS	6'-10'	U235	0.098	BJ	0.01	A	0.022	0.068	0.114	0.153
	2451949	55293	BH50106AS	0'-6'	U235	0.09	J	0.017	A	0.022	0.068	0.114	0.153

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
	2420013	55493	BH50033AS	6'-12.4'	U235	0.0831		0	V	0.022	0.068	0.114	0.153
	2451934	55193	BH50090AS	0'-6'	U238	1.4	B	0.015	A	0.733	1.109	1.485	1.807
	2451941	55193	BH50099AS	6'-8'	U238	1.4	B	0.011	A	0.733	1.109	1.485	1.807
	2420082	55493	BH50034AS	12.4'-19.3'	U238	1.34		0	V	0.733	1.109	1.485	1.807
133.6	2451977	54893	BH50017AS	0'-6.5'	U235	0.09	J	0.016	A	0.022	0.068	0.114	0.153
	2451991	54993	BH50035AS	0'-6'	U235	0.083	BJ	0.01	A	0.022	0.068	0.114	0.153
	2451976	54893	BH50017AS	0'-6.5'	U238	1.3	B	0.007	A	0.733	1.109	1.485	1.807
	2451983	54893	BH50031AS	4.4'-12'	U238	1.3	B	0.031	A	0.733	1.109	1.485	1.807
	2451969	55093	BH50131AS	6'-13.2'	U238	1.2	B	0.02	A	0.733	1.109	1.485	1.807
Concrete Pad	5112084	56194	BH00043AS	0.0-6.0	U238	1.454		0.0145	V	0.733	1.109	1.485	1.807
	4954863	56194	BH00043AS	0.0-6.0	U238	1.2218		0.0334	V	0.733	1.109	1.485	1.807
Magnetic Anomaly W. of 133	3671439	64493	BH50632AS	12'-14'	U233234	2.2162		0.0754	Y	0.779	1.711	2.643	3.441
	3671449	64693	BH50638AS	0'-6'	U235	0.074		0.0202	Y	0.022	0.068	0.114	0.153
	3671471	64593	BH50634AS	0'-6'	U238	1.3318		0.0184	Y	0.733	1.109	1.485	1.807
	3671468	64693	BH50638AS	0'-6'	U238	1.3286		0.0202	Y	0.733	1.109	1.485	1.807
	3335616	64493	BH50652AS	0'-2'	U238	1.3		0.2	A	0.733	1.109	1.485	1.807
	3671475	64493	BH50630AS	0'-6'	U238	1.2046		0.0208	Y	0.733	1.109	1.485	1.807
	3335623	64593	BH50653AS	0'-2'	U238	1.2		0.1	A	0.733	1.109	1.485	1.807
	3671470	64693	BH50640AS	12'-16'	U238	1.167		0.0206	Y	0.733	1.109	1.485	1.807
	3671473	64593	BH50636AS	12'-18'	U238	1.1653		0.0219	Y	0.733	1.109	1.485	1.807
	3671474	64593	BH50637AS	18'-20'	U238	1.1475		0.0217	Y	0.733	1.109	1.485	1.807
	3671476	64493	BH50631AS	6'-12'	U238	1.1303		0.0271	Y	0.733	1.109	1.485	1.807
	3671469	64693	BH50639AS	6'-12'	U238	1.1098		0.0199	Y	0.733	1.109	1.485	1.807
S133	2695361	57793	BH50322AS	6.3'-12'	U235	0.0814		0.053	A	0.022	0.068	0.114	0.153
	2695360	57993	BH50316AS	4.9'-8.1'	U235	0.07345		0.026	A	0.022	0.068	0.114	0.153
	3671562	57893	BH50355AS	0'-2'	U238	1.1521		0.0303	Y	0.733	1.109	1.485	1.807
TDEM-1	5362673	55194	BH00028AS	0.0-6.0	U233234	1.845		0.021	Y	0.779	1.711	2.643	3.441
	5362682	55194	BH00029AS	6.0-12.0	U235	0.08957		0.022	Y	0.022	0.068	0.114	0.153
	5362674	55194	BH00028AS	0.0-6.0	U235	0.0855		0.018	Y	0.022	0.068	0.114	0.153
	5362699	55294	BH00031AS	0.0-6.0	U238	1.42		0.0139	Y	0.733	1.109	1.485	1.807
	5362707	55294	BH00032AS	6.0-12.0	U238	1.404		0.0232	Y	0.733	1.109	1.485	1.807
	5362715	55294	BH00033AS	12.0-15.2	U238	1.4		0.0177	Y	0.733	1.109	1.485	1.807
	5362691	55194	BH00030AS	12.0-16.1	U238	1.341		0.0146	Y	0.733	1.109	1.485	1.807
TDEM-2	5292588	56094	BH00039AS	12.0-18.0	U238	1.427		0.023	Y	0.733	1.109	1.485	1.807
	5112044	55894	BH00036AS	0.0-6.0	U238	1.243		0.0184	V	0.733	1.109	1.485	1.807
TDEM-W133	5068983	58894	BH00064AS	0.0-2.7	U235	0.07		0.01	Y	0.022	0.068	0.114	0.153
W209	2695403	57693	BH50319AS	0'-6'	U238	1.18		0.033	A	0.733	1.109	1.485	1.807
Exceeds the Background Mean plus two Standard Deviations but is less than Background Mean plus three Standard Deviations													
115/196	2689769	58693	BH50349AS	12'-19.5'	U235	0.1491	BJ	0.012	A	0.022	0.068	0.114	0.16
	3671231	59493	BH50520AS	0'-6.3'	U235	0.1386		0.0179	Y	0.022	0.068	0.114	0.16
	3671232	59493	BH50521AS	6.9'-12.9'	U235	0.13665		0.0199	Y	0.022	0.068	0.114	0.16
	2689782	58693	BH50405AS	25.5'-29.5'	U238	1.8	B	0.016	A	0.733	1.109	1.485	1.861
	3671261	59593	BH50553AS	6'-12'	U238	1.7904		0.0188	Y	0.733	1.109	1.485	1.861
	2262671	50992	BH50138AS	0'-6'	U238	1.7	B	0.005	A	0.733	1.109	1.485	1.861
	2642373	58693	BH50348AS	0'-6'	U238	1.7	B	0.015	A	0.733	1.109	1.485	1.861
	2689775	58693	BH50350AS	19.5'-25.5'	U238	1.7	B	0.019	A	0.733	1.109	1.485	1.861
	3671422	60993	BH50588AS	0'-6'	U238	1.6485		0.0216	Y	0.733	1.109	1.485	1.861
	2252999	50692	BH50088AS	6'-12'	U238	1.6	B	0.013	A	0.733	1.109	1.485	1.861
	2262657	50792	BH50105AS	0'-10'	U238	1.6	B	0.02	A	0.733	1.109	1.485	1.861
	2262636	50892	BH50121AS	0'-6'	U238	1.6	B	0.005	A	0.733	1.109	1.485	1.861
	2262643	50892	BH50122AS	6'-12'	U238	1.6	B	0.02	A	0.733	1.109	1.485	1.861
	2695015	58593	BH50347AS	0'-6'	U238	1.5995		0.045962	V	0.733	1.109	1.485	1.861
	3671105	61293	BH50504AS	0'-6'	U238	1.527		0.0283	Y	0.733	1.109	1.485	1.861
	2252985	50692	BH50089AS	0'-14'	U238	1.5	B	0.025	A	0.733	1.109	1.485	1.861
	2642380	58693	BH50417AS	6'-12'	U238	1.5	B	0.061	A	0.733	1.109	1.485	1.861
133.1	2695393	56393	BH50211AS	0'-2'	U233234	3.27		0.022	A	0.779	1.711	2.643	3.575
	2525794	56293	BH50206AS	0'-6'	U238	1.621		0.043	A	0.733	1.109	1.485	1.861
	2439078	56193	BH50176AS	0'-2'	U238	1.5	B	0.011	A	0.733	1.109	1.485	1.861
	2550467	56493	BH50220AS	0'-2'	U238	1.5	B	0.049	A	0.733	1.109	1.485	1.861
133.2	2522251	57293	BH50253AS	6'-12'	U233234	2.9	B	0.038	A	0.779	1.711	2.643	3.575
	2522243	57293	BH50252AS	0'-6'	U235	0.15	BJ	0.015	A	0.022	0.068	0.114	0.16
	2522271	57293	BH50292AS	26'-30'	U235	0.13	BJ	0.018	A	0.022	0.068	0.114	0.16
	2522257	57293	BH50254AS	12'-18'	U235	0.12	BJ	0.01	A	0.022	0.068	0.114	0.16
	2522235	57293	BH50251AS	0'-2'	U238	1.8	B	0.013	A	0.733	1.109	1.485	1.861
	2522256	57293	BH50254AS	12'-18'	U238	1.8	B	0.01	A	0.733	1.109	1.485	1.861
	2522284	57393	BH50257AS	0'-6.6'	U238	1.6	B	0.011	A	0.733	1.109	1.485	1.861
	2624781	56893	BH50236AS	0'-2'	U238	1.531		0.067023	A	0.733	1.109	1.485	1.861
133.3	3671528	61193	BH50649AS	0'-2'	U233234	3.2214		0.0286	Y	0.779	1.711	2.643	3.575
	3671546	61193	BH50649AS	0'-2'	U235	0.1417		0.0227	Y	0.022	0.068	0.114	0.16
	2439142	56593	BH50223AS	6'-12'	U235	0.12	J	0.059	A	0.022	0.068	0.114	0.16

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background: Mean	X = 1	X=2	X=3
	2439113	56693	BH50226AS	0'-2'	U238	1.6	B	0.031	A	0.733	1.109	1.485	1.861
	2550481	56793	BH50233AS	6'-12'	U238	1.6	B	0.045	A	0.733	1.109	1.485	1.861
133.4	3671075	58993	BH50482AS	6.4'-12'	U235	0.1568		0.0181	Y	0.022	0.068	0.114	0.16
	2695366	58093	BH50315AS	10'-12'	U235	0.151		0.029	A	0.022	0.068	0.114	0.16
	2653835	55793	BH50306AS	0'-2'	U235	0.1377		0.053241	A	0.022	0.068	0.114	0.16
	2522229	55593	BH50057AS	0'-6'	U235	0.12	BJ	0.012	A	0.022	0.068	0.114	0.16
	2439050	55593	BH50058AS	6'-12'	U238	1.8	B	0.026	A	0.733	1.109	1.485	1.861
	2525773	55893	BH50141AS	0'-2'	U238	1.7		0.047	A	0.733	1.109	1.485	1.861
	2653843	55793	BH50307AS	0'-6'	U238	1.546		0.053116	A	0.733	1.109	1.485	1.861
	2695412	58093	BH50313AS	0'-2'	U238	1.5		0.021	A	0.733	1.109	1.485	1.861
133.6	2451984	54893	BH50031AS	4.4'-12'	U235	0.12	J	0.036	A	0.022	0.068	0.114	0.16
	2451990	54993	BH50035AS	0'-6'	U238	1.5	B	0.017	A	0.733	1.109	1.485	1.861
	2451997	54993	BH50042AS	6'-10'	U238	1.5	B	0.011	A	0.733	1.109	1.485	1.861
Magnetic	3335615	64493	BH50652AS	0'-2'	U235	0.14	U	0.2	A	0.022	0.068	0.114	0.16
Anomaly	3335622	64593	BH50653AS	0'-2'	U235	0.14	U	0.2	A	0.022	0.068	0.114	0.16
W. of 133	3671477	64493	BH50632AS	12'-14'	U238	1.6662		0.0497	Y	0.733	1.109	1.485	1.861
S133	3335601	57793	BH50329AS	0'-2'	U235	0.14	U	0.2	A	0.022	0.068	0.114	0.16
TDEM-1	5362683	55194	BH00029AS	6.0-12.0	U238	1.636		0.0207	Y	0.733	1.109	1.485	1.861
TDEM-2	4954862	55894	BH00036AS	0.0-6.0	U238	1.4931		0.0301	V	0.733	1.109	1.485	1.861
Exceeds the Background Mean plus three Standard Deviations													
115/196	2642396	58493	BH50346AS	6'-12'	U233234	30	B	0.015	A	0.779	1.711	2.643	3.575
	2642410	58393	BH50344AS	6'-12.7'	U233234	9.3	B	0.047	A	0.779	1.711	2.643	3.575
	2642389	58493	BH50345AS	0'-6'	U233234	9.1	B	0.02	A	0.779	1.711	2.643	3.575
	3671207	59493	BH50520AS	0'-6.3'	U233234	3.7629		0.0343	Y	0.779	1.711	2.643	3.575
	2642395	58493	BH50346AS	6'-12'	U235	2.3		0.015	A	0.022	0.068	0.114	0.16
	2642409	58393	BH50344AS	6'-12.7'	U235	0.53		0.02	A	0.022	0.068	0.114	0.16
	3671082	61293	BH50505AS	6'-10.6'	U235	0.3395		0.0431	Y	0.022	0.068	0.114	0.16
	2642388	58493	BH50345AS	0'-6'	U235	0.32		0.02	A	0.022	0.068	0.114	0.16
	2642394	58493	BH50346AS	6'-12'	U238	12	B	0.025	A	0.733	1.109	1.485	1.861
	2642408	58393	BH50344AS	6'-12.7'	U238	7.2	B	0.062	A	0.733	1.109	1.485	[illegible]
	2262692	50692	BH50087AS	0'-6'	U238	3.1	B	0.042	A	0.733	1.109	1.485	[illegible]
	3671255	59493	BH50520AS	0'-6.3'	U238	2.9341		0.0179	Y	0.733	1.109	1.485	1.861
	2642387	58493	BH50345AS	0'-6'	U238	2.9	B	0.037	A	0.733	1.109	1.485	1.861
	3671423	61093	BH50603AS	6'-13'	U238	2.2229		0.0306	Y	0.733	1.109	1.485	1.861
	3671256	59493	BH50521AS	6.9'-12.9'	U238	2.21265		0.0199	Y	0.733	1.109	1.485	1.861
133.1	2695392	56393	BH50212AS	2'-6'	U233234	117		0.36	Z	0.779	1.711	2.643	3.575
	2695390	56393	BH50213AS	6'-8'	U233234	13.2		0.089	A	0.779	1.711	2.643	3.575
	5069676	57294	BH00091AS	0.0-4.0	U233234	9.934		0.0159	V	0.779	1.711	2.643	3.575
	2695364	56393	BH50212AS	2'-6'	U235	19.5		0.6	Z	0.022	0.068	0.114	0.16
	2695367	56393	BH50213AS	6'-8'	U235	1.7		0.08	A	0.022	0.068	0.114	0.16
	5069677	57294	BH00091AS	0.0-4.0	U235	0.6879		0.0111	V	0.022	0.068	0.114	0.16
	2695365	56393	BH50211AS	0'-2'	U235	0.47		0.028	A	0.022	0.068	0.114	0.16
	2695408	56393	BH50212AS	2'-6'	U238	1130		0.49	Z	0.733	1.109	1.485	1.861
	2695406	56393	BH50213AS	6'-8'	U238	120		0.065	A	0.733	1.109	1.485	1.861
	5069678	57294	BH00091AS	0.0-4.0	U238	38.37		0.00627	V	0.733	1.109	1.485	1.861
	2695409	56393	BH50211AS	0'-2'	U238	26.1		0.023	A	0.733	1.109	1.485	1.861
	3671092	58893	BH50458AS	0'-6'	U238	2.7069		0.0207	Y	0.733	1.109	1.485	1.861
	2525787	56293	BH50210AS	0'-2'	U238	2.101		0.049	A	0.733	1.109	1.485	1.861
133.2	2624795	56893	BH50238AS	4'-8.3'	U233234	105.7		0.275116	A	0.779	1.711	2.643	3.575
	2624787	56893	BH50237AS	2'-4'	U233234	33.03		0.062518	A	0.779	1.711	2.643	3.575
	2467548	56993	BH50200AS	8.1'-10.1'	U233234	15.3		0.028	V	0.779	1.711	2.643	3.575
	2624796	56893	BH50238AS	4'-8.3'	U235	37.68		0.227704	A	0.022	0.068	0.114	0.16
	2624788	56893	BH50237AS	2'-4'	U235	1.015		0.067032	A	0.022	0.068	0.114	0.16
	2467518	56993	BH50200AS	8.1'-10.1'	U235	0.916		0	V	0.022	0.068	0.114	0.16
	2465692	57593	BH50299AS	0'-6'	U235	0.18	J	0.026	A	0.022	0.068	0.114	0.16
	2550615	57493	BH50262AS	0'-6'	U235	0.17	J	0.023	A	0.022	0.068	0.114	0.16
	2624797	56893	BH50238AS	4'-8.3'	U238	1160		0.194178	A	0.733	1.109	1.485	1.861
	2467562	56993	BH50200AS	8.1'-10.1'	U238	29.7		0.028	V	0.733	1.109	1.485	1.861
	2624789	56893	BH50237AS	2'-4'	U238	19.41		0.057163	A	0.733	1.109	1.485	1.861
	2467561	56993	BH50202AS	8.1'-14'	U238	2.97		0.023	V	0.733	1.109	1.485	1.861
	2522242	57293	BH50252AS	0'-6'	U238	2.5	B	0.026	A	0.733	1.109	1.485	1.861
	2522249	57293	BH50253AS	6'-12'	U238	2.3	B	0.02	A	0.733	1.109	1.485	1.861
	2522291	57393	BH50258AS	4.6'-12.1'	U238	2.1	B	0.021	A	0.733	1.109	1.485	[illegible]
	2522270	57293	BH50292AS	26'-30'	U238	2	B	0.03	A	0.733	1.109	1.485	[illegible]
	2625477	57193	BH50247AS	0'-5.5'	U238	1.923		0.04808	A	0.733	1.109	1.485	[illegible]
133.3	2550489	56793	BH50233AS	6'-12'	U235	0.26	J	0.027	A	0.022	0.068	0.114	0.16
	3671564	61193	BH50649AS	0'-2'	U238	9.344		0.0227	Y	0.733	1.109	1.485	1.861
	3671103	61193	BH50500AS	0'-6'	U238	4.6052		0.0206	Y	0.733	1.109	1.485	1.861
	2439127	56593	BH50221AS	0'-2'	U238	2.4	B	0.06	A	0.733	1.109	1.485	1.861
133.4	5411953	55694	BH00042AS	6.0-10.6	U233234	241		4.73	Y	0.779	1.711	2.643	3.575
	2695394	58093	BH50314AS	0'-8'	U233234	126		0.77	A	0.779	1.711	2.643	3.575

Table 4-5
Summary of Radionuclide COCs Exceeding Background in Subsurface Soil

IHSS/Site	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background			
										Mean	X = 1	X=2	X=3
	2695395	58093	BH50314AS	0'-8'	U233234	126		0.18	Z	0.779	1.711	2.643	3.575
	2525876	55993	BH50151AS	0'-6'	U233234	113.3		0.069	A	0.779	1.711	2.643	3.575
	2525757	55993	BH50161AS	4'-9.3'	U233234	84.93		0.238	A	0.779	1.711	2.643	3.575
	5411952	55694	BH00041AS	0.0-6.0	U233234	58.4		1	Y	0.779	1.711	2.643	3.575
	3671532	58993	BH50647AS	0'-2'	U233234	25.7624		0.0444	Y	0.779	1.711	2.643	3.575
	3671049	58993	BH50480AS	0'-6.4'	U233234	12.9864		0.0476	Y	0.779	1.711	2.643	3.575
	2525877	55993	BH50151AS	0'-6'	U235	17		0.066	A	0.022	0.068	0.114	0.16
	5411957	55694	BH00042AS	6.0-10.6	U235	16.1		4.5	Y	0.022	0.068	0.114	0.16
	2695369	58093	BH50314AS	0'-8'	U235	10		0.23	Z	0.022	0.068	0.114	0.16
	2695363	58093	BH50314AS	0'-8'	U235	6.64		0.37	A	0.022	0.068	0.114	0.16
	5411956	55694	BH00041AS	0.0-6.0	U235	5.84		0.685	Y	0.022	0.068	0.114	0.16
	2525758	55993	BH50161AS	4'-9.3'	U235	5.624		0.207	A	0.022	0.068	0.114	0.16
	3671550	58993	BH50647AS	0'-2'	U235	1.5278		0.0352	Y	0.022	0.068	0.114	0.16
	3671073	58993	BH50480AS	0'-6.4'	U235	0.65315		0.0249	Y	0.022	0.068	0.114	0.16
	5411961	55694	BH00042AS	6.0-10.6	U238	848		3.63	Y	0.733	1.109	1.485	1.861
	2695411	58093	BH50314AS	0'-8'	U238	519		0.088	Z	0.733	1.109	1.485	1.861
	2695410	58093	BH50314AS	0'-8'	U238	485		0.63	A	0.733	1.109	1.485	1.861
	2525759	55993	BH50161AS	4'-9.3'	U238	244.2		0.187	A	0.733	1.109	1.485	1.861
	5411960	55694	BH00041AS	0.0-6.0	U238	216		0.749	Y	0.733	1.109	1.485	1.861
	2525878	55993	BH50151AS	0'-6'	U238	183		0.059	A	0.733	1.109	1.485	1.861
	3671568	58993	BH50647AS	0'-2'	U238	97.2346		0.0352	Y	0.733	1.109	1.485	1.861
	3671097	58993	BH50480AS	0'-6.4'	U238	47.1546		0.0249	Y	0.733	1.109	1.485	1.861
	2695405	58093	BH50315AS	10'-12'	U238	8.5		0.03	A	0.733	1.109	1.485	1.861
	3671099	58993	BH50482AS	6.4'-12'	U238	8.27275		0.0265	Y	0.733	1.109	1.485	1.861
	2653836	55793	BH50306AS	0'-2'	U238	3.338		0.091294	A	0.733	1.109	1.485	1.861
	2525871	55993	BH50162AS	0'-2'	U238	2.522		0.043	A	0.733	1.109	1.485	1.861
	2525857	56093	BH50271AS	2'-8'	U238	2.414		0.044	A	0.733	1.109	1.485	1.861
	2653769	55693	BH50100AS	0'-6'	U238	2.195		0.145224	A	0.733	1.109	1.485	1.861
133.5	2451948	55293	BH50106AS	0'-6'	U238	2.3	B	0.007	A	0.733	1.109	1.485	1.861
	2420074	55493	BH50033AS	6'-12.4'	U238	2.07		0.018	V	0.733	1.109	1.485	1.861
M[illegible] 133	3671458	64493	BH50632AS	12'-14'	U235	0.3204		0.0394	Y	0.022	0.068	0.114	0.16
T[illegible]	5362675	55194	BH00028AS	0.0-6.0	U238	1.951		0.0235	Y	0.733	1.109	1.485	1.861
TDEM-2	5394391	55994	BH00034AS	0.0-6.0	U233234	288.2869		5.764328	Y	0.779	1.711	2.643	3.575
	5292570	56094	BH00037AS	0.0-6.0	U233234	21.24		0.0126	Y	0.779	1.711	2.643	3.575
	5292594	56094	BH00040AS	18.0-22.0	U233234	15.31		0.048	Y	0.779	1.711	2.643	3.575
	5292578	56094	BH00038AS	6.0-12.0	U233234	11.94		0.0411	Y	0.779	1.711	2.643	3.575
	5394393	55994	BH00035AS	6.0-11.2	U233234	10.1869		0.162069	Y	0.779	1.711	2.643	3.575
	5394395	55994	BH00034AS	0.0-6.0	U235	36.11686		3.601073	Y	0.022	0.068	0.114	0.16
	5394397	55994	BH00035AS	6.0-11.2	U235	0.849322		0.138323	Y	0.022	0.068	0.114	0.16
	5292571	56094	BH00037AS	0.0-6.0	U235	0.7023		0.0113	Y	0.022	0.068	0.114	0.16
	5292595	56094	BH00040AS	18.0-22.0	U235	0.6218		0.0306	Y	0.022	0.068	0.114	0.16
	5292579	56094	BH00038AS	6.0-12.0	U235	0.3899		0.0338	Y	0.022	0.068	0.114	0.16
	5394399	55994	BH00034AS	0.0-6.0	U238	933.0405		3.936487	Y	0.733	1.109	1.485	1.861
	5394401	55994	BH00035AS	6.0-11.2	U238	22.84702		0.138323	Y	0.733	1.109	1.485	1.861
	5292572	56094	BH00037AS	0.0-6.0	U238	16.62		0.0137	Y	0.733	1.109	1.485	1.861
	5292596	56094	BH00040AS	18.0-22.0	U238	15.75		0.0416	Y	0.733	1.109	1.485	1.861
	5292580	56094	BH00038AS	6.0-12.0	U238	10.93		0.0455	Y	0.733	1.109	1.485	1.861

These data are graphically displayed on Figures 4-5a and 5b.

Table 4-6
Summary of Organic COCs in Subsurface Soil

IHSS	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in ug/kg	Qualifier	Reporting Limit	Valid.
Detected at concentration less than Reporting Limit									
115/196	2744797	58493	BH50345AS	0'-6'	Benzo(a)anthracene	330	J	330	A
	2086490	50992	BH50139AS	6'-12'	Benzo(a)anthracene	240	J	330	A
	2632850	58593	BH50403AS	6'-12.5'	Benzo(a)anthracene	180	J	330	A
	2744293	58393	BH50343AS	0'-6'	Benzo(a)anthracene	170	J	330	A
	2035976	50492	BH50037AS	0'-6'	Benzo(a)anthracene	130	J	330	A
	2086132	50692	BH50087AS	0'-6'	Benzo(a)anthracene	44	J	330	A
	2744803	58493	BH50345AS	0'-6'	Benzo(a)pyrene	280	J	330	A
	2086496	50992	BH50139AS	6'-12'	Benzo(a)pyrene	250	BJ	330	A
	5045251	57594	BH00087AS	84.9-90.4	Benzo(a)pyrene	130	J	330	A
	5045343	57594	BH00086AS	24.0-60.0	Benzo(a)pyrene	110	J	330	A
	2744299	58393	BH50343AS	0'-6'	Benzo(a)pyrene	100	J	330	A
	2632856	58593	BH50403AS	6'-12.5'	Benzo(a)pyrene	98	J	330	A
	5160749	59894	BH00164AS	19.9-31.9	Benzo(a)pyrene	58	J	330	A
	2086138	50692	BH50087AS	0'-6'	Benzo(a)pyrene	47	J	330	A
	2086494	50992	BH50139AS	6'-12'	Benzo(b)fluoranthene	260	BJ	330	A
	2744297	58393	BH50343AS	0'-6'	Benzo(b)fluoranthene	250	J	330	A
	2632854	58593	BH50403AS	6'-12.5'	Benzo(b)fluoranthene	220	J	330	A
	2035980	50492	BH50037AS	0'-6'	Benzo(b)fluoranthene	100	J	330	A
	2086136	50692	BH50087AS	0'-6'	Benzo(b)fluoranthene	81	J	330	A
Exceeds Reporting Limit but is less than ten times the Reporting Limit									
115/196	2711716	59493	BH50520AS	0'-6.3'	Benzo(a)anthracene	2400		330	V
	2712569	59493	BH50520AS	0'-6.3'	Benzo(a)anthracene	2200	D	330	Z
	2712398	59493	BH50521AS	6.9'-12.9'	Benzo(a)anthracene	1700	D	330	Z
	2744971	58693	BH50349AS	12'-19.5'	Benzo(a)anthracene	1500		330	V
	2745063	58693	BH50349AS	12'-19.5'	Benzo(a)anthracene	1400	D	330	Z
	2711300	59493	BH50521AS	6.9'-12.9'	Benzo(a)anthracene	1310		330	V
	2086398	50992	BH50138AS	0'-6'	Benzo(a)anthracene	1300		330	V
	2086582	50992	BH50140AS	0'-16'	Benzo(a)anthracene	950		330	V
	2086766	51092	BH50154AS	0'-12'	Benzo(a)anthracene	860		330	V
	2086674	51092	BH50153AS	0'-6'	Benzo(a)anthracene	850		330	V
	2744527	58393	BH50344AS	6'-12.7'	Benzo(a)anthracene	510		330	V
	2745322	58693	BH50348AS	0'-6'	Benzo(a)anthracene	500		330	V
	2711482	59493	BH50522AS	12.9'-17.8'	Benzo(a)pyrene	3200	E	330	Z
	2711722	59493	BH50520AS	0'-6.3'	Benzo(a)pyrene	2200		330	V
	2712575	59493	BH50520AS	0'-6.3'	Benzo(a)pyrene	2200	D	330	Z
	2712404	59493	BH50521AS	6.9'-12.9'	Benzo(a)pyrene	1700	D	330	Z
	2744977	58693	BH50349AS	12'-19.5'	Benzo(a)pyrene	1400		330	V
	2086404	50992	BH50138AS	0'-6'	Benzo(a)pyrene	1300	B	330	V
	2711306	59493	BH50521AS	6.9'-12.9'	Benzo(a)pyrene	1220		330	V
	2745069	58693	BH50349AS	12'-19.5'	Benzo(a)pyrene	1200	D	330	Z
	2086588	50992	BH50140AS	0'-16'	Benzo(a)pyrene	920	B	330	V
	2086680	51092	BH50153AS	0'-6'	Benzo(a)pyrene	840		330	V
	2086772	51092	BH50154AS	0'-12'	Benzo(a)pyrene	830		330	V
	5141798	56694	BH00122AS	43.0-150.0	Benzo(a)pyrene	480	J	330	A
	5140749	57594	BH00121AS	24.0-105.0	Benzo(a)pyrene	470	J	330	A
	2744533	58393	BH50344AS	6'-12.7'	Benzo(a)pyrene	460		330	V
	2745328	58693	BH50348AS	0'-6'	Benzo(a)pyrene	390		330	V
	5141710	56694	BH00113AS	43.0-150.0	Benzo(a)pyrene	350	J	330	A
	2711720	59493	BH50520AS	0'-6.3'	Benzo(b)fluoranthene	2700		330	V
	2712573	59493	BH50520AS	0'-6.3'	Benzo(b)fluoranthene	2500	D	330	Z
	2712402	59493	BH50521AS	6.9'-12.9'	Benzo(b)fluoranthene	1900	D	330	Z
	2711304	59493	BH50521AS	6.9'-12.9'	Benzo(b)fluoranthene	1610		330	V
	2086402	50992	BH50138AS	0'-6'	Benzo(b)fluoranthene	1500	B	330	V
	2744975	58693	BH50349AS	12'-19.5'	Benzo(b)fluoranthene	1500		330	V
	2745067	58693	BH50349AS	12'-19.5'	Benzo(b)fluoranthene	1500	D	330	Z

Table 4-6
Summary of Organic COCs in Subsurface Soil

IHSS	Sequence ID	Location	Sample No.	Depth Interval	Constituent	Result in ug/kg	Qualifier	Reporting Limit	Valid.
	2086586	50992	BH50140AS	0'-16'	Benzo(b)fluoranthene	1000	B	330	V
	2086770	51092	BH50154AS	0'-12'	Benzo(b)fluoranthene	940		330	V
	2086678	51092	BH50153AS	0'-6'	Benzo(b)fluoranthene	910		330	V
	2744531	58393	BH50344AS	6'-12.7'	Benzo(b)fluoranthene	660		330	V
	2745326	58693	BH50348AS	0'-6'	Benzo(b)fluoranthene	520		330	V
	2744801	58493	BH50345AS	0'-6'	Benzo(b)fluoranthene	370		330	V
	2604357	58693	BH50417AS	6'-12'	PCB-1254	960	X	160	V
	2087591	50992	BH50140AS	0'-16'	PCB-1254	870		160	V
	2702888	61093	BH50603AS	6'-13'	PCB-1254	860		160	V
	2704838	59493	BH50520AS	0'-6.3'	PCB-1254	630		160	V
	2087535	50992	BH50138AS	0'-6'	PCB-1254	600		160	V
	2087619	51092	BH50153AS	0'-6'	PCB-1254	500		160	V
	2604133	58393	BH50344AS	6'-12.7'	PCB-1254	440		160	V
	2087563	50992	BH50139AS	6'-12'	PCB-1254	320		160	V
	2087647	51092	BH50154AS	0'-12'	PCB-1254	240		160	V
	2604189	58493	BH50345AS	0'-6'	PCB-1254	210		160	V
Exceeds ten times the Reporting Limit but is less than one hundred time the Reporting Limit									
115/196	2711476	59493	BH50522AS	12.9'-17.8'	Benzo(a)anthracene	4300	E	330	Z
	2712481	59493	BH50522AS	12.9'-17.8'	Benzo(a)anthracene	3700	D	330	V
	2712487	59493	BH50522AS	12.9'-17.8'	Benzo(a)pyrene	3800	D	330	V
	2712485	59493	BH50522AS	12.9'-17.8'	Benzo(b)fluoranthene	4500	D	330	V
	2711480	59493	BH50522AS	12.9'-17.8'	Benzo(b)fluoranthene	4100	E	330	Z
Exceeds one hundred times the Reporting Limit									
115/196	2745413	58693	BH50417AS	6'-12'	Benzo(a)anthracene	48000		330	JA
	2745491	58693	BH50417AS	6'-12'	Benzo(a)anthracene	40000	D	330	Z
	2745419	58693	BH50417AS	6'-12'	Benzo(a)pyrene	43000		330	JA
	2745497	58693	BH50417AS	6'-12'	Benzo(a)pyrene	35000	DJ	330	Z
	2745417	58693	BH50417AS	6'-12'	Benzo(b)fluoranthene	48000		330	JA
	2745495	58693	BH50417AS	6'-12'	Benzo(b)fluoranthene	40000	D	330	Z

These data are graphically displayed on Figures 4-6a and 6b.

Table 4-7
Summary of Metal COCs Exceeding Background Mean in Subsurface Soil

IHSS	Sequence ID	Location	Sample No.	Sample Date	TGC	Constituent	Result in ug/l	Qualifier	Reporting Limit	Valid.	Mean	Mean + (X * STD DEV) of background X = 1	X=2	X=3
Exceeds the Background Mean but is less than Background Mean plus one Standard Deviation														
115/196	5196762	58094	GW50102AS	12/21/94	DISSOLVED	ALUMINUM	319	U	200	JA	113.66	708.46	1303.26	1898.06
	5196791	58094	GW50103AS	12/21/94	DISSOLVED	ALUMINUM	264	U	200	JA	113.66	708.46	1303.26	1898.06
	2815138	59493	GW01166WC	8/11/93	DISSOLVED	ALUMINUM	200	U	200	JA	113.66	708.46	1303.26	1898.06
	5368668	59894	GW02201GA	3/7/95	DISSOLVED	BARIUM	113	B	200	Y	84	117.1	150.2	183.3
	4927315	59593	GW01619GA	10/24/94	DISSOLVED	BARIUM	108	B	9	V	84	117.1	150.2	183.3
	3526634	59593	GW01481WC	11/10/93	DISSOLVED	BARIUM	106	B	23	V	84	117.1	150.2	183.3
	5170624	60293	GW50143AS	1/22/95	DISSOLVED	BARIUM	85.4	B	200	V	84	117.1	150.2	183.3
	5473754	57594	GW02352GA	4/11/95	DISSOLVED	BERYLLIUM	2.5	U	5	Y	2.22	2.91	3.6	4.29
	5170567	57894	GW50141AS	1/22/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5170596	57894	GW50161AS	1/22/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5196765	58094	GW50102AS	12/21/94	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5196794	58094	GW50103AS	12/21/94	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5196823	58594	GW50104AS	12/21/94	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	4674393	59493	GW01247GA	8/18/94	DISSOLVED	BERYLLIUM	2.5	U	5	V	2.22	2.91	3.6	4.29
	5201436	59493	GW50113AS	1/4/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5201519	59493	GW50114AS	1/4/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5170310	59593	GW50131AS	1/11/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5170741	59594	GW02058GA	1/25/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5368752	59694	GW02202GA	3/7/95	DISSOLVED	BERYLLIUM	2.5	U	5	Y	2.22	2.91	3.6	4.29
	5170625	60293	GW50143AS	1/22/95	DISSOLVED	BERYLLIUM	2.5	U	5	V	2.22	2.91	3.6	4.29
	5170654	60293	GW50144AS	1/22/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5170857	60893	GW50157AS	1/26/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5170799	61093	GW50151AS	1/25/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5170828	61093	GW50154AS	1/25/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5170397	61293	GW50126AS	1/7/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5201867	63193	GW50130AS	1/10/95	DISSOLVED	BERYLLIUM	2.5	U	5	V	2.22	2.91	3.6	4.29
	5201664	63893	GW50120AS	1/5/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5201635	63993	GW50119AS	1/5/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5201606	64093	GW50118AS	1/5/95	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5170634	60293	GW50143AS	1/22/95	DISSOLVED	MANGANESE	88.4		15	V	32.66	120.09	207.52	294.95
	4927517	59593	GW01619GA	10/24/94	DISSOLVED	MANGANESE	81.9		1	V	32.66	120.09	207.52	294.95
	5170663	60293	GW50144AS	1/22/95	DISSOLVED	MANGANESE	70.9		15	V	32.66	120.09	207.52	294.95
	5196831	58594	GW50104AS	12/21/94	DISSOLVED	MANGANESE	46.2		15	V	32.66	120.09	207.52	294.95
	5368678	59894	GW02201GA	3/7/95	DISSOLVED	MANGANESE	44.3		15	Y	32.66	120.09	207.52	294.95
	5368826	71494	GW02241GA	3/14/95	DISSOLVED	VANADIUM	12.9	B	50	Y	12.37	22.34	32.31	42.28
133	2657525	58793	GW01017WC	6/18/93	DISSOLVED	ALUMINUM	200	U	200	JA	113.66	708.46	1303.26	1898.06
	2815167	58793	GW01168WC	8/12/93	DISSOLVED	ALUMINUM	200	U	200	JA	113.66	708.46	1303.26	1898.06
	5389507	58793	GW02189GA	3/7/95	DISSOLVED	BARIUM	112	B	0.6	Y	84	117.1	150.2	183.3
	5389478	63093	GW02188GA	3/7/95	DISSOLVED	BARIUM	107	B	0.6	Y	84	117.1	150.2	183.3
	5196881	55394	GW50106AS	12/22/94	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5196852	56594	GW50105AS	12/22/94	DISSOLVED	BERYLLIUM	2.5	U	5	JA	2.22	2.91	3.6	4.29
	5201693	58793	GW50123AS	1/6/95	DISSOLVED	BERYLLIUM	2.5	U	5	V	2.22	2.91	3.6	4.29
	5201548	63793	GW50115AS	1/4/95	DISSOLVED	BERYLLIUM	2.5	U	5	V	2.22	2.91	3.6	4.29
	4940442	58793	GW01615GA	10/20/94	DISSOLVED	MANGANESE	34.8		1	V	32.66	120.09	207.52	294.95
142	2393064	51193	GW00466WC	3/20/93	DISSOLVED	ALUMINUM	200	U	200	JA	113.66	708.46	1303.26	1898.06
	5281511	50092	GW02174GA	2/21/95	DISSOLVED	BARIUM	105	B	0.4	V	84	117.1	150.2	183.3
Exceeds the Background Mean plus one Standard Deviation but is less than Background Mean plus two Standard Deviations														
115/196	4779519	59593	GW01248GA	8/18/94	DISSOLVED	BARIUM	150	B	14	V	84	117.1	150.2	183.3
	2763936	59593	GW01025WC	6/24/93	DISSOLVED	BARIUM	139		17	V	84	117.1	150.2	183.3
	5389275	59393	GW02175GA	3/6/95	DISSOLVED	BARIUM	133	B	0.6	Y	84	117.1	150.2	183.3
	3342469	59593	GW01167WC	8/13/93	DISSOLVED	BARIUM	118		16	V	84	117.1	150.2	183.3
	5196802	58094	GW50103AS	12/21/94	DISSOLVED	MANGANESE	163		15	V	32.66	120.09	207.52	294.95
133	4940432	58793	GW01615GA	10/20/94	DISSOLVED	BARIUM	145	B	1	V	84	117.1	150.2	183.3
	4763950	58793	GW01245GA	9/13/94	DISSOLVED	BARIUM	140	B	1	V	84	117.1	150.2	183.3
	5201692	58793	GW50123AS	1/6/95	DISSOLVED	BARIUM	139	B	200	V	84	117.1	150.2	183.3
	5201547	63793	GW50115AS	1/4/95	DISSOLVED	BARIUM	131	B	200	V	84	117.1	150.2	183.3
	4763960	58793	GW01245GA	9/13/94	DISSOLVED	MANGANESE	148		1	V	32.66	120.09	207.52	294.95
Exceeds the Background Mean plus two Standard Deviations but is less than Background Mean plus three Standard Deviations														
115/196	5170396	61293	GW50126AS	1/7/95	DISSOLVED	BARIUM	179	B	200	JA	84	117.1	150.2	183.3
	5368809	71494	GW02241GA	3/14/95	DISSOLVED	BARIUM	162	B	200	Y	84	117.1	150.2	183.3
	5170309	59593	GW50131AS	1/11/95	DISSOLVED	BARIUM	156	B	200	V	84	117.1	150.2	183.3
	5201866	63193	GW50130AS	1/10/95	DISSOLVED	BARIUM	155	B	200	V	84	117.1	150.2	183.3
	5368751	59694	GW02202GA	3/7/95	DISSOLVED	BARIUM	151	B	200	Y	84	117.1	150.2	183.3
	3526954	59593	GW01481WC	11/10/93	DISSOLVED	MANGANESE	286		2	V	32.66	120.09	207.52	294.95
	5368761	59694	GW02202GA	3/7/95	DISSOLVED	MANGANESE	234		15	Y	32.66	120.09	207.52	294.95
	5196773	58094	GW50102AS	12/21/94	DISSOLVED	MANGANESE	212		15	V	32.66	120.09	207.52	294.95
133	2657506	58793	GW01017WC	6/18/93	DISSOLVED	BARIUM	156	B	200	V	84	117.1	150.2	183.3
	2815170	58793	GW01168WC	8/12/93	DISSOLVED	BARIUM	155	B	200	V	84	117.1	150.2	183.3
	3526635	58793	GW01482WC	11/10/93	DISSOLVED	BARIUM	154	B	23	V	84	117.1	150.2	183.3
142	2614508	50092	GW00670WC	4/27/93	DISSOLVED	BARIUM	156		17	V	84	117.1	150.2	183.3
Exceeds the Background Mean plus three Standard Deviations														
115/196	5170306	59593	GW50131AS	1/11/95	DISSOLVED	ALUMINUM	4900		200	V	113.66	708.46	1303.26	1898.06
	3526633	59493	GW01480WC	11/9/93	DISSOLVED	BARIUM	647		23	V	84	117.1	150.2	183.3
	4940461	59493	GW01618GA	10/20/94	DISSOLVED	BARIUM	457		1	V	84	117.1	150.2	183.3
	2815141	59493	GW01166WC	8/11/93	DISSOLVED	BARIUM	417		200	V	84	117.1	150.2	183.3

Table 4-7
Summary of Metal COCs Exceeding Background Mean in Subsurface Soil

IHSS	Sequence ID	Location	Sample No.	Sample Date	TGC	Constituent	Result in ug/l	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background: Mean	X = 1	X=2	X=3
	2763878	59493	GW01024WC	6/24/93	DISSOLVED	BARIUM	396		17	V	84	117.1	150.2	183.3
	4674392	59493	GW01247GA	8/18/94	DISSOLVED	BARIUM	393		200	V	84	117.1	150.2	183.3
	5201663	63893	GW50120AS	1/5/95	DISSOLVED	BARIUM	348		200	V	84	117.1	150.2	183.3
	5329028	59493	GW02176GA	3/9/95	DISSOLVED	BARIUM	344		12	V	84	117.1	150.2	183.3
	5201518	59493	GW50114AS	1/4/95	DISSOLVED	BARIUM	340		200	V	84	117.1	150.2	183.3
	5201435	59493	GW50113AS	1/4/95	DISSOLVED	BARIUM	326		200	V	84	117.1	150.2	183.3
	5201634	63993	GW50119AS	1/5/95	DISSOLVED	BARIUM	315		200	V	84	117.1	150.2	183.3
	5201605	64093	GW50118AS	1/5/95	DISSOLVED	BARIUM	238		200	V	84	117.1	150.2	183.3
	5207158	56994	GW02089GA	2/3/95	DISSOLVED	BARIUM	216		12	V	84	117.1	150.2	183.3
	5170740	59594	GW02058GA	1/25/95	DISSOLVED	BARIUM	213		200	V	84	117.1	150.2	183.3
	3526953	59493	GW01480WC	11/9/93	DISSOLVED	MANGANESE	10500		2	V	32.66	120.09	207.52	294.95
	2763890	59493	GW01024WC	6/24/93	DISSOLVED	MANGANESE	4240		1	V	32.66	120.09	207.52	294.95
	2815151	59493	GW01166WC	8/11/93	DISSOLVED	MANGANESE	3650		15	V	32.66	120.09	207.52	294.95
	5201643	63993	GW50119AS	1/5/95	DISSOLVED	MANGANESE	3530		15	V	32.66	120.09	207.52	294.95
	4940471	59493	GW01618GA	10/20/94	DISSOLVED	MANGANESE	3480		1	V	32.66	120.09	207.52	294.95
	5201672	63893	GW50120AS	1/5/95	DISSOLVED	MANGANESE	3170		15	V	32.66	120.09	207.52	294.95
	5201527	59493	GW50114AS	1/4/95	DISSOLVED	MANGANESE	3130		15	V	32.66	120.09	207.52	294.95
	5201444	59493	GW50113AS	1/4/95	DISSOLVED	MANGANESE	2960		15	V	32.66	120.09	207.52	294.95
	4674402	59493	GW01247GA	8/18/94	DISSOLVED	MANGANESE	2920		15	V	32.66	120.09	207.52	294.95
	5329290	59493	GW02176GA	3/9/95	DISSOLVED	MANGANESE	2510		1	V	32.66	120.09	207.52	294.95
	5368819	71494	GW02241GA	3/14/95	DISSOLVED	MANGANESE	2090		15	Y	32.66	120.09	207.52	294.95
	5201614	64093	GW50118AS	1/5/95	DISSOLVED	MANGANESE	1300		15	V	32.66	120.09	207.52	294.95
	5170750	59594	GW02058GA	1/25/95	DISSOLVED	MANGANESE	1160		15	V	32.66	120.09	207.52	294.95
	5170866	60893	GW50157AS	1/26/95	DISSOLVED	MANGANESE	1100		15	V	32.66	120.09	207.52	294.95
	3342481	59593	GW01167WC	8/13/93	DISSOLVED	MANGANESE	761		2	V	32.66	120.09	207.52	294.95
	2763948	59593	GW01025WC	6/24/93	DISSOLVED	MANGANESE	680		1	V	32.66	120.09	207.52	294.95
	4779662	59593	GW01248GA	8/18/94	DISSOLVED	MANGANESE	608		2	V	32.66	120.09	207.52	294.95
	5170319	59593	GW50131AS	1/11/95	DISSOLVED	MANGANESE	514		15	V	32.66	120.09	207.52	294.95
	5170406	61293	GW50126AS	1/7/95	DISSOLVED	MANGANESE	356		15	JA	32.66	120.09	207.52	294.95
	5389285	59393	GW02175GA	3/6/95	DISSOLVED	MANGANESE	321		0.6	Y	32.66	120.09	207.52	294.95
133	5196889	55394	GW50106AS	12/22/94	DISSOLVED	MANGANESE	843		15	V	32.66	120.09	207.52	294.95
	5201556	63793	GW50115AS	1/4/95	DISSOLVED	MANGANESE	765		15	V	32.66	120.09	207.52	294.95
	2657494	58793	GW01017WC	6/18/93	DISSOLVED	MANGANESE	515		15	V	32.66	120.09	207.52	294.95
	2815180	58793	GW01168WC	8/12/93	DISSOLVED	MANGANESE	480		15	V	32.66	120.09	207.52	[illegible]
	3526955	58793	GW01482WC	11/10/93	DISSOLVED	MANGANESE	477		2	V	32.66	120.09	207.52	[illegible]
142	2393067	51193	GW00466WC	3/20/93	DISSOLVED	BARIUM	257		200	V	84	117.1	150.2	[illegible]
	4927310	51193	GW01612GA	10/24/94	DISSOLVED	BARIUM	244		9	V	84	117.1	150.2	183.3
	4927313	51193	GW01613GA	10/24/94	DISSOLVED	BARIUM	243		9	V	84	117.1	150.2	183.3
	4779516	51193	GW01242GA	8/18/94	DISSOLVED	BARIUM	239		14	V	84	117.1	150.2	183.3
	5252975	51193	GW02110GA	2/8/95	DISSOLVED	BARIUM	239		12	V	84	117.1	150.2	183.3
	3449296	51193	GW01477WC	11/12/93	DISSOLVED	BARIUM	235.5		200	V	84	117.1	150.2	183.3
	2614566	51193	GW00672WC	4/26/93	DISSOLVED	BARIUM	234.5		17	V	84	117.1	150.2	183.3
	4779517	51193	GW01243GA	8/19/94	DISSOLVED	BARIUM	226		14	V	84	117.1	150.2	183.3
	3342245	51193	GW01163WC	8/16/93	DISSOLVED	BARIUM	219.5		16	V	84	117.1	150.2	183.3
	3449306	51193	GW01477WC	11/12/93	DISSOLVED	MANGANESE	3005		15	V	32.66	120.09	207.52	294.95
	2393077	51193	GW00466WC	3/20/93	DISSOLVED	MANGANESE	2930		15	V	32.66	120.09	207.52	294.95
	4927512	51193	GW01612GA	10/24/94	DISSOLVED	MANGANESE	2910		1	V	32.66	120.09	207.52	294.95
	2614578	51193	GW00672WC	4/26/93	DISSOLVED	MANGANESE	2890		1	V	32.66	120.09	207.52	294.95
	4927515	51193	GW01613GA	10/24/94	DISSOLVED	MANGANESE	2850		1	V	32.66	120.09	207.52	294.95
	4779660	51193	GW01243GA	8/19/94	DISSOLVED	MANGANESE	2810		2	V	32.66	120.09	207.52	294.95
	4779659	51193	GW01242GA	8/18/94	DISSOLVED	MANGANESE	2780		2	V	32.66	120.09	207.52	294.95
	3342257	51193	GW01163WC	8/16/93	DISSOLVED	MANGANESE	2775		2	V	32.66	120.09	207.52	294.95
	5253105	51193	GW02110GA	2/8/95	DISSOLVED	MANGANESE	2470		1	V	32.66	120.09	207.52	294.95

These data are graphically displayed on Figures 4-7a and 7b.

Table 4-8
Summary of Radionuclide COCs Exceeding Background Mean in Groundwater

IHSS	Sequence ID	Location	Sample No.	Sample Date	TGC	Constituent	Result in PCI/L	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background: Mean	X = 1	X = 2	X = 3
Exceeds the Background Mean but is less than background Mean plus one Standard Deviation														
115/196	5186130	61093	GW50154AS	1/25/95	DISSOLVED	U233234	16.06		0.204	Y	6.914	32.354	57.794	83.234
	5179279	59793	GW50133AS	1/15/95	DISSOLVED	U233234	14.14		0.124	V	6.914	32.354	57.794	83.234
	5186114	61093	GW50151AS	1/25/95	DISSOLVED	U233234	14.05		0.328	Y	6.914	32.354	57.794	83.234
	2891018	61093	GW50012AS	7/13/93	DISSOLVED	U233234	11.5	B	0.042	A	6.914	32.354	57.794	83.234
	5186131	61093	GW50154AS	1/25/95	DISSOLVED	U235	0.6157		0.223	Y	0.195	0.835	1.475	2.115
	5179280	59793	GW50133AS	1/15/95	DISSOLVED	U235	0.5459		0.124	V	0.195	0.835	1.475	2.115
	2891046	63193	GW50013AS	7/12/93	DISSOLVED	U235	0.53	J	0.075	A	0.195	0.835	1.475	2.115
	3348328	59593	GW01167WC	8/13/93	DISSOLVED	U235	0.37	J	0.22	A	0.195	0.835	1.475	2.115
	4780715	59593	GW01248GA	8/18/94	DISSOLVED	U235	0.351491		0.219133	V	0.195	0.835	1.475	2.115
	2891017	61093	GW50012AS	7/13/93	DISSOLVED	U235	0.34	J	0.071	A	0.195	0.835	1.475	2.115
	5126081	58094	GW50102AS	12/21/94	DISSOLVED	U235	0.3006		0.18	V	0.195	0.835	1.475	2.115
	5422179	56994	GW02089GA	2/3/95	DISSOLVED	U235	0.269029		0.137205	Y	0.195	0.835	1.475	2.115
	5014072	59593	GW01619GA	10/24/94	DISSOLVED	U235	0.231264	Y	0.184722	A	0.195	0.835	1.475	2.115
	2891291	59593	GW01025WC	6/24/93	DISSOLVED	U235	0.2	BJ	0.059	A	0.195	0.835	1.475	2.115
	5456180	59393	GW02175GA	3/6/95	DISSOLVED	U235	0.195893		0.121974	Y	0.195	0.835	1.475	2.115
	5179281	59793	GW50133AS	1/15/95	DISSOLVED	U238	10.61		0.124	V	4.832	22.502	40.172	57.842
	2891016	61093	GW50012AS	7/13/93	DISSOLVED	U238	8.8		0.071	A	4.832	22.502	40.172	57.842
	2891045	63193	GW50013AS	7/12/93	DISSOLVED	U238	5.4		0.14	A	4.832	22.502	40.172	57.842
133.2	3348392	58793	GW01168WC	8/12/93	DISSOLVED	AM241	0.018		0.005	V	0.011	0.021	0.031	0.041
	5178939	56594	GW50105AS	12/22/94	DISSOLVED	U235	0.2769		0.163	Y	0.195	0.835	1.475	2.115
142.10	2595924	50092	GW00465WC	3/21/93	DISSOLVED	U235	0.39		0.115	A	0.195	0.835	1.475	2.115
	3548656	50092	GW01476WC	11/9/93	DISSOLVED	U235	0.347146		0.13696	Y	0.195	0.835	1.475	2.115
	5014067	51193	GW01613GA	10/24/94	DISSOLVED	U235	0.312575	Y	0.159788	A	0.195	0.835	1.475	2.115
	4780708	51193	GW01242GA	8/18/94	DISSOLVED	U235	0.271692		0.289707	V	0.195	0.835	1.475	2.115
	2626193	50092	GW00670WC	4/27/93	DISSOLVED	U235	0.25	J	0.14	A	0.195	0.835	1.475	2.115
	5424574	50092	GW02174GA	2/21/95	DISSOLVED	U235	0.21	U	0.46	Y	0.195	0.835	1.475	2.115
Exceeds the Background Mean plus one Standard Deviation but is less than background Mean plus two Standard Deviations														
115/196	5186115	61093	GW50151AS	1/25/95	DISSOLVED	U235	1.076		0.283	Y	0.195	0.835	1.475	2.115
	5186132	61093	GW50154AS	1/25/95	DISSOLVED	U238	28.18		0.223	Y	4.832	22.502	40.172	57.842
	5186116	61093	GW50151AS	1/25/95	DISSOLVED	U238	26.97		0.255	Y	4.832	22.502	40.172	57.842
142.10	3548575	50092	GW01476WC	11/9/93	DISSOLVED	RA226	0.386215		0.2391	V	0.258	0.368	0.478	0.588
Exceeds the Background Mean plus two Standard Deviations but is less than background Mean plus three Standard Deviations														
115/196	2889861	59593	GW01025WC	6/24/93	DISSOLVED	RA226	0.56	B	0.07	A	0.258	0.368	0.478	0.588
133.2	2889862	58793	GW01017WC	6/18/93	DISSOLVED	RA226	0.55	B	0.08	A	0.258	0.368	0.478	0.588
142.10	2889793	50092	GW00670WC	4/27/93	DISSOLVED	RA226	0.55		0.2	A	0.258	0.368	0.478	0.588
Exceeds the Background Mean plus three Standard Deviations														
115/196	3548576	59493	GW01480WC	11/9/93	DISSOLVED	RA226	1.02928		0.16835	V	0.258	0.368	0.478	0.588
	5387052	71494	GW02241GA	3/14/95	DISSOLVED	RA226	0.8898		0.0337	Y	0.258	0.368	0.478	0.588

These data are graphically displayed on Figures 4-8a and 8b.

Table 4-9 Summary of Radionuclide COCs Exceeding Background Mean in Surface Water

IHSS/Site	Sequence ID	Location	Sample No.	Sample Date	TGC	Constituent	Result in PCI/L	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background: Mean	X = 1	X=2	X=3
Exceeds the Background Mean but is less than Background Mean plus one Standard Deviation														
142	2596118	SW50193	SW50208JE	3/24/93	TOTAL	U233234	0.5		0.02	A	0.4862	1.0362	1.5862	2.1362
	2596158	SW50293	SW50210JE	3/24/93	TOTAL	U238	0.73		0.282	A	0.3642	0.7962	1.2282	1.6602
	2596156	SW50193	SW50208JE	3/24/93	TOTAL	U238	0.43		0.039	A	0.3642	0.7962	1.2282	1.6602
SID	2596117	SW507	SW50203JE	3/24/93	DISSOLVED	U233234	4.2		0.033	A	0.92	5.13	9.34	13.55
	2802121	SW027	SW50222JE	5/17/93	DISSOLVED	U233234	2.0995		0.287212	A	0.92	5.13	9.34	13.55
	2802105	SW507	SW50221JE	5/17/93	DISSOLVED	U233234	1.85		0.314962	A	0.92	5.13	9.34	13.55
	2802107	SW507	SW50221JE	5/17/93	DISSOLVED	U238	3.049		0.168335	A	0.708	3.949	7.19	10.431
	2802123	SW027	SW50222JE	5/17/93	DISSOLVED	U238	2.4495		0.256975	A	0.708	3.949	7.19	10.431
	2596168	SW507	SW50217JE	3/29/93	DISSOLVED	U238	0.88		0.026	A	0.708	3.949	7.19	10.431
	2596163	SW027	SW50220JE	3/29/93	DISSOLVED	U238	0.8		0.032	A	0.708	3.949	7.19	10.431
	5020062	SW027	SW00545GS	10/17/94	TOTAL	AM241	0.011		0.01	V	0.0039	0.0119	0.0199	0.0279
	1897475	SW500	SW50000AS	10/5/92	TOTAL	AM241	0.009538	J	0	A	0.0039	0.0119	0.0199	0.0279
	2802094	SW507	SW50221JE	5/17/93	TOTAL	AM241	0.007072	J	0.010152	A	0.0039	0.0119	0.0199	0.0279
	2802109	SW027	SW50222JE	5/17/93	TOTAL	AM241	0.006386	J	0.010758	A	0.0039	0.0119	0.0199	0.0279
	1897478	SW500	SW50000AS	10/5/92	TOTAL	U233234	0.7748		0.156	A	0.4862	1.0362	1.5862	2.1362
	2596126	SW027	SW50218JE	3/29/93	TOTAL	U233234	0.77		0.228	A	0.4862	1.0362	1.5862	2.1362
	1897480	SW500	SW50000AS	10/5/92	TOTAL	U238	0.6967		0.22	A	0.3642	0.7962	1.2282	1.6602
Woman Ck.	2321602	SW026	SW50213WC	11/4/92	DISSOLVED	U233234	2.103		0	A	0.92	5.13	9.34	13.55
	2616182	SW026	SW50201JE	3/24/93	DISSOLVED	U233234	1.8		0.1458	A	0.92	5.13	9.34	13.55
	2549133	SW501	SW50205JE	3/24/93	DISSOLVED	U233234	1.537		0.264	A	0.92	5.13	9.34	13.55
	2616200	SW029	SW50204JE	3/24/93	DISSOLVED	U233234	1.5		0.14767	A	0.92	5.13	9.34	13.55
	2616227	SW033	SW50207JE	3/24/93	DISSOLVED	U233234	1.3		0.14242	A	0.92	5.13	9.34	13.55
	2549161	SW040	SW50211JE	3/24/93	DISSOLVED	U233234	1.0705		0.226	A	0.92	5.13	9.34	13.55
	2321616	SW029	SW50216WC	11/4/92	DISSOLVED	U233234	1.00875		0	A	0.92	5.13	9.34	13.55
	2616245	SW107	SW50214JE	3/24/93	DISSOLVED	U233234	0.99		0.20696	A	0.92	5.13	9.34	13.55
	2321604	SW026	SW50213WC	11/4/92	DISSOLVED	U238	1.304		0	A	0.708	3.949	7.19	10.431
	2616184	SW026	SW50201JE	3/24/93	DISSOLVED	U238	1.1		0.1335	JA	0.708	3.949	7.19	10.431
	2616229	SW033	SW50207JE	3/24/93	DISSOLVED	U238	1.1		0.15164	JA	0.708	3.949	7.19	10.431
	2102016	SW033	SW50221WC	11/4/92	DISSOLVED	U238	0.9946		0.131	A	0.708	3.949	7.19	10.431
	2101998	SW501	SW50219WC	11/4/92	DISSOLVED	U238	0.8965		0.16	A	0.708	3.949	7.19	10.431
	2616202	SW029	SW50204JE	3/24/93	DISSOLVED	U238	0.76		0.12081	JA	0.708	3.949	7.19	10.431
	2549135	SW501	SW50205JE	3/24/93	DISSOLVED	U238	0.752		0.274	A	0.708	3.949	7.19	10.431
	2616167	SW029	SW50204JE	3/24/93	TOTAL	AM241	0.0094		0.00629	A	0.0039	0.0119	0.0199	0.0279
	2321606	SW029	SW50216WC	11/4/92	TOTAL	AM241	0.009255	J	0	Z	0.0039	0.0119	0.0199	0.0279
	2103896	SW034	SW50220WC	11/4/92	TOTAL	AM241	0.005712	J	0	A	0.0039	0.0119	0.0199	0.0279
	2616248	SW107	SW50214JE	3/24/93	TOTAL	AM241	0.0053	U	0.00642	A	0.0039	0.0119	0.0199	0.0279
	2616257	SW041	SW50215JE	3/24/93	TOTAL	AM241	0.0045	U	0.00654	A	0.0039	0.0119	0.0199	0.0279
	2024634	SW040	SW50223WC	11/4/92	TOTAL	AM241	0.004117	J	0	A	0.0039	0.0119	0.0199	0.0279
	2103906	SW033	SW50221WC	11/4/92	TOTAL	U233234	0.9116		0.141	A	0.4862	1.0362	1.5862	2.1362
	2616236	SW033	SW50207JE	3/24/93	TOTAL	U233234	0.88		0.18413	A	0.4862	1.0362	1.5862	2.1362
	2675623	SW55193	SW70040JE	5/24/93	TOTAL	U233234	0.69	B	0.15	A	0.4862	1.0362	1.5862	2.1362
	2616175	SW029	SW50204JE	3/24/93	TOTAL	U238	0.77		0.17916	JA	0.3642	0.7962	1.2282	1.6602
	2549141	SW506	SW50209JE	3/24/93	TOTAL	U238	0.6992		0.335	A	0.3642	0.7962	1.2282	1.6602
	2103908	SW033	SW50221WC	11/4/92	TOTAL	U238	0.583	J	0.215	A	0.3642	0.7962	1.2282	1.6602
Exceeds the Background Mean plus one Standard Deviation but is less than Background Mean plus two Standard Deviations														
SID	5020064	SW027	SW00545GS	10/17/94	TOTAL	U233234	1.2		0.3	V	0.4862	1.0362	1.5862	2.1362
	2596164	SW027	SW50218JE	3/29/93	TOTAL	U238	1.026		0.114	A	0.3642	0.7962	1.2282	1.6602
Woman Ck.	2321593	SW026	SW50213WC	11/4/92	TOTAL	U233234	1.429		0.197	A	0.4862	1.0362	1.5862	2.1362
	2103892	SW501	SW50219WC	11/4/92	TOTAL	U233234	1.346		0.149	A	0.4862	1.0362	1.5862	2.1362
	2549125	SW501	SW50205JE	3/24/93	TOTAL	U233234	1.244		0.216	A	0.4862	1.0362	1.5862	2.1362
	2549139	SW506	SW50209JE	3/24/93	TOTAL	U233234	1.133		0.335	A	0.4862	1.0362	1.5862	2.1362
	2321607	SW029	SW50216WC	11/4/92	TOTAL	U233234	1.0664		0	A	0.4862	1.0362	1.5862	2.1362
	2549153	SW040	SW50211JE	3/24/93	TOTAL	U233234	1.066		0.207	A	0.4862	1.0362	1.5862	2.1362
	2616193	SW026	SW50201JE	3/24/93	TOTAL	U238	1.2		0.19753	JA	0.3642	0.7962	1.2282	1.6602
	2103894	SW501	SW50219WC	11/4/92	TOTAL	U238	1.131		0.189	A	0.3642	0.7962	1.2282	1.6602
	2616238	SW033	SW50207JE	3/24/93	TOTAL	U238	1.1		0.16477	JA	0.3642	0.7962	1.2282	1.6602
	2321609	SW029	SW50216WC	11/4/92	TOTAL	U238	0.94385		0.114	A	0.3642	0.7962	1.2282	1.6602
	2549127	SW501	SW50205JE	3/24/93	TOTAL	U238	0.9062		0.245	A	0.3642	0.7962	1.2282	1.6602
	2549155	SW040	SW50211JE	3/24/93	TOTAL	U238	0.8653		0.174	A	0.3642	0.7962	1.2282	1.6602
Exceeds the Background Mean plus two Standard Deviations but is less than Background Mean plus three Standard Deviations														
SID	2596155	SW507	SW50203JE	3/24/93	DISSOLVED	U238	7.5		0.032	A	0.708	3.949	7.19	10.431
	2802113	SW027	SW50222JE	5/17/93	TOTAL	U233234	1.9755		0.256933	A	0.4862	1.0362	1.5862	2.1362
	5020066	SW027	SW00545GS	10/17/94	TOTAL	U238	1.5		0.2	V	0.3642	0.7962	1.2282	1.6602
Woman Ck.	2616191	SW026	SW50201JE	3/24/93	TOTAL	U233234	1.9		0.22604	A	0.4862	1.0362	1.5862	2.1362
	2616173	SW029	SW50204JE	3/24/93	TOTAL	U233234	1.6		0.15809	A	0.4862	1.0362	1.5862	2.1362
	2321595	SW026	SW50213WC	11/4/92	TOTAL	U238	1.437		0.171	A	0.3642	0.7962	1.2282	1.6602
	2675621	SW55193	SW70040JE	5/24/93	TOTAL	U238	1.3	B	0.22	A	0.3642	0.7962	1.2282	1.6602
Exceeds the Background Mean plus three Standard Deviations														
142	2596228	SW50293	SW50210JE	3/24/93	TOTAL	AM241	0.38		0.202	A	0.0039	0.0119	0.0199	0.0279
SID	2596234	SW027	SW50218JE	3/29/93	TOTAL	AM241	0.18		0.228	A	0.0039	0.0119	0.0199	0.0279
	2596224	SW507	SW50203JE	3/24/93	TOTAL	AM241	0.075		0.079	A	0.0039	0.0119	0.0199	0.0279
	2802098	SW507	SW50221JE	5/17/93	TOTAL	U233234	4.675		0.196649	V	0.4862	1.0362	1.5862	2.1362
	2596116	SW507	SW50203JE	3/24/93	TOTAL	U233234	3.7		0.056	A	0.4862	1.0362	1.5862	2.1362
	2596154	SW507	SW50203JE	3/24/93	TOTAL	U238	7		0.052	A	0.3642	0.7962	1.2282	1.6602
	2802100	SW507	SW50221JE	5/17/93	TOTAL	U238	5.206		0.196649	V	0.3642	0.7962	1.2282	1.6602
	2802115	SW027	SW50222JE	5/17/93	TOTAL	U238	2.144		0.365052	V	0.3642	0.7962	1.2282	1.6602

These data are graphically displayed on Figure 4-10.

Table 4-10
Summary of Metal COCs Exceeding Background Mean in Stream Sediments

IHSS	Sequence ID	Location	Sample No.	Constituent	Result in mg/kg	Qualifier	Reporting Limit	Valid.	Mean + (X * STD DEV) of background Mean	X = 1	X=2	X=3
Exceeds the Background Mean but is less than Background Mean plus one Standard Deviation												
Wmn. Ck.	1883115	SED501	SD50004WC	COPPER	14.5		5	JA	10.24	18.01	25.78	33.55
Wmn. Ck.	1883255	SED506	SD50008WC	COPPER	13.4		5	JA	10.24	18.01	25.78	33.55
Exceeds the Background Mean plus one Standard Deviation but is less than Background Mean plus two Standard Deviations												
SID	1883072	SED025	SD50002WC	ZINC	164	E	4	JA	53.86	136.94	220.02	303.1
Exceeds the Background Mean plus two Standard Deviations but is less than Background Mean plus three Standard Deviations												
SID	1883059	SED025	SD50002WC	COPPER	27.1		5	V	10.24	18.01	25.78	33.55
Exceeds the Background Mean plus three Standard Deviations												
SID	1883171	SED507	SD50005WC	COPPER	135.5		5	JA	10.24	18.01	25.78	33.55
SID	1883176	SED507	SD50005WC	MERCURY	3.05		0.1	JA	0.09	0.15	0.21	0.27
SID	1883184	SED507	SD50005WC	ZINC	709	E	4	JA	53.86	136.94	220.02	303.1
These data are graphically displayed on Figures 4-11a and 11b.												

Table 4-11
Summary of Radionuclide COCs Exceeding Background Mean in Stream Sediments

IHSS	Sequence ID	Location	Sample No.	Constituent	Result in PCI/G	Qualifier	Reporting Limit	Valid.	Mean	Mean + (X * STD DEV) of background X = 1	X=2	X=3
Exceeds the Background Mean but is less than Background Mean plus one Standard Deviation												
SID	2341693	SED025	SD50002WC	AM241	0.29		0.021	A	0.173	0.657	1.141	1.625
	2341717	SED507	SD50005WC	AM241	0.25		0.007	A	0.173	0.657	1.141	1.625
	2341697	SED025	SD50002WC	PU239240	1.6		0.007	V	0.537	2.147	3.757	5.367
	2341721	SED507	SD50005WC	PU239240	0.915		0.006	V	0.537	2.147	3.757	5.367

These data are graphically displayed on Figures 4-12a and 12b.

5.0 CHEMICAL FATE AND TRANSPORT

This section discusses the chemical fate-and-transport modeling performed in support of the HHRA for OU 5. The objectives of this modeling were to simulate the transport of COCs from OU 5 to potential exposure points for human receptors under present and anticipated future site conditions, and to provide information needed for the evaluation of potential remedial alternatives at OU 5.

5.1 POTENTIAL ROUTES OF MIGRATION

Figures 5-1 through 5-3 illustrate potential routes of migration for groundwater, surface water, and air, respectively. Understanding these routes of migration is not only fundamental to chemical fate-and-transport modeling, but also is the basis for assessing potential exposure routes to human receptors for the risk assessment. The potential routes of migration in each environmental medium are discussed briefly below. The human-health exposure assessment is presented in detail in TM12 (DOE, 1995b), and is discussed in Section 6.4.

The hydrogeologic profile of the OU 5 groundwater flow and contaminant transport system, including saturated and unsaturated zones, illustrates the potential migration of contaminants from a source (e.g., the landfill area). This potential migration route runs through the unsaturated and saturated zones of the UHSU to the creek or to seeps along the hillsides adjacent to Woman Creek (Figure 5-1). The profile also depicts the potential contamination of groundwater and soils with VOCs. Once the contaminants reach the seeps, they evaporate or migrate downslope in surface flow or near-surface groundwater flow in the unconsolidated material to the creek. They may then be transported via surface-water processes. Surface-water processes are discussed in Sections 2.2.3 and 3.5. VOC contaminants in the unsaturated zone could be mobilized by desorption, dissolution, or vaporization from contaminated soil. Once mobilized, contaminants would migrate to the surface and escape into the atmosphere by volatilization. The contaminants could also migrate into groundwater.

The hydrogeologic profile does not include all of the contaminant sources, such as metals and particulate radioactive contamination in soils, that may exist at the site. However, under the hydrogeochemical conditions of OU 5, metals and radionuclides are not expected to be very mobile (see Section 5.2). Therefore, migration of metals and radionuclides through the groundwater pathway is considered to be negligible and is not illustrated in Figure 5-1. Nevertheless, the selected transport model has the capability to incorporate radioactive decay and sorption of radionuclides.

The profile of surface-water pathways (Figure 5-2) illustrates numerous potential mechanisms for contaminant migration. Storm-water runoff may transport contaminated soils to surface waters through erosion with subsequent transport to downstream receptors. Surface waters and suspended sediments may be impacted from the discharge of contaminated groundwater via seeps and springs. Once groundwater-borne contaminants reach surface waters, the potential migration routes are identical to those described above for contaminated storm water.

The air emissions and dispersion models selected to assess concentrations of air contaminants at sensitive receptors, estimated the exposure-point concentrations for the exposure pathways associated with air transport (Figure 5-3). VOCs may be transported through the vadose zone from underlying soils or groundwater and may intrude into a hypothetical building located within OU 5 (volatilization into indoor air and subsequent inhalation by a future onsite office worker). Chemicals in surface soils may be transported via fugitive particulate emissions from OU 5 to onsite exposure points (inhalation of particulates by the future onsite outdoor worker and ecological researcher). Fugitive dust emissions from OU 5 may also result in the deposition of chemicals in airborne particulates on surface soils and plants.

5.2 CONTAMINANT MOBILITY AND BEHAVIOR

Potential mechanisms for the release of contaminants from OU 5 sources are described in Section 5.1, above, and are discussed in additional detail in Exposure Assessment TM for the HHRA TM12 (DOE, 1995b) for those pathways determined to be significant to the HHRA. Observed contaminant distributions at OU 5 are the result of chemical and physical interactions between contaminants and the environmental media in which the contaminant resides. These interactions involve processes that determine the transport and fate of contaminants in site soils, sediments, surface waters, and groundwater. These processes include, but are not limited to, adsorption/desorption reactions (including ion exchange), oxidation/reduction, complexation, precipitation/dissolution, volatilization, hydrolysis, dehalogenation, radioactive and chemical decay, and biodegradation. The migration potential for each of the COCs for OU 5 are discussed briefly in the remainder of this section.

5.2.1 Volatile Organic Compounds in Groundwater

The only VOCs identified as COCs in OU 5 were acetone, 1,1-DCE, 1,2-DCE, PCE, and TCE. These compounds were detected in "seep" water collected at only one location, at the seep northeast of the landfill. Although the medium containing these VOCs is referred to as seep water, the water was collected from a wellpoint just downgradient of this seep. The wellpoint was screened from 10 to 15 ft below ground surface. The water containing the VOCs is actually groundwater that may be associated with the seep. This distinction should be recalled when seep water is mentioned elsewhere in this report.

The three primary mechanisms influencing the transport and fate of VOCs in groundwater are advection, volatilization, and biodegradation. The process by which dissolved chemicals (VOCs exist primarily in the dissolved state) are transported by the bulk motion of the flowing groundwater is known as advection. Groundwater flow and advective chemicals transport occur in response to hydraulic gradients, with water and chemicals moving from areas of higher hydraulic head to areas of lower hydraulic head. Nonreactive dissolved chemicals, such as some VOCs, are carried at an average rate approximately equal to the average linear velocity of the groundwater flow.

Volatilization is a process by which a chemical is transferred from soil (adsorbed on soil), water (dissolved phase), or liquid (free product) into soil gas or the atmosphere. VOCs present in groundwater may migrate by volatilizing to soil gas, which then migrates through the vadose zone to the atmosphere or collects in manmade structures such as basements of buildings. The release of VOCs to soil gas occurs in subsurface pores at the interface between the contaminated material and the adjoining subsurface layer. The soil gas diffuses away from the contaminated subsurface zone toward the ground surface in response to chemical concentration gradients. The emission of soil gas at the ground surface is maximized when the existing soil gas concentration of the chemical of interest at the ground surface is zero. In general, the tendency of a chemical to volatilize depends upon the physical properties of the chemical (vapor pressure and Henry's Law constant), and environmental factors, such as temperature, pressure, and the available pathways.

In the surface water environment, the degree of volatilization is influenced by the depth and the velocity of surface water, and chemical-specific properties. In the subsurface saturated or vadose zone environments, volatilization of chemicals is influenced by the depth of the aquifer, the intrinsic permeability of the geologic material, and the soil-water content in the vadose zone.

Biodegradation is a combination of chemical transformations, including oxidation, reduction, and dehydrohalogenation, that are catalyzed by the action of microorganisms in the subsurface environment. Biodegradation is, potentially, a significant process affecting the fate of organic chemicals, under certain conditions. Four of the COCs at OU 5 are classified as volatile chlorinated hydrocarbons. Biodegradation of halogenated aliphatic compounds, such as chlorinated hydrocarbons, may occur under both aerobic and anaerobic conditions. Biodegradation of highly chlorinated hydrocarbons occurs more slowly under aerobic conditions than under anaerobic conditions.

The physical and chemical properties of VOCs that most influence their mobility and behavior in groundwater include water solubility, vapor pressure and Henry's Law constant (K_h), the octanol-water partition coefficient (K_{ow}), and the organic carbon partition coefficient (K_{oc}) (see Table 5-1). Organic compounds with high water solubility tend to desorb from soils and sediments, are less likely to volatilize from water, and are generally more susceptible to biodegradation. Conversely, organic compounds with low solubilities tend to adsorb onto soils and sediments, volatilize more readily from water, and bioconcentrate in aquatic organisms.

The vapor pressure of a substance is defined as the pressure exerted by the vapor (gas) of a substance when it is under equilibrium conditions, given specific temperature and total pressure. Vapor pressure is used to calculate the Henry's Law Constant, K_h, which is defined as the ratio of the partial pressure of a compound in air to the concentration of the compound in water at a given temperature under equilibrium conditions. K_h is a function of both solubility and vapor pressure, being directly proportional to the vapor pressure and inversely proportional to the solubility. K_h provides an indication of the relative volatility of a substance from the liquid phase. Chemicals with a K_h of less than 10^{-7} atm-m^3/mole are considered to have a low volatility. Chemicals with a K_h on the order of 10^{-7} to 10^{-5} atm-m^3/mole are considered moderately volatile and will volatilize slowly. Volatilization becomes an important transfer mechanism if K_h is in the range of 10^{-5} to

10^{-3} atm-m^3/mole. Values of K_h exceeding 10^{-3} atm-m^3/mole indicate volatilization will proceed rapidly.

The octanol-water partition coefficient, K_{ow}, is a measure of the degree to which an organic substance will preferentially dissolve in an organic solvent compared to water. The coefficient is the ratio of the equilibrium concentration of the substance in octanol to the equilibrium concentration in water (Fetter, 1993). The greater the K_{ow} value, the greater the tendency for the chemicals to partition from dissolved aqueous phase to solid organic phase.

The organic carbon partition coefficient, K_{oc}, is defined as the ratio of adsorbed chemical per unit weight of organic carbon to the aqueous solute concentration (Montgomery and Welkom, 1989). This parameter provides an indication of the tendency of dissolved organic compounds to partition on geologic materials containing organic carbon. The greater the K_{oc} value, the greater the tendency for the chemical to partition on geologic materials.

Acetone is a chemical that is very soluble in water (solubility equals 1,000,000 milligrams per liter [mg/l]), will readily volatilize (K_h equals 2.06E-05 atm-m^3/mole), and is not likely to adsorb onto organic matter (K_{oc} equals 2 milliliters per gram [ml/g]). Therefore, acetone would be highly mobile in groundwater, but would likely volatilize when groundwater daylights to surface water. Acetone is also a common laboratory contaminant and was detected in several of the OU 5 laboratory blanks; this chemical may not be a true COC in OU 5 groundwater.

The following four chlorinated hydrocarbons: 1,1-DCE; 1,2-DCE; PCE; and TCE, are halogenated aliphatic compounds that behave similarly under similar environmental conditions. They are fairly soluble in water, will volatilize rapidly, and will not adsorb readily to particulates. The degradation series for these chemicals is as follows: PCE → TCE → DCE → vinyl chloride, with half-lives in groundwater ranging from 8 weeks to 4.5 years (see Table 5-2). 1,1-DCE, 1,2-DCE, PCE, and TCE were also identified during the soil-gas survey conducted within the landfill. However, a VOC groundwater plume map constructed for RFETS shows that the groundwater associated with the seep northeast of the landfill is likely a part of a VOC plume migrating southward from the industrial area. As yet, these VOCs do not appear to have surfaced in either the SID or in Woman Creek. This VOC plume is discussed further in the Groundwater Conceptual Plan for RFETS.

5.2.2 Semivolatile Organic Compounds in Soil

The SVOCs identified in surface and/or subsurface soil include PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, fluoranthene, indeno(123-cd)pyrene, and pyrene] and the PCB, Aroclor-1254. These compounds will be discussed together as SVOCs because of their similar mobility characteristics.

The characteristics that are considered the most important for understanding the mobility and behavior of SVOC compounds are solubility, Henry's Law constant, octanol-water partition coefficient, and organic carbon partition coefficient. The SVOC COCs identified in OU 5 soil have very low water solubilities that range from 5E-4 mg/l [dibenzo(a,h)anthracene] to 2.6E-1 mg/l [fluoranthene] (Table 5-1). These compounds have low solubilities due, in part, to the high molecular weight of the nonpolar molecules. The K_h for PAH COC compounds identified in OU 5 ranges from approximately 7E-8 for dibenzo(a,h)anthracene to 1.2E-5 atm m^3/mole for benzo(b)fluoranthene, indicating low to moderate volatility. Aroclor-1254 has a somewhat higher capacity to volatilize than the PAHs because of its higher K_h of 2.7E-3. The K_{oc} values for SVOCs at OU 5 range from approximately 30,900 ml/g [indeno(123-cd)pyrene] to 3,300,000 ml/g [dibenzo(a,h)anthracene], indicating a high capacity to adsorb to carbon. Microbial metabolism is the major process for degradation of PAHs in soil environments, with half-lives in soil ranging from 57 days [benzo(a)pyrene] to 20 years [indeno(123-cd)pyrene]. In general, biodegradation is slower for compounds with higher molecular weights than for compounds with lower molecular weights. In conclusion, the SVOCs identified in OU 5 soils are expected to be fairly stable; they are not expected to volatilize to a significant degree, because of their strong adsorption coefficients and moderate to low Henry's Law constants.

5.2.3 Metals

Metals identified as surface soil COCs were copper, mercury, and silver. Antimony, beryllium, cadmium, copper, molybdenum, nickel, and silver were identified as COCs in subsurface soil. Mercury and zinc were identified as COCs in stream and pond sediment, while seep sediments contained antimony, beryllium, and zinc as COCs. Aluminum, barium, beryllium, manganese, and vanadium were identified as COCs in groundwater and barium, lithium, and strontium were identified as surface water COCs. No metals were identified as seep water COCs.

The physical and chemical properties of metals that influence their mobility and behavior include oxidation states, solubility, precipitation, and co-precipitation. At OU 5, the oxidation states and solubility, and their effects on sorption appear to be the key processes influencing mobility and behavior. Physico-chemical properties of the COC metals are provided in Table 5-3 and are discussed below.

Aluminum (Al) is the third-most abundant elements in the earth's crust and comprises a significant proportion of many common rock-forming minerals. Clays, micas, feldspars, and other alumino-silicate minerals contain the trivalent aluminum ion. Weathering reactions of rock-forming minerals can produce amorphous aluminum silicates. Gibbsite is the common hydroxide phase in soils, although oxyhydroxides may also be present. At the pH levels found in RFETS soil (neutral to slightly alkaline), aluminum minerals are insoluble. Therefore, the presence of aluminum as a groundwater COC suggests that it exists as a suspended solid rather than in dissolved form.

Antimony (Sb) exists in the valence states of -3, 0, +3, and +5, with Sb (III) and (V) the prevalent oxidation states in aqueous solution. In an oxidizing environment, such as that found at OU 5, the predominant species of antimony would be expected to be $Sb(OH)_6$. Sorption or coprecipitation of antimony onto hydrous iron and aluminum oxides appears to be important in removing antimony from solution (Battelle, 1984).

Barium (Ba) occurs in barite ($BaSO_4$), a fairly common mineral. As is the case for other alkaline earth elements such as calcium and magnesium, barium exhibits only the +2 valence state in aqueous solutions (Battelle, 1984).

Beryllium (Be) is a trace metal with a mean crustal concentrations of 3 milligrams per kilogram (mg/kg); shales also average 3 mg/kg of beryllium. Beryllium occurs most often as the divalent cation, its complex ions may also be present. It is present in soils primarily in oxidic-bonded forms and in an alkaline environment forms complex anions, such as $Be(OH)CO_3^-$ and $Be(CO_3)_2^{2-}$, which are insoluble in cold water.

Cadmium (Cd) is a heavy metal that occurs in trace amounts in crustal materials. In surficial soils, cadmium is reported to range from about 0.2 to 7.0 mg/kg. The most important valence state of cadmium in the natural environment is +2, and the most important factors that control the cadmium ion mobility are pH and oxidation potential. Under conditions of strong oxidation, cadmium is likely to form minerals (CdO, $CdCO_3$). At pH values above 7.5, Cd^{2+} activity is limited by cadmium carbonate, which is insoluble.

The average copper (Cu) content for soil is 30 mg/kg. Although copper exists in the +1 and +2 valence states, the +2 form is most prevalent in soils. At the pHs commonly found in RFETS soils, copper is likely to form insoluble compounds.

Lithium (Li) is an alkali metal, with a mean crustal concentration of 20 mg/kg; shales are enriched with respect to lithium. Baseline surficial soils along the Front Range Corridor contain 7.7 to 52 mg/kg lithium. Lithium occurs in the +1 valence state and is soluble in water in most of its natural mineral forms.

Manganese (Mn) is the twelfth-most abundant element in the earth's crust; baseline surficial soils along the Front Range Corridor contain from 90 to 850 mg/kg of manganese. Manganese exists in valence states of 1, 2, 3, 4, 6, and 7, with Mn(II), Mn(III), and Mn(IV) the most prevalent forms in soil. Manganese forms hydrated oxides with mixed valency states. Solubility is affected by pH, redox, and complexation. Common minerals of manganese include oxides, carbonates, silicates, and sulfates. Mn^{2+} is the predominant solution species, and the hydrolysis species of manganese are of only minor importance in soil. On rock surfaces in arid regions, impure manganese oxides can form a ubiquitous coating known as "desert varnish."

Mercury (Hg) occurs in trace amounts in crustal rocks, but is highly enriched in shales. Along the Front Range Corridor, baseline surficial soils contain from 0.01 to 0.099 mg/kg mercury. Mercury is one of the most volatile metals and has undergone significant anthropogenic enrichment and redistribution in the environment. Mercury exists primarily in three oxidation states: 0, +1, and +2. The fact that mercury was identified as a COC in surface soil, pond sediment, and stream sediment indicates that it is present in one of its many stable forms, likely as a halide.

Molybdenum (Mo) is found in trace amounts in crustal rocks, and is slightly enriched in shales (mean = 2.0 mg/kg). Molybdenum exists in several valence states: 2, 3, 4?, 5?, or 6. At the soil pH conditions found at RFETS, molybdenum is expected to be insoluble in soil.

Nickel (Ni) is a trace metal in the earth's crust and is slightly enriched in shales and basalts. In baseline surficial soils of the Front Range Corridor, the mean concentration is 6.8 mg/kg. Nickel occurs in valence states of 0, 1, 2, or 3. Nickel is easily mobilized during weathering and then is coprecipitated mainly with iron and manganese oxides. However, unlike Mn^{2+} and Fe^{2+}, Ni^{2+} is relatively stable in aqueous solutions and is capable of migration over a long distance.

Silver (Ag) occurs as a native element and with some sulfides and chlorides. The +1 oxidation state occurs in aqueous solution, although other oxidation states are assigned in silver compounds. Silver is strongly sorbed by manganese oxide and, thus, is expected to concentrate in sediments.

Strontium (Sr), an alkaline earth metal, is a very common element replacing calcium or potassium in igneous rock. Strontium occurs only in the +2 valence state in the environment. $SrSO_4$ is very soluble in water, whereas, $SrCO_3$ is only slightly soluble in water.

The aqueous geochemistry of vanadium (V) is very complicated. Three oxidation states (+3, +4, and +5) can be stable in an aqueous system, but the dominant forms are +5 anionic complexes with oxygen and hydroxide. Vanadium does not naturally occur in highly concentrated forms; native soil concentrations for vanadium range from 20 to 500 mg/kg.

In aqueous solutions, zinc (Zn) is present in the +2 oxidation state. At pH values up to about 8, zinc occurs in aqueous solution as Zn^{2+} (and zinc sulfate species if sulfate is present); whereas at higher pH values, zinc carbonate and zinc hydroxide species predominate (Battelle, 1984). Zinc would be expected to be a relatively mobile metal in oxidizing conditions such as those believed to exist at OU 5. Zinc is sorbed onto hydrous oxides of manganese and iron, organic material, and clay minerals.

Metal COCs have been observed in all the various media (except seep water) at OU 5. It is expected that the majority of mass transport of these COCs in OU 5 occurs above the ground surface due to wind erosion and sediment transport. Transport of metals in the subsurface (groundwater and/or soil) appears to be limited due to the strong adsorption of these species onto the soil matrix. However, transport of adsorbed compounds may occur in association with migration of colloids in groundwater.

5.2.4 Radionuclides

Radionuclide COCs in UHSU groundwater and pond sediment at OU 5 are plutonium-239/240, americium-241, uranium-233/234, uranium-235, and uranium-238. Radium-226 was also identified as a COC in groundwater. Uranium-233/234, uranium-235, and uranium-238 were identified as COCs in surface soil, subsurface soil, and seep sediments. Surface water COCs included americium-241, uranium-233/234, and uranium-238. Americium-241 and plutonium-239/240 were also identified as radionuclide COCs in OU 5 stream sediment. The physical and chemical properties of these species that most influence the mobility and behavior in environmental media are: oxidation state, solubility, and radioactive decay. Oxidation states of radionuclides control their stability and solubility in the environment.

Plutonium (Pu) is stable in two oxidation states in most natural environments, as Pu(III) or Pu(IV). Pu(III) is the dominant species in acidic environments, whereas Pu(IV) is the dominant species as solid plutonium dioxide (PuO_2) under alkaline or oxidizing conditions (Brookins, 1988). Pu(IV) has a very low solubility at near-neutral and oxidizing conditions (National Research Council, 1983). This suggests that the activity concentrations of dissolved Pu in groundwater or vadose zone soil water will be low at OU 5, given the near-neutral pH and oxidizing subsurface site conditions. Therefore, the primary phase of plutonium existing at OU 5 appears to be the solid phase.

Americium (Am) has the potential to exist in two oxidation states under natural conditions, as Am(III) and Am(VI). For soil-water pH values greater than 6, the carbonate solid, $Am_2(CO_3)_3$, and the solid americium dioxide, AmO_2, are stable (Brookins, 1988). The solubility of americium under oxidizing and near-neutral conditions, such as occur in OU 5, is also very low (National Research Council, 1983).

In the environment, uranium (U) species are found in three oxidation states, U(IV), U(V), and U(VI). Under most redox conditions, U(VI) complexes are more stable than U(IV) and U(V) species. An increase in the oxidation state increases the mobility of uranium in the soil system.

In the environment, radium (Ra) species are found in one oxidation state, Ra (II). Isotopes of radium are radioactive, the longest lived being Ra-226. This isotope is formed in the natural decay series of U-238. Radium chloride and bromide are soluble in water, whereas the carbonate and sulfate are insoluble in water.

Radioactive decay is another key behavior of radionuclides. It is a first-order kinetic process and can be expressed in terms of a constant half-life. The radionuclides of concern have very long half-lives, ranging from 433 years (Am-241) to 4.47 x 10^9 years (U-238) (Gilbert et al., 1989) as listed in Table 5-4.

Radionuclide COCs have been observed in all the various media (except seep water) at OU 5. It is expected that the majority of mass transport of these COCs in OU 5 occurs above the ground surface, due to wind erosion and sediment transport. Transport of radionuclides in the subsurface (groundwater and/or soil) appears to be limited, due to the strong adsorption of these species onto the soil matrix. However, transport of adsorbed compounds may occur in association with migration of colloids in groundwater.

Contaminant behaviors and mobilities, as determined in the fate-and-transport models described in the following sections, are derived from the physical and chemical properties of individual contaminants in the context of the physical and chemical properties of the site, as determined from field and laboratory data collected for the specific media at OU 5. Each of the fate-and-transport models described below, are capable of modeling the processes affecting contaminant mobility applicable to the medium/media being modeled. The capabilities of the models are described in detail in TM13 (DOE, 1994b) and are summarized in the following sections. In all cases, when model parameters affecting contaminant mobility were varied to achieve calibration, the parameter estimates used would provide the most conservative results for use in the HHRA.

5.3 CHEMICAL FATE-AND-TRANSPORT MODELING

The following sections discuss the procedures followed for the modeling of contaminant fate and transport in groundwater, surface water, and air, and the results of this modeling. For each modeling effort, the rationale used for selecting the specific numerical modeling codes is also discussed. Additional detail regarding the selection of fate-and-transport models is provided in TM13 (DOE, 1994b).

5.3.1 Groundwater Modeling

This section describes the groundwater modeling, including flow and solute-transport modeling in the groundwater system, and simulation of contaminant transport in the vadose zone.

5.3.1.1 Purpose

The purpose of the OU 5 groundwater modeling was to provide an evaluation of contaminant transport via the groundwater pathway, in order to support the OU 5 HHRA. This purpose was satisfied by the production of a realistic representation of the subsurface system, which was used to estimate contaminant concentrations at locations that are relevant to risk assessment. These locations include areas where potentially contaminated groundwater might flow into Woman Creek. The model area covered by the modeling is depicted on Figure 5-4.

5.3.1.2 Scope

The scope of the groundwater modeling is limited to providing estimates of concentrations of COCs that originate in OU 5 IHSSs. Concentrations are calculated at regularly spaced points in a grid that covers present and possible future contaminant plumes. Radium-226, barium, and manganese have been identified as the only COCs in groundwater (DOE, 1995a).

5.3.1.3 Design

Buried ash and debris in OU 5 are potential sources for groundwater contamination. The base elevations of some of these sources are located above the water table, and are separated from the water table by unconsolidated surficial materials (such as colluvium). Consequently, some contaminant movement is through unsaturated material above the water table (vadose zone), and the remainder of the subsurface transport pathway is within the saturated zone. For the purposes of the present modeling, numerical flow-and-transport modeling was used to simulate contaminant movement below the water table in the groundwater system. A one-dimensional, solute-transport modeling code was used to represent contaminant transport above the water table (i.e., the vadose zone).

Selection of Model Codes - Groundwater-flow and contaminant-transport modeling are combined to produce a representation of contaminant movement in a subsurface system. Computer codes that perform the modeling are commonly called models. Many types of models are available. Mathematical models range from the solution of simple equations to very complex computer programs. In general, the greater the complexity of the model, the closer its behavior approaches that of the actual system (Javandel, 1984). Therefore, more complex mathematical models tend to produce better estimates of the actual behavior of the system than simpler mathematical models. The physical systems and processes can be more completely represented in complex models. The selection of a mathematical groundwater model is guided by the complexity of the actual groundwater system, the amount and quality of data available, and the degree of representativeness needed. Model selection for OU 5 is discussed in detail in TM13 (DOE, 1994b).

Selection of the Groundwater Flow Model - The OU 5 groundwater system is complex. There is a large amount of data for the groundwater system, and a good representation of the groundwater system is appropriate because of the importance of the HHRA. The risk assessment may be partially based on the results of groundwater modeling. Consequently, a complex mathematical model was selected for simulation of the groundwater flow system.

The complexity of the groundwater flow system is caused by the following site conditions:

- Location of the IHSSs on the slope of a valley wall where the surficial materials include heterogeneous colluvium, landslide deposits, and artificial fill, that result in a wide range of hydraulic conductivity along the flow path

- Groundwater flowing downhill along an irregular bedrock surface

- Highly variable, saturated thickness between the bedrock surface and the water table, including some areas where the bedrock surface is consistently above the water table

- Complex water-table configuration

- Areal variation of groundwater recharge rate, as indicated by different vegetation types

A complex numerical modeling code, MODFLOW, was selected to simulate the complex groundwater flow system in OU 5. MODFLOW is a widely used, finite-difference modeling code developed by the U.S. Geological Survey (USGS) (McDonald and Harbaugh, 1988). The simulated geologic medium is discretized into rectangular volumes (cells).

Selection of the Contaminant Transport Model - The complexity of the factors affecting contaminant transport in the groundwater system is indicated by:

- The irregular shape of IHSS 115 (Original Landfill)
- The irregular distribution of contamination in the groundwater and soils
- The variation of contaminant concentrations in groundwater and soils

The numerical modeling code selected to simulate the complex transport of dissolved contaminants in the groundwater system was MT3D (Papadopulos and Assoc., 1992). This code places imaginary particles into the flow system simulated by MODFLOW. The particles are generated in cells that represent contaminant sources. Multiple cells may be used to represent large, irregularly shaped sources. Each particle represents a certain mass of contaminant. These particles move with the groundwater. MT3D can simulate variable rates of contaminant supply at the source. The contaminant mass represented by particles in a cell at any given time may be converted to a corresponding contaminant concentration.

Selection of the Vadose Zone Model - The computer code selected to simulate the transport of contaminants downward from a buried source through the vadose zone to the water table was ONED-3 (Beljin and van der Heijde, 1993). This code is a one-dimensional solute transport model, which uses a mass-flux boundary condition at the upstream end of the model (Javandel, 1984). This simple representation of contaminant transport in the vadose zone is conservative because it represents the shortest possible pathway to the water table. It is compatible with the amount and quality of relevant data that are available for the vadose zone in OU 5.

Model Code Verification - MODFLOW has been successfully applied to many complex flow problems and is a widely used and well-documented, finite-difference groundwater flow model supported by the USGS. Verification of MODFLOW has been performed by comparing the numerical results with analytical solutions to the partial differential equation for groundwater flow through porous media (Anderson, 1993). MT3D verification is described in Chapter 7 of the user's manual (Papadopulos and Assoc., 1992).

5.3.1.4 Groundwater Flow Model

The preceding sections used the term "model" to refer to computer codes. This section will use "model" to refer to the actual simulation of OU 5 conditions produced by using MODFLOW. Usage of "model" is revealed by the context.

Time Dependency - Groundwater flow in the numerical model is treated as steady-state. The steady-flow assumption significantly reduces the calibration effort compared to simulating transient flow and attempting to calibrate against time-varying heads. Furthermore, steady-state modeling reduces the amount of input required by MT3D.

The long-term behavior of the groundwater system is adequately represented by steady conditions, because transient short-term fluctuations in the configuration of the water table will not significantly affect the long-term movement of contaminants. Only long-term movement is relevant to risk assessment involving future COC concentrations in groundwater.

Grid - The model grid (Figures 5-5A through D) is extensive enough to include all of the IHSSs in OU 5 that were found to contain contaminants during the OU 5 RFI/RI field investigation. The grid includes the reach of Woman Creek that passes through OU 5 and is aligned with the course of the creek. Woman Creek receives groundwater inflow during high water-table stages and may carry contaminated groundwater downstream, mixed with surface water from other sources. The grid also includes local features that could affect the groundwater flow system, including the SID and Pond C-2. The French drain on the 881 Hillside is included as a no-flow boundary.

The grid contains only one layer, which is sufficient to represent groundwater flow in relatively permeable surficial materials above the relatively impermeable claystone bedrock surface.

Bedrock is the undifferentiated Arapahoe and Laramie Formations, which contain sandstone lenses; however, no significant thickness greater than 5 ft of permeable sandstone was found in contact with the surficial materials in OU 5 boreholes. Therefore, no representation of Arapahoe Formation or Laramie Formation sandstone is included in the model.

The grid spacing near the IHSSs that are potential sources of groundwater contamination is 50 ft. The spacing is increased to 100 ft elsewhere in the model. In accordance with accepted practice, a transitional spacing of 75 ft is used between the small and large cells (Trescott, 1976). Using larger cells in the peripheral parts of the model has little effect on the model results. Contaminant sources and plumes are not located in these areas, and small cells are not needed for detailed solute transport analysis. Hydraulic conductivity zones with dimensions less than 100 ft are not relevant and may be treated by using equivalent hydraulic conductivities (Freeze and Cherry, 1979), applied to 100-ft distances.

Model Boundaries - The undifferentiated Arapahoe/Laramie Formation (claystone bedrock) underlying the surficial materials is relatively impermeable (EG&G, 1995a). Consequently, the base of the model was treated as a no-flow boundary. The bedrock surface is uneven, therefore this boundary is uneven.

The model is composed primarily of active cells, that represent the part of the model where groundwater movement is simulated. The lateral boundaries of the active cells are shown in Figures 5-5A through D. The boundaries approximate the OU 5 boundary on the north and west sides of the model. The eastern boundary was placed to include effects of Pond C-2 and the Woman Creek diversion on groundwater flow to Woman Creek.

The south boundary of the active cells follows Woman Creek west of Pond C-2. This boundary is a groundwater divide and is simulated as a constant-head boundary. This type of boundary is suitable because the average water-table elevation at Woman Creek is within the limited range between the creek bottom and bedrock. This limited range is indicated by average water-level elevations in monitoring wells located near the creek. It is also indicated by a seepage study that showed Woman Creek within OU 5 to be losing water most of the year (Fedors and Warner, 1993).

Initially, the active part of the model grid extended to the south of Woman Creek, and the creek was represented by the MODFLOW river package. However, early model runs were not successful because the water table beneath Woman Creek is too close to the bedrock surface. Consequently some cells at Woman Creek became dry during head oscillations while model runs were converging, even when under-relaxation (dampening of head oscillations) was used. This problem was solved by using constant heads in the cells following Woman Creek. Because no contaminant sources are known to be present south of Woman Creek, the southern part of the model became extraneous, and these cells were inactivated.

Most of the remaining boundary of the active part of the model is represented by constant heads, because water levels at a boundary can be more accurately estimated than flux or a proportionality constant for the general head-boundary package. Estimation of the constant heads at boundaries is facilitated because the water table must be within the thin surficial deposits. Furthermore, heads are indicated by some monitoring wells that are present near the model boundaries.

No-flow boundaries were used where the model boundary is parallel to the water-table gradient. A no-flow boundary also follows the French drain on the 881 Hillside. The drain is treated as completely effective in preventing downslope movement of groundwater.

Bedrock Elevation - Bedrock elevation throughout the OU 5 area was mapped using bedrock-surface data from boreholes. In areas of sparse coverage, the thickness of surficial materials and the configuration of the land surface were considered when interpreting the configuration of the bedrock surface. The model behavior is very sensitive to bedrock configuration because water flows downhill on the bedrock surface. Consequently, bedrock elevations supplied to the individual cells were transferred from the bedrock map (Figure 3-5) to the MODFLOW input file by hand to avoid any unrealistic values that might be generated by software interpolation and extrapolation.

<u>Hydraulic Conductivity</u> - Zones of initial hydraulic conductivity corresponded to the areal distribution of units on the Surficial Geologic Map of the Rocky Flats Site and Vicinity (Shroba and Carrara, 1994). Five surficial materials are mapped within the active model area. They are landslide deposits, colluvium, Rocky Flats Alluvium, Piney Creek Alluvium, and artificial fill. Landslide deposits and colluvium were lumped together in the initial hydraulic conductivity zones

because of their similar origin and texture. Consequently, there were four zones of initial hydraulic conductivity, as shown on Figures 5-6A through D.

The initial estimate of hydraulic conductivity for the zones representing colluvial material and artificial fill was 0.0029 ft per day (ft/day), which is in the range of conductivity values for a silt matrix (Freeze and Cherry, 1979). Shroba and Carrara (1994) describe the colluvial deposits as silty sand, sandy silt, clayey silt, and silty clay. The textural composition of the fill is similar to the colluvium and landslide deposits.

The initial estimate of hydraulic conductivity for the Rocky Flats Alluvium was 2.6 ft/day, which is within the range of values reported for pumping tests and slug tests adjacent to OU 5 (about 0.005 to 8.8 ft/day).

The initial estimate of hydraulic conductivity for the Piney Creek Alluvium along Woman Creek was 34.6 ft/day. This value is based on the geometric mean of late-match drawdown in a delayed-yield analysis of test data from a well near Woman Creek west of Pond C-1 (Doty and Associates, 1992).

<u>Recharge</u> - No site-specific recharge studies are available to provide hard data for recharge estimates for OU 5. Consequently, recharge was treated as a calibration parameter for OU 5 modeling. Previous modeling studies at the RFETS have used recharge values ranging from -2.96 inches per year to 2.25 inches per year (DOE 1993k; EG&G 1993b; EG&G 1994f; Fedors and Warner 1993; ICF Kaiser 1993). However, initial recharge estimates were made to begin the calibration with realistic recharge zones and relative recharge rates. The initial recharge zones were based on vegetation types shown on the Rocky Flats Plant Vegetation Map, Figure 3.2-3, of the Baseline Bilogical Characterization Report (DOE, 1992c). Initial recharge estimates are presented in Table 5-5. These estimates are based on precipitation minus consumptive use for the period from May 1993 through April 1994, which is the period used to calculate the water-table calibration targets described below. Precipitation at the RFETS for the period was 14.73 in. (EG&G, 1993a, 1994c). The monthly distribution of the precipitation is shown in Table 5-6. Figures 5-5A through D shows the initial allocation of recharge rates to the model grid. Positive recharge indicates inflow to a cell and, negative recharge indicates outflow from a cell and represents net extraction by phreatophytes. The uncertainty associated with these recharge rates is

great, and rates changed during the model calibration. However, relative rates associated with the vegetation types were retained.

The Blaney-Criddle Method was used to estimate consumptive use for the initial estimates of relative recharge because the method is well established and documented. In addition, Blaney-Criddle consumptive-use coefficients have been published for many vegetation types, including natural vegetation types that occur in semi-arid regions. Applicability of the Blaney-Criddle Method at the RFETS was investigated by comparing potential evapotranspiration (PET) calculated by the Blaney-Criddle method to PET calculated by the more elaborate Penman Method when RFETS climatic data are used. The Penman calculations were made by Koffer (1989). The Blaney-Criddle calculations were made by employing the consumptive-use coefficients for short green grass (Quackenbush and Phelan, 1965). Results are shown in Figure 5-8. The plots for monthly PET are similar for the two methods, except for an unexplained atypical data point for the month of May in the Penman curve.

The consumptive-use rates calculated by the Blaney-Criddle method for the period May 1993 through April 1994 are shown on Table 5-7. These calculated rates correspond to water used by plants that are relatively well watered. However, much of the modeled area is a south-facing hillside that becomes dry in the summer. The grasses wilt and turn brown, indicating the development of a soil moisture deficiency. Experiments with grasses at Fort Collins, Colorado have shown that grass remains green when irrigated at about 50 percent of the Blaney-Criddle consumptive-use rate and continues to live when moisture supply is only about 20 percent of that required for optimum growth (Quackenbush and Phelan, 1965). Using this behavior as a guide, a medial value of 33 percent of the calculated consumptive-use rates in the dry grassland areas was used as a rough approximation of actual consumptive use. Consumptive use by phreatophytes calculated by the Blaney-Criddle Method was adjusted upward (three-percent increase). This adjustment is consistent with the slightly higher PET calculated by the more elaborate Penman equation for July through mid-September (Figure 5-8).

When recharge rates shown in Table 5-5 are compared to the precipitation distribution in Table 5-6 and potential evapotranspiration shown on Figure 5-8, they suggest that groundwater recharge for the dominant dryland vegetation types may represent a large proportion of precipitation during the part of the year when evapotranspiration rates are low. This calculated amount of recharge seems plausible; however, it could be greater than actual recharge because the soil moisture deficiency developed between precipitation events in the growing season is unknown.

The hydrographs shown in Figure 5-9 are in general agreement with winter/spring recharge. They show a tendency to have low water levels in the summer and a rise in water levels beginning sometime in the September-to-December interval. Well 58793 is an exception, as it shows only a slight rise by March, suggesting a more delayed response to recharge. Actual recharge is unlikely to be much greater than the initial recharge estimates, because the annual recharge approaches the measured amount of spring precipitation.

Because of the large values of PET (approximately 40 in. per year ([Fedors and others, 1993]), the recharge rates at RFETS are probably considerably less that the spring precipitation. Previous documented studies contain lower estimates of recharge. Because of the uncertainty in the recharge estimate, it was considered as a calibration parameter subject to restructions obtained from previous modeling studies.

<u>Calibration</u> - Development of the groundwater flow model included calibration to representative water levels measured in monitoring wells. Calibration involves modifying model variables that are not accurately known. In the present model, these calibration variables are hydraulic conductivity and recharge rate. Modification of bedrock elevation and boundary heads was also necessary in some cells where they had not been measured. The variables are changed in successive trial computer runs until the field-measured hydraulic heads are adequately approximated by the model. The values assigned to the variables must be within the ranges appropriate for the hydrologic and geologic conditions of the area. Calibration does not produce a unique solution to the problem of representing the actual system, because more than one combination of parameters may cause hydraulic heads to be approximated equally well. However, if adequate constraints are applied to the values of the variables, calibration can produce a realistic solution for a complex problem. The representativeness of the solution may be judged by comparison of values assigned to model variables to measured values in the model area and to values reported in the scientific literature for similar subsurface materials and recharge conditions.

If sufficient data are available, the predictive capability of the model may be validated by testing its ability to predict heads that were not included in the calibration. In the present case, insufficient data are available to test the predictive capability of the flow model. However, an analysis of uncertainty in the contaminant concentrations predicted by the linked flow-and-transport model was performed.

Calibration Targets - Selection of calibration targets involved identifying a period when water levels were representative and water-level data were relatively abundant. The period selected was May 1, 1993 to April 30, 1994. Long-term precipitation data from the Boulder, Colorado station (NOAA, National Climatic Data Center) shows that precipitation in 1993 was normal (Figure 5-10). Precipitation data for all of 1994 are not yet available. Monitoring-well hydrographs also indicate normal hydrologic conditions in 1993-1994 (Figure 5-11). Most of the existing monitoring wells and wellpoints in OU 5 were installed in 1993, and water-level measurements from these wells and wellpoints are available for the period from May 1993 through April 1994.

Target water levels are restricted to those wells screened in the surficial material and these wells show water levels above the bedrock top throughout the selected period. Wells that satisfied this restriction were wells 5686, 6586, 7086, 51193, 58793, 59493, and 59593. The locations of these wells are shown on Figure 5-5A. Average water levels in the wells for the selected period were used as the target water levels. Hydrographs displayed in Figure 5-9 show the degree of representativeness of the average water level for the selected period. Departures from the mean are generally less than 2 ft and the mean is not affected by extreme values. Wells that were consistently dry throughout this period were also considered in the calibration. Consistently dry wells were 50192, 50292, and 61293. Calibration included producing dry model cells at these well locations.

Most of the water-level data in the OU 5 area are from wells and wellpoints that do not satisfy the criteria for target water levels. However, data from these wells were considered semi-quantitatively in the calibration by calculating average water levels regardless of the period represented or the number of water levels available. Dry measurements were not included in the average. These averages were treated as secondary information for identifying any further modifications that should be made in model variables to obtain agreement with all available data.

Calibration Procedure - The general calibration procedure was to start with initial estimates of the calibration parameters (hydraulic conductivity and recharge) and minimize deviations from them. Water-level elevations on the hillslope were found to be sensitive to bedrock configuration and boundary heads, and some adjustment from initial estimates in certain cells was also required. The initial estimates of values for the calibration parameters were based on analysis of available climatologic, hydrologic, and geologic data. This calibration procedure is equivalent to estimating the parameters of the groundwater flow system and then improving the estimate via model calibration. If sufficient site-specific data are available for the calibration parameters (hydraulic conductivity and recharge) and geologic controls (bedrock elevation), the expected result is a realistic model.

The first phase of the calibration involved adjusting parameter values to produce calculated water levels below land-surface elevations throughout the model. Model parameters were adjusted after successive modeling runs until all heads were below land-surface elevations. Boundary conditions were also altered during the first phase of the calibration. The southern boundary of the model consisted of constant heads in the southernmost row of the model, with Woman Creek simulated by the MODFLOW river package. However, as discussed in Section 5.3.1.4, some river cells contained bedrock elevations estimated at only a foot below the streambed elevation. These cells converted to dry cells prior to completion of the modeling run. The dry cells produced by the numerical process resulted in unrealistically high calculated heads north of Woman Creek. When riverbed conductance (capacity to transmit water) was increased to prevent the conversion to dry cells, the model did not converge. Consequently, cells along the course of Woman Creek were converted to constant-head cells to obtain better results. Cells south of Woman Creek were inactivated. For cells along reaches of the creek that lose water most of the year, the head was initially set 0.5 ft below the stream-bottom elevation. For cells along reaches classified as gaining, the head was initially set 0.5 ft above the bottom elevation. Gaining and losing reaches were based on results of an infiltration/exfiltration study conducted from December 1991 through October 1992 (Fedors and Warner, 1993). Setting heads 0.5 ft below the elevation of the stream bottom is consistent with a field search that revealed no bedrock exposed at the stream. The initial constant heads were subject to change during subsequent calibration runs, if necessary, to adequately simulate heads measured in observation wells near the stream.

The change of the southern model-boundary condition did not represent a significant change in representativeness and usefulness of the model. The change eliminated riverbed conductance as a calibration parameter that would have to be adjusted to produce heads in the river cells. Instead, heads were supplied directly as a constant head boundary. Groundwater flow south of the creek is not needed for solute transport analysis because no contaminant sources were identified there by soil borings during the OU 5 field investigation.

Additional convergence problems were caused by cells converting to dry cells during the modeling runs if the wetting capability in the BCF2 package was inactive. However, when wetting capability in BCF2 was activated, wet/dry oscillations were produced. To eliminate this oscillation, BCF2 wetting was inactivated and extreme under-relaxation was used in the model to prevent drying of cells early in the simulation run. Calculated heads near dry cells were inspected on spreadsheets during the calibration process. When dry cells produced by calibration runs were not realistic and caused adverse effects on the calibration, model parameters were modified to increase flow to these cells.

During the first phase of calibration, hydraulic conductivity in the initial zone 1 (colluvium and landslide materials) was increased from the initial value of 0.00288 ft/day to 7.0 ft/day west of Pond C-2 and to 1.152 ft/day east of Pond C-2. Zone 2 (fill) was increased from an initial value of 0.00289 ft/day to 0.185 ft/day. These increases in hydraulic conductivity are within the range expected for these materials. These changes reduced heads in hillslope areas throughout the model. A new zone was created from zone 1 east of the Woman Creek diversion around Pond C-2 to reduce heads east of the pond. The hydraulic conductivity initially assigned to this zone was 5.76 ft/day. Heads east of Pond C-2 were also reduced by extending the initial zone 4 (alluvium) to cover alluvial material shown on a "worms eye" map of geologic materials present at the bedrock surface (EG&G, 1995a). In addition, constant heads along Woman Creek east of Pond C-2 were reduced to 0.5 ft above bedrock. Other minor adjustments were made to bedrock elevations and constant-head boundaries to reduce water levels below land surface in local areas. Hydraulic conductivity in the zones representing colluvium, landslide material, and fill was adjusted further in local areas.

During the first phase of calibration, the effectiveness of reducing recharge to reduce heads was tested by setting recharge zones 6, 8 and 9 (grassland and disturbed areas on the hillside) to zero.

The effect on water levels south of the east end of the Original Landfill near cell (17,51) (row, column) showed that although the head in the cell (17,51) was reduced by 6 ft, it was still 2 ft above the land surface. It was necessary to increase hydraulic conductivity in the area to reduce the head to below land surface. Because this test showed that recharge adjustment was less effective for calibration than varying hydraulic conductivity, recharge was subordinated to hydraulic conductivity as a calibration parameter.

The goal of the second phase of the calibration was to reduce deviations of calculated heads from target heads and to produce dry cells where monitoring wells are consistently dry. This phase primarily involved local adjustment of hydraulic conductivity to raise or lower calculated heads corresponding to individual target heads. In addition, constant heads were adjusted along some reaches of Woman Creek and localized sections of the northern boundary. Phase 2 produced a model in which all interpolated heads were within a half foot of heads in target wells, and dry wells were represented by dry cells. This is a high degree of calibration. The root mean squared residual is 0.22 (Table 5-8), whereas a good calibration would only require the statistic to be less than 2.0. This calibration criterion is based on the dimensionless error variance measure of goodness of fit (Cooley, 1977) and calibrated models described in Anderson and Woesener (1991).

The third phase of the calibration was a refinement in which water-level information from miscellaneous wells and wellpoints was used to check the representativeness of the model. Data from an additional 49 water-level observation points were assembled, and average water levels were calculated. These averages represented different periods, included variable numbers of measurements, and did not include instances when wells were reported to be dry. Although such information at any point does not necessarily provide a good representation of long-term water levels, the model should be compatible with them. Consequently, the averages were placed in a HeadCompare (Papadopulos & Assoc., 1993) input file as secondary observed water levels. Interpolated model heads were compared to these secondary water levels to identify observation points where model heads were not compatible with miscellaneous observations.

One point of incompatibility was at wellpoint 62893 in cell (6,83), which measured water levels in a wet area. This wet area is believed to be caused by an impedance to groundwater flow from downslope decreases in hydraulic conductivity. Simulated heads were too low at this location, and hydraulic conductivity was decreased in a new zone downslope to reflect the probable cause for the wet area. New hydraulic conductivity zones were also introduced to obtain better model results by increasing water levels in the vicinity of wellpoint 52193 in cell (20,34) and wellpoint 53292 in cell (12,72), and by decreasing water levels near well 52693 in cell (14,62).

Constant heads at Woman Creek were changed near wellpoints 53593, 53993 and 54793 in cells (21,96), (13,107), and (8,135), respectively, to reflect their proximity to the creek. Additional miscellaneous changes in constant heads and local hydraulic conductivities were necessary to maintain calibration in the target wells and deal with minor calculated head incompatibilities with the secondary data points.

The third phase also involved improving the agreement between model hydraulic conductivities and hydraulic conductivities from aquifer tests that were conducted within the active area of the model. The hydraulic conductivity in cell (13,68) was reduced from 7.0 to 6.0 ft/day to obtain agreement with a slug test in well 59593. Hydraulic conductivity near well 51193 was changed to 15 ft/day, which agrees with pumping test results and treats the cells as being transitional between nearby cells that were 34.56 and 7.0 ft/day. The transitional nature of this area could be caused by the presence of alluvium in the area covered by the cell. The third phase produced a well-calibrated model; however, the hydraulic conductivity of much of the colluvium that covers a large part of the model area remained at the high value introduced in the first phase of the calibration.

High values for hydraulic conductivity were used to reduce water levels at this early calibration stage, because reducing recharge rates to zero did not produce adequate water-level reduction. The final phase of calibration was an adjustment so that hydraulic conductivity in the colluvium agreed with pumping test results obtained from colluvium on the 881 Hillside (there were no successful pump tests for colluvial wells within the active model area). The 881 Hillside is located north of the middle part of the active model. Much of the colluvium in the model remained at the value of 7.0 ft/day set in phase one of the calibration. However, the average hydraulic conductivity for drawdown-recovery tests reported for the 881 Hillside is 0.95 ft/day. To bring hydraulic conductivity of colluvium in the model into better agreement with this value, hydraulic conductivities throughout the model were divided by 7.0 to bring the large areas of colluvium down to 1.0 ft/day. All recharge values in the model were also divided by 7.0 to maintain the calibration. The resulting recharge values were still within the range of possible values because uncertainty associated with the initial values was high. A few additional changes in model hydraulic conductivity values were made to maintain agreement between model hydraulic conductivity values and pumping test results within the active part of the model. Minor adjustments in model parameters were also made at this time. Some boundary heads were changed to bring them into better agreement with monitoring-well data; and hydraulic conductivities and recharge rates were changed in a wet area near the east end of the Original Landfill where particle tracking indicated that the shape of a hydraulic conductivity zone was not natural. The resulting hydraulic conductivities and recharge rates were still within realistic ranges throughout the model, and this result was accepted as the calibrated flow model.

Calibration Results - The degree of calibration produced by the modeling is indicated by Table 5-8. The maximum residual for target water levels is 0.27 ft. The degree of correspondence between calculated heads and secondary water levels is shown by Table 5-9. The largest absolute residual for a secondary water level is 6.54 ft for wellpoint 60693. This wellpoint is only 78 ft from wellpoint 60593, which has an absolute residual of only 1.12 ft. These wellpoints have only two water-level measurements each and are in an area with a relatively steep-sloping land surface. Well 63093 has a residual of 6.46 ft. It has only two measurements and is 82 ft from well 51493, which has 10 measurements and an absolute residual of just 0.20 ft. Wellpoint 54193 has an absolute residual of 5.70 ft. It is only 28 ft from 54093, which has an absolute residual of just 0.35 ft. Both 54093 and 54193 are in the same 50 x 100 ft model cell. The model is not intended to represent such small-scale hydrologic features. Wellpoint 62793 has an absolute residual of 5.20 ft. Its water level is based on only two measurements taken at about the same time. The well is along the same topographic contour as well 59793, which is about 75 ft away and has a residual of 2.48 ft. Because one of the calculated water levels is higher than the measured one and the other is lower than the measured one, the model results are reasonably representative. The remainder of the residuals for secondary water-level data indicate that the model results are compatible with the secondary data, considering the data distribution in space and time.

The final distribution of hydraulic conductivity values in the model is shown on Figures 5-12A through D and Table 5-10. A detailed map of hydraulic conductivity is in Appendix F. The initial four zones of hydraulic conductivity, which ranged from 0.00288 ft/day for colluvial and landslide material to 34.56 ft/day for alluvium, evolved into 25 zones ranging from 0.014 ft/day in a heterogeneous area in the south-central part of the Original Landfill to 29 ft/day for alluvium east of Pond C-2.

The final range of hydraulic conductivity in colluvium and landslide areas is 0.0357 to 28.6 ft/day. The calibrated value of 2.86 and 0.063 ft/day were applied to zones in the vicinity of Ash Pit IHSSs 133.1 and 133.2, respectively. As previously stated, most of the colluvium and landslide area in the model was assigned a hydraulic conductivity of 1.00 ft/day. These values for colluvium are in the range of expected values for silt and silty sand given by Freeze and Cherry (1979) and are compatible with the description of the colluvium. In addition, hydraulic conductivities corresponding to alluvial material were expanded into the area originally treated as colluvial and landslide material near Woman Creek. This expansion suggests that alluvium is present beneath colluvium at a few places near the creek. The final range of hydraulic conductivity in artificial fill was 0.0143 to 0.929 ft/day, which is consistent with some of the fill composed of disturbed and compacted colluvium.

The final range of hydraulic conductivity of alluvium near Woman Creek was 4.94 to 28.6 ft/day. The final range of hydraulic conductivity for Rocky Flats Alluvium was 0.357 to 0.429 ft/day.

The final bedrock configuration is shown in Figures 5-13A through D. The model was sensitive to bedrock configuration because the groundwater is flowing down the bedrock slope through thin surficial materials. Recharge zones and recharge rates resulting from the calibration are shown in Figure 5-14A through D and Table 5-11. The simulated water-table configuration is shown in Figure 5-15A through D, which also reflects the final constant-head values in boundary cells.

Water Budget - The water budget for the model is shown in Table 5-12. The inflow from constant-head cells is nearly all from the cells along the northern boundary of the model and represents groundwater from upslope areas. This contribution is from groundwater flowing along the bedrock surface that slopes southward toward the OU 5 area.

Nearly all outflow to constant-head cells is to cells along the southern boundary of the model. This boundary follows Woman Creek and the outflow represents discharge of groundwater to the stream during periods of high water table when the stream is gaining. It represents an average flow of 0.036 cfs or 26.6 ac-ft/year. In the real system, this water would evaporate from Ponds

C-1 and C-2 or be carried around Pond C-2 by the Woman Creek diversion. Actual discharges for Woman Creek in the Pond C-1 and C-2 area range from about 300 to 1975 ac-ft per year, corresponding to 0.4 to 2.72 cfs (ASI, 1991). The simulated water budget represents a minor contribution to Woman Creek flow.

Particle Tracking - Results of particle tracking are shown in Figures 5-16A through D. The particle tracking was performed using MODPATH (Pollock, 1989). This software uses output from MODFLOW to compute the path and rate of movement of water from selected source locations. Although particle tracking does not include the effects of dispersion, it provides a good overview of the nature of the flow system and potential rate of contaminant movement. It is helpful in identifying the sources for contaminants observed in groundwater and provides initial information on the rate of contaminant movement.

Estimates of effective porosity must be supplied to MODPATH, in addition to the output from MODFLOW. The effective porosity estimates used to produce the particle tracks are shown on Table 5-10. They are based on a general relationship between specific yield and hydraulic conductivity (Luthin, 1966, Figure 10-10). Specific yield is similar to effective porosity (Fetter, 1980). Effective porosity in each cell of the model was determined by the hydraulic conductivity in the cell. As shown in Table 5-10, these effective porosities ranged from 0.01 for the lowest hydraulic conductivity (0.0143 ft/day) to 0.19 for the highest hydraulic conductivity (2.86 ft/day).

The particle tracks show that the groundwater flow rate is variable throughout the model area and that paths are deflected around areas of relatively low hydraulic conductivity. Pond C-2 captures groundwater from sources to the west of the pond. Groundwater originating east of Pond C-2, including seepage from the Woman Creek Diversion, moves toward Woman Creek where it exits the eastern edge of the model.

5.3.1.5 Solute Transport Model

COCs in Groundwater - To assess the potential risk to human health from exposure to OU 5 groundwater, constituents of the groundwater were evaluated as PCOCs. TM11 defines PCOCs as "metals or radionuclides whose concentrations exceed background concentrations and organic chemicals present at levels greater than analytical detection limits" (DOE, 1995a). The PCOC list was reduced to the COC list through an evaluation of detection frequency and the concentration/toxicity screening process. Eleven groundwater constituents were identified as COCs for OU 5, including five metals and six radioactive elements (DOE, 1995). They are aluminum, barium, manganese, vanadium, beryllium, americium-241, plutonium-239/240, radium-226, uranium-233/234, uranium-235, and uranium-238. Further discussion of the COCs and the methods of their selection are provided in TM11.

Target Wells - As potential calibration targets for solute transport modeling, OU 5 wells were evaluated with respect to the eleven COCs. Only 1993 analytical data were used in this evaluation, corresponding to the time period selected for the flow-model calibration. All analytical data for dissolved constituents in groundwater collected from the OU 5 RFI/RI wells were reviewed for occurrences of the COCs. Results of these data were flagged as: rejected (R); laboratory replicate (LR); field blank (FB); trip blank (TB); and rinsate, and removed from the data set. Additionally, duplicates were averaged with the corresponding real samples and all results listed as nondetects were set at values of one-half the detection limit (DOE, 1995a). To detect the presence of a COC in concentrations that satisfactorily set it apart from the background population, well maxima for each COC were screened for values above background mean plus two standard deviations. This screening provides a means of identifying chemicals that are present in concentrations greater than most of the background population, and which, therefore, may reflect actual contamination. The screening procedure resulted in the identification of three COCs; barium, manganese, and radium-226. The eleven COCs, the screening values, the well means, and the results of the screening procedure are presented in Table 5-13.

Target Concentrations - Inspection of the 1993 data for the COCs showed no general trends in concentration over time (Table G-1, Appendix G). During this relatively short period, the observed concentration in each well was sufficiently stable that any general, temporal trend that may exist was too small to separate from the scatter of the data. The scatter of the data at each well may be caused by many factors, including short-term variation in groundwater recharge rate, variation in source concentration, and geochemical variability of the aquifer system combined with temporal variation in flow direction and rate. In such aquifer systems, the population of random variations in concentration at an observation point might be expected to be approximately normally distributed about a central value (Mood and Graybill, 1963). This central value (population mean) is the most representative value, because concentrations near this value will be most frequently observed. Because a sample mean is an unbiased estimate of the population mean, the mean of observed concentrations for each contaminant at a well was used to generate a target value at that well.

The chemical-specific means from each well were compared to the background mean of that chemical. Target concentrations for each COC were established by subtracting the background means from the well means. Those means that were found to be greater than the background mean were used as calibration targets. Those that fell below background mean were considered zero for the purposes of calibration. This second screening resulted in targets for the three COCs, and is presented in Table 5-14. Borehole logs and completion details of the target wells, 58793, 59493, 59593, 50092, and 51193 are presented in Appendix H.

Sources for COCs - To identify potential sources for the three COCs, the following documents were reviewed:

- Historical Release Report for the Rocky Flats Plant, EG&G Rocky Flats, Volume I - Text, Manual No. 21100-TR-12501.01, June 1992. Pages SE-1 to SE-14; SW-1 to SW-16; 400-1 to 400-2; 800-1 to 800-2; 900-1 to 900-2; and 900-10 to 900-12

- Health Studies on Rocky Flats Phase 1, Rocky Flats Toxicologic Review and Dose Reconstruction Task 3/4 Draft Report, ChemRisk, February 1992

In the sections reviewed in the Historical Release Report (HRR) (EG&G, 1992i) there is no mention of spills or releases of radium-226, barium, or manganese, or chemicals containing these constituents. There are, however, several references to depleted uranium sources, which may account for the presence of radium-226.

Neither barium nor manganese are contained in the list of materials of concern as selected in Task 2 of the Health Studies on Rocky Flats. Manganese is not referenced anywhere in the HRR. However, barium is mentioned once in the document as barium chromate listed on the 1988/89 inventories of the chemicals for Buildings 559 and 771. One pound was reported in a utility room in Building 559 and another pound was reported in Room 180F in Building 771.

From this review, no distinct sources of barium or manganese have been identified. It appears unlikely that the barium chromate located in the buildings in 1989 would be a possible source of barium. However, if its earlier presence onsite were undocumented, that occurrence could be a source. No source of manganese related to plant operations was identified.

IHSS 115 - The three COCs in the Original Landfill (IHSS 115) wells appear to be related to the same source, the northernmost former filter-backwash pond, Pond 6 (IHSS 196). Wells 59593 and 59493 are on the same particle track (Figure 5-16A through D) originating at the site of the former pond. Well 59493 has a mean of 1.03 pCi/L for radium-226 and well 59593 has a mean of 0.56 pCi/L for radium-226. These values are consistent with the supposition that the pond is the source of the radium-226 and that well 59493 is closer to the source than 59593. This relationship is also supported in the manganese means of 6,130 micrograms per liter (μg/L) in well 59493, and 575.7 μg/L in well 59593.

Pond 6 is mentioned in a discussion of the Southwest Buffer Zone, Section 3.4 of the HRR (EG&G, 1992i) as PAC reference number SW-196 (IHSS 196), the backwash pond for the water treatment plant. This pond apparently originated as an evaporation/settling pond, and was used for "the backflushing of sand filters from the Waste Treatment Plant located north of the Original Landfill." The location of the pond is noted as about 800 ft south of Building 124; this is consistent with TM15 (DOE, 1994a) maps, but not with the HRR map. The site of the pond may have originally been used as an incineration pit for the burning of contaminated waste from Building 444 and also as a dump site for ashes from the plant incinerator, graphite, used caustic drums, and general trash. The area was probably used as a burn pit for only one or two years (1952-1954), prior to the construction of the evaporation/settling pond between January and March 1955 (EG&G, 1992i). A likely source of the radium is the incinerator ash derived from uranium-contaminated (depleted uranium) waste from Building 444, although radium-226 is not noted. There is no estimate of the mass of uranium in the HRR.

Well logs from 59493, the well constructed within the Original Landfill at the south end of the Pond 6, indicate that landfill debris, including graphite and broken glass, extend to within 1.2 to 2.2 ft above bedrock (bedrock at 14.1 ft). The water table was 2 ft below ground surface during drilling in June, 1993, and was 5 to 6 ft below ground surface during pump testing in August, 1993 (DOE, 1994a). This is interpreted to mean that the source is below the water table. The area of the former pond as shown on TM15 maps is based on aerial photography and is estimated as 45 ft in diameter, and circular in shape. The size is very close to that of the model cell size in the Original Landfill area, 50 ft by 50 ft.

IHSS 133 - The relationship of the COCs in well 58793 to a source in the north ash pit of IHSS 133.2 is supported by the particle tracks generated by MODPATH (Figure 5-16A through D). In addition, the presence of radium is consistent with the history of the ash pit, in that ash buried in the pit contained depleted uranium (EG&G, 1992i) and ash sample monitoring in 1956 showed 1.9 grams of depleted uranium per kilogram of ash (1.7 kilograms/ton). The south ash pit is not modeled as a source, even though target well 58793 is located just to the south and downgradient of the south ash pit. The pit does not show up on a time-domain electromagnetic survey and, therefore, probably does not contain metal (DOE, 1994a). Additionally, borings in the south trench did not encounter ash material (DOE, 1994a).

The HRR describes the pits as trenches, "150- to 200-ft long, 12-ft wide, 10-ft deep, and covered with 3 ft of earth." However, the HRR also contains documentation of a trench as 8 ft deep with 6 ft of compacted ash and 2 ft of earth cover. The ash pits/trenches were in use from 1959-1968. The HRR does not indicate when each trench was filled, but the 133.2 pit is not present in 1966 aerial photography, and is present with no apparent overgrowth in a 1969 photograph. The trenches were closed in 1968. The 133.2 trench was probably opened in 1967. This year will be used as the time of contaminant introduction to the vadose zone, giving a total transport time of 26 years to the end of 1993 (the midpoint of the modeled period).

Logs of boreholes 56893 and 56993 (DOE, 1994a) within the trench indicate that ash is present 2.4 to 7.7 ft below ground surface (6019.7 - 6025.0) in 56893 and 4.0 to 8.7 ft below ground surface (6016.3 - 6021.0) in 56993, giving an average thickness of fill of 5.0 ft. This number is somewhat consistent with the trench-design fill depth of 6 ft, mentioned above. No ash was encountered in the third of the three boreholes in the trench, borehole 57093. However, the borehole is located along the northern edge of the approximately 200-ft long and 40- to 45-ft wide trench depicted on TM15 maps, and may be outside of the area containing waste. Based on information provided in the HRR and borehole data, the source appears to be a volume 175 ft long, 5-ft thick and 12-ft wide.

IHSS 142 - The target wells for IHSS 142 are wells 51193 and 50092, both located immediately east of Pond C-1 dam near Woman Creek. Because the wells are downgradient from the pond, it is postulated that Pond C-1 is the source of contaminants found in these wells. A boring through the center of the dam (Merrick & Company, 1992) indicates that the dam is not keyed to bedrock; in fact, approximately 8 ft of unconsolidated material underlies the clayey gravel of dam fill, strongly suggesting a hydraulic path for contaminant transport from the pond.

Radium-226 can be traced back to Pond C-1 as a source, particularly because Pond C-1 sediments contain americium, plutonium, and uranium. Uranium-238 is a COC for surface water in OU 5. The first introduction of uranium is not known. Reported occurrences, include the following:

- In October 1954 backwash water drained through the Original Landfill burning pit down to Woman Creek. The pit was used as a dump for uranium-contaminated incinerator ash and for burning of contaminated waste from Building 444 (used for manufacture of uranium and beryllium components).

- A steam condensate release (2,700 gallons) from Building 881 to Pond 7, and Pond 7 overflowed to Pond C-1. This release occurred in September, 1955. Building 881 housed enriched uranium components.

- Drainage from the 903 Pad and Lip area occurred over its lifetime from 1955 or 1958 through June 1968. Waste stored at the 903 Pad included uranium from Building 444 (depleted uranium).

Vadose Zone Transport - Logs of materials encountered in boreholes 56893 and 56993 indicate that constituents released from Ash Pit 133.2 must traverse about 9 ft of material in the vadose zone to reach the water table (DOE, 1994a). Nine feet is the distance from the elevation of the bottom of ash in borehole 56993 to the elevation of the water table calculated by MODFLOW. Transport through this vadose zone was simulated with a one-dimensional model, as described in Section 5.3.1.1.

A simulation using the distribution coefficient of 0.67 ml/g, which corresponds to the radium-226 distribution coefficient in the calibrated MT3D model, and a downward seepage velocity of 0.0013 ft/day showed that the radium-226 would not yet have arrived at the water table by 1993.

The downward seepage velocity was calculated from:

$Q_{pw} = Q_r/n$, in which
Q_{pw} is the seepage rate (L/T),
Q_r is the groundwater recharge rate (L/T), and
n is effective porosity (dimensionless).

The groundwater recharge rate was set at 0.0002286 ft/day (from the calibrated MODFLOW run), and n was 0.03, the effective porosity from Table 5-10 and Figure F-1, Appendix F.

The mechanism for rapid transport of COCs through the vadose zone beneath the ash pit has not been investigated and is not known. For the present modeling, the rapid transport was simulated by reducing the distribution coefficient to zero. This simulation shows the 50 percent C/C_o concentration arriving at the water table in about three years (Figure 5-17). Based upon this result, MT3D source loading beneath the ash pit was initiated three years after the ash pit was constructed. Because the ash pit was constructed in 1969, the impact to groundwater was assumed to begin in 1972, for purposes of the MT3D simulations. The MT3D source-loading rate was considered to be constant from 1972, onward.

<u>Transport Model</u> - The MT3D simulation of contaminant transport in the groundwater system is described in this section.

Interface with Groundwater Flow Model - MT3D requires values for discharge across each cell face as a model input. These discharges are derived from the flow model. MODFLOW/mt, an enhanced version of MODFLOW provided with MT3D contains an interface package, LinkMT3D. LinkMT3D allows MODFLOW to write heads and fluxes along cell faces into an unformatted file, which is then used as an input file to MT3D.

Grid - The same grid that was used for MODFLOW was used for MT3D, facilitating linkage of the models. The size of the MT3D model was reduced by making irrelevant cells located west (upstream) of the IHSSs inactive.

Model Boundaries - The MT3D boundaries are the same as those used for the MODFLOW model. The constant heads along Woman Creek allow movement of COCs out of the system.

Stress Periods - The model execution consists of two stress periods for each COC. The first stress period is 18 years (6574 days) in length, beginning in 1952, when Pond 6 (IHSS 196) was first used as an incinerator pit. The stress period ends (and the second begins) with the arrival of COCs at the water table beneath the ash pit in IHSS 133.2 in 1970. This second stress period lasts 24 years, to the mid-point of the RFI/RI investigation in 1994.

Calibration - The numerical solute transport model was calibrated by adjusting input parameters to produce simulated concentrations that were close to target concentrations for the wells identified as containing COCs. Professional judgment was used to decide when the simulated concentrations were close enough to target concentrations to support human health risk assessment. A separate calibration was performed for each COC (radium-226, barium, and manganese). The simulated plumes from Pond 6 (IHSS 196) and Ash Pit 133.2 are independent. Changing the source concentration for one plume does not affect concentrations in the other.

The calibration for each COC was a two-step process. First, the distribution coefficient was adjusted by successive trials until the ratio of simulated concentration values in the two wells in the Pond 6 (IHSS 196) plume approximated the ratio of the target concentration values in the two wells. Second, the source concentration values for each plume were adjusted by multiplying them by the ratio of target concentration value to calculated concentration value at wells in the plume. Calculated and target concentrations will match when this procedure is followed.

The initial estimate of longitudinal dispersivity was 45 ft. This estimate was based on the formula : $\alpha_l = 0.1L$ where α_l is longitudinal dispersivity, and L is the contaminant travel distance. This scale-dependence is discussed by Walton (1985) and Droppo, et al. (1991). In the present case, the travel distance was taken as 450 ft, which is the distance from Pond 6 to the farthest observation well containing radium-226 activities above background, well 59593. The ratio between longitudinal and transverse (lateral) dispersivity was set at $0.2\alpha_l$, which is consistent with the recommendation of Droppo et al., and with ratios given by Walton. The effectiveness of adjusting dispersivity for calibration was examined by increasing longitudinal dispersivity by one order of magnitude while holding the initial distribution coefficient constant at 100 ml/g, as shown in Table 4.1 from Strenge and Peterson (1989). This change resulted in a decrease in the computed ratio between wells 59493 and 59593 from 1.66E6 to 182.8. The observed ratio is 2.9. Therefore, no combination of dispersivity and source loading could produce the desired ratio, because source loading will have no effect on the ratio. Calibration cannot be achieved solely by manipulating dispersivity. Consequently, the dispersivity was returned to its original estimated value, which is consistent with published scale-dependent values. This dispersivity was retained throughout the calibration. The results of the calibration are presented in Table 5-15. The computed concentrations for well 59493 were interpolated from the four adjacent cell nodes, because the well is located where the concentration gradient is high. Other wells were adequately represented by calculated concentrations at the nearest node.

Analytical Transport at Pond C-1 - Simulation of contaminant transport from Pond C-1 was accomplished by one-dimensional analytical modeling using ONED-3. This procedure was adopted because the transport from the pond is along the bottom of the Woman Creek valley, which is represented by constant-head boundary cells in the MT3D model. MT3D does not simulate transport in the boundary cells. The one-dimensional analytical simulation is conservative because it does not include the dissipation produced by transverse dispersion. The results of the calibration to wells downstream from Pond C-1 are shown in Table 5-15. No useful data were found on total contaminant mass deposited in the source.

Future Concentrations - The calibrated solute transport models were used to calculate future concentrations of COCs in groundwater near Woman Creek. Concentrations were calculated for 30 years from the present, based on exposure duration guidance in accordance with Risk Assessment Guidance for Superfund (RAGS) (EPA, 1989; Chapter 6.0). The greatest calculated 30-year concentrations are for cells located along Woman Creek (Table 5-16). These represent the greatest concentrations for groundwater that would flow into Woman Creek from the model area during high groundwater stages, when the creek is gaining water in the reach through OU 5.

These concentrations were calculated by extending the simulation period of the calibrated transport models by 30 years. The source loading obtained in the model calibration was treated as remaining constant for the 30 years, and the only input variable that changed was the duration of the simulation period. The use of undiminished source loading is conservative, because it neglects the possible effects of source depletion and decay.

Uncertainty Analysis - Uncertainty is caused by various attributes of the models. The hydrogeology conceptual model, while attempting to account for what is known about the OU 5 hydrogeologic system, may not actually reflect reality. Some uncertainty in the results of the groundwater flow and transport modeling is caused by uncertainty in the variables that must be input, including hydraulic conductivity, groundwater recharge, distribution coefficients, and dispersivities. The finite-difference approximation of the groundwater system also contributes to uncertainty, because the finite-difference representation of the system is much simpler than the real groundwater system. Additional uncertainty arises from the nonunique model calibration, which can be achieved with more than one set of values for the variables.

The uncertainty in the COC concentrations was accounted for by calculating worst-case concentrations for each COC. The worst case is represented by the greatest 30-year concentration at Woman Creek that is not improbable. This worst-case approach requires calculation of an upper limit for the concentrations at Woman Creek. The upper limit was calculated using statistical analysis. The general procedure was the following:

1. The plume that produced the greatest 30-year concentration at Woman Creek was identified.

2. Observation (target) wells near the axis of the plume were identified.

3. Where two observation wells were near the axis, the well nearest Woman Creek was selected for statistical analysis.

4. The 95-percent confidence interval for the mean of the reported concentrations of each contaminant was calculated.

5. The maximum likely concentration for each contaminant at the observation well was calculated by adding the confidence interval to the mean concentration.

6. The ratio of maximum likely concentration and mean concentration was calculated.

7. The MT3D model was run for each COC until its concentration at Woman Creek reached a steady state (would not increase whatever the duration of the model run).

8. The greatest steady-state concentration at Woman Creek was multiplied by the ratio calculated in Step 6, to produce the maximum likely concentration (i.e., the worst-case concentration).

In Step 1, the greatest 30-year concentration was chosen because it corresponds to the greatest risk. In Step 2, observation wells near the plume axis were selected because concentrations from such wells are more representative of the variation of maximum concentrations. In Step 3, more than one reported concentration is required for calculation of the 95-percent confidence limits for the mean. The 95-percent confidence interval for the mean was calculated using a sample variance and the t-distribution with a critical region of 0.025 (two-tailed test). This test is described in Dixon and Massey (1957).

Regarding Steps 4, 5, and 6, the 95-percent confidence interval is conservative because the probability of a measured concentration exceeding the upper confidence limit is only 2.5 percent, if the population is normally distributed. If no well in the plume had more than one concentration measurement, then the concentration of the well nearest the axis was multiplied by 10 to get the maximum likely concentration (Smith, 1989).

In Step 7, the steady-state concentration is equal to or greater than the maximum calculated 30-year concentration at Woman Creek. It also implies that the leading edge of the plume has intercepted the creek, so that the worst-case groundwater velocity is considered. Consequently, using the steady-state concentration is conservative.

Step 8 yields the worst-case concentration because the ratio of the maximum likely concentration to the calculated concentration is the same at any point in the steady-state portion of a plume. The results of the uncertainty analysis are shown in Table 5-17. The degree of uncertainty in concentrations that are related to human health risk is indicated by the differences in worst-case concentrations and greatest 30-year concentrations reported in Table 5-16. In general, differences are less than an order of magnitude.

5.3.2 Surface-Water Modeling

This section documents the surface-water chemical fate-and-transport model and parameters used, COCs analyzed, and the statistical results of the simulation models runs over multiple 30-year time periods.

5.3.2.1 Purpose

The objectives of the OU 5 surface-water modeling of the Woman Creek watershed are as follows:

- To characterize the general surface-water system of OU 5 using a semiregional-scale, surface-water, flow-and-transport model.
- To support the HHRA portion of the RFI/RI for OU 5. This was accomplished by simulating the transport of COCs from OU 5 to potential exposure points for human receptors under present and anticipated future site conditions and as needed for ecological receptors.
- To support the evaluation of potential remedial alternatives for the FS at OU 5.

5.3.2.2 Scope

The scope of the surface-water modeling is limited to providing simulated concentrations of the COCs detected within the OU 5 Areas of Concern (AOCs). Concentrations have been simulated at various points along the Woman Creek thalweg (line joining the deepest points of a stream channel), for which there are documented stream-gage and water-quality data. These points were chosen to calibrate the model to observed data.

Once calibrated, the surface-water model was used to simulate COC concentrations based on 30 different 30-year climatological time-series. The daily mean concentration of each of the time-series was determined for each of the COCs. From these 30 daily means, one mean concentration was determined for each COC. This process was performed for 11 COCs: americium-241, barium, copper, lithium, mercury, plutonium-239/240, strontium, uranium-233/234, uranium-235, uranium-238, and zinc.

5.3.2.3 Description of Modeled Area

Woman Creek Watershed - OU 5 is located within the Woman Creek drainage basin (Figure 5-18) which generally trends west to east. Although seasonal flows can be low, Woman Creek receives continuous flow from Antelope Springs Creek. Detention Ponds C-1 and C-2 are located within the eastern reach of the Woman Creek basin. Pond C-1 is located on the Woman Creek channel, whereas Pond C-2 is located off of the Woman Creek channel. Pond C-2 receives relatively minor local flow from its surrounding drainage basin. It receives the majority of its flow from the SID, located on the northern flank of the Woman Creek basin. Woman Creek drains OU 5 and discharges, via Mower Ditch, into Mower Reservoir. During periods of high flow, Woman Creek may discharge directly to Standley Lake.

The Smart Ditch, South Boulder Diversion Canal, Rocky Flats Lake, and Coal Creek are water storage and/or conveyance facilities located near the upper part of the Woman Creek watershed. Rocky Flats Lake collects irrigation flows from the Last Chance ditch for storage, before discharging into Smart 1 and 2 ditches. Flows conveyed eastward in the Smart 1 ditch are used to maintain water storage in the D-Series pond, located south of Woman Creek. A headgate on Smart 1 ditch allows irrigation flows to be diverted to Woman Creek. Records and information provided by the ditch operator indicate that water is rarely diverted to Woman Creek from Smart 1 ditch. South Boulder Diversion Canal (SBDC) flows across the Woman Creek watershed from north to south in an elevated, unlined earthen ditch. At the crossing with Woman Creek, the SBDC flows are carried over the creek in a metal flume. Leakage occurs from this flume with the SBDC contributing minor amounts of water to the drainage. Coal Creek is a natural drainageway flowing northeast, past the western edge of the Woman Creek watershed. At this point, the contributing watershed area of Coal Creek is approximately 15.1 square miles.

South Interceptor Ditch - The SID collects runoff from the southern industrial area and diverts it eastward to Pond C-2 (Figure 5-18). The Pond C-2 water is not discharged to Woman Creek but is pumped to the Broomfield Diversion Ditch (around Great Western Reservoir) approximately semiannually (DOE, 1992a).

The SID was constructed in 1980 to intercept surface runoff that previously entered Woman Creek. Since construction of the SID in 1980, Woman Creek has not received runoff directly from the southern part of the plant facility. Surface-water flow in the SID is intermittent and usually occurs only following precipitation events or snowmelt. When flow is low, water tends to pond in several low areas of the ditch. The SID begins approximately 200 ft east of the Ash Pits (IHSS 133), and extends for almost two miles to Pond C-2, passing through the Original Landfill (IHSS 115). The SID is approximately 4 to 8 ft in depth, and is unlined.

Areas of Concern - For HHRAs conducted at RFETS, onsite exposures will be evaluated in separate AOCs identified in the operable unit. AOCs are defined as one or several contaminant source areas that are in close proximity and can be evaluated as a unit in the HHRA. A detailed description of the AOCs and the associated IHSSs in OU 5 are presented in TM12 (DOE, 1995b).

Three AOCs have been identified in OU 5 (Figure 5-18) and are identified as:

- AOC No. 1 (AOC1) - The landfill area is located north of Woman Creek, and the SID passes through the lower part
- AOC No. 2 (AOC2) - The ash pits are located north of Woman Creek, and the SID begins east of this AOC
- AOC No. 3 (AOC3) - Contains the SID, Woman Creek, and Ponds C-1 and C-2

5.3.2.4 General Design

The surface-water model will contribute to the overall HHRA effort by simulating the fate and transport of COCs along several exposure pathways. The profile of surface-water pathways (Figure 5-2) illustrates the numerous potential mechanisms for human exposures. Storm-water runoff may transport contaminated soils to surface waters through erosion with subsequent transport to downstream receptors (DOE, 1994b).

The Woman Creek streamflow can be attributed to storm runoff from both rainfall and snowmelt, groundwater inflow, and inflows originating from irrigation ditches. Each of these sources has been included in the flow-and-transport model.

Surface-water and sediment-associated chemicals can be transported from sources located within the watershed, from groundwater inflows or from sediments located along the stream and reservoir bottoms. These chemicals are then transported during baseflow or highflow runoff events in Woman Creek. Dissolved chemicals can be transported in the water and sediment-associated chemicals can be transported with the sediment moved along the stream reaches.

5.3.2.5 Fate-and-Transport Model

Selection of Model Codes - The surface-water modeling of the Woman Creek watershed was done using the Hydrologic Simulation Program - Fortran, Version 10 (HSPF10) (Bicknell et al., 1993). The ANNIE program (Lumb et al., 1989) was used to manipulate meteorological and other types of data for input into the HSPF10 computer model.

The HSPF10 model was selected because of its flexibility and ability to be expanded to meet future project demands. HSPF10 permits simulation of branching, one-dimensional stream/reservoir systems, with groundwater simulation and pond simulation also available. The model is capable of simulating water and sediment budgets, water temperature, dissolved oxygen, biochemical oxygen demand (BOD), organic-nitrogen, ammonia-nitrogen, nitrate-nitrogen, organic phosphorus, dissolved phosphorus, pesticides, pH, CO_2, total inorganic carbon, alkalinity, plankton populations, arbitrary nonconservative constituents using a first-order decay function, and conservative constituents.

Verification of Model Codes - Verification is the process that demonstrates if the computer program correctly performs its stated mathematical capabilities (Brooks and Coplan, 1988). Code verification involves comparing numerical code results with analytical solutions (Cole and others, 1988). HSPF10 modules have been verified using empirical formulas and analytical solutions for the various processes being simulated (Crawford and Lindsey, 1966; Ambrose and Barnwell, 1989).

5.3.2.6 Model Capabilities

The HSPF10 computer modeling code is a comprehensive package for simulation of watershed hydrology and water quality. Figure 5-19 shows the hydrologic cycle components that are simulated using the HSPF10 model. HSPF10 is the only comprehensive modeling code of watershed hydrology and water quality that allows the integrated simulation of land and soil runoff with instream hydraulic and sediment/chemical interactions (Ambrose and Barnwell, 1989).

The surface-water flow in the model is treated as varying with time (unsteady). The basin geometry is input into the model, enabling simulation of "real-time" conditions. External variables are input as hourly values and the simulated results are output as daily values.

Precipitation and Runoff - Hydrologic simulation in HSPF10 is performed using moisture-accounting techniques initially developed in the Stanford Watershed Model (Crawford and Lindsey, 1966). This technique computes the movement of water into, between, and out of a set of conceptual storages using a fixed time-step. Figure 5-20 is a flow chart of the precipitation and runoff processes that are simulated in the HSPF10 surface-water code. Figure 5-21 is a schematic diagram showing the interrelationships between the precipitation, ground storages, evapotranspiration, surface runoff and streamflow. Rainfall and/or snowfall are subject to interception by vegetation. If the interception storages are full, water infiltrates into the soil layers (if not limited by the upper-zone storage capacity). Water that does not infiltrate the upper zone exits the system as surface or interflow outflows. Water that infiltrates the upper-zone storage and subsurface can then be routed into and/or through the upper-, lower-, and active-groundwater storage layers, based on the available capacities of those storage layers. If all of these storage capacities are exceeded, water leaves the system as active-groundwater outflow. Evapotranspiration is calculated for all of the storage layers before capacity exceedance is calculated.

Soil Erosion and Sediment Transport - Soil erosion from the watershed in HSPF10 is simulated as illustrated in Figure 5-22. Erosion can occur either because of particle detachment from rainfall impact and subsequent washoff, or as a result of rill and gully scour. Sediment transport along each stream reach is intended to simulate the transport, deposition, and scour of inorganic sediment in free-flowing stream reaches and mixed reservoirs.

Stream and Pond Hydraulics - Flow routing is modeled using the catchment-stream network technique, which is divided into separate calculations for reaches and flow routes that proceed from upstream to downstream. The stream network can be of any complexity, including flows that are split and later recombined downstream. Impoundments (ponds, lakes, and reservoirs) also are included, although HSPF10 assumes such impoundments to be completely mixed; that is, stratification is not modeled. The site reservoir modeled in this study, Pond C-1, has been determined to be fully mixed based on its depth and turnover ratio (Appendix A).

Contaminant Fate and Transport - Several important mechanisms affect the chemicals being modeled, including partitioning between dissolved and particulate phases, interactions between chemicals in the water column and the sediment bed, and any of a number of chemical-specific decay-flux processes, such as volatilization, biodegradation, and oxidation. Figure 5-23 is a flow chart of the pollutant-fate processes that are simulated in the HSPF10 surface-water model.

5.3.2.7 Model Structure

This surface-water model includes the Woman Creek segments and contributing watershed beginning at the upper end of the watershed extending east to Indiana Street (Figure 5-24). The model uses both pervious land modules and stream-reach/reservoir modules to simulate the total Woman Creek surface-water system. The regional model may be expanded in the future to include Woman Creek segments downstream of Indiana Street and/or other watersheds for investigations other than the OU 5 RFI/RI.

Six pervious-land basins and five stream and/or reservoir segments, or reaches, were used to model the Woman Creek watershed (Figure 5-24). Table 5-18 describes the geometric properties of the basins and stream/reservoir reaches used in the HSPF10 model. Beginning at the upstream end of the watershed and moving eastward, reach 1 extends east to the South Boulder Diversion Canal. Reach 2 extends to the west boundary of the RFETS at surface-water monitoring sites GS05 and GS06. Reach 3 extends to the confluence of Woman Creek with Antelope Spring

Creek. Reach 4 extends to GS17 (upstream of Pond C-1). Reach 5 extends to the outlet of Pond C-1 at GS07, and reach 6 extends to Indiana Street at GS01 and GS02.

The stream reaches and contributing pervious-land basins were set up to allow calibration of the water-balance portion of the model at the gaging-station sites located at the downstream end of each stream reach. These were also used for the calibration of the sediment transport portion of the model based on sediment deposition into Pond C-1.

5.3.2.8 Climatological Conditions

The following hourly climatological data are needed for the HSPF10 modeling application:

- Total precipitation depth
- Mean air temperature
- Mean dewpoint temperature
- Mean wind speed
- Total solar radiation
- Mean evaporation rates
- Potential evapotranspiration rates

For this modeling-application use, these specified daily records for the period from July 1989 through April 1994 have been compiled into daily values (Appendix A). All data, with the exception of the evaporation and evapotranspiration rates, were recorded at the RFETS west buffer-zone meteorological station (W. MetSta). The basic data were recorded in 15-minute increments using an automated meteorological recording system. This system consists of individual recording devices that relay the data to a data logger, which has a one-way telemetry link to a computer database located on the site.

The data obtained from the W. MetSta had the date, time, and all six meteorological parameters on a single line delimited by commas. These data were reformatted through the creation of a separate computer code in order to format the data for input into the Watershed Data Management (WDM) file. The comma-delimited file was first converted to a space-delimited format. The six parameter, space-delimited, 15-minute-interval file was then converted to six separate, space-delimited, 15-minute-interval files with a format compatible with the WDM input requirements.

Upon entering the files into the WDM it was discovered that significant data were missing and that much of the data were "out-of-range." Therefore, the files were then manually edited by inserting missing data with appropriate data from a similar, adjacent time period. The out-of-range data were revised as required.

Precipitation - The basic data for precipitation were recorded as total accumulated depth in inches over a 15-minute interval. These raw data were aggregated into an hourly time-series sequence for use as input into the HSPF10 computer program. These data were then plotted in order to check for missing and out-of-range values. Missing data were manually added, based on the data available from the tables of daily precipitation values obtained from the W. MetSta for the NPDES Stormwater Discharge Permit Application report (ASI, 1993). The hourly values were further aggregated to daily values and tables were generated for the daily precipitation values (Appendix A). Table 5-19 provides a summary of monthly and annual precipitation at the RFETS from 1971 through 1994.

Air Temperature - The basic data for air temperature were recorded as the mean temperature in degrees Celsius (°C) over each 15-minute interval. These raw data were converted to degrees Fahrenheit (°F) and aggregated into a mean hourly time-series sequence for use as input into the HSPF10 computer program. These data were then plotted to check for missing and out-of-range values. Missing data were manually inserted by copying data from an adjacent day and corresponding time period. Out-of-range data were determined to be air temperatures that are higher than 122°F or less than minus 58°F. No out-of-range data were found. All adjusted data were checked for reasonableness. The mean hourly values were aggregated to maximum and minimum daily values and tables were generated showing daily maximum and minimum air temperatures (Appendix A).

Dew-Point Temperature - The basic data for dew-point temperature were recorded as the average dew-point temperature in degrees Celsius over each 15-minute interval. These raw data were converted to degrees Fahrenheit and aggregated into a mean hourly time-series sequence for use as input into the HSPF10 computer program. These data were then plotted in order to check for missing and out-of-range values. Missing data were manually inserted by copying data from an adjacent day and corresponding time period. Out-of-range data were determined to be dew-point temperatures that are higher than the corresponding air temperature or less than minus 58°F. These values were edited to be equal or slightly less than the air temperature. All adjusted data were checked for reasonableness. The mean hourly values have been further aggregated to maximum and minimum daily values and tables have been generated showing daily maximum and minimum dew-point temperatures (Appendix A).

Wind Speed - The basic data for windspeed were recorded as the average horizontal wind speed in meters per second over each 15-minute interval. These raw data were converted to miles per hour (mph) and aggregated into a mean hourly time-series sequence for use as input into the HSPF10 computer program. These data then were plotted in order to check for missing and out-of-range values. Missing data were manually inserted by copying data from an adjacent day and corresponding time period. Out-of-range data were determined to be mean 1-hour wind speeds higher than 75 mph. No out-of-range data were found. All adjusted data were checked for reasonableness. The mean hourly values were further aggregated to mean daily values and tables were generated showing the daily mean of wind speeds (Appendix A).

Solar Radiation - The basic data for solar radiation were recorded as the average solar radiation in watts per square meter over each 15-minute interval. These raw data were converted to langleys per hour and aggregated into a mean one-hour interval time-series sequence for use as input into the HSPF10 computer program. These data were then plotted in order to check for missing and out-of-range values. Missing data were manually inserted by copying data from an adjacent day and corresponding time period. Out-of-range data were determined to be a mean hourly solar radiation rate higher than 1000 watts per hour. The out-of-range data were examined, found to be reasonable, and left unchanged. All adjusted data were checked for reasonableness. The mean hourly values were aggregated to mean daily values and tables were generated showing the daily mean for solar-radiation rates (Appendix A).

Evaporation - The monthly mean data for evaporation rates were calculated by Andis Berzins (EG&G, 1993d), based on observed data from the Great Western Reservoir, located approximately one mile northeast of the Woman Creek drainage basin. These data were provided in in. per hour for each one-month interval between October 1991 and September 1992. These mean monthly values were disaggregated into mean hourly evaporation rates for use in the HSPF10 computer program. Summary tables have been generated showing the daily mean rates of evaporation (Appendix A).

Potential Evapotranspiration - Because data for potential evapotranspiration were not available from the MetSta, the required mean hourly time-series sequence was developed using the available meteorological data as input to the code (Kiusalaas and Kunkel, 1993). The input parameters were air and dew-point temperature, solar radiation, and wind speed. These parameters were downloaded from the WDM as four, 3-year, 1-hour time-series and then each time-series was divided into three 1-year time-series. The four variables were then combined into one time-series for each of the 3 years and reformatted to become the input data. The three resultant 1-hour time-series of evapotranspiration were reformatted, then combined into one 3 year time-series and input into the WDM. Summary tables have been generated showing the daily mean rates of evapotranspiration (Appendix A).

5.3.2.9 External Inflows

It has been determined that lateral inflows of groundwater are entering the Woman Creek watershed from sources that located outside the watershed boundaries (EG&G, 1995c). Based on inspections of topographic maps (USGS, 1971, 1979 and 1980), it was determined that the Rocky Flats Lake, SBDC and Coal Creek (Figure 5-24), which are all located upgradient of Woman Creek, can contribute water to the alluvium. This contributory water later appears as surface-water runoff in Woman Creek.

A time-series plot of surface flows was developed from gain/loss flow measurements at Station 13, located on Antelope Spring Creek immediately upstream of its confluence with Woman Creek (Fedors and Warner, 1993). Monthly flow-rate measurements taken January through December during 1992 and 1993 were averaged and the results plotted (Figure 5-25). A time-series sequence of mean daily values was developed by interpolating between the monthly values. The annual recorded precipitation in 1992 was 13.7 in. and in 1993 was 11.7 in.; slightly less than the median value of 13.9 in. between 1971 and 1994 (Table 5-25). This precipitation time-series sequence was duplicated and used to represent all years used during both the model calibration and the 30-year simulation period. The Antelope Spring Creek time-series sequence was added to Basin 4 as surface inflow.

Hydrographs of the water levels in wells 1989 (Antelope Springs Creek), 2689 (Woman Creek) and 5386 (South Woman Creek) (Figures 5-26A through C), and the surface level of Rocky Flats Lake (Figure 5-27) were developed, and the seasonal trends were found to be similar. This would indicate that the inflow of groundwater is relatively uniform throughout the upper part of the Woman Creek watershed near the western boundary of the RFETS. Therefore, the Antelope Spring Creek time-series sequence was added to Basins 2 and 3 as a source of lateral inflow of groundwater.

The SBDC passes through the upper part of Basin 2, delivering water from Gross Reservoir, located north and west of the RFETS, to Arvada Reservoir, located south of theRFETS. The headgate records indicate the time periods that the ditch is carrying flow and the dry periods. No stage or flow data were obtained. These records were obtained from the Denver Water Board (DWB, 1994). The exfiltration rate from the ditch to the groundwater was determined to be 0.06 in. per hour during the periods with flow and zero when the ditch was dry. This time-series sequence was added to Basin 2 to represent a source of lateral inflow of groundwater.

The uppermost part of the Woman Creek watershed extends approximately 1.6 miles west of Highway 93 (Figure 5-24) to the foothills at the point where Coal Creek flows into the plains area. The stream-gage records for Coal Creek (Coal Creek near Plainview, No. 06730300) were obtained from the Colorado Water Resources Division on November 15, 1994 for water years (WY) 1986 to 1993. These data were used to develop an average annual time-series sequence to be used for all of the future simulation years as representative of lateral groundwater inflow into Basin 1. Figure 5-28 shows the 1986 to 1993 average, mean daily discharge for Coal Creek at the Plainview gaging station.

5.3.2.10 Soils

One of the most important factors that influence the sediment transport processes is surface-soil grain size. Grain-size analyses were performed by Colorado State University (CSU) on 115 surface-soil samples collected from OU 2, OU 5, and OU 6 during the Phase II OU 2 RFI/RI (EG&G, 1995c). Results indicate that 49 percent of grains from the samples have diameters greater than 100 microns (μ), 22 percent of grain sizes are between 10 and 100 μ, and 30 percent of grain sizes are less than 10 μ.

In the Unified Soil Classification System, particles smaller than 74 μ are considered to be fines (silt or clay). Thus, a high percentage of surface soils in the area are fine-grained soils. Fine-grained surface soils are more easily transported by runoff than are coarser-grained soils. The high percentage of clay also provides a larger surface-to-volume ratio, which allows more adsorption sites per volume of soil than does a coarser-grained soil. The higher capacity for adsorbed contaminants results in a higher potential for contaminant migration.

5.3.2.11 Chemicals of Concern

PCOCs are those metals or radionuclides whose concentrations exceed a statistical screening above background concentrations, and VOCs whose concentrations exceed the reported detection limits. The COCs used in this OU 5 surface-water model have been identified in TM11 (DOE, 1995a). These COCs can be found in one or more media, such as surficial soils, groundwater, surface water, pond sediments and stream sediments. For the purposes of the HSPF10 model, the COCs found in surface water and stream/pond sediments have been modeled.

A total of 11 COCs have been identified for inclusion in the HSPF10 fate-and-transport model (Table 5-20). These chemicals have been grouped into four different sets of three (or two), based on their general geochemical behavior and the media in which they are found.

Surface-Water COCs - Six of the 11 COCs were detected in the surface water sampled in Woman Creek:

- Barium
- Lithium
- Strontium
- Americium-241
- Uranium-233/234
- Uranium-238

Barium, lithium, and strontium are COCs for surface water only. These elements are also alkaline or alkaline-earth metals, with similar geochemical behavior. Therefore, these COCs have been grouped together as Group 1 for calibration and HSPF10 simulation purposes. The remaining COCs in the list are found in several media, as shown in Table 5-20.

<u>Sediment COCs</u> - Eight of the 11 COCs were detected in the pond and stream sediments sampled in Pond C-1 and Woman Creek, respectively:

- Copper
- Mercury
- Zinc
- Americium-241
- Plutonium-239/240
- Uranium-233/234
- Uranium-235
- Uranium-238

Copper, mercury, and zinc are all metals that are found in Woman Creek stream sediments (mercury and zinc are also found in Pond C-1 sediments). These three COCs have been grouped together as Group 2 for calibration and HSPF10 simulation purposes. Americium-241 and plutonium-239/240, both of which are radionuclides, are found in pond and stream sediments and have been included in Group 3. Uranium-233/234, uranium-235 and uranium-238 are radionuclides that are found in Pond C-1 sediments, and have been included together in Group 4.

Source Terms - Source-term concentrations were calculated for both the calibration and simulation of the COC concentrations in surface water. Table 5-20 provides a listing of the COCs and indicates the media in which the chemical has been detected. For the model calibration, the COCs associated with surficial soils were used as source-term data. Groundwater inflow concentrations were checked and it was found that groundwater did not appear to be contributing surface-water COCs to the flow regime. For the data to be used as a calibration source-term value, the following criteria must be satisfied:

- Source-term media must be located upstream of the COC media (observed target-data).
- The source-term data must have originated within an AOC.
- The data must have been collected as part of the OU 5 FSP.

Each source-term value was calculated as a mean concentration of a COC within the associated sub-basin. The Thiessen polygon method was used to determine the area of influence for each sampling location within the AOC. The remainder of the watershed was assumed to have a zero concentration of each COC. An area-weighted concentration for each COC located in each watershed sub-basin was calculated for input into both the calibration and simulation models.

For the purposes of the HSPF10 model calibration, the source terms were calculated with the assumption that the SID was in-place and functional. Therefore, in the landfill (AOC1), only the COCs located south of the SID were included in the calculations. Conversely, in the ash pits (AOC2) and in Woman Creek and Pond C-1 (AOC3), all the observed COC concentration data were used in the computation of source terms contributing to the observed concentrations found in Woman Creek and Pond C-1.

For the purposes of the HSPF10 future-concentration model simulation, the source terms were calculated assuming the SID had been abandoned. The COC concentrations north of the SID, within the landfill area (AOC1), were included in the composite source-term calculations. This assumption will permit surface runoff and any associated contaminants to drain south into Woman Creek during the 30-year simulation runs.

5.3.2.12 HSPF10 Model Calibration

Calibration of the HSPF10 computer model is required before the model can be reliably used for simulation purposes. The model was calibrated to past observed conditions for which 6 months of continuous data were available. The following sections describe the targets, procedures, and results of the model calibration process.

Calibration Targets - Three documented hydrologically dependent conditions were calibrated:

- Water budget
- Sediment transport
- Concentrations of COCs

These conditions were modeled in individual modules and each process was calibrated in the above-listed sequence to systematically calibrate the entire model.

Water Budget: Calibration Targets - The observed hydrograph data and the associated rating curve equations for gage station GS01, GS02, GS05, GS06, GS07 and GS17 were obtained from EG&G-SWD. Table 5-21 lists each gage station, its general location, the type of flow-recording device in-place, and the rating equation for depth versus flow. The data were plotted and reviewed for reasonableness. Each gage station was found to have missing and erroneous data at various times throughout the stream-gaging periods. Based on the reliable data available, the watershed mass-balance and hydrograph shapes were calibrated for the period beginning on April 9, 1993 and ending on September 26, 1993.

A field investigation revealed that the corrugated metal culvert carrying Woman Creek flows under Indiana Street (GS01) had a high point in the middle resulting in 0.29 ft of ponded water upstream of the invert of the culvert. The rating curve was analyzed and found to be accurate for stages of 2 ft or more, and incorrect for stages less than 2 ft.

Therefore, the hydrograph data obtained for GS01 had to be adjusted using a 0.29-ft stage shift and a revised rating curve. No associated stage data were available because the flows were adjusted by EG&G without corresponding stage adjustments. Therefore, the stage for each associated flow had to be determined mathematically from the rating-curve equation (EG&G, 1994d). A polynomial equation was developed for the existing rating curve data. By substituting the flow value into the equation, the corresponding stage was determined. That stage was then decreased by 0.29 ft and all negative stage values were set to zero. A new rating curve was developed and a polynomial equation was developed for that rating curve. The revised hydrograph values were obtained mathematically using the revised stage values in the new rating-curve equation. The resultant hydrograph values are approximately half of the previous values.

The rating curve for GS02 was analyzed and found to be inaccurate for low stages. The same procedure used for GS01 was used to revise the GS02 rating curve. The revised hydrograph for GS02 was combined with GS01 and used as the target for calibration of Woman Creek. The remaining gage-station data were reviewed and found to be reliable for use in calibrating the water-balance portion of the HSPF10 model.

Sediment Transport: Calibration Targets - Empirical data for total suspended sediment (Table 5-22) along Woman Creek and for the total accumulation of pond-bottom sediments within Pond C-1 were chosen as calibration targets for the sediment transport portion of the HSPF10 model. Data used for calibration included total suspended sediment values measured during the OU 5 field-sampling phase of the Phase I RFI/RI and total suspended sediment values measured in high-flow samples collected during other RFETS programs (EG&G, 1994e). The calibration time-period was expanded from the 6 months used for water mass-balance to 7 years for the sediment transportation. Three pond-bottom sediment core samples were taken on November 5, 1992; two of which had core depths of 6 in. and one that had core depths between 6 and 12 in. The average accumulated sediment in the bottom of Pond C-1, since the pond was constructed in 1973, was estimated to be 8 to 10 in. Therefore, over the 20-year period that Pond C-1 has been in operation, the average sediment accumulation was calculated to be approximately 0.4 in. per year, or roughly 3 in. in a 7-year period.

Water Quality: Calibration Targets - Table 5-20 provides a listing of the COCs and indicates the media in which the chemical has been detected. For the model calibration, the concentrations of COCs associated with both surface-water and stream/pond sediments were used as observed target data. Each target concentration was calculated as a mean concentration of a COC within the associated watershed sub-basin. To determine the area of influence for each sampling location along Woman Creek (AOC3), an average stream width of 5 ft was used, and the stream length was measured from topographic maps. An area-weighted concentration for each COC located in each watershed sub-basin was calculated for input into both the calibration, and simulation models. For the three pond-bottom sediment samples, the arithmetic average of the observed concentrations was calculated for use as the observed target values.

<u>Calibration Procedure</u> - A surface-water, flow-and-transport model is generally calibrated by adjusting a set of model parameters to produce simulated flows, total suspended sediment concentrations, and chemical concentrations that match field-measured values within a quantifiable range of error or within reasonable limits. There are basically two ways of adjusting model parameters to achieve calibration:

- The manual trial-and-error adjustment
- The automated parameter estimation

Calibration of the HSPF10 computer model for the Woman Creek drainage basin was achieved using the manual trial-and-error method.

Water Budget: Calibration Procedure - The flow module was calibrated by isolating each of the six sub-basins and achieving a mass-balance within each sub-basin while using the observed hydrograph data from the upstream basins as inflow and the observed hydrograph data at the outflow point as the calibration target. After the individual sub-basins were calibrated, the model was restructured allowing the simulated outflow of each upstream basin to be the inflow to the adjoining downstream basin.

Two methods were used for comparing observed data to simulated flow rates and mass-volumes:

1. Quantitative comparisons - The simulated mean daily flows and observed flows were each summed to obtain the total simulated and observed mass-volume at each calibration location for the 6-month period (April to September 1993). The percent differences between the observed and simulated results were then calculated for each location.

2. Qualitative comparisons - The time-series sequences of observed and simulated hydrograph data were plotted and the results were compared to determine the similarities or differences in the data. Specifically, the magnitude and temporal location of the hydrograph peaks were compared.

The simulated hydrograph shape and peak flow rate were adjusted only after the simulated mass-balance was found to be within 25 percent of observed values.

Sediment Transport: Calibration Procedure - After the flow models were calibrated and integrated into a single model, the sediment calibration was performed. The first sediment calibration procedure was to approximate the estimated 3 in. of sediment accumulation to have occurred in Pond C-1 during the last 7 years. The 7-year timeframe was chosen based on the greatest length of site-specific, continuous meteorological data that was available without significant data gaps. It is imperative to obtain the greatest length of time available, because the bulk of sediment can accumluate during a very few, widely separated, high-intensity precipitation events. It is also important to use site-specific data when available.

The 7-year time period covers the dates of January 1, 1986 through December 31, 1992. Data for 1993 were not included because a full year of data were not available at the time of calibration. Full years only were used in the sediment calibration because the sediment transport is seasonally dependent, and estimation errors are likely to occur when extrapolating incomplete years to a complete year. Furthermore, the start and end dates of the year should occur during a relatively inactive period, that is, when little or no rainfall occurs.

Simulated sediment accumulation in Pond C-1 was compared against the sediment target and sediment transport parameters were adjusted to bring the simulated sediment budget within

10 percent of the target sediment budget. The significant parameters used to calibrate the sediment processes for the pervious-land basins are:

- Soil detachment by precipitation
- Soil scour due to precipitation
- Soil washoff due to precipitation

The significant parameters used to calibrate the sediment processes for the stream reaches are:

- Settling velocity of the sediment particles
- Critical shear stress of particles for resuspension of bed sediments
- Critical deposition stress for deposition of suspended sediments

After the sediment accumulation approximated the target accumulation, the frequency and magnitude of the sediment transport was calibrated. The timeframe chosen for this portion of the calibration was the same as the flow calibration, May to September 1993. This period encompasses the only three sampling events when total suspended sediment in Woman Creek was measured during high-flow events. The observed values in stream reaches 2, 3 and 4 were used as the calibration target values. The total suspended sediment values in stream reach 6 (downstream of Pond C-1) have been influenced by the detention effects by Pond C-1, and therefore, stream reach 6 was not considered in the sediment calibration.

The parameters used to adjust the frequency and magnitude of the simulated total suspended sediment in the Woman Creek stream reaches are the same as those used in the accumulation calibration. Total suspended sediment calibration involves adjusting HSPF10 model sediment parameter values until the simulated total suspended sediment concentrations for both relatively small and large storm events adequately approximate the observed concentrations on target dates. This procedure is based on the fact that the sediment source of the total suspended sediment in a stream reach will vary based upon the size and intensity of the storm event. That is, small storm events have a tendency to generate total suspended sediment by scouring the stream bed, while receiving little washoff from the pervious-land basins. Conversely, during larger storm events, contributions from pervious-land basins to total suspendended sediment increase significantly. Therefore, the ratio of sediment load from the basins to the sediment scoured from the reaches was adjusted until the proper sediment magnitude and frequency were reached. The two calibrations methods discussed in this section were then iteratively repeated until both sediment calibration targets were satisfied.

Water Quality: Calibration Procedure - The water-quality calibration of the OU 5 surface-water model was accomplished using two distinct methods. These calibration methods are analogous to the methods used in the sediment model calibration, where the calibration target values were total sediment accumulation in Pond C-1 and point total suspended sediment values as measured in the water column. This relationship is explicit, because the COCs are considered to be closely associated with sediments. In the case of fate and transport of constituents, the calibration targets are:

- Concentration values of bed-sediment-associated constituents in Pond C-1 accumulated since source placement

- The average values of the suspended-sediment-associated and dissolved constituents in the stream reaches

The first calibration method involves simulating the fate and transport of a constituent from an upgradient source area to a downgradient depositional area, where the resulting depth and concentration of the constituent are known. This method is useful for the initial calibration of the fate-and-transport parameters for the model, and for a gross characterization of the system. The second method involves fine-tuning the water-quality calibration parameters, to simulate the actual water-quality concentrations as closely as possible.

The actual accumulation calibration was performed by simulating the deposition of the COCs currently present in AOC3, by using AOC1 and AOC2 as the constituent sources. Water-quality, fate-and-transport parameters were adjusted until the concentrations simulated for AOC3 reasonably matched the existing concentrations present in AOC3, as determined by field sampling. The following assumptions are inherent in the calibration:

- Any COCs currently present in AOC3 are the result of transport from AOC1 and AOC2, and are not attributable to any other source term
- The length of time from source placement to sampling date of the calibration target can be reasonably estimated
- The model input and boundary conditions used for the simulations represent the actual conditions present during the time from source placement to measurement date
- The source term is constant and not depleted

The water-quality calibration was performed on both a 7-3/4-year and 30-year timeframe. The 7-3/4-year timeframe selected was the same period used in the sediment-transport calibration, with the meteorological data extended three-quarters of a year to include dates when storm-event total suspended sediment measurements were taken for OU 5. The period of January 1, 1986 to September 30, 1993 was the primary calibration period, because the data are site-specific to the RFETS.

Thirty-year meteorological data sets, generated for use when running simulations for the HHRA and discussed in the section, were also used during the water-quality calibration as a qualitative calibration check. It was determined that the 30-year sets could function in this capacity because source placement is thought to have occurred between 20 and 43 years ago. It is fairly certain that no source existed prior to the opening of Rocky Flats Plant in 1952.

It is also assumed that a significant amount of the source-term material was in place 20 years ago. This is the estimated point in time at which the Original Landfill and incinerator had been operating for approximately 20 years. Using 30 years as the source-placement timeframe yields a 70 to 150 percent uncertainty of the source initiation. This range is well within the criteria required for a qualitative calibration check.

The simulated concentrations in Pond C-1 were compared against the bed-sediment concentration targets when calibrating with the 7-3/4-year set, and the water-quality and sediment-transport parameter values were adjusted to bring the simulated concentrations to within 25 percent of the target concentrations. The 7-3/4-year simulation period is roughly 25 percent of the 30-year, source-term-placement time period. The significant parameter used in calibrating the quality processes are the adsorption/desorption rates of the constituents. Other parameter values, such as partition coefficients (K_d) (Table 5-23) or quantity of constituent associated with transported sediment are either calculations, field measurements, or literature values.

It is assumed that all modeled COCs are sediment-associated, although they may exist in the dissolved state during water-quality processes. That is, hydrolysis, oxidation, first-order decay, and biodegradation, are not considered relevant for the OU 5 COCs.

Once the simulated bed concentrations approximated the observed results, the suspended-sediment water-quality concentrations and dissolved water-quality concentrations were calibrated. Because adsorption/desorption was the only water-quality parameter used in the calibration, the adjustment of simulated dissolved concentrations directly affects the bed-associated concentrations (i.e., increasing the water column concentrations will decrease the bed concentrations). The calibration of the dissolved constituents was performed to further define the ratio of pervious-land sediment washoff to sediment scour from the stream reaches. For example, using a high-desorption value for a constituent results in much of the transported constituent leaving the OU 5 system in the dissolved flow. This fate then requires the transport of greater amounts of sediment from the source areas to achieve the target concentration in the bed sediments of Pond C-1. If, during the iteration between adsorbed and dissolved concentration calibrations, a realistic simulation of both concentrations could not be obtained, it was necessary to return to the sediment calibration to adjust the pervious-land washoff (constituent source) and stream scour (clean sediments) ratio. In this manner, the calibration loop for the bed concentration, water-column concentration, sediment accumulation, and total suspended sediment was iteratively performed until all three calibrations were satisfied.

After calibration was completed, the model was run using the 30-year meteorological data sets as a qualitative check. High-intensity precipitation events were investigated to determine if the resulting maximum water-quality concentrations are reasonable and if the means/medians of the 30-year data sets approximate the measured values.

Calibration Results - The results of the HSPF10 model calibration for the water budget, sediment transport and water quality modules are presented in this section. The individual modules have been calibrated to achieve the best correlation to observed data for that module, while balancing the calibration results of the other two modules within as narrow a range as possible.

Water Budget: Calibration Results - Figures 5-29A through D show the calibration hydrographs at each of the gage stations along the mainstream of Woman Creek. The individual hydrographs of the simulation runs and observed gage-station flow data were quantitatively and qualitatively compared.

The quantitative results for each sub-basin analyzed have been shown in the respective figures and tabulated in Table 5-24. The comparison of the total observed and simulated mass-volumes indicates that the model under-simulates the volume by 25 percent at GS05 and over-simulates the volumes by 22 percent at GS02. The under-simulation of volumes at GS05 reflects the approximately 250,000 cubic-ft of observed flows during the May 15 to May 26, 1993 time-period, which are considered to be over-estimated due to instrument error. The overall mass-balance is considered satisfactory.

The temporal spacing of the simulated storm peaks compares favorably with the observed storm peaks. However, for the April 13, 1993 storm event, the magnitudes of the peak flows are under-simulated, whereas the peak flows for storms during the time period from June 20 to September 15, 1993 are over-simulated.

Sediment Transport: Calibration Results - The calibration results for the 7-year, bottom-sediment accumulation for Pond C-1 are summarized in Figure 5-30. The simulated depth of 0.25 ft represents 100 percent of the target accumulation goal of 0.25 ft, as discussed in Section 5.3.2.12.

It was not possible to precisely calibrate to a specific target value, because the range of sediment accumulation in Pond C-1 has been estimated at 0.66 to 1.0 ft. Any calibration within the calculated target range could be considered valid. Therefore, the final calibration value was determined when the sediment module was modified to be calibrated to observed total suspended sediment values.

Observed and calibrated total suspended sediment values for reaches 2, 3 and 4 of Woman Creek are shown in Figures 5-31A through 5-31C. The average values for the reaches were also calculated, because measured total suspended sediment values are highly variable and dependent upon location of the sampling site. Therefore, an average daily total suspended sediment value for all of the stream segments combined was considered in the calibration. The average observed and simulated total suspended sediment values for Woman Creek stream reaches are presented in Figure 5-31D. The average total suspended sediment values were used to objectively finalize the sediment calibration parameters. When each reach was individually calibrated, there still existed some latitude in determining the final calibration parameters for the system as a whole. At this point, the sediment calibration parameters were adjusted to best match the average observed total suspended sediment, without significantly affecting the individual reach calibrations.

Reaches 5 and 6 of the model were not directly calibrated to observed values. Pond C-1 (reach 5) was not sampled for total suspended sediment during storm-event sampling. Because storm-event total suspended sediment values are the primary calibration criteria, this reach was limited to a qualitative comparison of estimated "baseflow" total suspended sediment values. Similarly, the four sampling locations that are situated in reach 6, were not sampled during storm events, and therefore, can not be reliably used for sediment calibration.

This lack of observed total suspended sediment data for reaches 5 and 6, however, is not critical to the calibration of the sediment model. Pond C-1 is highly efficient in functioning as a sediment trap, and is not expected to discharge any significant amount of suspended sediment. Also, because reaches 2, 3, and 4 were calibrated using the same sediment calibration parameters (as opposed to using different initial and/or boundary values for each reach), reach 6 was calibrated using the same sediment calibration parameters.

The final simulated total suspended sediment peaks, shown in Figures 5-31A through D, are somewhat lesser in magnitude than in the original total suspended sediment calibration, because the sediment calibration is ultimately dependent upon the water-quality calibration. This adjustment was required to adequately calibrate the simulated COC water-quality concentrations. The calibration is considered within the range expected of sediment transport models.

Water Quality: Calibration Results - Water-quality calibration was performed for data collected over 7 years; the results are depicted graphically on Figures 5-32A1 through 5-32C2. Additionally, qualitative checks were performed to scrutinize the model's response to large precipitation events. This check was accomplished by using a few of the 30-year data sets developed for the HHRA simulations as input to the model, and obtaining a mean of the predicted concentrations for all COCs.

The construction of the SID during the middle of the estimated accumulation period for pond sediments complicates the calibration process. It is impossible to quantify the degree of accumulation of COCs in the sediments of Pond C-1 before the SID construction and compare it to the accumulation in the pond after the SID construction. The 7-year calibrations, that are extrapolated to 30-year estimates, were performed with the SID in place for the following reasons:

- The observed target values for the water column were measured with the SID in place
- The flow and sediment models were calibrated to the period after construction of the SID
- Water quality "calibration" derived while excluding source areas north of the SID produces conservative concentration values

The fate and transport of mercury was not calibrated, because the observed source area for mercury is insufficient to produce the required target value in Pond C-1. Because mercury is highly volatile, the source area would begin to deplete itself immediately after placement. Therefore, the sampled source-area measurements for mercury are considered unreliable for use as a calibration source term.

Parameter values for mercury were obtained by using the parameters of calibrated COCs whose behavior during fate-and-transport processes would best approximate that of mercury. Given the COCs investigated in this project, copper or zinc are the most similar in behavior to mercury (EG&G, 1995g). Because the copper and zinc were calibrated to identical parameter values, these same values were used for mercury during the simulations for the HHRA.

The observed COC concentrations, along with the results of the 7-year simulation period (with the SID in place), the extrapolated 30-year simulation results (with the SID in place), and the extrapolated 30-year simulation results (without the SID in place) are listed in Tables 5-25 and 5-26 for the 4 COC groups considered. For Group 1, there is no target for the streambed sediment, because these constituents are not COCs for that medium.

The results for the 7-year simulation were multiplied by 4.28 to estimate the sediment accumulation for a 30-year period with the SID in place. Concentration estimates for a 30-year period without the SID in place were estimated by multiplying the previous results (i.e., 30 years with the SID) by 1.5 times the quotient of the source concentration north of SID divided by the source concentration south of SID. This ratio represents a source area upgradient of the SID that is 1.5 times greater in size than the area downgradient of the SID, along with its respective change in COC concentrations.

The "7-year with the SID" scenario represents the condition with the minimum simulated concentrations and the "30-year without the SID" scenario represents the condition with the maximum simulated concentrations. The simulated concentrations for the bottom-sediment quality were compared to the observed COC concentrations and reported as a percentage of the observed concentration. Because the simulated concentrations for each stream reach and each COC group vary greatly, a mean of all percentages was determined (see Table 5-26). The mean of these percentages brackets the observed concentrations listed in Table 5-26.

The mean water-column and sediment-associated calibrations are within plus or minus one order of magnitude, which is sufficient resolution for the HHRA. The mean 7-year simulation of the water-column COC concentrations for individual COCs ranged from 0.3 percent to 48.3 percent, with a mean estimation of 22.8 percent of observed concentrations (see Table 5-25). For streambed-associated COCs, the mean of the "7-year with the SID" and "30-year without the SID" simulation ranged from 63.4 percent to 781.8 percent of the observed concentrations (see Table 5-26).

A review of the percent differences between simulated and observed concentrations in the Pond C-1 water column reveals that Group 3 COCs are under-simulated by 2 to 3 orders of magnitude.

The simulated americium-241 and plutonium-239/240 activities in Pond C-1 were not increased for the following reasons:

- The adsorption/desorption parameters for Group 3 are set at the lowest possible values, thus maximizing accumulation in bed sediments

- The adsorption/desorption parameters for Group 2 metals, which are over-simulated in bed concentrations, are set at their highest effective value, thus minimizing simulated bed concentrations

- Sediment accumulation in Pond C-1 is already simulated at the permissible upper range of the estimated sediment target value

An attempt to increase the simulated, bed-load activities of americium-241 and plutonium-239/240 would result in unrealistic behavior of the entire, simulated sediment/water system, given the three factors listed above.

5.3.2.13 Fate-and-Transport Modeling

The final task of the OU 5 modeling was to estimate the future concentrations of COCs along Woman Creek in support of HHRA for the OU 5 RFI/RI. This involved estimating long-term average concentrations of COCs in the stream flow, sediment in the Pond C-1, and in Woman Creek at Indiana Street. These estimates were based on the results of thirty 30-year simulations. This section discusses the generation of thirty 30-year meteorological data series and the results of the 30 HSPF10 simulations.

<u>30-Year Time-Series</u> - The 30-year climate data generated by the CLIGEN model (Nicks, 1985) were used as input to the HSPF10 model to simulate the conditions for the last 30 years. Though it is not assumed that any of the 30-year meteorological data sets precisely simulates the conditions of the last 30 years, it is assumed the CLIGEN data sets are fairly representative of average 30-year conditions. Therefore, the maximum, minimum, and mean values for the simulated concentrations were used to bracket the target concentration values.

Source Terms - Source terms for the 30-year simulation runs were calculated for the simulation of the COC concentrations in the water column. The source terms in the model calibration were used with some modifications for the simulation runs. Specifically, COC concentrations in sediment sampled from the SID were used as a source-term for sediments and water flowing into Woman Creek. Also, COC concentrations in surficial soils of the Original Landfill, which is located north of the SID in AOC1, were included in the chemical loading for basin washoff that may enter Woman Creek during a storm event.

Simulation Results - Simulation and result summaries for both the water-column (dissolved) and sediment-associated (total) fractions of the 11 COCs in surface-water media are provided in Tables 5-27A through 5-30B. In addition, mean daily concentrations have been determined at the downstream end of four stream reaches along Woman Creek, as follows:

- Reach 3 - confluence with Antelope Spring Creek
- Reach 4 - approximately 400-ft upstream of Pond C-1
- Reach 5 - Pond C-1
- Reach 6 - Indiana Street (east boundary of RFETS)

The results of these statistical summaries are shown in Tables 5-27 through 5-30C for COC Groups 1 through 4, respectively, and have been used as input for the HHRA.

To condense the simulated mean daily concentrations produced from the four groups of thirty 30-year computer runs (120 computer runs), to a series of values more easily used in the HHRA, the daily means were statistically summarized. The first step involved condensing the data in each of the thirty 30-year simulations for each COC group, to 30-mean daily concentrations, resulting in 30-mean daily concentrations for each of the 11 COCs. These 30-mean daily concentrations were then statistically summarized to produce a final-mean daily concentration for each COC.

5.3.3 Air Modeling

5.3.3.1 Air-Modeling Objectives

Wind suspension of potentially contaminated soil from the IHSSs within OU 5 to downwind receptors has been identified as the mechanism for several exposure pathways. Human exposure could occur by inhalation, ingestion, or dermal contact of this airborne, contaminated particulate matter. Receptor populations are current and future onsite workers, future onsite ecological researchers, and open-space users. The air pathways for these receptors have been designated as potentially complete, although relatively insignificant, and have been selected for quantitative risk assessment (DOE, 1995b).

The purpose of the air-dispersion modeling is to estimate COC concentrations and deposition rates at the potential receptor locations of interest. These specific, exposure-point concentration and deposition values will provide input to the risk calculations of the HHRA.

5.3.3.2 Selection of Air Models

The air-dispersion model selected for the OU 5 HHRA is the Fugitive Dust Model (FDM) (Winges, 1991). Development of the FDM has been sponsored by EPA, Region X, to address the concentration and deposition of particulate matter from fugitive dust sources. The FDM is described fully in TM13 (DOE, 1994b), as well as in the source document (Winges, 1991).

5.3.3.3 Wind-Resuspension Potential Study Objectives

Air-dispersion modeling provides the primary basis for assessing the inhalation risks posed by windblown, contaminated dust to current and future onsite workers. Perhaps the most critical input parameters to air-dispersion models are those associated with the source terms. In OU 5, the important source-input factors are the contaminant levels in the surface soils and the wind-resuspension potentials of those soils. The original investigations of the OU 5 RFI/RI Work Plan focused on the contaminant levels in the surface soils and those findings are discussed extensively in TM15. The objective of the additional air-quality study was to assess the wind-resuspension potential of the soils in the IHSSs in OU 5.

In 1993, EG&G Rocky Flats, Inc. conducted a field investigation throughout OU 3 to determine the wind-resuspension potentials of the soils in the areas east of Indiana Street (DOE, 1994c). The OU 3 study utilized a portable wind tunnel. That study yielded important information about the wind-erosion potential of the OU 3 areas, possibly the most valuable of which was the calculation of specific threshold friction velocities and threshold wind speeds of the sites that were examined. Friction velocity, which is a measure of the wind shear at the erodible surface, characterizes the capacity of the wind to cause movement of surface particles. Threshold friction velocity is the minimum velocity that results in particle movement. Threshold wind speed is equivalent wind speed at a specified elevation above the ground surface; for example, approximately 30 ft (10 meters[m]) - the standard height of a reference anemometer. The purpose of the study of wind-resuspension potential in the Woman Creek Drainage was to estimate the threshold friction velocities of the OU 5 sites and compare these to the results of the OU 3 wind-tunnel study. If the OU 5 investigation results compare favorably with the threshold friction velocity values determined in the OU 3 wind-tunnel study, then the OU 3 data can be utilized reliably for the OU 5 RFI/RI air dispersion modeling and, henceforth, the HHRA.

Methodology for the Study of Wind Resuspension Potential - The investigation of the wind resuspension or erosion potential of contaminated soils in areas of interest in OU 5 - including IHSS 115, IHSS 133, the surface disturbance south of IHSS 133, IHSS 209, and the surface disturbance west of IHSS 209 - was proposed as a phased approach. The first phase involved a limited field investigation of the site and comparisons of these results with those of the more intensive wind-tunnel study that was performed at OU 3. If the first phase results were inconclusive, then a second phase was recommended. The second phase would be the replication at OU 5 of the intensive field studies that were conducted in 1993 at OU 3.

The wind-resuspension study relied on the rapid assessment methodology described by Cowherd et al., (1985). The field examinations consisted of observations about sites selected as representative of the areas of interest in both OU 3 and OU 5 (see Figures 2-5 through 2-7 for observation locations). At each location, visual examinations of soil type and conditions and vegetative cover were conducted. The soil type was characterized, along with the soil moisture and presence or absence of soil crusting. The extent of bare soil, vegetative cover, and other nonerodible elements (gravels and cobbles larger than 1-centimeter [cm] diameter) were estimated. Finally, a soil-sieving procedure was conducted at each location with 4 millimeter (mm), 2 mm, 1 mm, 0.5 mm, and 0.25 mm sieves to estimate the aggregate size mode of the surface soil. From the estimate of the aggregate size mode, the threshold friction velocity of the soil was determined from a figure in the reference document. A correction factor was calculated to account for the increase in threshold friction velocity due to the nonerodible elements.

In working with the rapid assessment method, several limitations and difficulties with the procedures and calculations were encountered. The reference document (Cowherd et al., 1985) cautions that the procedures provide only a "first-cut, order-of-magnitude" estimate of exposure in limited applications. Nevertheless, the Cowherd method is endorsed as affording a degree of accuracy consistent with simplified quantitative estimation procedures (EPA, 1988b). Approaches such as the Soil Conservation Service method (Woodruff and Siddoway, 1965) to estimate wind erosion apply to annual losses from crop land and cannot be applied to generate short-term estimates. The Cowherd method was selected because of the current land use of the RFETS, the nature of the soils and vegetative cover in OU 5, and the episodic high-wind events characteristic of the region.

Certain assumptions incorporated into the rapid assessment method somewhat limited the interpretations of the OU 5 study. Most apparent was the utilization of only a few sieve sizes to estimate the mode of the aggregate size. Soil elements larger than 1 cm (nonerodible elements) were not included in the sieve analysis. At some locations, this fraction composed the most volummetric fraction. Standard soil-sieving techniques quantify the fractions by weight. The Cowherd rapid assessment method calls for visual estimates of the relative sizes of the catches. Investigators for this study improved the technique by volummetrically measuring the individual fractions to estimate the mode. In addition, it was difficult to estimate how much of the nonerodible elements were embedded in the ground surface. When in doubt, 50 percent seemed like a reasonable estimate. A serious limitation that was noted by the investigators, was the poor quantitative accounting for the mitigating effects of partial vegetative cover. Correction factors for nonerodible elements could not be assigned values greater than 10, due to limitations in the graph accompanying the reference document.

Results and Discussion of Wind-Resuspension Study - Field work was performed from January 20 to January 27, 1995. Weather conditions during the month prior to the field study were unusually dry. All soils were dry during the study period. Ambient temperatures were unseasonably warm, in the 40°F and 50°F ranges. Daytime winds during the study period were light from the southeast and east.

The 1993 OU 3 wind-tunnel study examined four terrestrial sites. These same four terrestrial sites were investigated as part of this study of wind-resuspension potential (Figure 2-5). Sites T-1, T-2, and T-3 of the OU 3 wind-tunnel study were chosen for that study as representative of the soil and vegetation conditions on areas directly east of the RFETS. Conditions were somewhat different at each site. At T-1, the soil was a clayey silt with some fine gravels, and vegetative cover was fair to good. Location T-3 was three-fourths of a mile or more east of T-1. Here the soil was a silty, sandy gravel. Although the vegetative cover was far less than at T-1, the other nonerodible elements provided a comparable overall coverage. Location T-2 displayed a silty sand with fair vegetative cover. The fourth terrestrial location, T-4, was about two miles southeast of the other three OU 3 wind-tunnel study sites. It had been selected because it was characteristically different from the other three sites. The soil was a silty sand, and although the aggregate size mode was comparable to two of the other OU 3 sites, the vegetative and other nonerodible cover at this fourth location was minimal.

Ten locations, in two groups of five each, were chosen as representative of soil and vegetation conditions within IHSS 115 (Figure 2-6). Surface slopes throughout the Original Landfill are fairly steep, 15 percent to 40 percent and facing south. Locations 115AQ1 through 115AQ5 were situated west to east along the top of the landfill slope. Soils were gravelly sands with larger aggregate size modes and noticeable bare soil. The extent of nonerodible elements, both gravels, cobbles, and vegetation, was variable. Location 115AQ5 was somewhat down the slope and displayed a smaller aggregate size mode and more vegetative cover. The remaining locations in IHSS 115, 115AQ6 through 115AQ10, were situated east to west along the lower elevations of the landfill. They were characterized generally by smaller aggregate size modes and very good vegetative cover.

Within IHSS 133, five locations were examined as representative of conditions in that area of interest (Figure 2-7). Area slopes were gentle, approximately 5 percent with a south orientation. Soils were gravelly sands and sandy silts with smaller aggregate size modes. Vegetative cover was excellent, usually complete.

At this writing, the three surface disturbance areas on the south side of Woman Creek are not considered areas of contaminant concern and have not included as radiological sources in the air dispersion modeling for the OU 5 RFI/RI. Fewer locations within these three areas were examined in this wind-resuspension study.

The Surface Disturbance South of IHSS 133 is located on a flat hilltop on the south side of Woman Creek. Within this area, two locations, identified as SASH-AQ16 and SASH-AQ17, were investigated (Figure 2-8). Soils were gravelly sands indicative of a hilltop situation. The aggregate size modes were smaller. Vegetative cover was very good.

IHSS 209 is a large, basically level, surface disturbance area on another hilltop on the south side of Woman Creek. Three locations, identified as 209AQ18 through 209AQ20, within IHSS 209 were examined (Figure 2-9). The soils on this hilltop were generally sandy gravels exhibiting larger aggregate modes. Vegetative cover was only fair, but other nonerodible elements added conspicuous protection from wind erosion.

The Surface Disturbance West of IHSS 209 is a moderately sloping hillside, north-facing, on the south side of Woman Creek. Two locations, W209AQ21 and W209AQ22, were examined in this homogeneous area (Figure 2-9). Gravelly and clayey sands characterized the slope. Aggregate size modes were smaller. Vegetative cover was uniformly very good.

The results of the OU 5 study of wind-resuspension potential are summarized in Table 2-11. The rapid assessment method produced values for threshold friction velocities at the four OU 3 wind-tunnel study sites that were within the same order of magnitude, but higher by several factors, as the results of the actual OU 3 wind-tunnel study (Table 2-12). Field observations of the vegetative and soil conditions at both the OU 3 wind-tunnel study sites and throughout OU 5 found that the two areas generally were comparable. Aggregate size modes of soil particles were typically larger throughout OU 5 than in OU 3. The vegetative cover was generally more extensive in OU 5 than in OU 3, excepting the top of the slope at the Original Landfill and IHSS 209.

The threshold friction velocities calculated for the OU 5 locations were consistently higher, sometimes by an order of magnitude, than the values reported in the OU 3 wind-tunnel study. Consequently, the threshold wind speed values from the OU 3 study can be applied to the air-dispersion modeling for the OU 5 RFI/RI and HHRA with the confidence that conservative, health-protecting assumptions are being exercised.

The rapid assessment method yielded values that are conservative estimates of the threshold friction velocities and threshold wind speeds around OU 5. With the availability of the results of the wind tunnel study at OU 3, where field conditions are generally comparable to OU 5, more accurate values are not required at this time for air-dispersion modeling.

5.3.3.4 Conceptual Model for Air Transport of COCs

COCs in surface soils may be transported via emissions of fugitive particulate matter to onsite and offsite exposure points. Inhalation of contaminated particulate matter is a potentially complete exposure pathway for current and future outdoor workers, ecological researchers, and open-space users. Potential contaminant intake and corresponding risks associated with these media will be evaluated in the HHRA (DOE, 1995b).

5.3.3.5 Assumptions and Limitations for Air Model

Although FDM has not been specifically approved by the EPA, it is based on the well-known analytical Gaussian plume formulation that constitutes the basis of almost all atmospheric-dispersion models approved by EPA for regulatory use (Turner, 1970; EPA, 1986). The FDM incorporates an improved gradient-transfer deposition algorithm based on analytical equations of Ermak (1977) for computing concentration and deposition values of fugitive particulate matter at user-selected receptors. The line source and area algorithms in the FDM are those in the CALINE3 model. The CALINE series is also based on the analytical Gaussian equation and is a preferred regulatory model of EPA (EPA, 1986).

Assumptions and limitations inherent in the FDM include those common to all air-dispersion models based on the Gaussian plume equation:

- The source emission rate is assumed to be constant.

- Diffusion in the direction of transport is assumed to be small compared with advection by wind speed in that direction.

- The material diffused is assumed to be a stable gas or aerosol that remains suspended in the air over long periods.

- All pollutants are assumed to exhibit perfect reflection from the ground and from an upper inversion surface.

- A mean wind speed is assumed to be representative of the diffusing layer chosen.

- The mean wind speed direction specifies the x-axis.

- Wind speed is assumed to be constant, and the turbulent fluctuations in the x-direction are much greater than in the y- or z-directions.

- The time-averaged concentrations of plume constituents are assumed to be distributed normally in both cross-wind and vertical directions.

- Values of sigma-y and sigma-z are representative for a sampling time of about 10 minutes.

- Downwind concentration values are limited to receptors with 50 km of the source (Turner, 1970).

With the FDM deposition routine, these assumptions and limitations apply:

- Eddy diffusivities are assumed to be functions only of downwind distance.

- Eddy diffusivity is assumed to be constant for all space and time.

- Concentration and deposition values are numerically integrated for a large number of cases involving different meteorological conditions, different particle sizes, and different release heights in the FDM program. A numerical solution was developed to correct the concentration values so that approximate mass conservation is obtained for all cases. In general, for particles smaller than 10 microns, the corrections are very small for all cases examined. Correction factors are built into the FDM and the use of corrections factors is entirely transparent to the user (Winges, 1991).

A number of assumptions relating to the input parameters for air-dispersion modeling for OU 5 were incorporated into the study:

- The particle size distribution of the parent soil determines the size distribution of suspended particles. This assumption is based on discussions in the *Superfund Exposure Assessment Manual* (EPA, 1988b).

- Potential emissions of fugitive particulate matter from the area sources are limited to those generated by wind erosion. There is no vehicular traffic on the sources.

- Particulate emissions are zero when wind speeds are less than the threshold wind speed.

- Erosion potential is completely and evenly depleted in one hour of an episodic wind event that exceeds the threshold wind speed. For wind events lasting more than one hour, the erosion potential is renewed at each subsequent hour.

5.3.3.6 Setup and Calibration of Air Model

This section describes in detail the FDM input parameters regarding sources, meteorology, and receptors. A discussion about the calibration or verification of the model is also presented.

Area Sources - Area sources must be specified as rectangles for the FDM. Coordinates and dimensions in ft were obtained from the Louisville Quadrangle 7.5-minute series (topographical) map (USGS, 1979). The last five digits of the coordinates were manually converted to meters for the FDM source input parameters.

For the OU 5 study, five area sources of radiological contamination were modeled (Figure 5-33A). These areas were selected on the basis of the analytical results for surface-soil samples with radionuclide activities greater than those of the background UTLs. They were defined and modeled prior to the decisions regarding the definition of the three AOCs in OU 5. FDM source input coordinates and dimensions (in meters) and radionuclide levels are presented in Table 5-31A.

Within IHSS 115, three area sources of radiological contamination were modeled. The sources of radiological contamination in the landfill are thought to be exhumed materials that were brought to the surface during past disturbances of landfill materials. Source 1 was specified as a rectangle to encompass a cluster of samples in the middle of the IHSS that showed radionuclide activities greater than those of corresponding UTLs. The rectangle was designated to represent uniform emissions within the source. Radionuclide levels were obtained by averaging the results of 18 surface-soil samples collected within the rectangle. Although only 13 samples within the rectangle actually showed radionuclide activities greater than the UTLs, data for all surface-sample points within the rectangle (except the two exhibiting unusually high results), were averaged together to represent the area-wide average. Source 2 was drawn as a small 25-ft square centered on one surface-soil sample that showed unusually elevated levels of uranium isotopes within the Source 1 rectangle. The americium-241 and plutonium-239/240 results for the Source 2 sample were negative values; so, a source strength of zero was assigned for modeling purposes. Similarly, Source 3 was drawn as a 50-ft square centered to represent a distinct area in the western portion of IHSS 115 where one surface sample showed elevated levels of uranium isotopes.

IHSS 133, the ash pits, was represented by Sources 4 and 5 as two contiguous rectangles. Source 4 was drawn as a larger rectangle encompassing IHSS 133.6, 133.5, 133.4, 133.1 and 133.3 and nearby surface-soil sample points. Source 5 was drawn as a smaller rectangle encompassing the IHSS 133.2 pits and two surface-soil sample points just east of IHSS 133.2. Radiological contamination is distributed more or less evenly across IHSS 133; that is, there are no outstanding hot spots. Both rectangles representing IHSS 133 were assigned radionuclide levels obtained from the averages of all surface-soil samples collected for the IHSS. The number of analyzed samples varied with constituent: 19 samples for americium-241, 22 for plutonium-239/240, 17 for uranium-233/234, 22 for uranium-235, and 21 for uranium-238.

For the OU 5 study, five area sources of organic and metallic chemical contamination were modeled (Figure 5-33B). These five areas are not the same as those for the area sources modeled for radiological contamination, although their locations are similar and were selected where results of statistically identified COCs were clustered. The FDM source input coordinates and dimensions (in meters) and the concentrations of organic and metallic COCs are presented in Tables 5-31B and 5-31C, respectively.

IHSS 115 contained four area sources of surface-soil contamination. Source 1 was drawn as a 10-acre square covering the approximate middle third of the old landfill. Source 1 contained elevated levels of all 11 COCs. Mean concentrations of COCs were obtained by averaging the results of as many as 35 surface-soil samples within the area. There are three small areas within the 10-acre, Source 1 area, from which samples yielded results that were one or more orders of magnitude higher than the other sample results in Source 1. These higher results were not included in the Source 1 averaging, but were treated as distinct, smaller area sources. Source 2 was drawn as a 25-ft square centered on one surface-soil sample that showed higher levels of benzo(a)anthracene, benzo(a)pyrene, benzo(b) fluoranthene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, and pyrene. Source 3 was drawn as a 25-ft square centered on one surface-soil sample that showed higher levels of dibenzo(a,h)anthracene, fluoranthene, and indeno(1,2,3-c,d)pyrene. Source 4 was drawn as a 25-ft square centered on one surface-soil sample that showed higher levels of silver.

IHSS 133 contained one area source for the surface soil COCs. Source 5 was drawn as a 10-acre rectangle covering the southeast portion of the ashpits (IHSS 133).

Particle Size Information - Particle size, distribution, and density characteristics were obtained from the Phase I RFI/RI field geotechnical investigation of OU 5 surface soils (DOE, 1994a). On the basis of discussions presented in the *Superfund Exposure Assessment Manual* (EPA, 1988b), three particle-size classes were selected: particles less than or equal to 10 μ aerodynamic equivalent diameter that are available for inhalation, particles 10-30 μ diameter range that are suspendible and can be transported considerable distances downwind, and particles 30-100 μ diameter range that abrade the soil surface and dislodge smaller particles but themselves settle within a few hundred ft of the source. The midpoints of each class were selected as the characteristic particle-size diameters: 5 μ; 20 μ; and 65 μ.

For particles less than 20 μ, the particle-size distribution of the parent soil determines the size distribution of suspended particles (EPA, 1988b). Field investigations of the grain size distributions were conducted for IHSS 115 , the surface disturbance west of IHSS 209, IHSS 209, and the surface disturbance south of the IHSS 133 ashpits (Table 5-32). The soil grain size distribution of IHSS 115 was assigned to IHSS 133.

Threshold Wind Speed - Friction velocity, which is a measure of the wind shear at the erodible surface, characterizes the capacity of the wind to cause surface particle movement. Threshold friction velocity is the minimum velocity that results in soil movement. Threshold wind speed is the equivalent wind speed at an elevation above ground surface; for example, 10 meters above ground, which is the standard height of a reference anemometer.

The soil surfaces of all IHSSs within OU 5 are nonhomogeneous, at least partially vegetated and impregnated with other nonerodible elements, such as pebbles, cobbles, and boulders. Such nonhomogeneous surfaces are characterized by the limited availability of erodible soil (Cowherd et al., 1985). Such surfaces have high threshold wind speeds for the commencement of wind erosion and particulate emission rates tend to decay rapidly during an erosion event.

In 1993, EG&G Rocky Flats, Inc., contracted Midwest Research Institute to perform a study to quantify wind resuspension emissions of particulate matter from the soils and sediments of OU 3 (DOE, 1994c). The test sites were concentrated in three locations: the shore around Standley Reservoir, the shore around Great Western Reservoir, and four terrestrial sites east of Indiana Street. When site conditions were undisturbed, the average threshold wind speed of the four terrestrial sites was greater than 102 mph. When site conditions were severely disturbed by vehicular traffic, the average threshold wind speed of three terrestrial sites was 42 mph (18.92 meters per second [m/sec]). (The fourth terrestrial site was not examined in a disturbed condition.)

Two approaches were applied to determine the threshold wind speed for OU 5 conditions. Both approaches were based on a rapid assessment methodology outlined by Cowherd et al. (1985) to estimate the threshold friction velocities of soils. The first approach used the detailed geotechnical data for OU 5 surface-soil samples obtained in the Phase I RFI/RI field investigation (DOE, 1994a) to estimate the soil particle-size distribution mode. Data were corrected for nonerodible elements as discussed in Appendix A of Cowherd et al., (1985). Finally, the corrected threshold friction velocity was calculated to be approximately 150 cm/sec. The corresponding threshold wind speed at a 10-m reference anemometer is 24.4 m/sec (54.6 mph). When hourly averaged meteorological data for the five years 1988 through 1993 collected at the Rocky Flats Plant were examined, not one hour exceeded this OU 5 calculated threshold wind speed of 24.4 m/sec.

The second approach to estimate a threshold wind speed for OU 5 conditions actually implemented the Cowherd rapid-assessment methodology in the IHSSs throughout OU 5 and at the four terrestrial sites examined in the 1993 OU 3 wind-tunnel study (Section 2.2.1.7). The rapid-assessment field study estimated threshold friction velocities at the OU 3 locations two to five times higher than those determined by the OU 3 wind-tunnel study. The rapid-assessment field study estimated threshold wind speeds for OU 5 conditions at 150 to 400 mph.

The average, 10-m threshold wind speed determined for the three, severely disturbed terrestrial sites in the OU 3 wind-tunnel study (18.92 m/sec) was used for the air dispersion modeling of wind-resuspended, contaminated soils from OU 5. This selection was considered to be conservative because soils at the OU 5 sites generally display more nonerodible elements (vegetation and pebbles, cobbles, and boulders) than the three OU 3 locations and, moreover, are not disturbed. A total of 11 days throughout the 5-year period were identified with wind speeds exceeding this lower threshold wind speed.

A threshold friction velocity of 1.17 m/sec was calculated from the 10-m threshold wind speed of 18.92 m/sec by using the logarithmic velocity profile equation (EPA, 1985; Seinfeld, 1986). A macro-scale roughness height for Rocky Flats, 1.5 cm, was used in the calculation (DOE, 1994c).

Erosion Potential and Emission Rates - The erosion potential for a dry, exposed surface is given by:

$$P(u) = 58(u^* - u^*_t)^2 - 25(u^* - u^*_t) \quad (5\text{-}1)$$

where

$P(u)$ = erosion potential, g/m^2

u^* = friction velocity, m/sec

u^*_t = threshold friction velocity, m/sec

This equation for erosion potential was determined empirically for industrial coal piles and other exposed materials using a portable wind tunnel like that utilized for the OU 3 wind-tunnel study (EPA, 1985; Midwest Research Institute, 1988). The OU 3 wind-tunnel study (DOE, 1994c) found that this equation for industrial wind-erosion potential substantially exceeds the measured erosion potentials for the highly disturbed surfaces tested in OU 3.

Again, using the logarithmic velocity profile equation, the ground-surface wind speed is related to the 10-m wind speed, $u_{(10m)}$, by $0.062u_{(10m)}$.

For the OU 5 conditions discussed above, the erosion potential equation becomes:

$$P(u) = 58(0.062u - 1.17)^2 + 25(0.062u - 1.17), g/m^2 \quad (5\text{-}2)$$

where

u = $u_{(10m)}$, wind speed at 10 m

Completing the multiplications, the equation becomes:

$$P(u) = 0.222952u^2 - 6.86464u + 50.1462 \quad (5\text{-}3)$$

Assuming that the entire erosion potential is depleted in a 1-hour, episodic wind event, the particulate matter emission rate can be calculated by dividing the P(u) equation by 3,600 s/hr:

$$E_{PM} = 6.19311E\text{-}05u^2 - 1.90684E\text{-}03u + 1.39295E\text{-}02 \quad (5\text{-}4)$$

where

E_{PM} = fugitive particulate matter emission rate, $g/m^2\text{-}s$

u = $u_{(10m)}$, wind speed at 10 m.

The erosion potential and the emission rate equations are dependent on wind speed in a quadratic format that the most current, published version of the FDM, version 94040, cannot accommodate. The FDM versions available through the EPA Technology Transfer Network are written in a first-order relationship to wind speed. Because of this limitation, Mr. Kirk Winges, the author of the FDM, prepared a special version of the 94040 FDM that provides the additional capability of entering emission sources as a quadratic formula for the threshold wind speed case (Winges, 1994). The modification is in Card 14A of the FDM input file, which is written in the format:

$$E_{PM} = G_1u^2 + G_2u + G_3 \tag{5-5}$$

where

E_{PM} = fugitive particulate matter emission rate, g/m^2-s; sometimes termed Q

G_1, G_2, G_3 = coefficients determined as discussed for Equations 5-3 and 5-4

u = $u_{(10m)}$, wind speed at 10 m.

The range of the FDM output values is limited to values that are neither too small nor too large for the number of significant figures and decimal point placement available in the model. If the concentration or deposition results are too small, the FDM reports the results as "0.0000." If the concentration or deposition results are too large, the FDM reports the results as "******." To accommodate this limitation, a multiplier can be applied to the G coefficients so that the FDM will provide actual numerical results. The multiplier is selected on a case-by-case basis, typically by trial and error, depending on the order of magnitude of the COC concentration. Interpreting the model output results must be done with this multiplier in mind, because the multiplier determines the order of magnitude of the output values (Table 5-33).

A COC emission rate is determined by multiplying the fugitive particulate-matter emission rate by the COC concentration in the soil (pCi/g of soil for radionuclides).

$$E_{contaminant} = X\,(E_{PM}) \qquad (5\text{-}6)$$

where

$E_{contaminant}$ = COC emission rate, pCi/m^2-s

X = contaminant concentration, pCi/g

E_{PM} = fugitive particulate matter emission rate, g/m^2-s.

To summarize, the coefficients, G_1, G_2, G_3, in the quadratic wind-speed-dependent equation for Card 14A of the FDM were determined multiplying the coefficients of the terms in the emission-rate equation for fugitive particulate matter, first by an arbitrary multiplier and second by the COC concentration. The FDM output values are in terms of COC - not particulate matter - concentrations and depositions, the magnitudes of which were determined by the selected multiplier. This process is summarized for americium-241 (Table 5-34). The values for all constituents are evident in the source terms of the FDM input files presented in Appendices I through L.

Meteorological Input - EG&G Air Quality Department provided preprocessed meteorological data for the full calendar years 1989 through 1993. Data originated from the RFETS meteorological tower, which is located about 2 km northwest of OU 5. Instrumentation is at 10-m elevation above ground level. The site meteorological data are collected in 15-minute averages. However, this time period is not suitable for air-dispersion modeling with the FDM. Consequently, the meteorological data were averaged to give hourly values for input to the FDM. Input included wind speed (m/sec), wind direction (degrees from north), stability class (Turner classification), mixing height (m), and ambient temperature (degrees Kelvin). Stability classes for the data were determined from the standard deviation of the horizontal wind speed after hourly averages were calculated (EPA, 1986). A mixing height of 1,405 meters was used for all FDM modelling. The value is the annual average of daytime and nighttime mixing heights measured at Stapleton Airport (Holzworth, 1972). Missing data were treated according to EPA policies (EPA, 1986).

Receptors - Selection of receptors was based on the potentially complete and relatively insignificant exposure pathways that were previously selected for quantitative risk assessment for exposures to radionuclides, organic compounds, and metals (DOE, 1995b). Potential receptors are associated with unspecified locations in the three AOCs within the OU 5 study area. AOC1 is IHSS 115, the original landfill; AOC2 is IHSS 133, the ash pits; and AOC3 is the Woman Creek drainage.

For modeling of maximum impacts of potential receptor points associated with AOC1 and AOC2, north-south rows of receptors at 100-ft spacing were positioned on the east (downwind) edge of the larger, rectangular area sources discussed above, or directly east of the area sources that were rotated from the north-south axis (Tables 5-35A and 5-35B, Figures 5-34A and 5-34B). These receptors were dubbed the "Near Group" receptors. The "Near Group" receptors for modeling of radionuclide COCs and organic compound COCs, although termed alike, were positioned somewhat differently because the area sources for each type of contamination were drawn differently. The "Near Group" receptors were modeled using the FDM convergent algorithm for area sources.

For modeling of maximum impacts within AOC3, the Woman Creek drainage, a "Grid Group" of receptors at 1,000-ft spacings throughout the entire OU 5 study area was designed. Receptor #22 was closest to Woman Creek and also downwind from IHSSs 115 and 133. RAAMP samplers 13, 14, 23, 32, and 38 were added to the "Grid Group" (Table 5-35C, Figure 5-35). RAAMP samplers 13, 14, 23, and 38 are situated in or near the Woman Creek Drainage; RAAMP sampler 32 was chosen as an upwind background sampler. The "Grid Group" was modeled using the 5-line integration default for area sources.

Verification - Verification of the FDM for the OU 5 investigation was accomplished by comparing model output with ambient-air monitoring data collected by the RAAMP and special OU 5 samplers. The conclusions of these verification procedures relate to the accuracy of the model and the uncertainty of the output. Ambient-air data available for verification are limited to those months when data from the OU 5 samplers were reported and when winds exceeding the threshold wind speed of 18.92 m/sec were recorded by the Rocky Flats Plant meteorological tower.

Three special OU 5 ambient-air samplers were installed in the summer of 1992 and became operable in October 1992. Sampler S102 is located north and west of OU 5, as an upwind monitor. Sampler S100 is situated downwind of IHSS 115. Sampler S101 is placed downwind of IHSS 133. Procedures for the OU 5 samplers are the same as for the RAAMP samplers; filters are collected biweekly. Once a month, the two filters collected from each air-monitoring station are composited prior to isotopic analysis. Radionuclides analyzed for the OU 5 filters are americium-241, plutonium-239/240, uranium-233/234, uranium-235, and uranium-238. As of March 1, results of 12 samples from each monitor representing the period October 9, 1992 to August 4, 1993 had been entered into RFEDS. Of the 12 samples, only the first two samples (October 9, 1992 and November 10, 1992) had been completely validated at the time of this modeling.

RAAMP samplers 13, 14, 23, and 38 are in or near the Woman Creek drainage. However, RAAMP data did not prove useful for verification purposes because filters from these samplers are analyzed only for plutonium-239/240. Furthermore, the locations of these samplers were chosen to monitor sitewide conditions rather than point sources, or even area sources such as OU 5.

During the period October 9, 1992 to August 4, 1993, only the period December 30, 1992 to January 26, 1993 exhibited wind speeds with 1-hour averages exceeding the selected threshold wind speed of 18.92 m/sec (42.32 mph). These occurred on January 21, 1993, hours 8 and 9, when winds averaged 22.96 m/sec and 19.23 m/sec, respectively. The wind speed of 22.96 m/sec is the highest 1-hour average wind speed recorded for the years 1989 through 1993.

Verification runs for the FDM, using the five-line integration default, modeled the period January 1-31, 1993. Model output was compared with the OU 5 ambient-air data for the period December 30, 1992 to January 26, 1993 (Table 5-36). FDM input and output files for the verifications runs are included in Appendix I. Model runs utilizing the convergent algorithm for near-source receptors produced output results substantially the same as model runs with the five-line integration. Model results for americium-241 were two and four orders of magnitude below ambient levels; for plutonium, model results were one order of magnitude below ambient levels. Model output values for uranium-233/234 and uranium-235 fell within the same order of magnitude as the ambient data. Model results for uranium-238 were one order of magnitude above the ambient data.

Uncertainty and Accuracy - A succinct discussion of the accuracy and uncertainty of models is presented in EPA's *Guidelines on Air Quality Models* (EPA, 1986). Air-dispersion models are more reliable for longer, term-averaged concentrations than for short-term concentrations at specific locations. Models are reasonably reliable for estimating the magnitude of highest concentrations occurring sometime, somewhere in the area. Air-dispersion models are recognized to exhibit an accuracy within a factor of two, and are typically more accurate.

Model uncertainties fall into two categories: inherent and reducible. Inherent uncertainties arise from unmeasured or unknown conditions of an event, and may vary among repetitions of the event. Such uncertainties would exist in even the "perfect" model and may account for a typical range of variation in output values of as much as 50 percent. Reducible uncertainties are associated with the model and it input conditions. Improvements in the physics of the model and the accuracy of the input parameters can minimize the amount of reducible uncertainty.

Improvements to the mathematical algorithms of a sanctioned, public-domain model like the FDM are generally limited. As discussed above, the source input mechanism of the FDM was adjusted by the model developer to account for the quadratic form of the wind-erosion equation as applied in this study (Winges, 1994). This modification addressed input formats rather than model mathematics.

Two important issues relate to the verification of the air-dispersion model in the OU 5 situation. The first is the multiplicity of radionuclide sources in the OU 5 and in the RFETS vicinity. The sources of the radionuclides on the OU 5 sampler media do not originate solely from the IHSSs of OU 5. An examination of the OU 5 sampler data for the period December 30, 1992 to January 26, 1993 for americium-241 illustrates this point (Table 5-36). Americium-241 levels on the upwind sampler, S102, are higher than on the downwind samplers, S101 and S100. Restricting the emission sources that contribute to any receptor in the site vicinity, such as the OU 5 samplers for verification purposes, to the IHSSs of OU 5 is a simplifying convention for modeling purposes only. In actuality, there are no real-world ambient data attributable only to OU 5 sources.

The second issue concerns the wind-resuspension rate of contaminated soil. As of the date of this report, a study of the wind-resuspension potential, such as that conducted at OU 3 (DOE, 1994c), has not been performed for OU 5. As a result, the values obtained in the OU 3 study were assumed to be applicable to OU 5 for the purposes of OU 5 air-dispersion modeling. Several model runs were performed to investigate the sensitivity of the FDM to values for roughness height and threshold friction velocity. Roughness height was varied from 0.022 cm to 1.5 cm. Threshold friction velocity was varied from 40 cm/sec to 117 cm/sec. Threshold wind speed was maintained at 18.92 m/sec. The model output values generally remained within the same or one order of magnitude during this sensitivity analysis (i.e., the FDM is relatively insensitive to variations related to threshold friction velocity).

Comparison of the model results with ambient-air data collected at OU 5 samplers and sensitivity runs indicates that the FDM output values of radionuclide concentrations are accurate within one order of magnitude.

5.3.3.7 Results of Air Modeling

Air-modeling runs to estimate the maximum values for deposition and exposure concentrations at the selected OU 5 receptor points were performed with the FDM using the input parameters described in Section 5.3.3.5. The input and output files for the FDM runs for radionuclide COCs are included in Appendix J, for organic COCs in Appendix K, and for metal COCs in Appendix L.

Modeling exercises utilizing the five-line integration algorithm on the "Grid Group" of receptors were conducted for each of the five years of available meteorological data (1989 through 1993), to ascertain the year of maximum exposure. The year demonstrating the maximum values for annual average concentration and deposition for the selected receptors was 1990 (Tables 5-37A through C). The year 1990 exhibited 14 hours of 1-hour average wind speeds exceeding the selected threshold wind speed of 18.92 m/sec. These high winds occurred in three episodes. For high-wind episodes lasting more than one hour, it was assumed that the erosion potential was renewed with each successive hour.

During 1990, the highest 24-hour averages of ambient concentration and deposition of COCs for the downwind receptors occurred on December 14 (Tables 5-38A through C). The highest 1-hour average wind speed during 1990 was 22.72 m/sec, which occurred toward the end of a sustained high-wind episode during Hour 22 on December 14. For all of 1990, the maximum 1-hour concentration and deposition values for selected OU 5 receptors generally occurred during that hour or on another hour of December 14 (Tables 5-39A through C). The times of the maximum values for the receptors vary somewhat because the readings at a particular receptor depend on wind direction as well as wind speed.

5.3.4 Indoor-Air Modeling

5.3.4.1 Objectives of Indoor-Air Modeling

The scenario of the intrusion of soil gases through the below-grade foundation floor and walls of a future on-site office building has been identified as significant air exposure pathway for the OU 5 IHSSs (DOE, 1995b). Presently, no buildings are located in OU 5. The objective of the indoor-air modeling was to estimate the exposure concentrations of COCs that are released into indoor air by intrusion of the gaseous phase directly from the vadose zone of the soils surrounding the floors and walls of future building foundations.

5.3.4.2 Selection of Indoor-Air Model

EPA provides technical guidance for assessing potential indoor air impacts for contaminated sites (EPA, 1992a). For modeling the concentrations of chemical vapors in indoor air due to soil-gas entry, the Johnson-Ettinger models are recommended (EPA, 1992a; Johnson and Ettinger, 1991). The model equation corresponding to an infinite contaminant source and vapor infiltration through cracks/openings in the foundation is the most useful for general application. This model equation was selected for supporting the HHRA of potential indoor-air impacts for OU 5. It is described fully in TM13 (DOE, 1994b), as well as in the resource documents (EPA, 1992a; Johnson and Ettinger, 1991).

5.3.4.3 Conceptual Model for Indoor Air

The transport of contaminants from soil gas into a building foundation is understood to occur by a combination of convective and diffusive transport mechanisms. The relative significance of these mechanisms depends on site characteristics. In the case where the contaminant source lies directly beneath the foundation, the convection mechanism dominates the transport of vapors into the building. If the source is distant from the foundation, transport is controlled by diffusion from the source to the foundation. Potential contaminant risks associated with indoor air of future buildings contaminated from VOCs in soils adjacent to the foundation will be evaluated in the HHRA.

5.3.4.4 Assumptions and Limitations for Indoor-Air Model

Assumptions and limitations inherent in the Johnson-Ettinger equation corresponding to the general application, in which the contaminant source is infinite with respect to the modeling time of interest and vapor infiltration is through cracks or openings in the foundation, include the following:

- The distance from the source to the building is assumed not to change with time and is assumed not to change in composition over the time of interest for the calculation.
- The contaminant source is assumed to lie directly beneath the foundation.
- The modeling equation applies to structures with crawl spaces and slab floor construction with solid (i.e., poured concrete) below-grade walls. Other Johnson-Ettinger modeling equations correspond to cases in which soil-gas transport into buildings is substantially higher through relatively permeable materials (e.g., concrete-block construction below grade) than through foundation cracks and openings or to cases in which a contaminant is located near the building and decreases over time (EPA, 1992a).

5.3.4.5 Set Up and Calibration of Indoor-Air Model

Information concerning dimensions and ventilation characteristics of typical commercial buildings for Jefferson County, Colorado was obtained from the Jefferson County Building Department (Nihiser, 1993). This information, along with building material published in the source documents (EPA, 1992a; Johnson and Ettinger, 1991), was used to determine those additional properties required for the indoor-air modeling of the intrusion of soil gas into future onsite building structures (Table 5-40).

A real-time, soil-gas survey was conducted as part of the Phase I RFI/RI field investigation. The purpose of this survey was to identify areas of VOC contamination within IHSS 115 and IHSS 196. The methodology and findings of the soil-gas survey are discussed in TM15 (DOE, 1994a). The survey resulted in the identification of three areas of anomalous concentrations of organic compounds above the reporting limits. The three identified VOCs were 1,1,1-TCA, TCE, and PCE (Table 5-41).

The volummetric flow rate of a soil gas into a building foundation is related to the vapor viscosity of the gas. Vapor viscosity is inversely proportional to temperature (Table 5-42). The lower values for vapor viscosity were used in the Johnson-Ettinger calculations.

The Johnson-Ettinger equation calculates a ratio (α) of the gas concentration inside the building to the soil-gas concentration at the source:

$$\alpha = [D_T^{eff} A_B / Q_{bldg} L_T] * \exp(Q_{soil} L_{crack} / D^{crack} A_{crack}) / \{\exp(Q_{soil} L_{crack} / D^{crack} A_{crack}) + [D_T^{eff} A_B / Q_{bldg} L_T] + [D_T^{eff} A_B / Q_{soil} L_T][\exp(Q_{soil} L_{crack} / D^{crack} A_{crack}) - 1]\} \quad (5\text{-}7)$$

where

α = $C_{building}/C_{source}$, vapor concentration in building/vapor concentration at source (i.e., soil)

D_T^{eff} = overall effective diffusion coefficient (cm^2/sec)

A_B = cross-sectional area through which contaminants may pass (approximated by area of floor and below-grade walls (cm^2)

Q_{bldg} = building ventilation rate (cm^3/sec)

L_T = distance from contaminant source to building foundation (cm)

Q_{soil} = volummetric flow rate of soil gas into the building (cm^3/sec)

L_{crack} = thickness of foundation (cm)

D^{crack} = effective vapor-pressure diffusion coefficient through a crack (cm^2/sec)

A_{crack} = area of cracks/openings through which vapors can pass (cm^2).

If the source lies directly beneath the foundation, as it would in the exposure scenario of contaminated soil adjacent to the foundation, then α approaches the value Q_{soil}/Q_{bldg}.

The soil-gas flow rate, Q_{soil}, is likely to be dependent of the basement crack area, A_{crack}, soil type and stratigraphy, building underpressurization, and basement geometry. For simplicity, Q_{soil} is estimated by:

(5-8)

$$Q_{soil} = 2\pi \Delta P k_v X_{crack} / \mu \ln(2Z_{crack}/r_{crack})$$

where

$$r_{crack}/Z_{crack} << 1$$

(Equation 5-8 is an analytical solution for flow to a cylinder of length X_{crack} and radius r_{crack} located at a depth Z_{crack} below the surface. This is an idealized model for soil-gas flow to cracks located at floor/wall seams.)

where

ΔP	=	building pressure difference relative to ambient pressure ($g/cm\text{-}sec^2$)
k_v	=	soil permeability to vapor flow (cm^2)
X_{crack}	=	total floor/wall seam perimeter distance (cm)
μ	=	vapor viscosity (g/cm-sec)
Z_{crack}	=	depth of crack below ground surface (cm)

and

$$r_{crack} = \eta A_B / X_{crack}$$

where

$$\eta = A_{crack}/A_B, \text{ so that } 0 <= \eta <= 1.$$

For a contaminant source adjacent to the building ($L_T = 0$), α is proportional to the soil permeability to vapor flow, k_v, at $k_v > 10^{-8}$ cm^2 (permeable soils). The effect of crack size on contaminant intrusion rates will be relatively insignificant in the limit of convective-dominated transport.

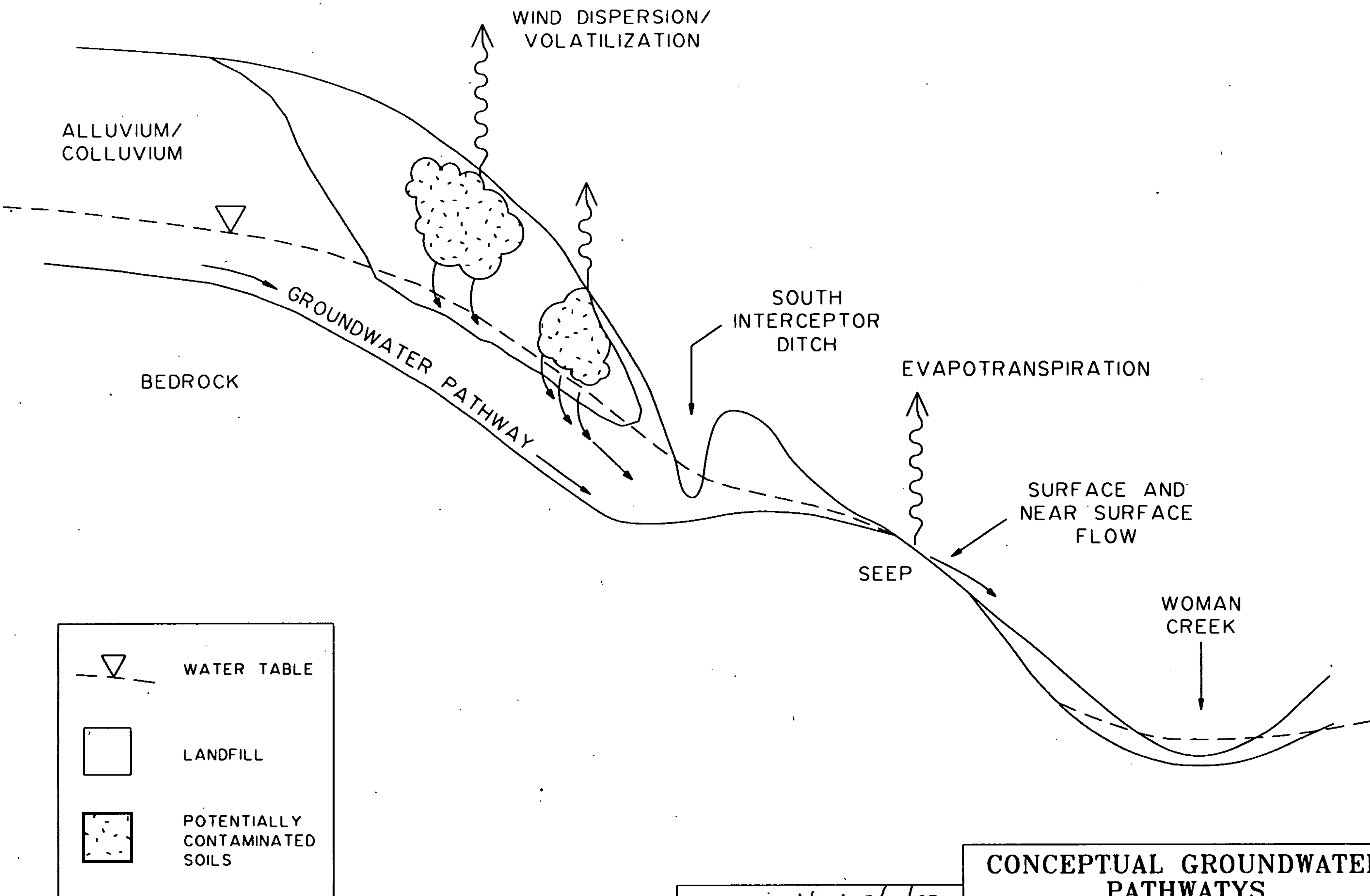
Resolution of uncertainty cannot be addressed fully within the scope of this assessment. The future exposure scenarios for onsite office structures are hypothetical. Calibration of any indoor-air models with actual onsite measurements is not feasible.

5.3.4.6 Results of Indoor-Air Modeling

Execution of the Johnson-Ettinger model was performed for the building, soil, and chemical properties as outlined in Section 5.3.4.5. A typical future onsite commercial building was considered to be 6,000 ft^2 (557 m^2) with 0.5 air changes per hour and a building underpressure of 1 Pa (10 $g/cm\text{-}s^2$). Modeling was performed for the building sizes and air changes per hour indicated in Table 5-40. A range of underpressure values was not modeled. The relationship of underpressure-air to indoor-air concentrations in the model is linear: a ten-fold increase in building would increase indoor gas concentrations by ten. A single soil permeability of 10 darcy (10×10^{-8} cm^2) was modeled as typical. Soil permeability also linearly affects indoor-air concentrations of COCs in the model: a ten-fold increase in soil permeability would increase indoor gas concentrations by ten. The maximum concentrations of soil gases detected during the field investigation were used as input to the model. Results of the modeling study are presented as typical values, and as ranges of values for concentrations of identified VOCs in the basement areas of the hypothetical buildings (Table 5-43).

A number of studies referenced in the EPA guidance document (EPA, 1992a) have indicated that the mean concentration of radon in basements is about twice the mean value for above-ground living spaces. The conclusion of these studies can be extended to organic gases. The levels of air-contaminant concentrations in the working spaces of future onsite buildings are estimated to be approximately half of those in the associated basements, as presented in Table 5-43.

Section 5.0
Figures



Drawn NAM 7/21/95 Date

Checked 7/27/95 Date

Approved Date

FILE OU5-5-1.DWG

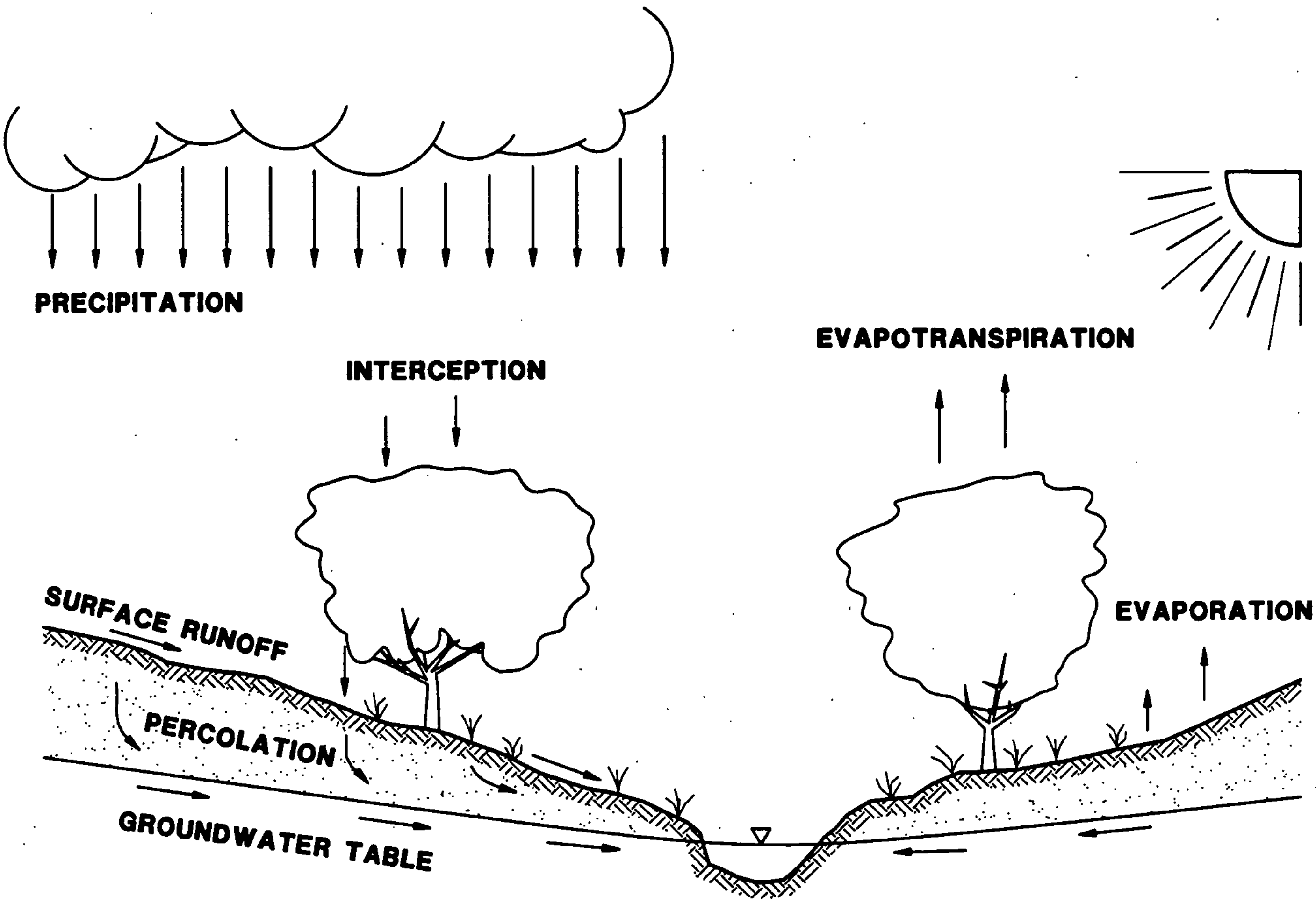
CONCEPTUAL GROUNDWATER PATHWATYS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

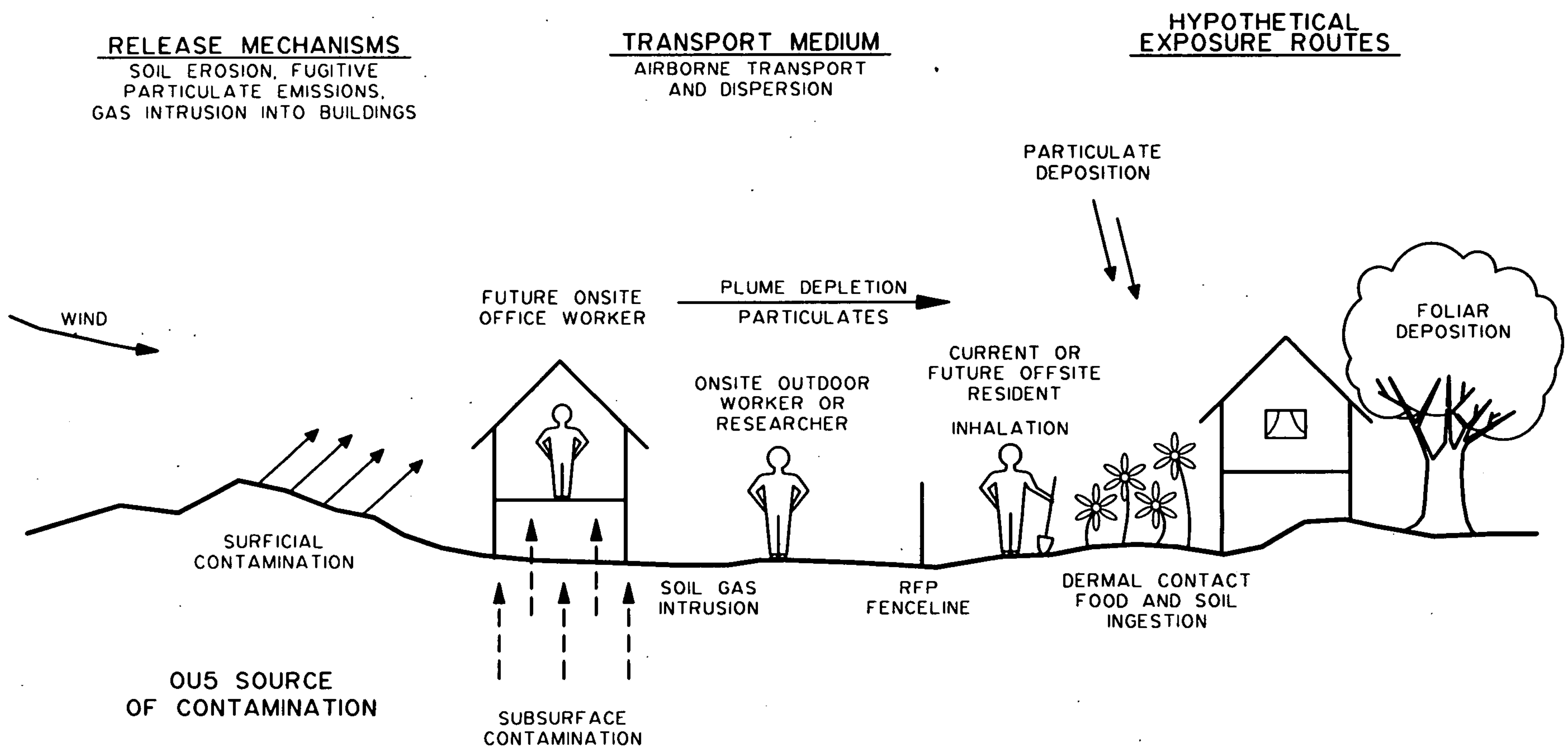
RFI/RI REPORT

FIGURE 5-1



Source: Bicknell and Others (1993).

Drawn NAM 8/1/97 Date	CONCEPTUAL SURFACE – WATER PATHWAYS
Checked 8/1/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Approved Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
FILE OU5-5-2.DWG	FIGURE 5-2



Drawn NAM 8/1/95 Date

Checked 8/1/95 Date

Approved ______ Date

FILE OU5-5-3.DWG

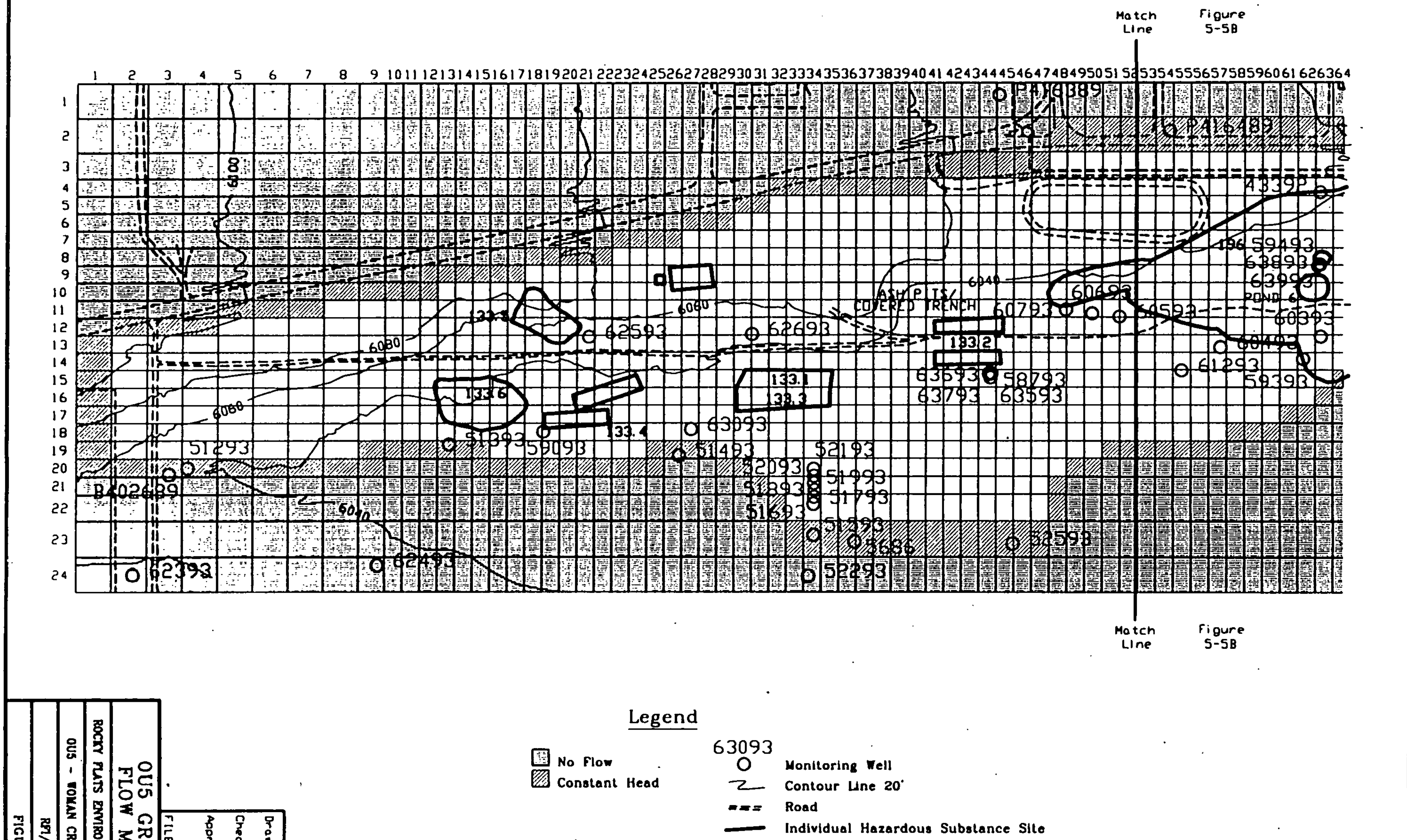
CONCEPTUAL AIR PATHWAYS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-3



OU5 GROUNDWATER FLOW MODEL GRID

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

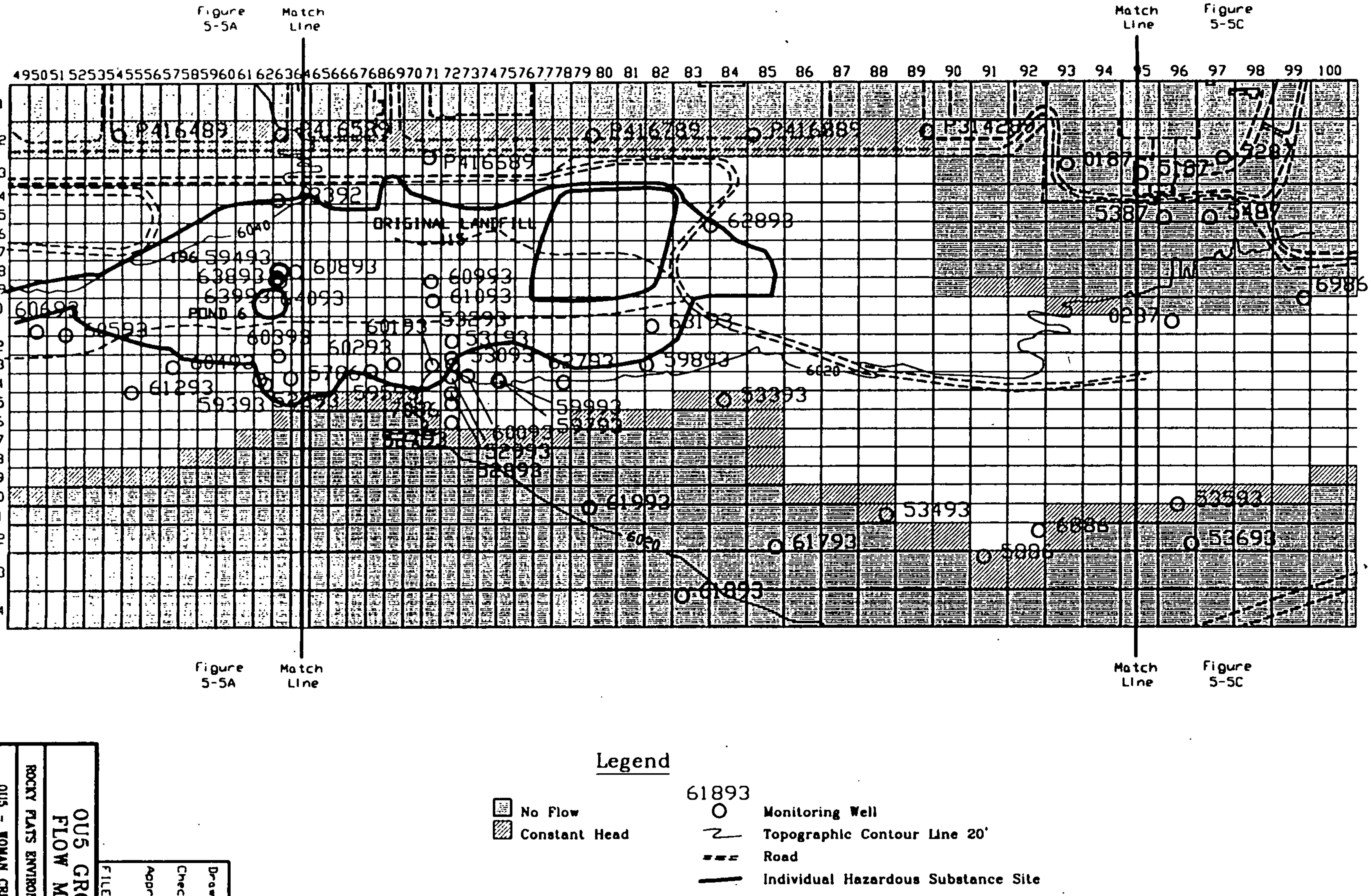
FIGURE 5-5A

FILE 5-5A.DWG

Drawn SMB Date 8/9/95

Checked TCY Date 8/9/95

Approved ____ Date ____



Drawn LAB 8/9/95 Date
Checked [initials] 8/6/95 Date
Approved ________ Date

FILE OU5-5-5B.DWG

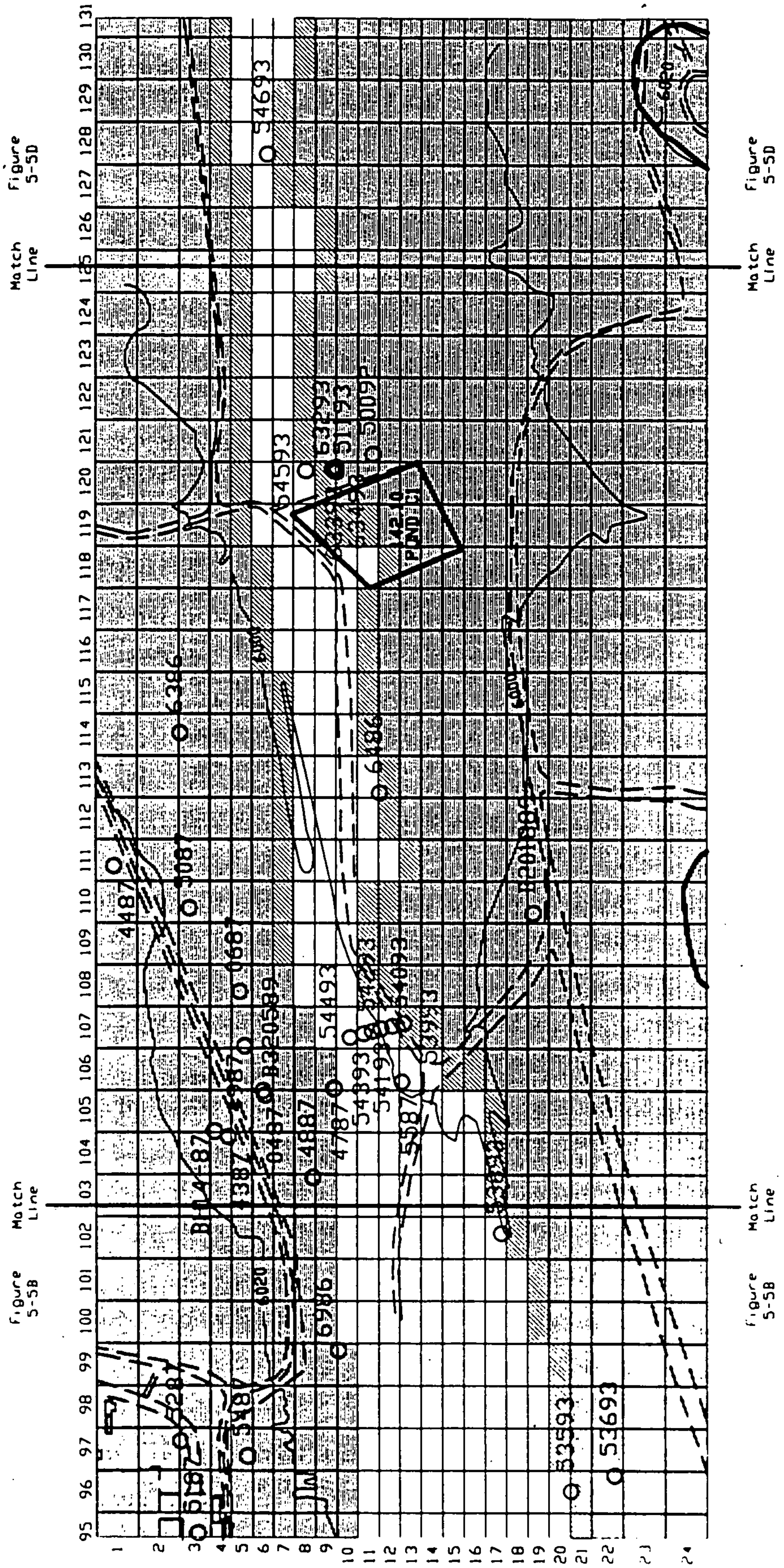
OU5 GROUNDWATER FLOW MODEL GRID

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-5B



Legend

No Flow
Constant Head
63693 Monitoring Well
Topographic Contour Line 20'
Road
Individual Hazardous Substance Site

N

200 feet

Drawn SAB 8/9/95 Date
Checked [signature] 8/9/95 Date
Approved ______ Date

FILE 5-5C.DWG

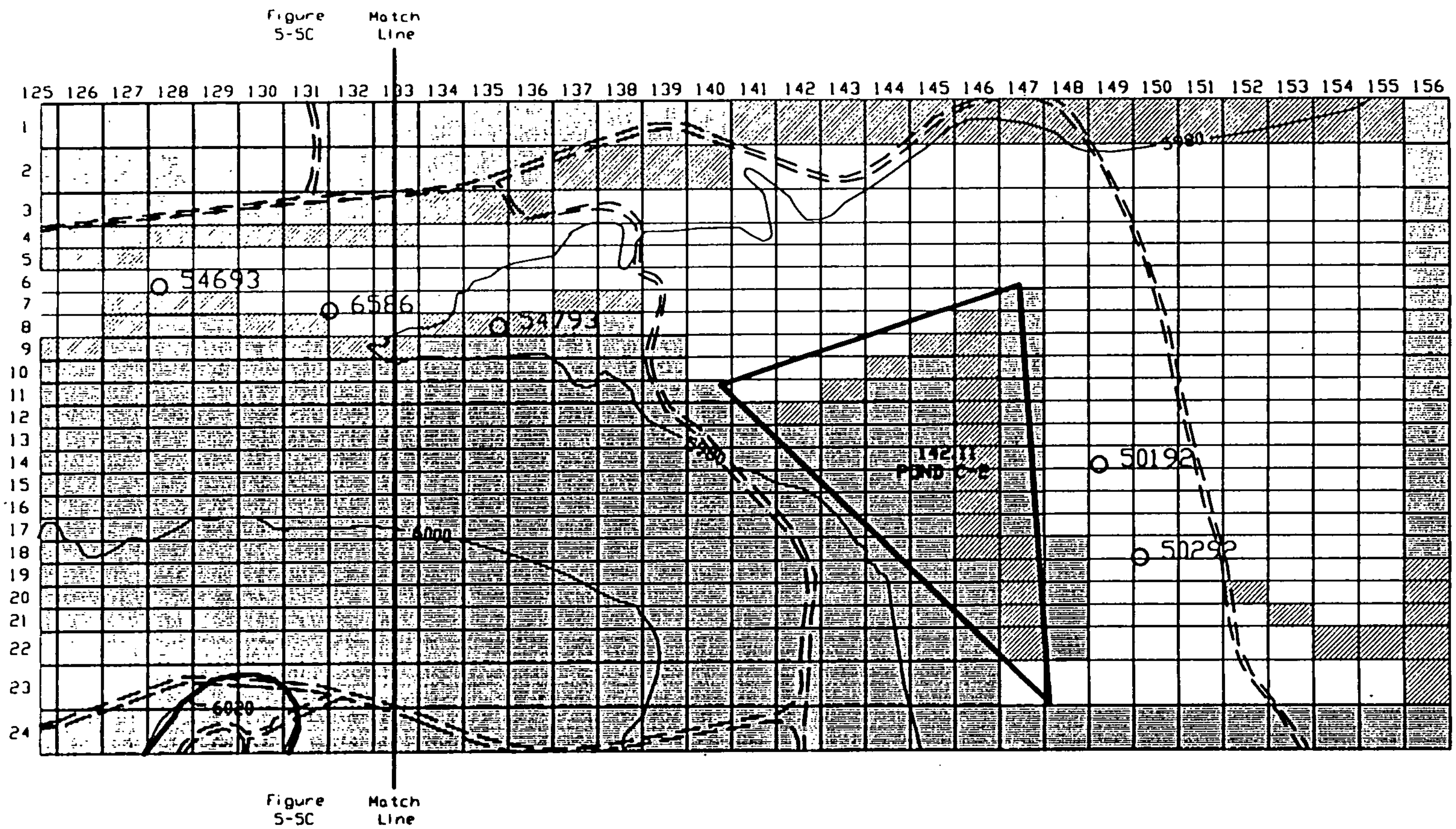
OU5 GROUNDWATER FLOW MODEL GRID

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-5C



Legend

No Flow
Constant Head

63093
Monitoring Well
Topographic Contour Line 20'
Road
Individual Hazardous Substance Site

N
200 feet

OU5 GROUNDWATER FLOW MODEL GRID

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

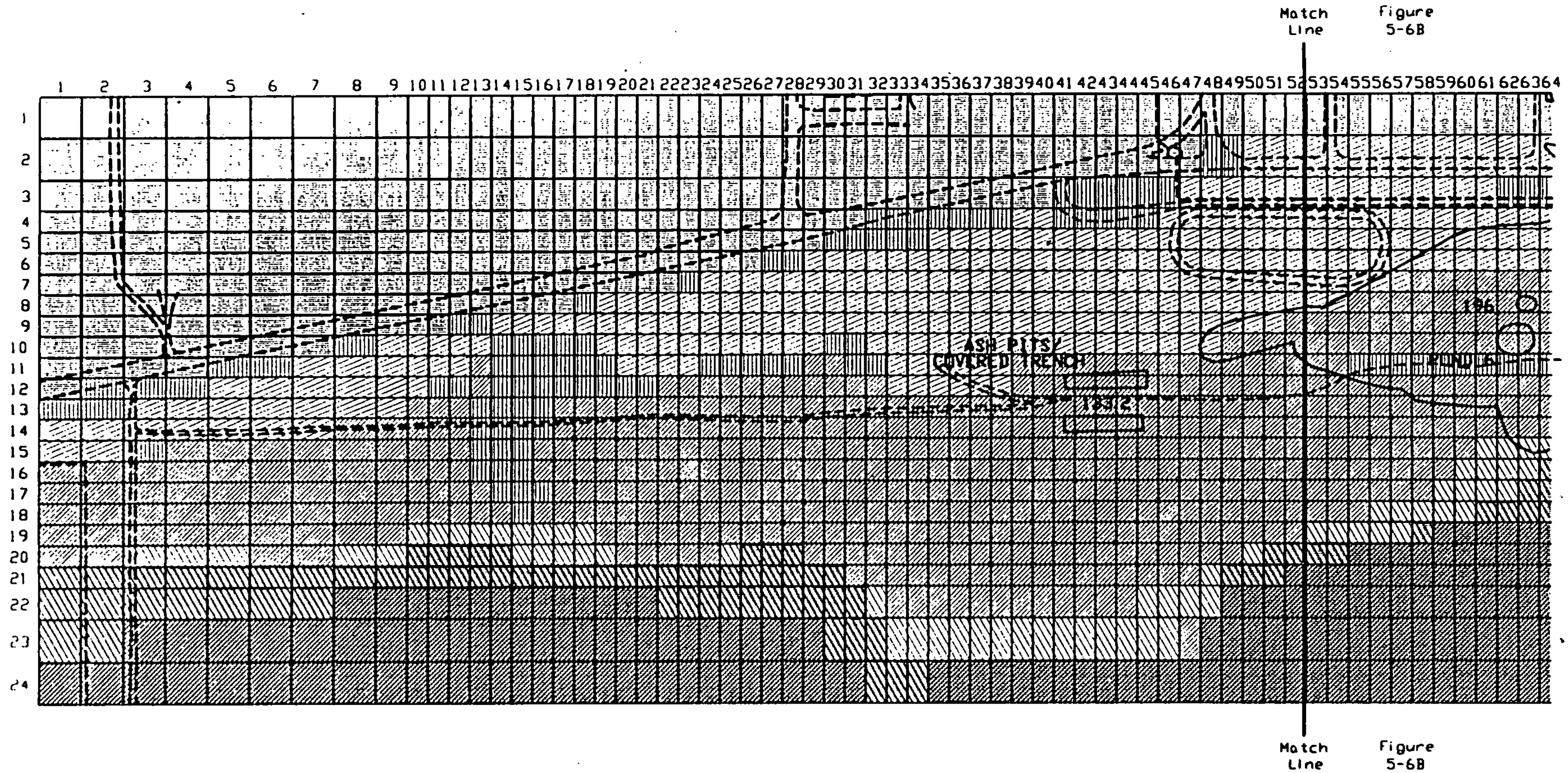
OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-5D

FILE OU5-5-5D.DWG

Drawn ___ Date ___
Checked ___ Date ___
Approved ___ Date ___



Legend

- No Flow
- Zone 1 = (2.88×10^{-3}) ft/day
- Zone 2 = (2.89×10^{-3}) ft/day
- Zone 3 = (2.59) ft/day
- Zone 4 = (34.56) ft/day

- Road
- Individual Hazardous Substance Site

N

200 feet

OU5 GROUNDWATER FLOW MODEL INITIAL HYDRAULIC CONDUCTIVITY ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

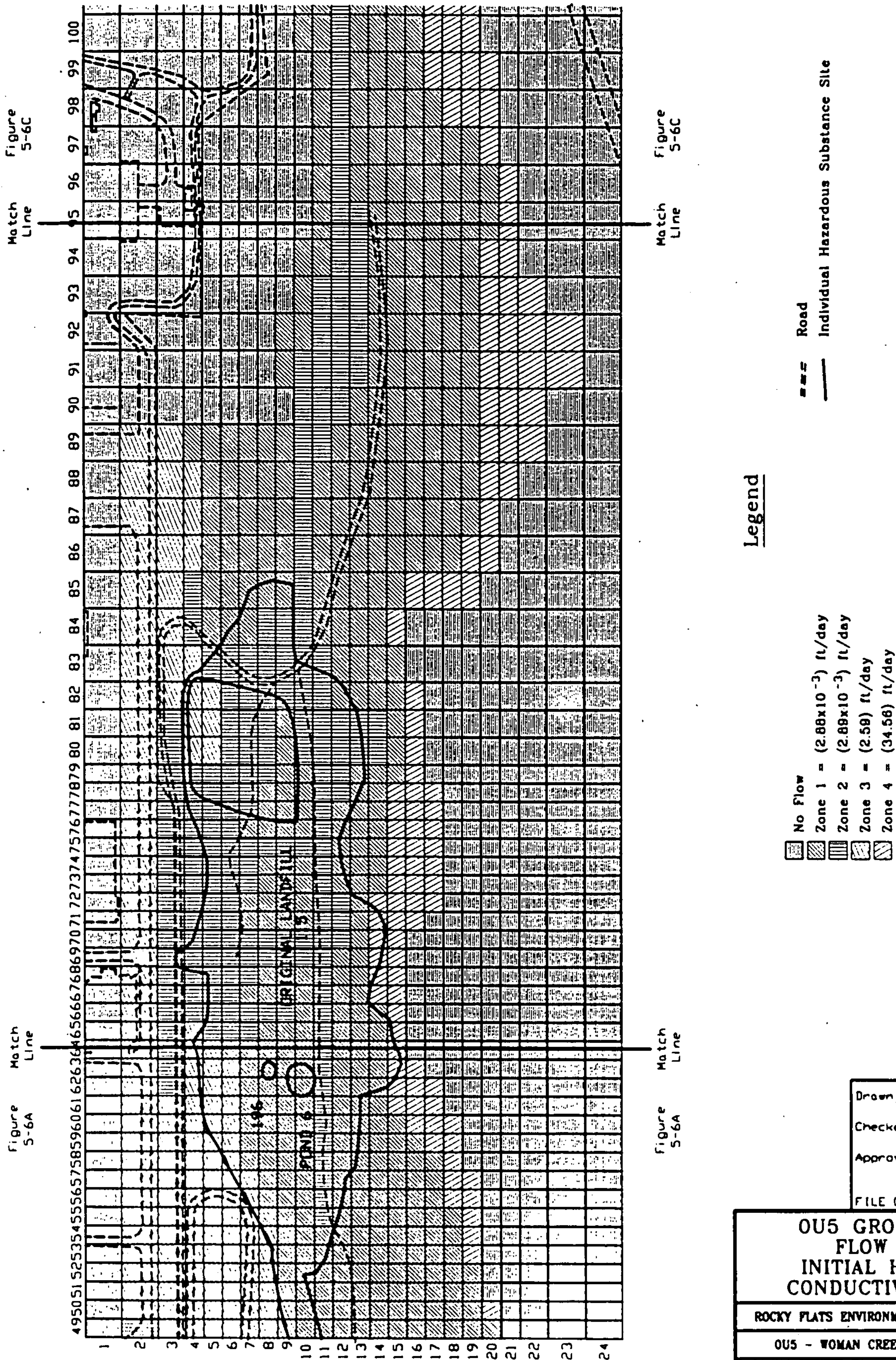
FIGURE 5-6A

FILE OU5-5-6A.DWG

Drawn ___ Date 8/9/95

Checked ___ Date 8/9/95

Approved ___ Date ___



Drawn SAB	8/9/95 Date
Checked TEP	8/5/95 Date
Approved	Date
FILE OU5-5-6B	

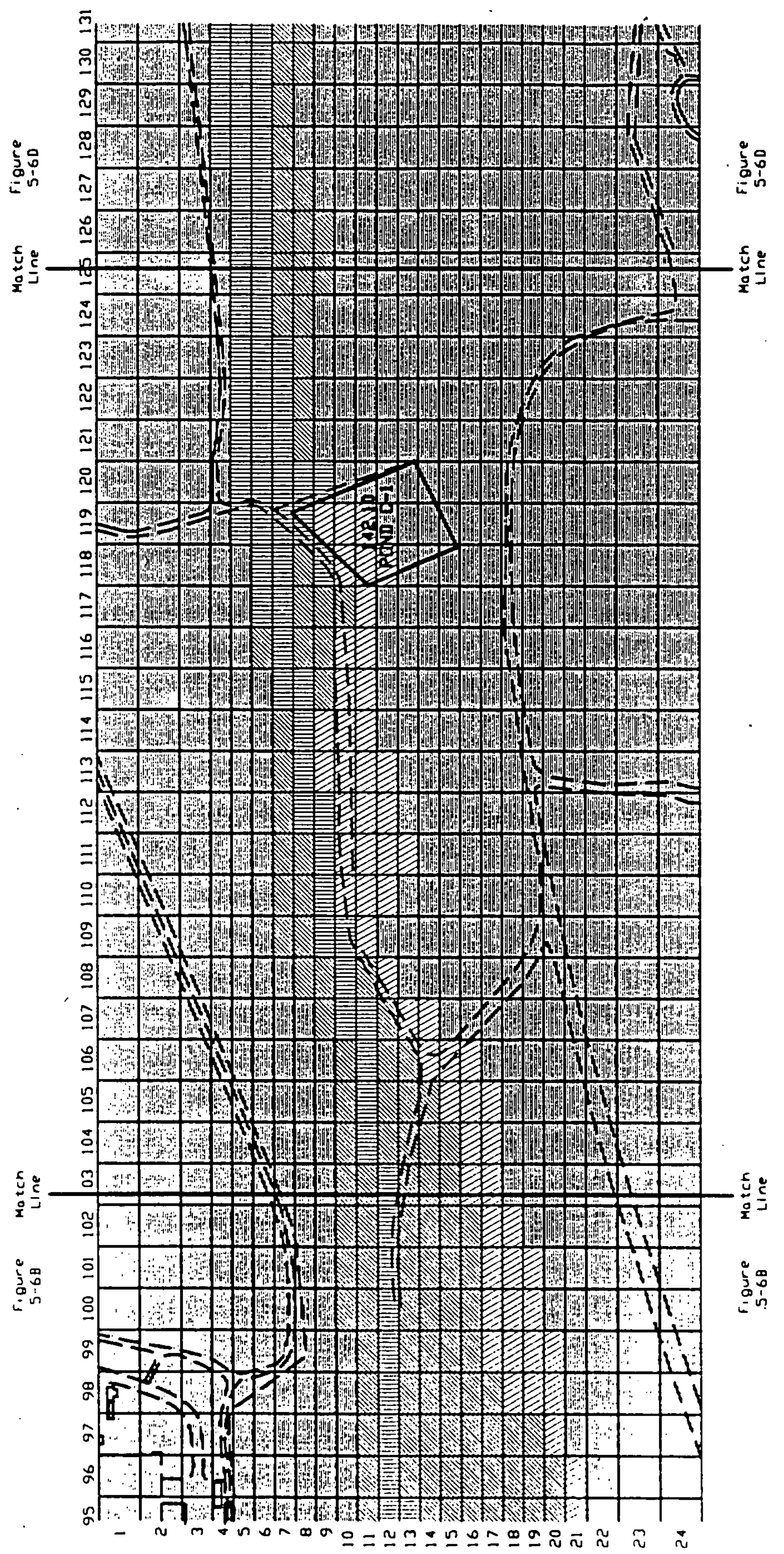
OU5 GROUNDWATER FLOW MODEL INITIAL HYDRAULIC CONDUCTIVITY ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-6B



Drawn ~~2AB~~ 8/9/95
Date
Checked ~~TZ~~ 8/9/95
Date
Approved
Date

FILE OU5-5-6C

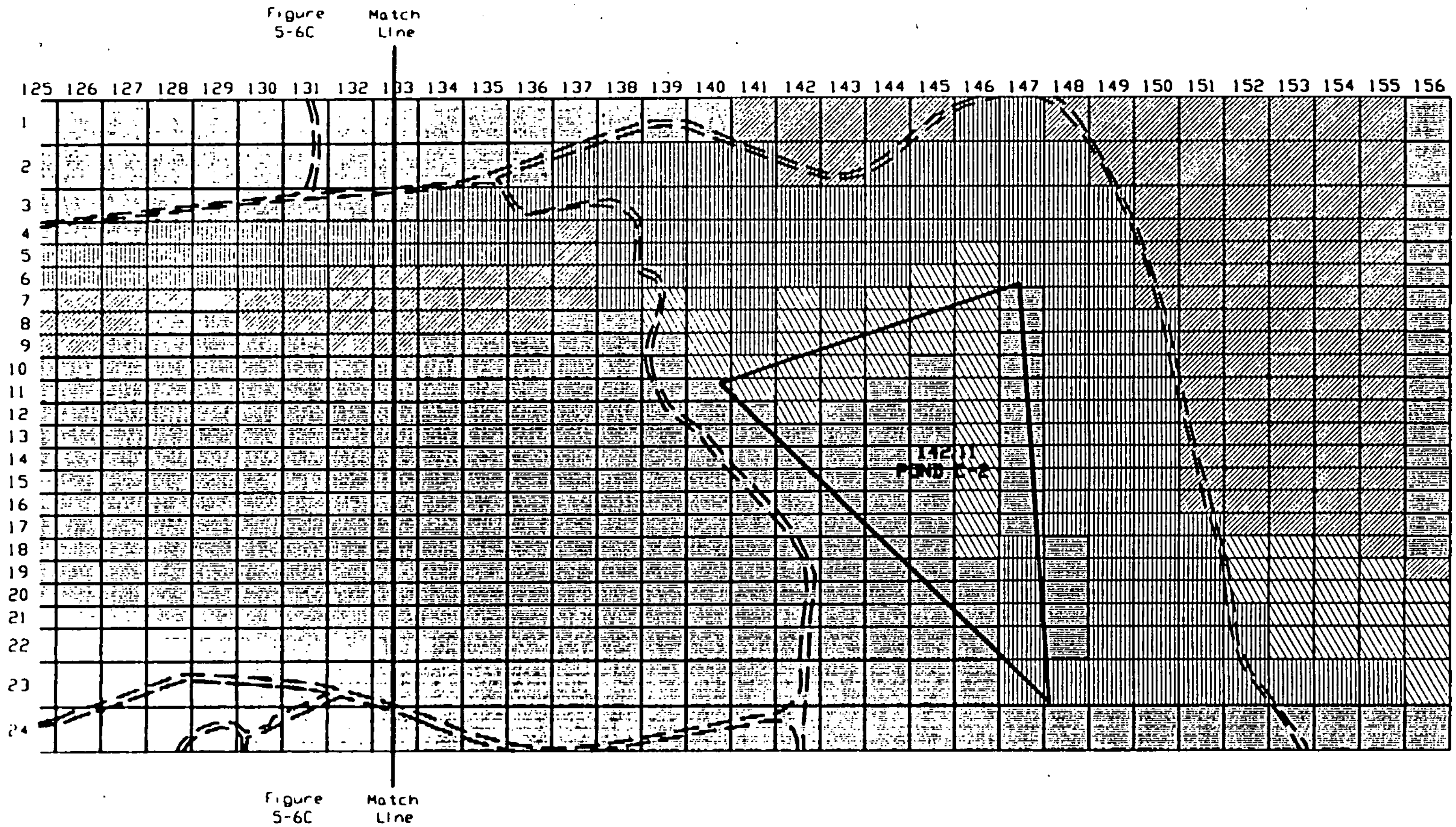
OU5 GROUNDWATER FLOW MODEL INITIAL HYDRAULIC CONDUCTIVITY ZONE

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-6C



Legend

- No Flow
- Zone 1 = (2.88x10^{-3}) ft/day
- Zone 2 = (2.89x10^{-3}) ft/day
- Zone 3 = (2.59) ft/day
- Zone 4 = (34.56) ft/day
- Road
- Individual Hazardous Substance Site

N

200 feet

Drawn SRB 8/9/95 Date
Checked [illegible] 8/9/95 Date
Approved ______ Date

FILE OU5-5-6D

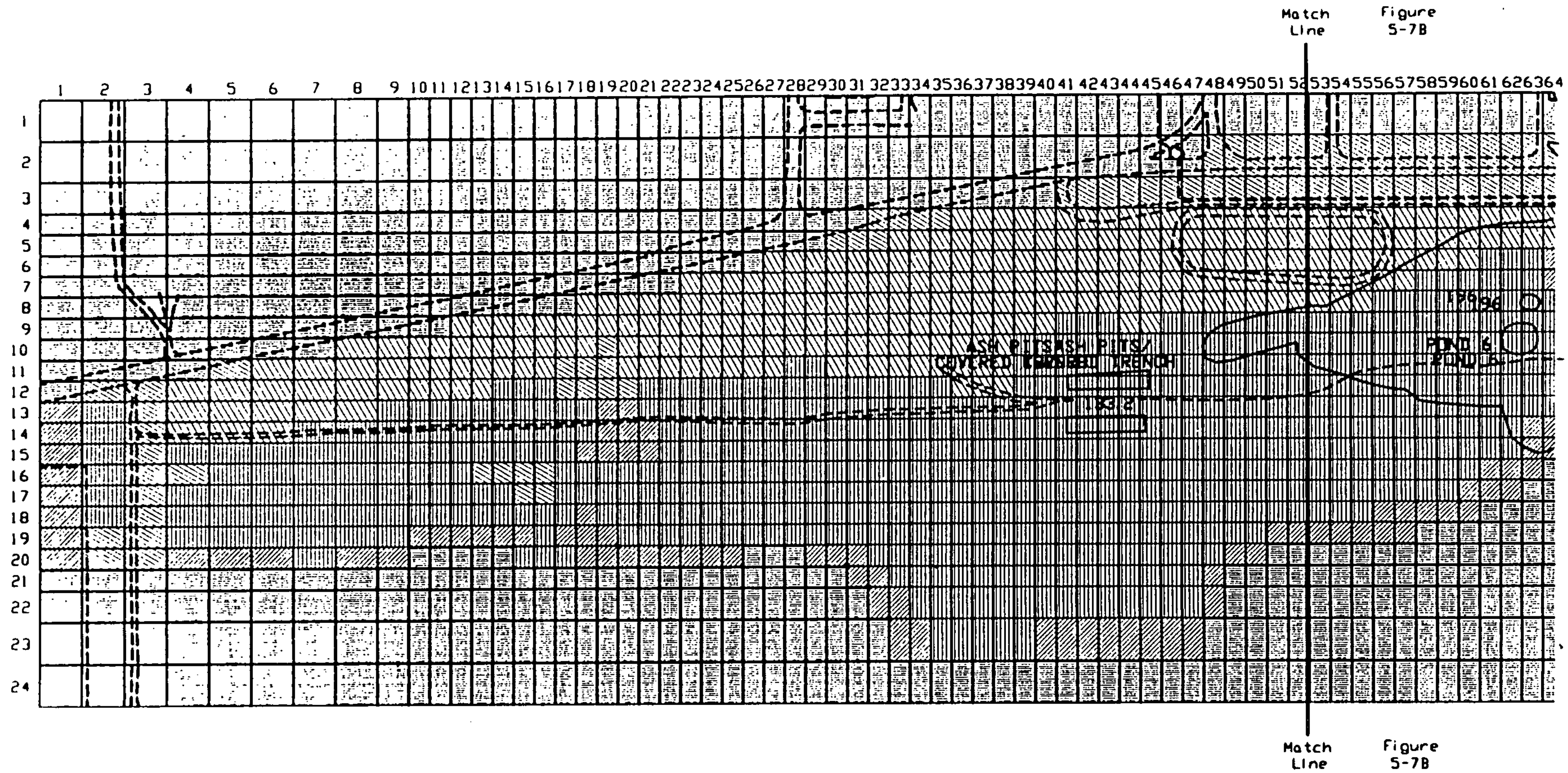
OU5 GROUNDWATER FLOW MODEL INITIAL HYDRAULIC CONDUCTIVITY ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-6D



Legend

- No Flow
- Zone 1 = $(-5.2\times10^{-3})-(-1.7\times10^{-3})$ ft/day
- Zone 2 = (1.6×10^{-3}) ft/day
- Zone 3 = (1.7×10^{-3}) ft/day
- Zone 4 = (1.9×10^{-3}) ft/day
- Zone 5 = (2.1×10^{-3}) ft/day
- Road
- Individual Hazardous Substance Site

N

200 feet

Drawn SAB 8/9/95 Date

Checked 8/9/95 Date

Approved ______ Date

FILE OU5-5-7A.DWG

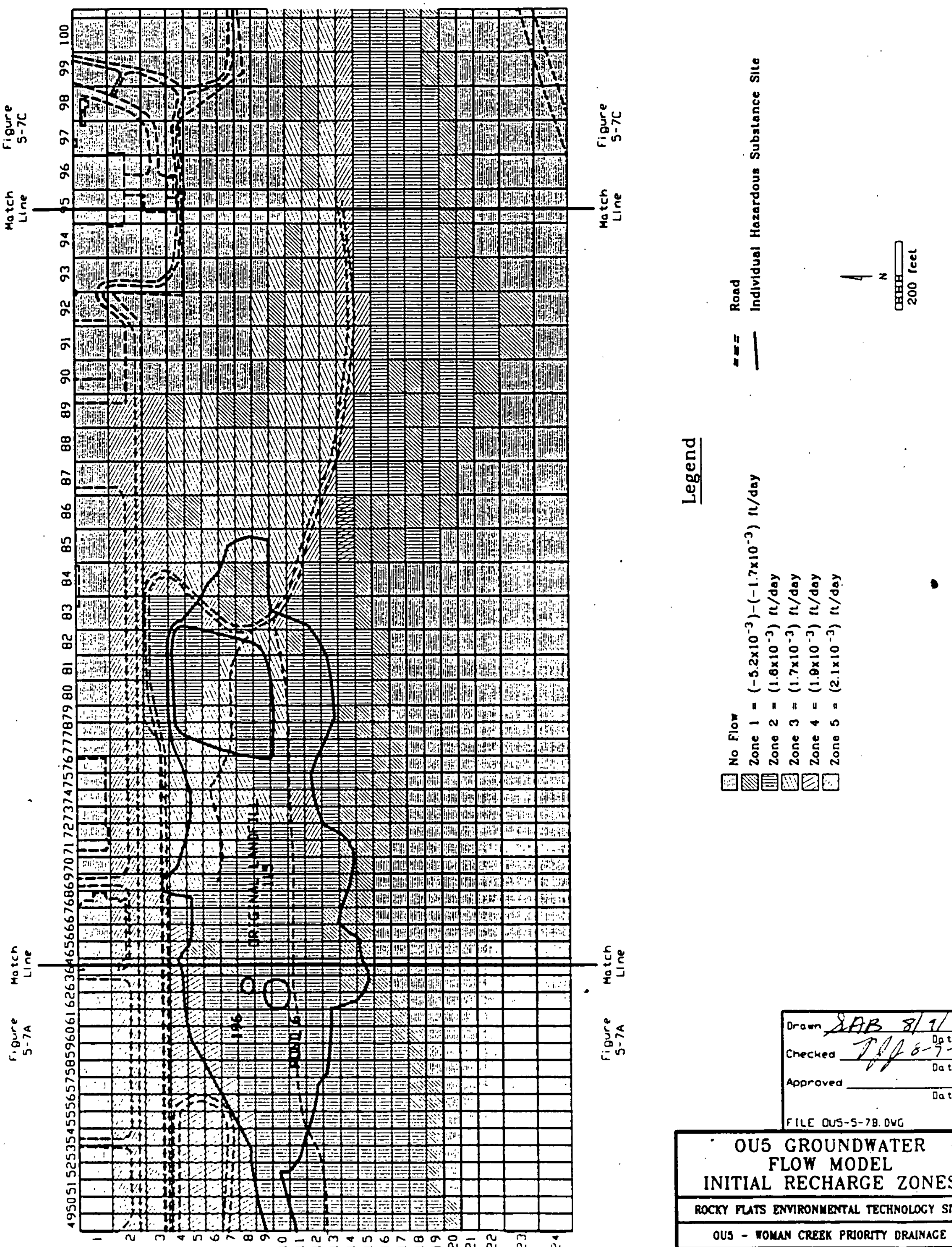
OU5 GROUNDWATER FLOW MODEL INITIAL RECHARGE ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-7A



Drawn SAB 8/1/95 Date
Checked TJJ 8-7-95 Date
Approved ____ Date
FILE OU5-5-7B.DWG

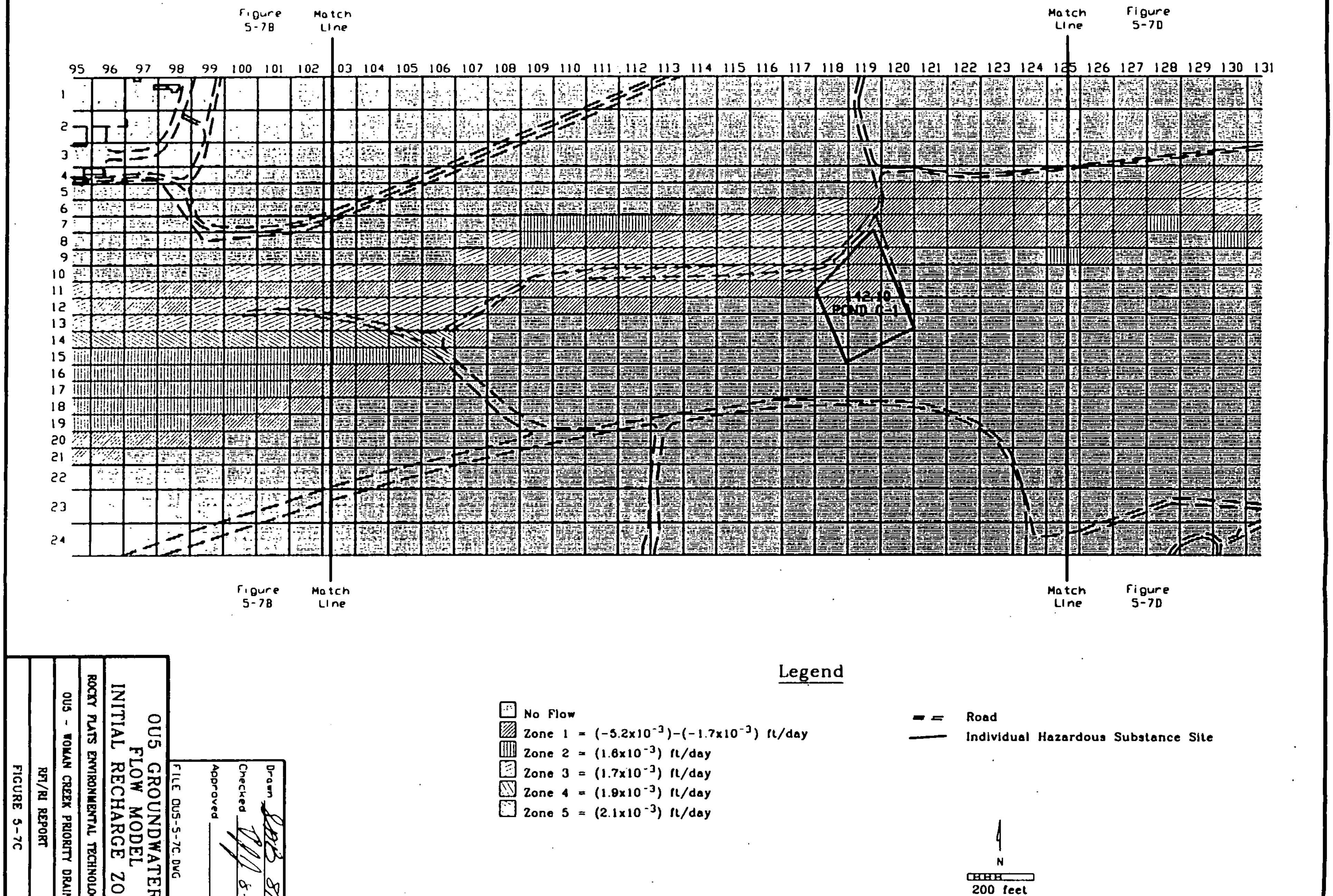
OU5 GROUNDWATER FLOW MODEL INITIAL RECHARGE ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-7B



Drawn 8/9/95 Date
Checked 8-9-95 Date
Approved Date

FILE OU5-5-7C.DWG

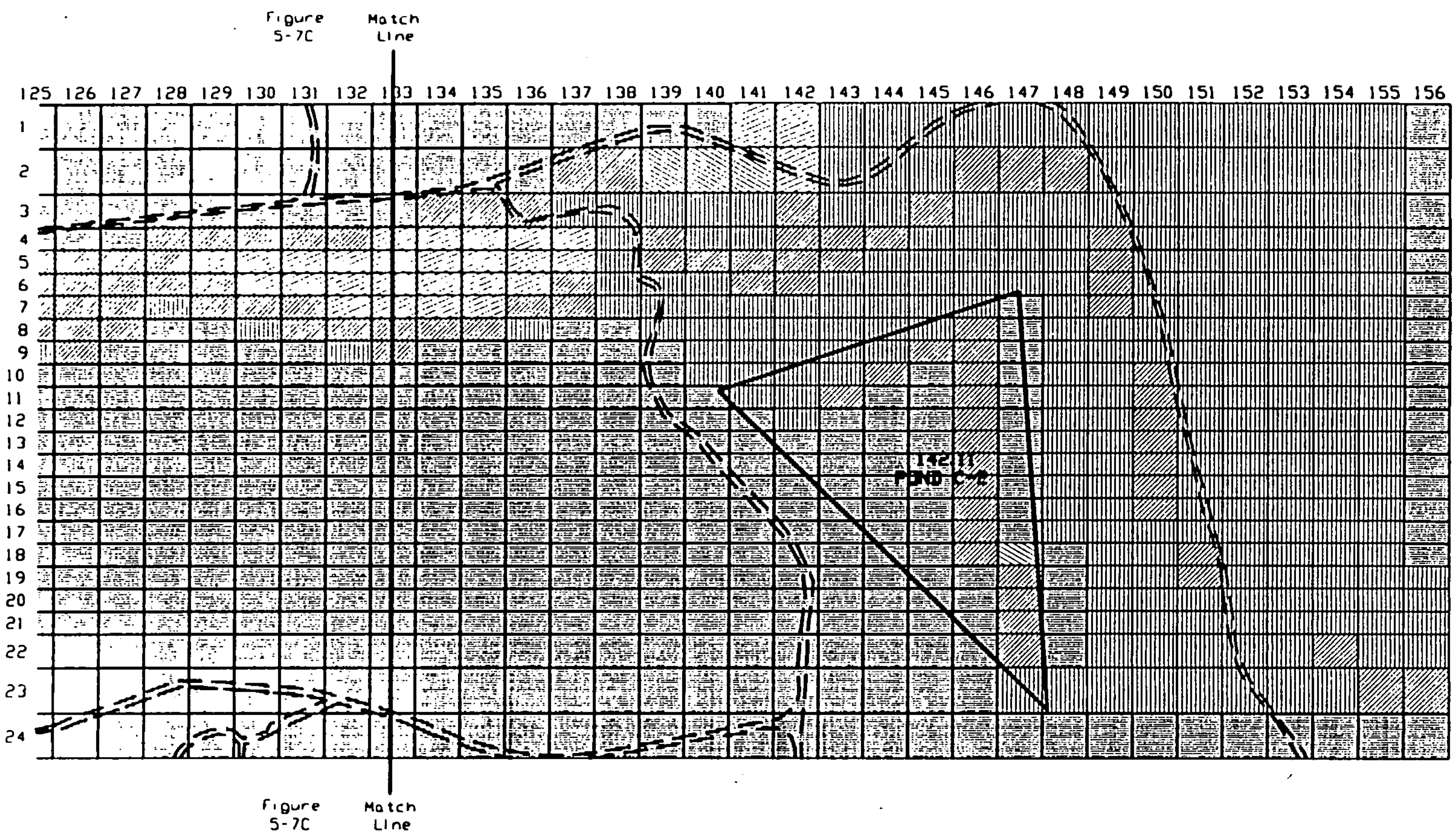
OU5 GROUNDWATER FLOW MODEL INITIAL RECHARGE ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-7C



Legend

- No Flow
- Zone 1 = $(-5.2\times10^{-3})-(-1.7\times10^{-3})$ ft/day
- Zone 2 = (1.6×10^{-3}) ft/day
- Zone 3 = (1.7×10^{-3}) ft/day
- Zone 4 = (1.9×10^{-3}) ft/day
- Zone 5 = (2.1×10^{-3}) ft/day
- Road
- Individual Hazardous Substance Site

N
200 feet

OU5 GROUNDWATER FLOW MODEL INITIAL RECHARGE ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

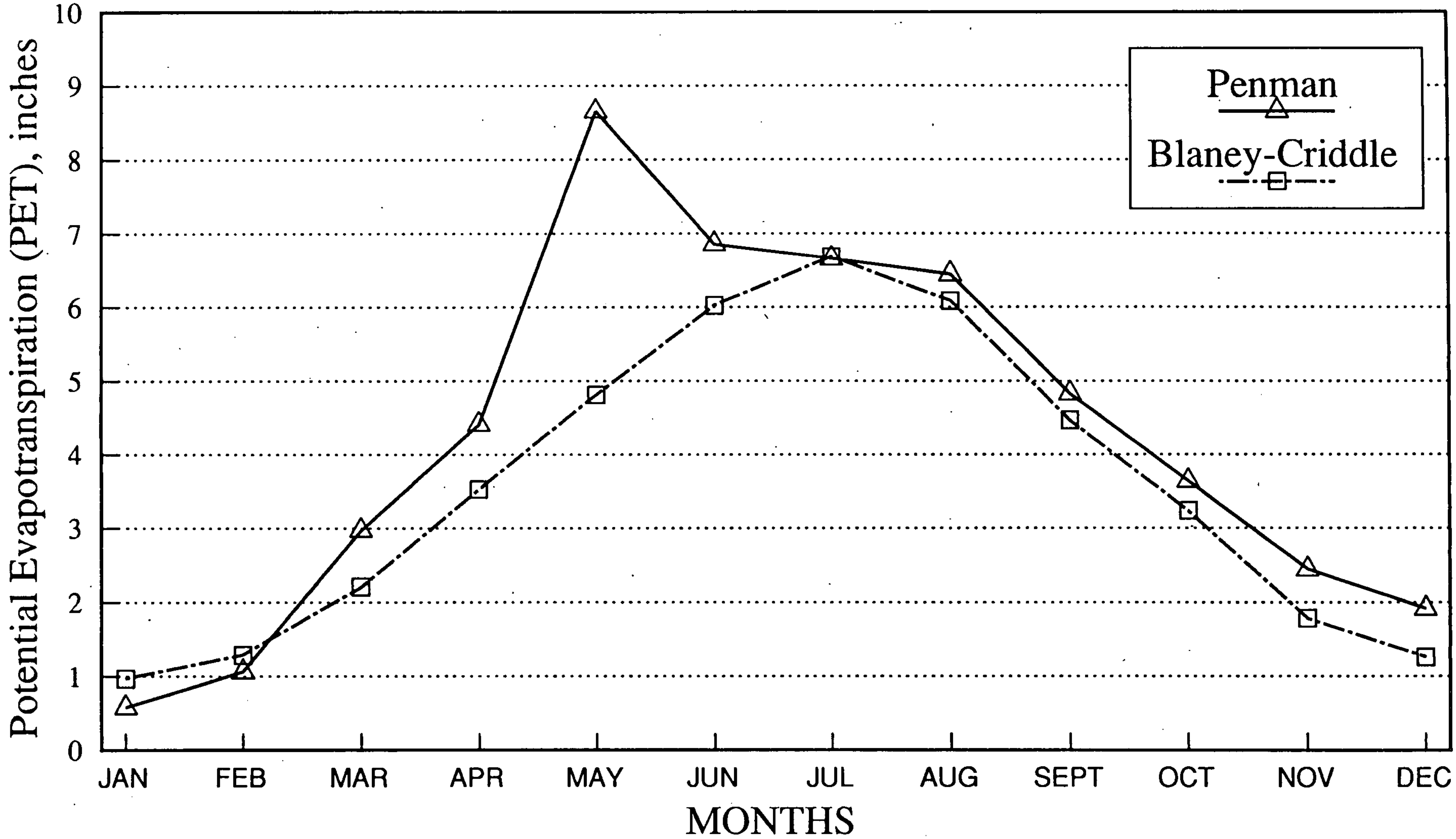
OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

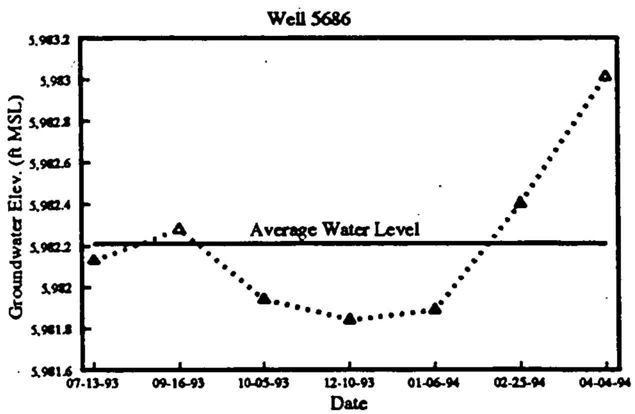
FIGURE 5-7D

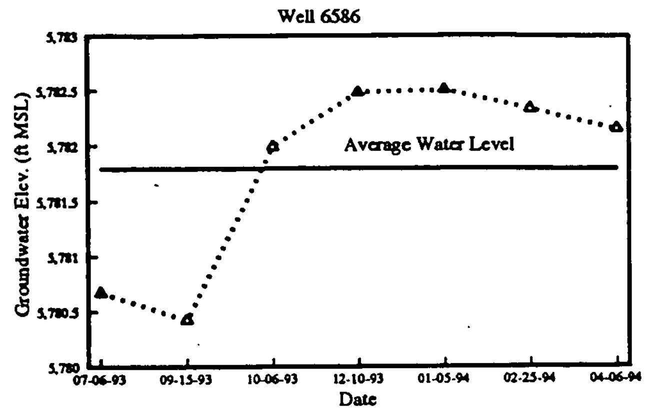
Drawn	Date 8/9/95
Checked	Date 8-9-95
Approved	Date

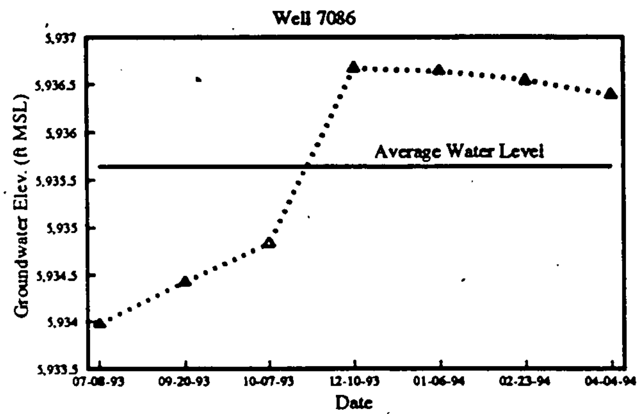
FILE OU5-5-7D.DWG

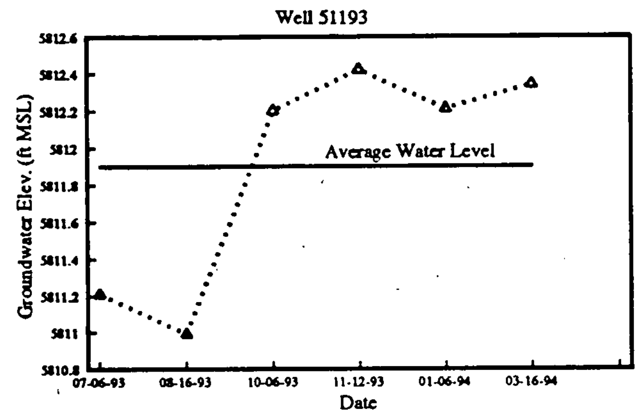


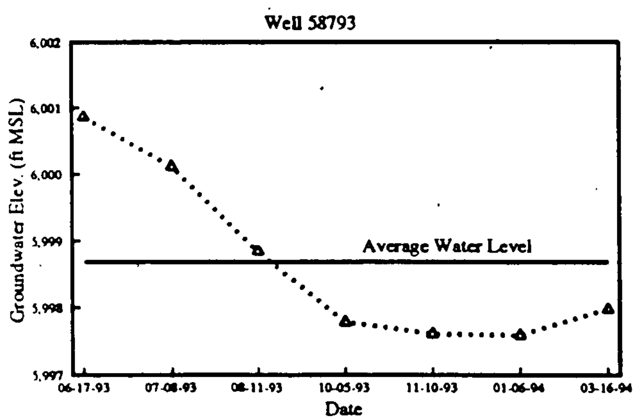
	COMPARISON OF POTENTIAL EVAPOTRANPIRATION CALCULATED BY PENMAN AND BLANEY-CRIDDLE METHODS
DRAWN JED 10/3/95 DATE	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
CHECKED JWH 10/3/95 DATE	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
APPROVED 10/16/95 DATE	FIGURE 5-8
F5-8.DRW	

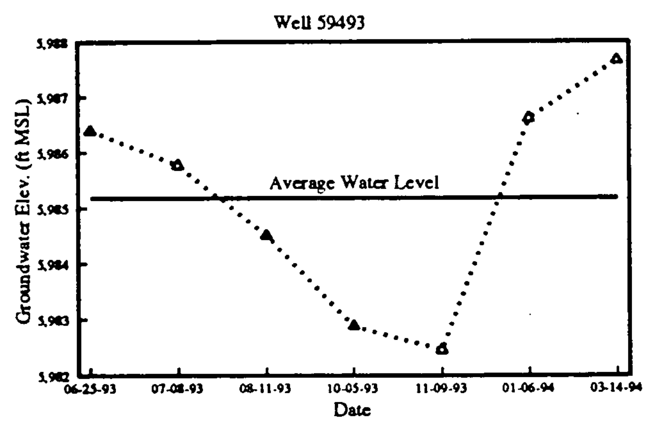


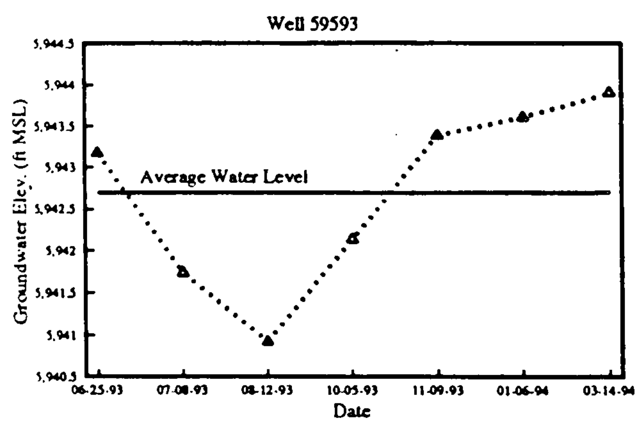










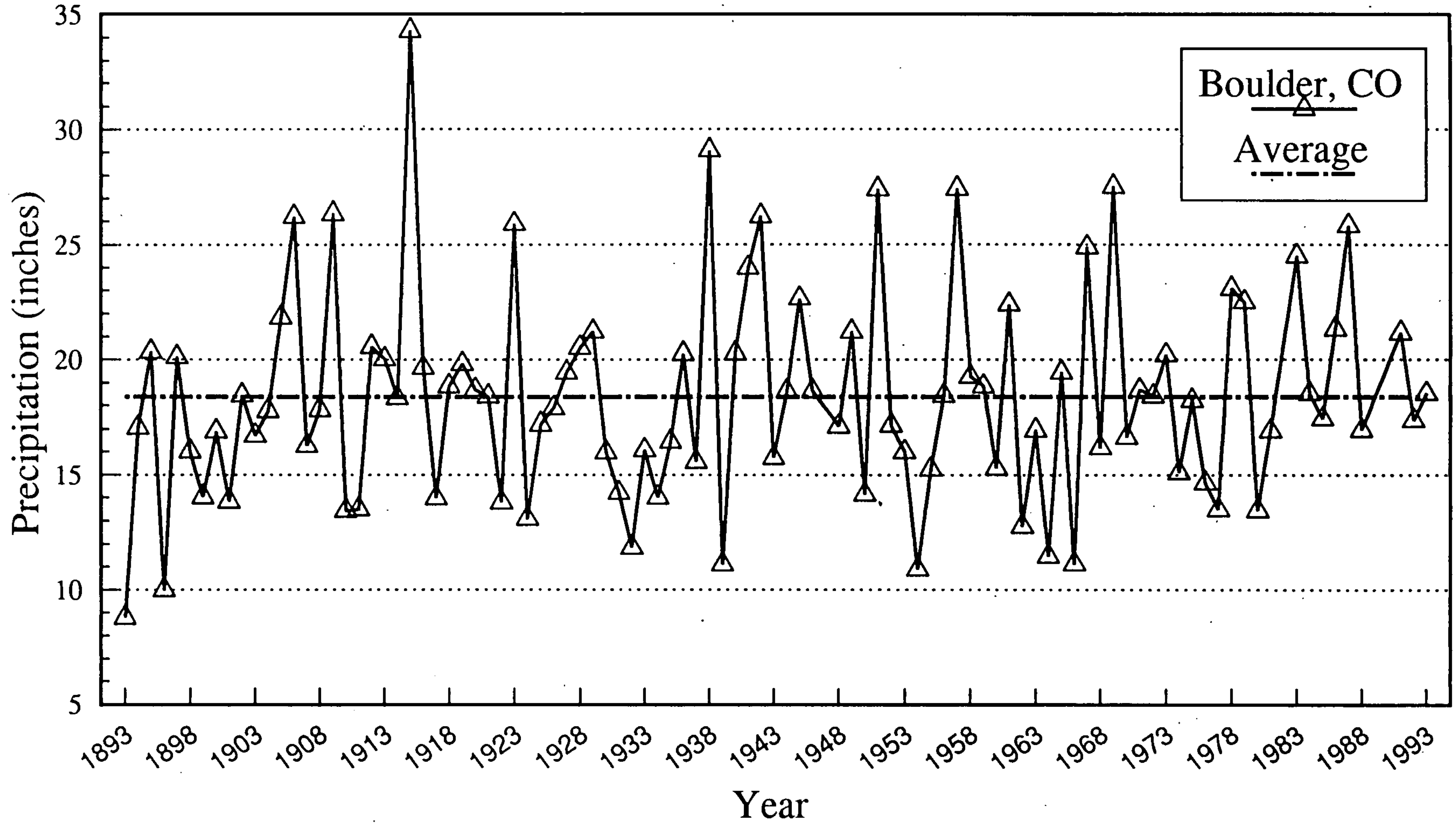


EXPLANATION

Measured Groundwater Elevation: ▲··▲

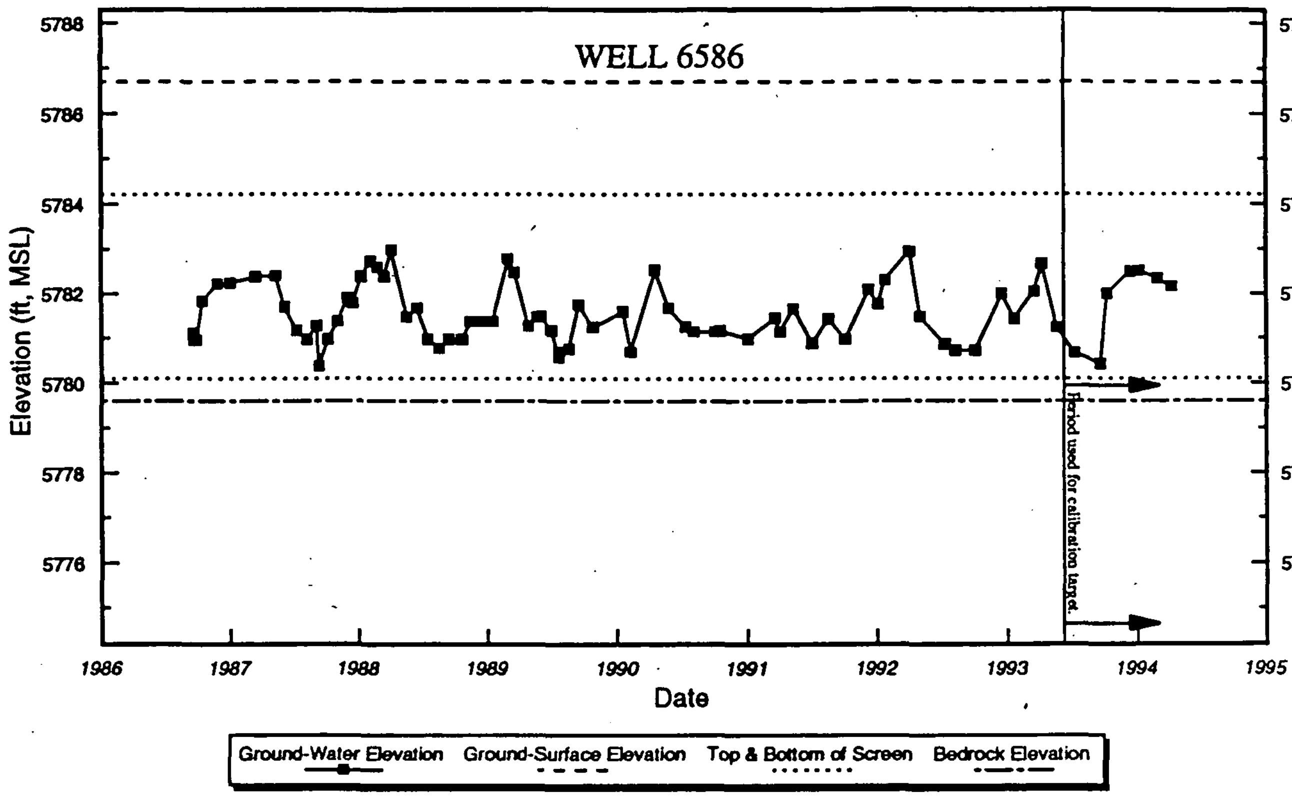
	HYDROGRAPHS OF TARGET WELLS
DRAWN [signature] 7/27/95 DATE	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
CHECKED [signature] DATE	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
APPROVED ______ DATE	FIGURE 5-9

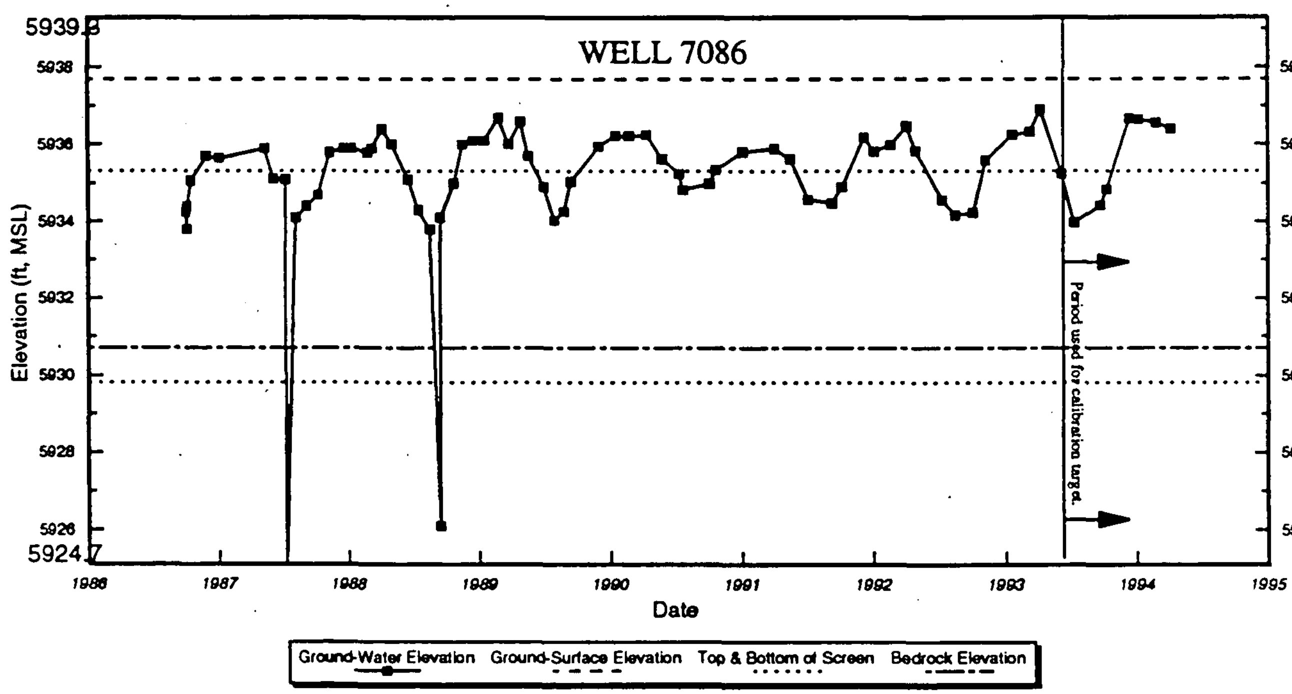
F5-9.DRW



NOTE: Average Precipitation at Boulder, CO is 18.38 inches.

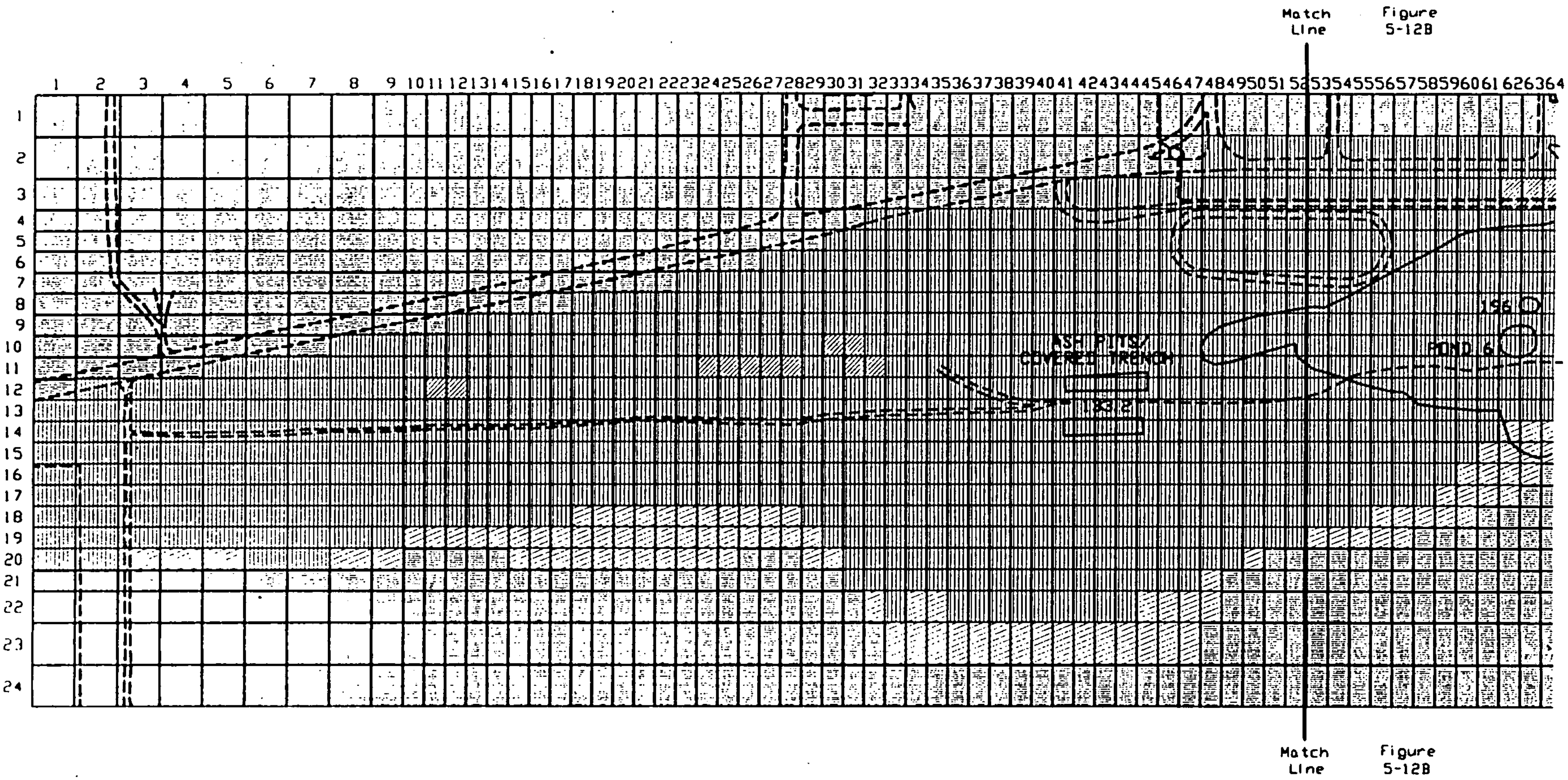
	PRECIPITATION AT BOULDER, COLORADO
DRAWN 10/3/95 DATE	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
CHECKED JWH 10/3/95 DATE	OU5 - WOMAN CREEK PRIORITY DRAINAGE
APPROVED 10/4/95 DATE	RFI/RI REPORT
F5-10.DRW	FIGURE 5-10





NOTES: The top and bottom lines of these hydrographs indicate the top of well casing and bottom of well elevations, respectively.
Elevations plotted at "Bottom of Well" indicate a "DRY" condition.

	HYDROGRAPHS OF WELLS 6586 AND 7086
DRAWN JDY 7/27/95 DATE	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
CHECKED 7/27/95 DATE	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
APPROVED ______ DATE	FIGURE 5-11
F5-11.DRW	



Legend

- No Flow
- Zone 1 = .01 - 0.1 ft/day
- Zone 2 = 0.1 - 1 ft/day
- Zone 3 = 1 - 10 ft/day
- Road
- Individual Hazardous Substance Site

N

200 feet

FILE OU5-S12A.DWG

Drawn [signature] Date 8/7/95

Checked [signature] Date 8-9-95

Approved ______ Date

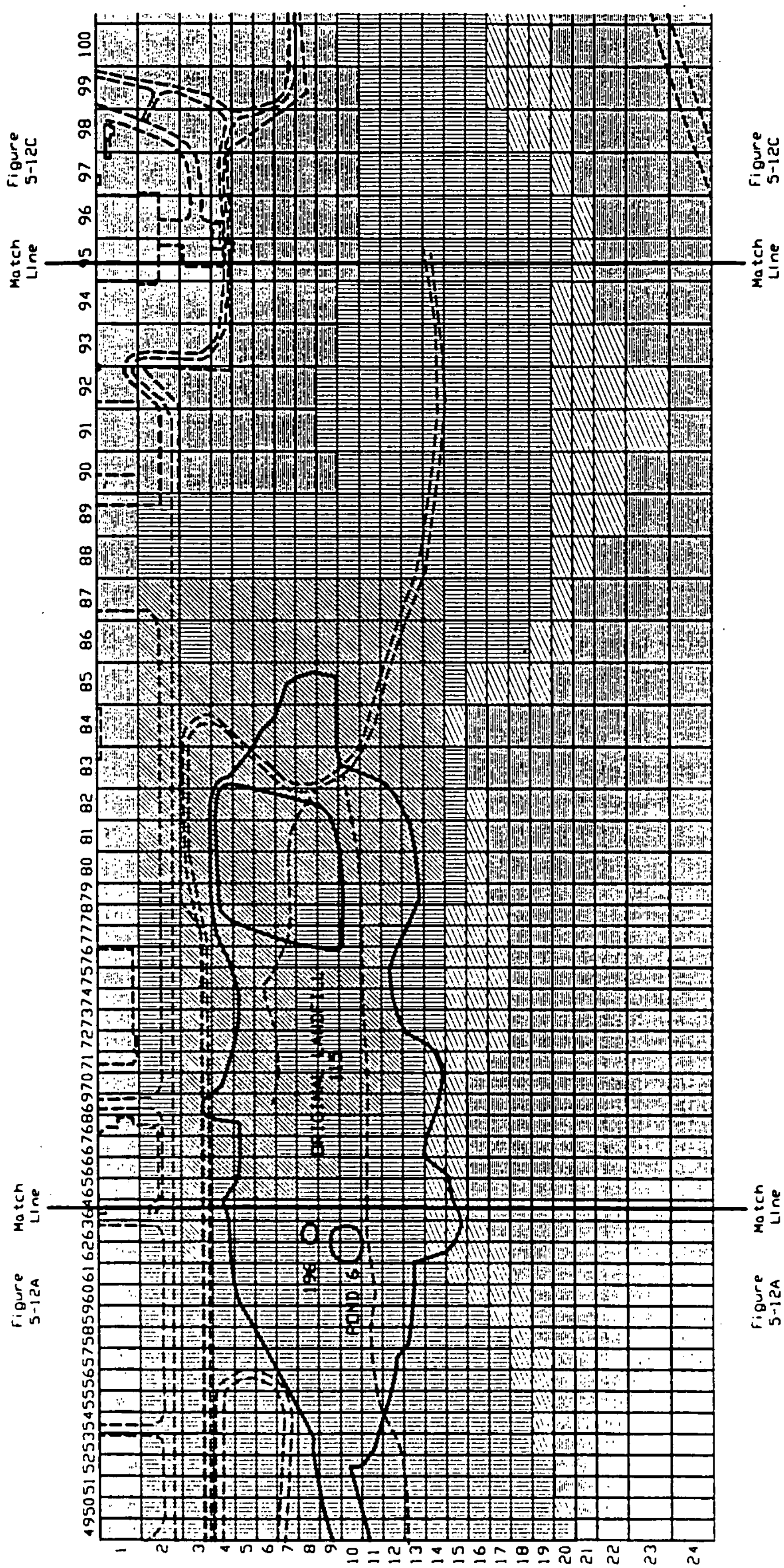
OU5 GROUNDWATER FLOW MODEL CALIBRATED HYDRAULIC CONDUCTIVITY ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-12A



Legend

No Flow
Zone 1 = .01 - 0.1 ft/day
Zone 2 = 0.1 - 1 ft/day
Zone 3 = 1 - 10 ft/day
Road
Individual Hazardous Substance Site

N
200 feet

Drawn SAB 8/9/95
Date
Checked [signature] 8-9-95
Date
Approved
Date
FILE OU5-512B.DWG

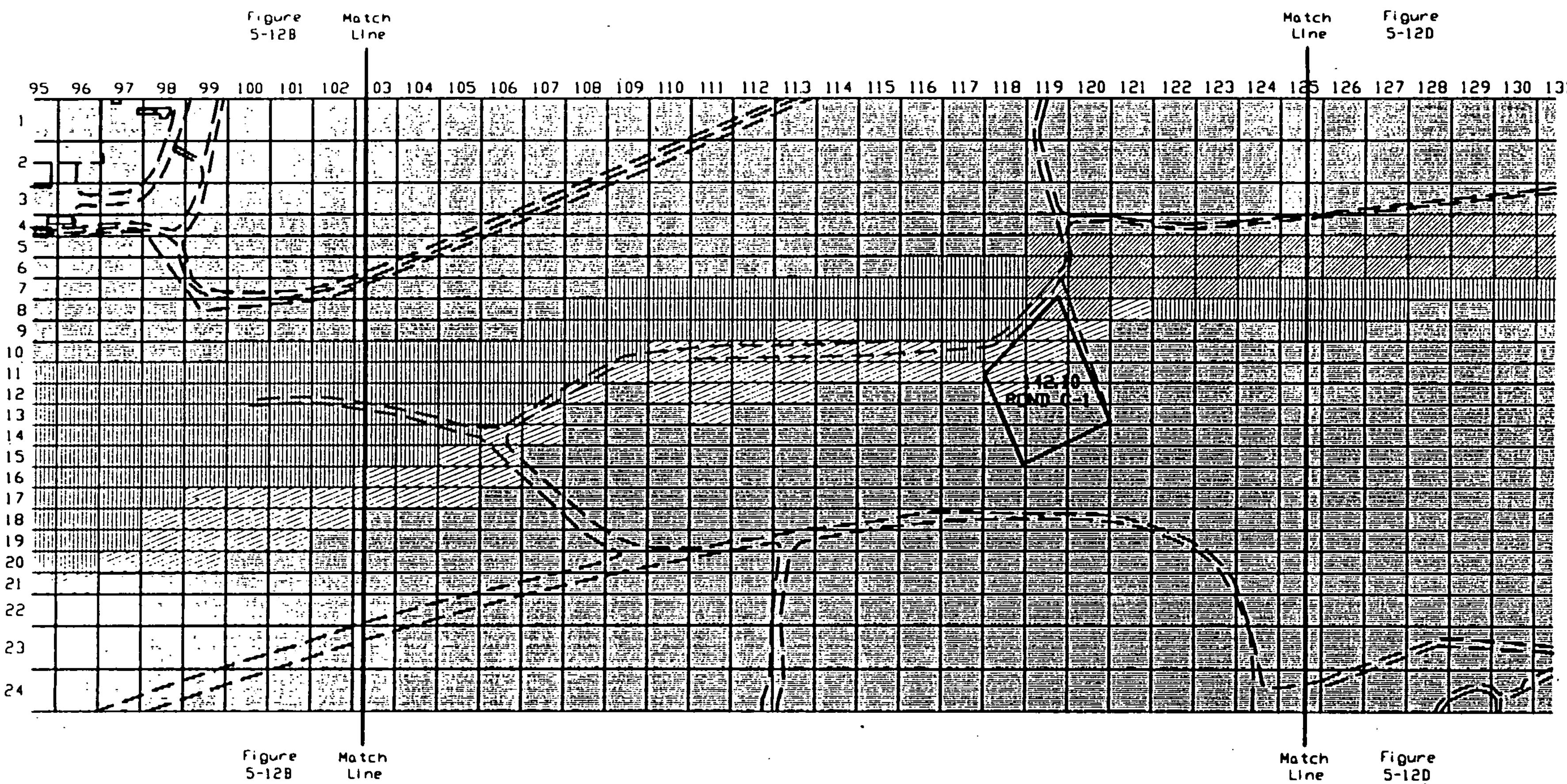
OU5 GROUNDWATER FLOW MODEL CALIBRATED HYDRAULIC CONDUCTIVITY ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-12B



Legend

- No Flow
- Zone 1 = .01 - 0.1 ft/day
- Zone 2 = 0.1 - 1 ft/day
- Zone 3 = 1 - 10 ft/day
- Road
- Individual Hazardous Substance Site

N
200 feet

OU5 GROUNDWATER FLOW MODEL CALIBRATED HYDRAULIC CONDUCTIVITY ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

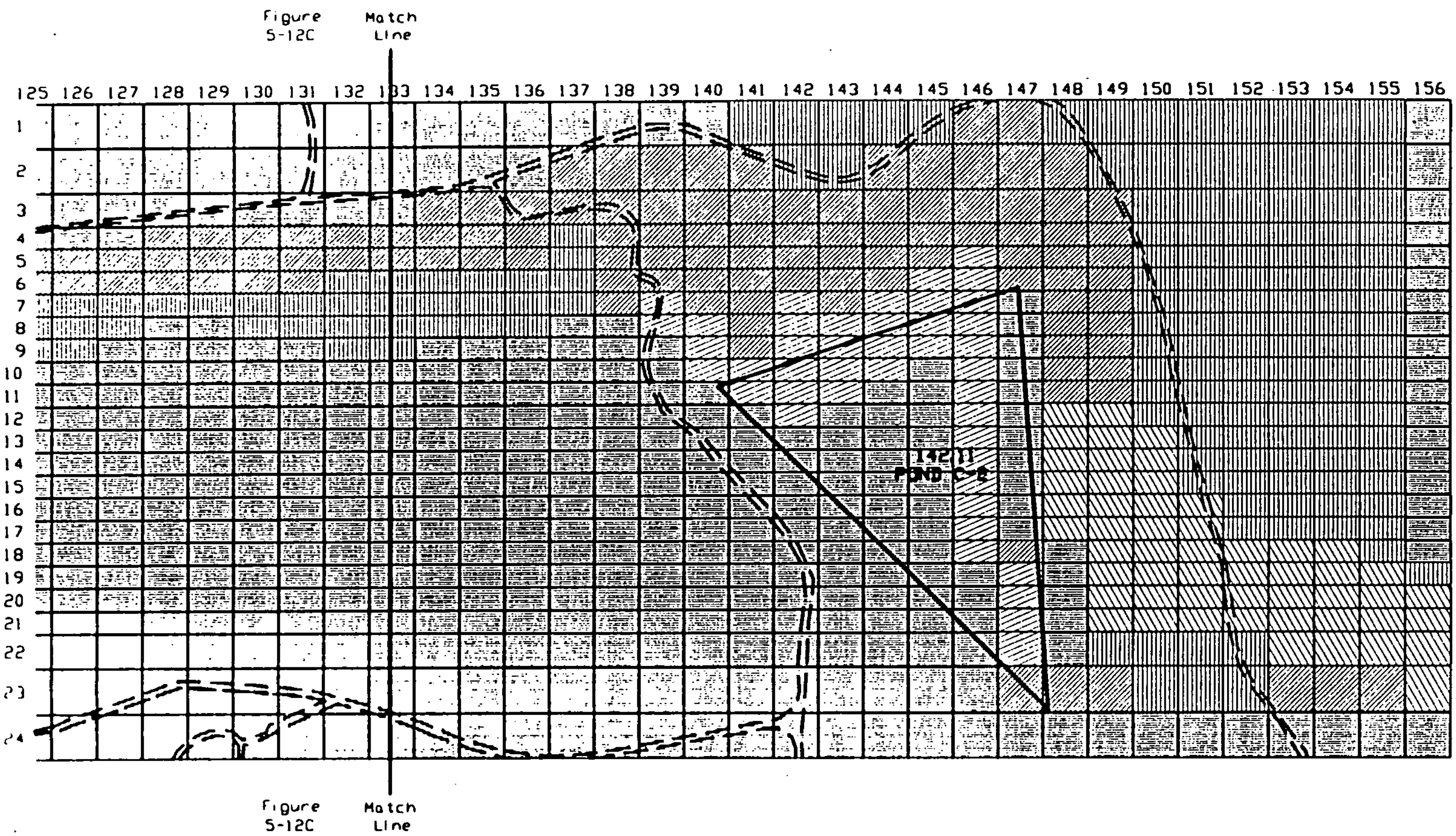
FIGURE 5-12C

FILE OU5-512C.DWG

Drawn ~~AB~~ Date 8/9/95

Checked ~~JZ~~ Date 8/9/95

Approved ______ Date ______



Legend

- No Flow
- Zone 1 = .01 - 0.1 ft/day
- Zone 2 = 0.1 - 1 ft/day
- Zone 3 = 1 - 10 ft/day
- Zone 4 = 10 - 100 ft/day
- Road
- Individual Hazardous Substance Site

N

200 feet

Drawn ____ Date
Checked ____ Date
Approved ____ Date
FILE OU5-512D.DWG

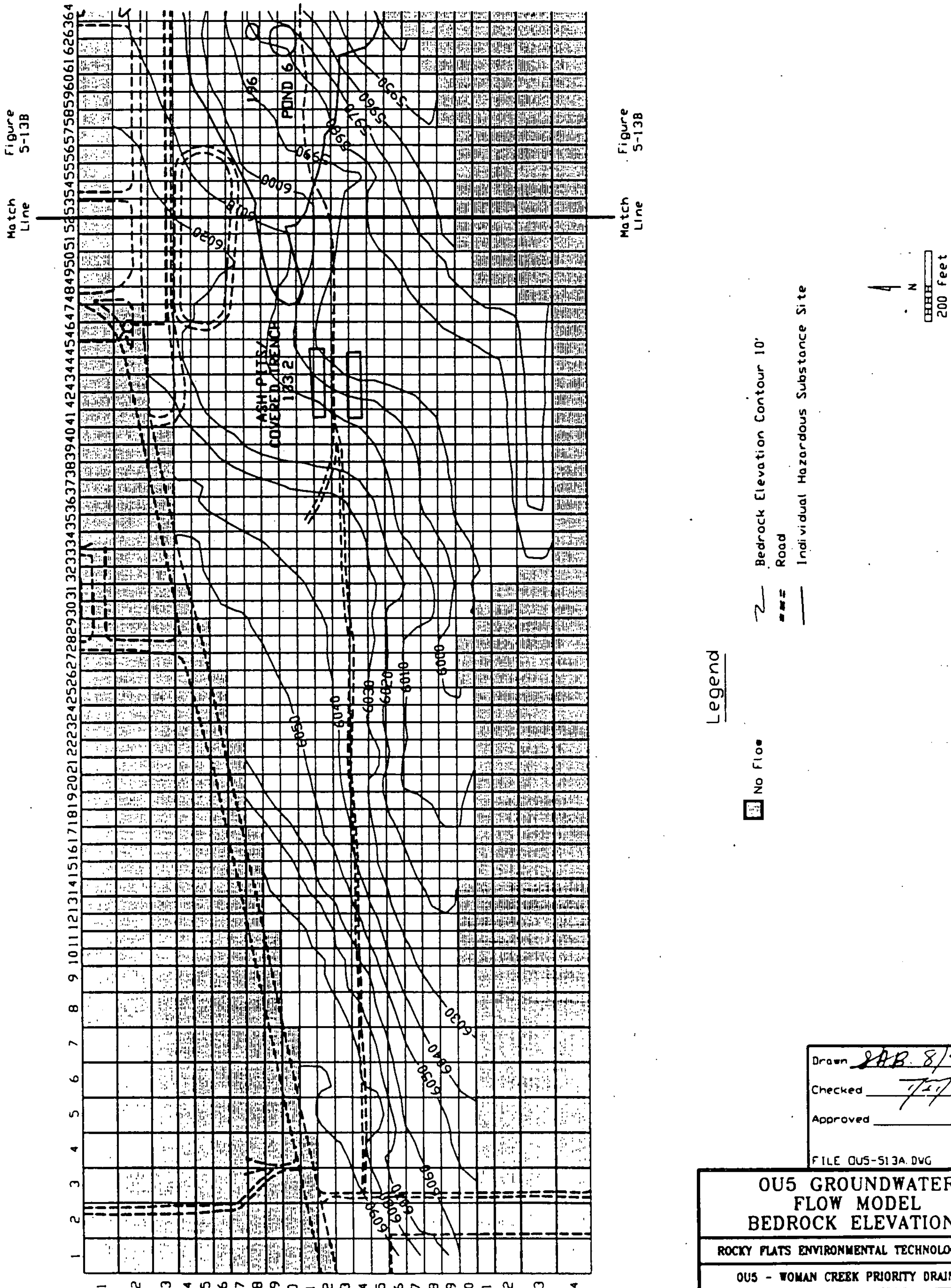
OU5 GROUNDWATER FLOW MODEL CALIBRATED HYDRAULIC CONDUCTIVITY ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-12D



Drawn SAB 8/9/95 Date
Checked TJ 8/9/95 Date
Approved ____ Date
FILE OU5-513A.DWG

OU5 GROUNDWATER FLOW MODEL BEDROCK ELEVATIONS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-13A

Figure 5-13A
Match Line
Match Line
Figure 5-13C

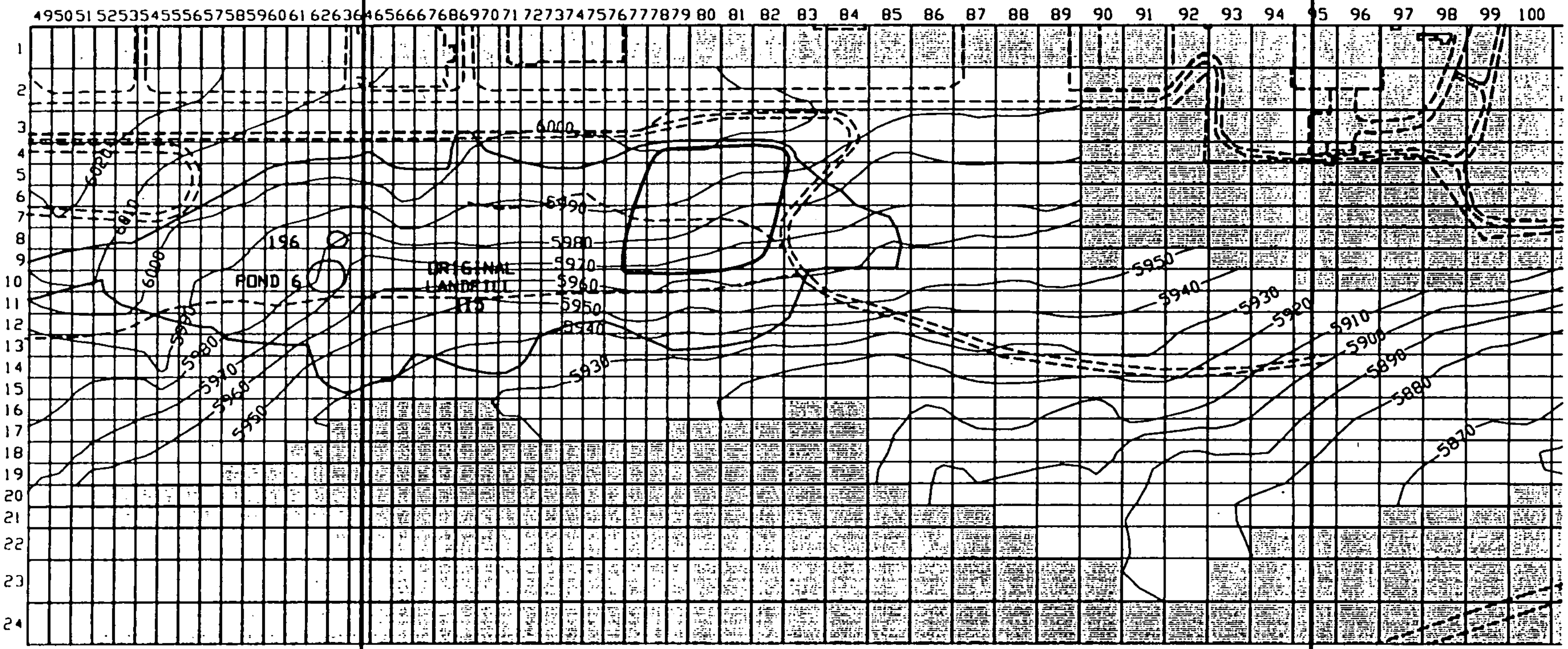


Figure 5-13A
Match Line
Match Line
Figure 5-13C

Legend

No Flow

Bedrock Elevation Contour 10'

Road

Individual Hazardous Substance Site

N

200 feet

Drawn ______ Date 8/1/95
Checked ______ Date 8/8/95
Approved ______ Date

FILE OU5-513B.DWG

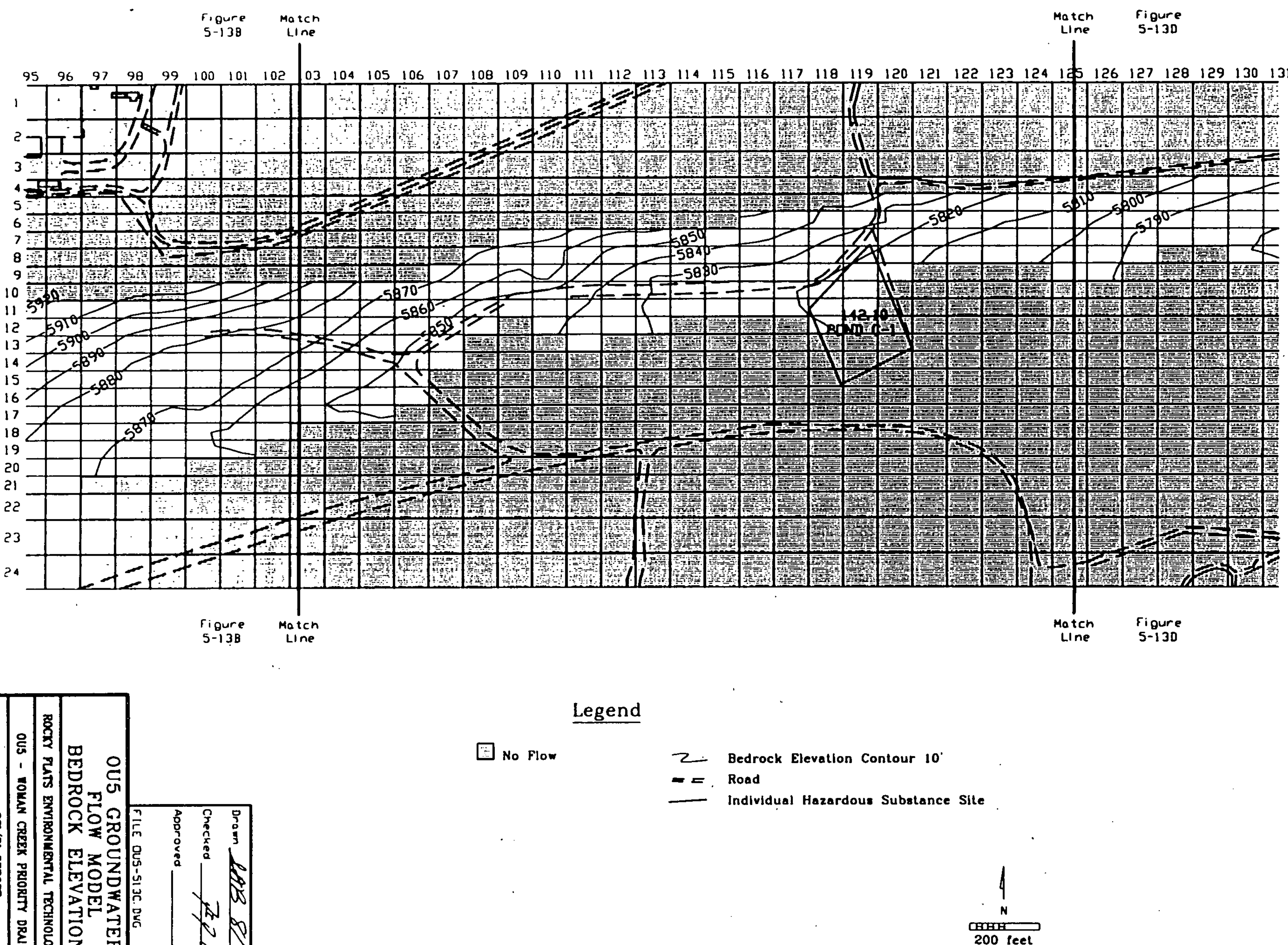
OU5 GROUNDWATER FLOW MODEL BEDROCK ELEVATIONS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-13B



Drawn LAB 8/9/95 Date
Checked [signature] Date
Approved ______ Date
FILE OU5-513C.DWG

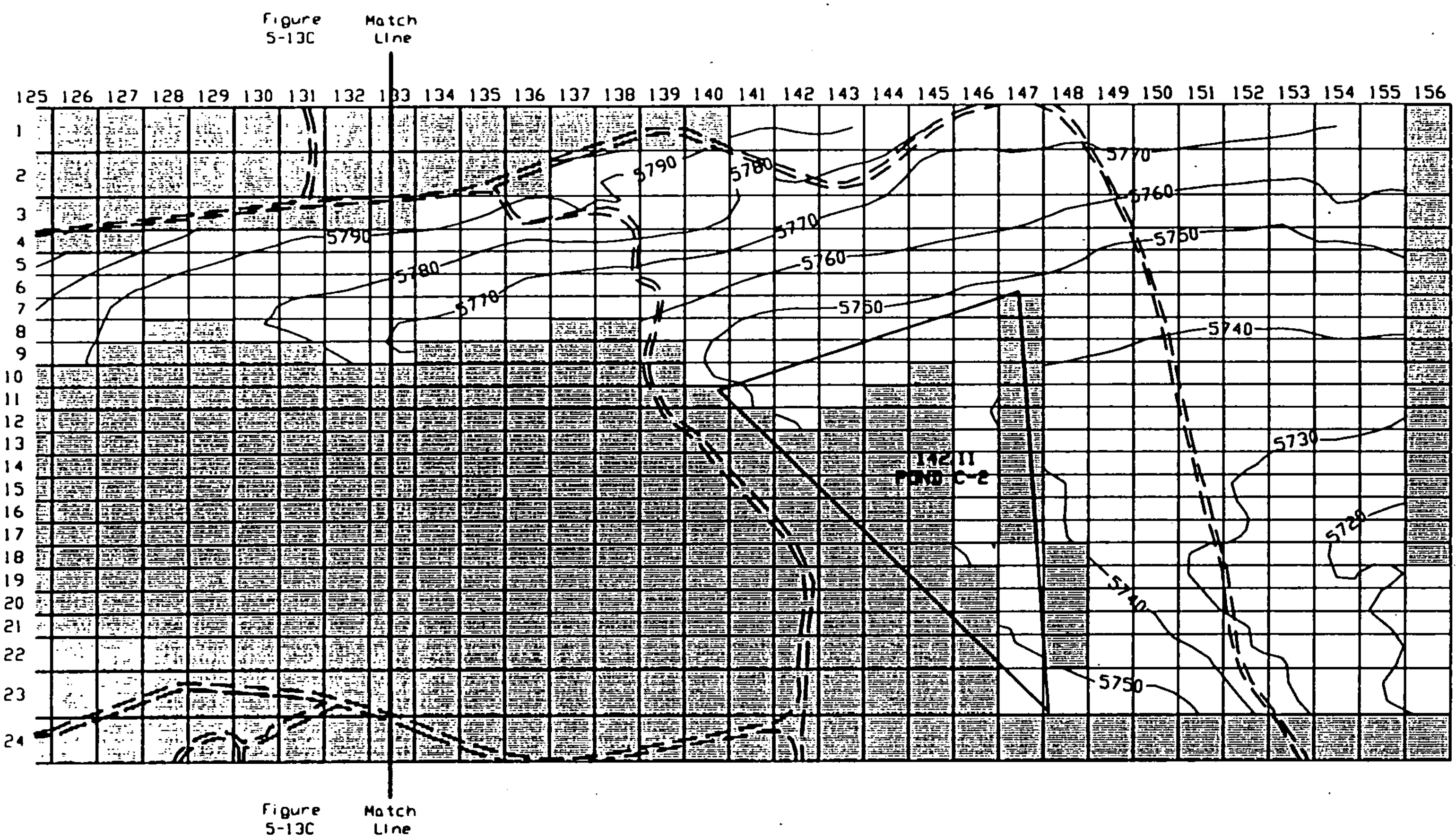
OU5 GROUNDWATER FLOW MODEL BEDROCK ELEVATIONS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-13C



Legend

No Flow

Bedrock Elevation Contour 10'

Road

Individual Hazardous Substance Site

N

200 feet

Drawn SRB 8/9/95 Date

Checked TJP 8-9-95 Date

Approved ______ Date

FILE OU5-513D.DWG

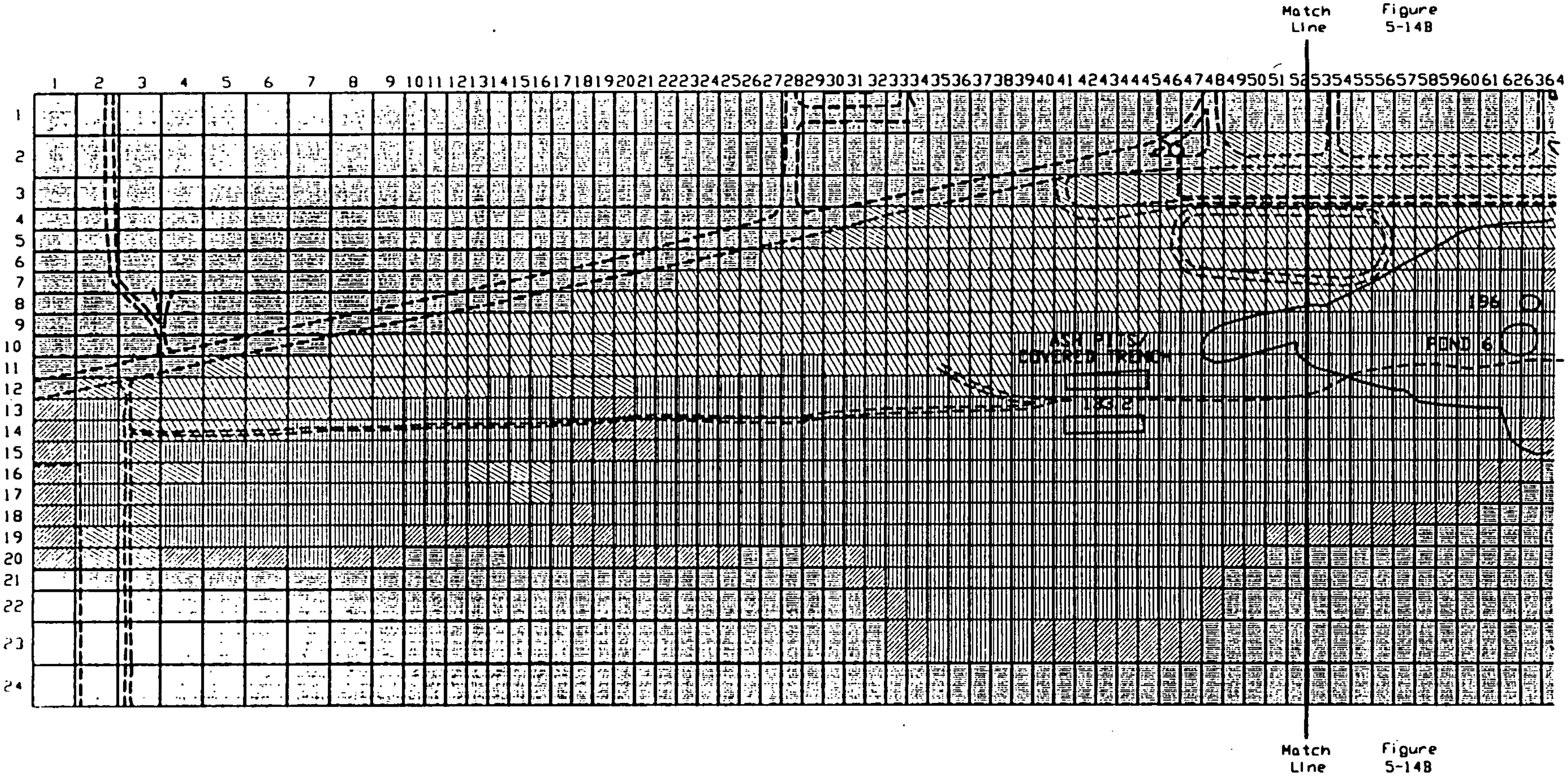
OU5 GROUNDWATER FLOW MODEL BEDROCK ELEVATIONS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-13D



Legend

- No Flow
- Zone 1 = $(-7.4286\times10^{-4})-(-2.4286\times10^{-4})$ ft/day
- Zone 2 = (2.2857×10^{-4}) ft/day
- Zone 3 = (2.4286×10^{-4}) ft/day
- Zone 4 = (2.7143×10^{-4}) ft/day
- Zone 5 = (3.0×10^{-4}) ft/day
- Road
- Individual Hazardous Substance Site

N

200 feet

OU5 GROUNDWATER FLOW MODEL CALIBRATED RECHARGE ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

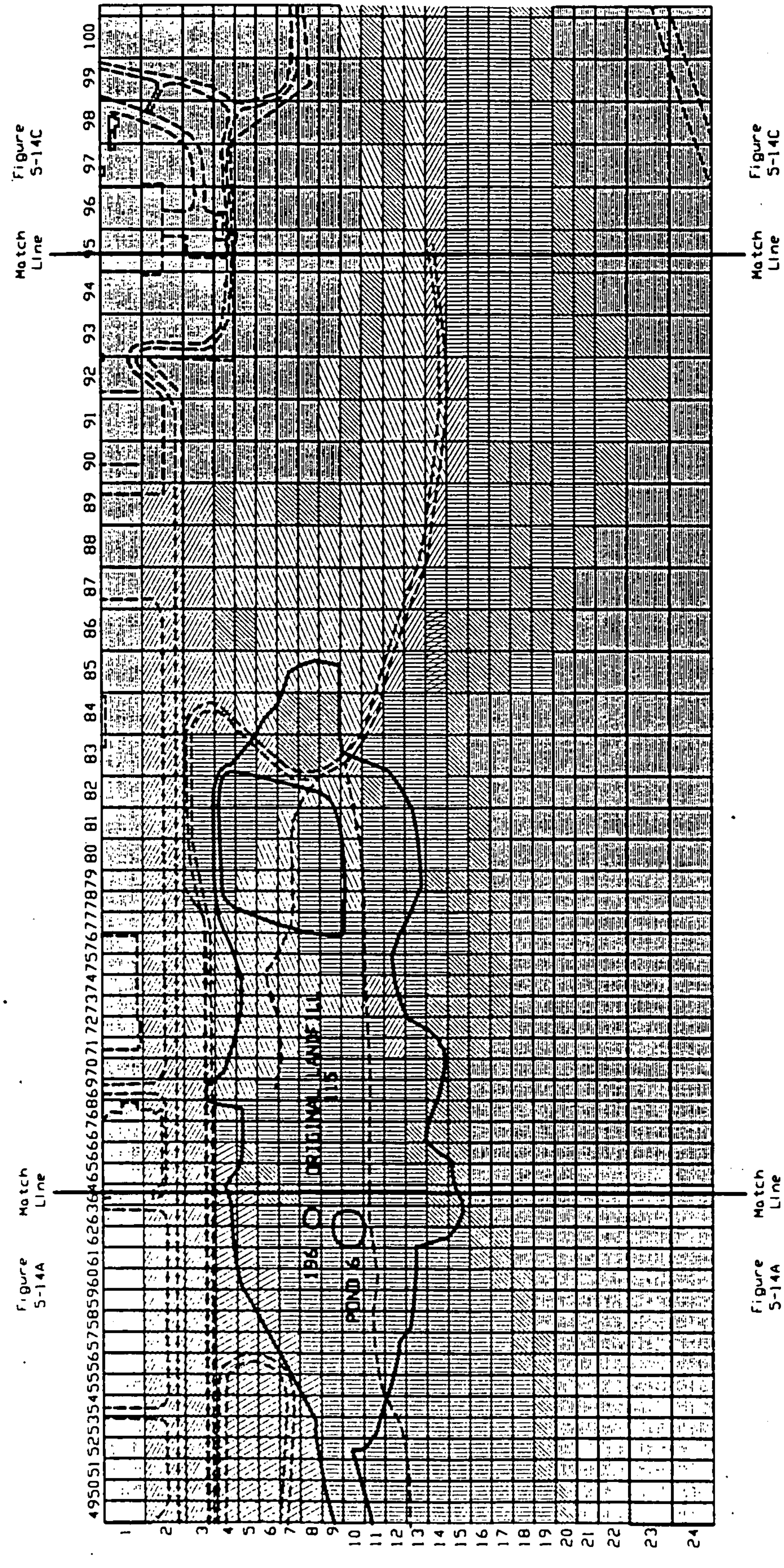
FIGURE 5-14A

FILE OU5-514A.DWG

Drawn ___ Date 8/9/95

Checked ___ Date 8-9-95

Approved ___ Date



Legend

- No Flow
- Zone 1 = (-7.4286×10^{-4})-(-2.4286×10^{-4}) ft/day
- Zone 2 = (2.2857×10^{-4}) ft/day
- Zone 3 = (2.4286×10^{-4}) ft/day
- Zone 4 = (2.7143×10^{-4}) ft/day
- Zone 5 = (3.0×10^{-4}) ft/day
- Road
- Individual Hazardous Substance Site

N

200 feet

Drawn: [signature] 8/9/95 Date

Checked: [signature] 8-9-95 Date

Approved ______ Date

FILE OU5-514B.DWG

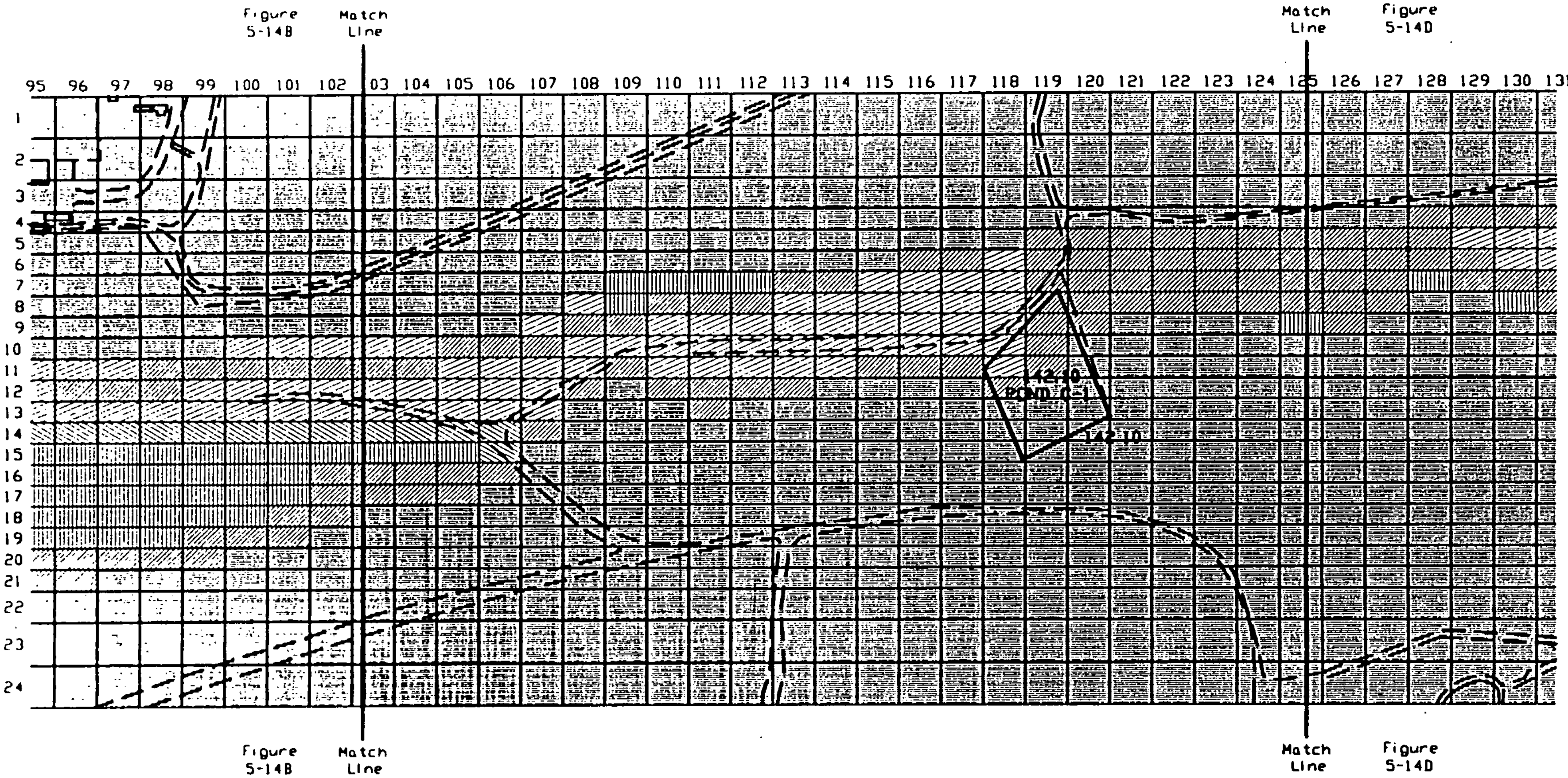
OU5 GROUNDWATER FLOW MODEL CALIBRATED RECHARGE ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-14B



Legend

- No Flow
- Zone 1 = $(-7.4286 \times 10^{-4})-(-2.4286 \times 10^{-4})$ ft/day
- Zone 2 = (2.2857×10^{-4}) ft/day
- Zone 3 = (2.4286×10^{-4}) ft/day
- Zone 4 = (2.7143×10^{-4}) ft/day
- Zone 5 = (3.0×10^{-4}) ft/day
- Road
- Individual Hazardous Substance Site

N

200 feet

Drawn [signature] 8/9/95
Checked [signature] Date 8-7-95
Approved ______ Date
FILE OU5-514C.DWG

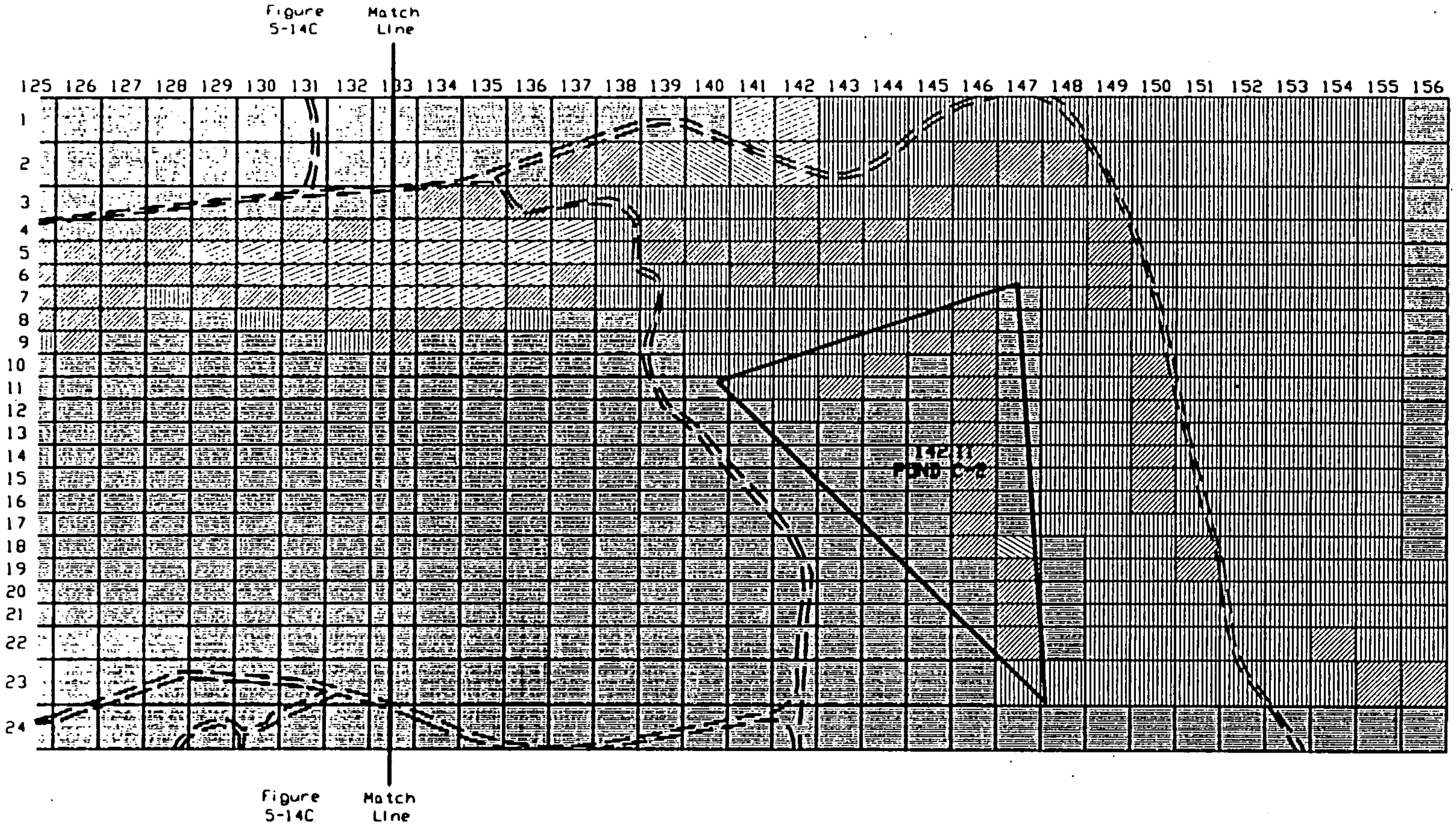
OU5 GROUNDWATER FLOW MODEL CALIBRATED RECHARGE ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-14C



Legend

- No Flow
- Zone 1 = (-7.4286x10^{-4})-(-2.4286x10^{-4}) ft/day
- Zone 2 = (2.2857x10^{-4}) ft/day
- Zone 3 = (2.4286x10^{-4}) ft/day
- Zone 4 = (2.7143x10^{-4}) ft/day
- Zone 5 = (3.0x10^{-4}) ft/day
- Road
- Individual Hazardous Substance Site

OU5 GROUNDWATER FLOW MODEL CALIBRATED RECHARGE ZONES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

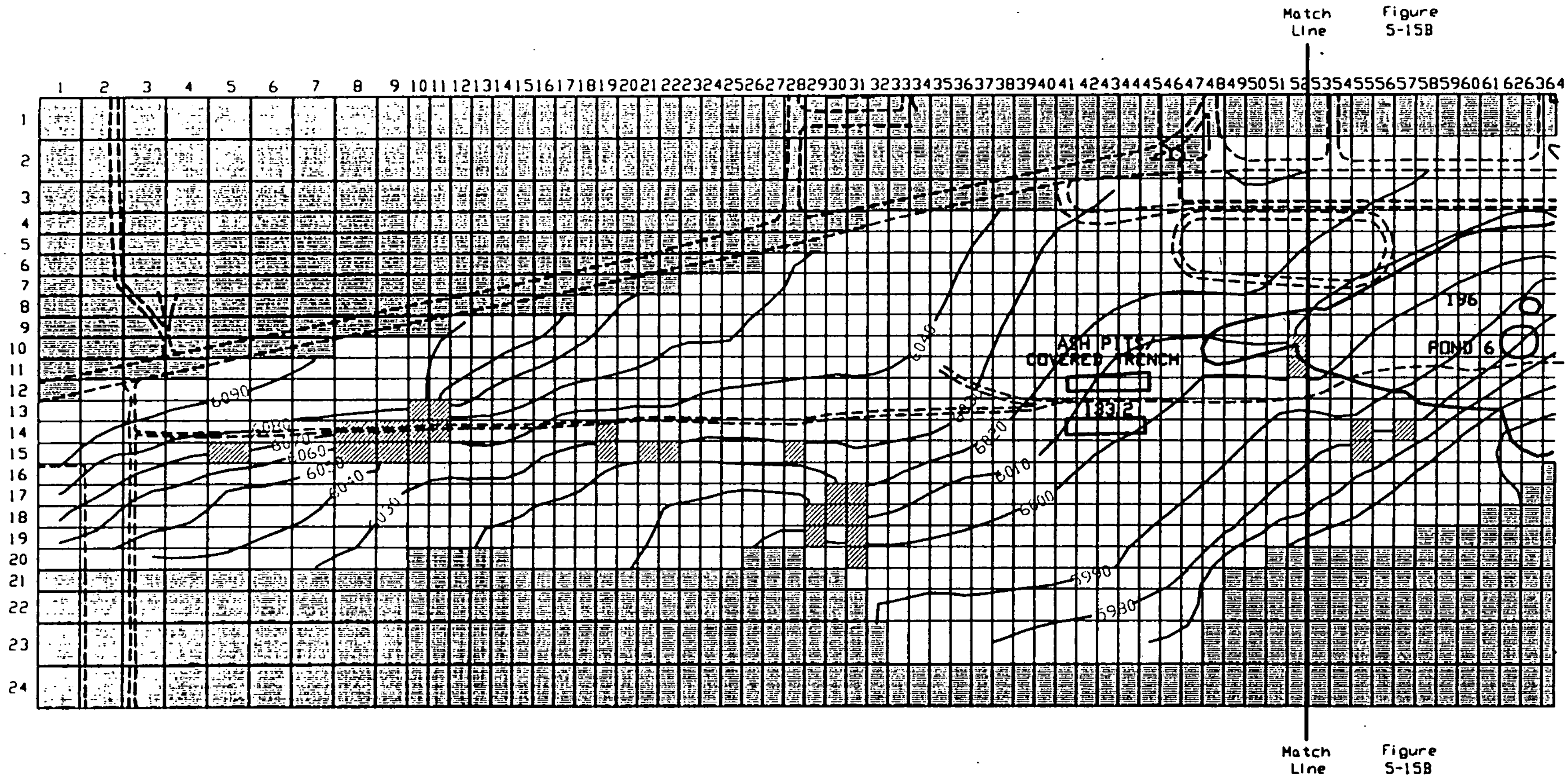
FIGURE 5-14D

FILE OU5-514D.DWG

Drawn Date

Checked Date

Approved Date



Legend

No Flow

Dry Area

Water Table Contour 10'

Road

Individual Hazardous Substance Site

N

200 feet

OU5 GROUNDWATER FLOW MODEL SIMULATED WATER TABLE

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

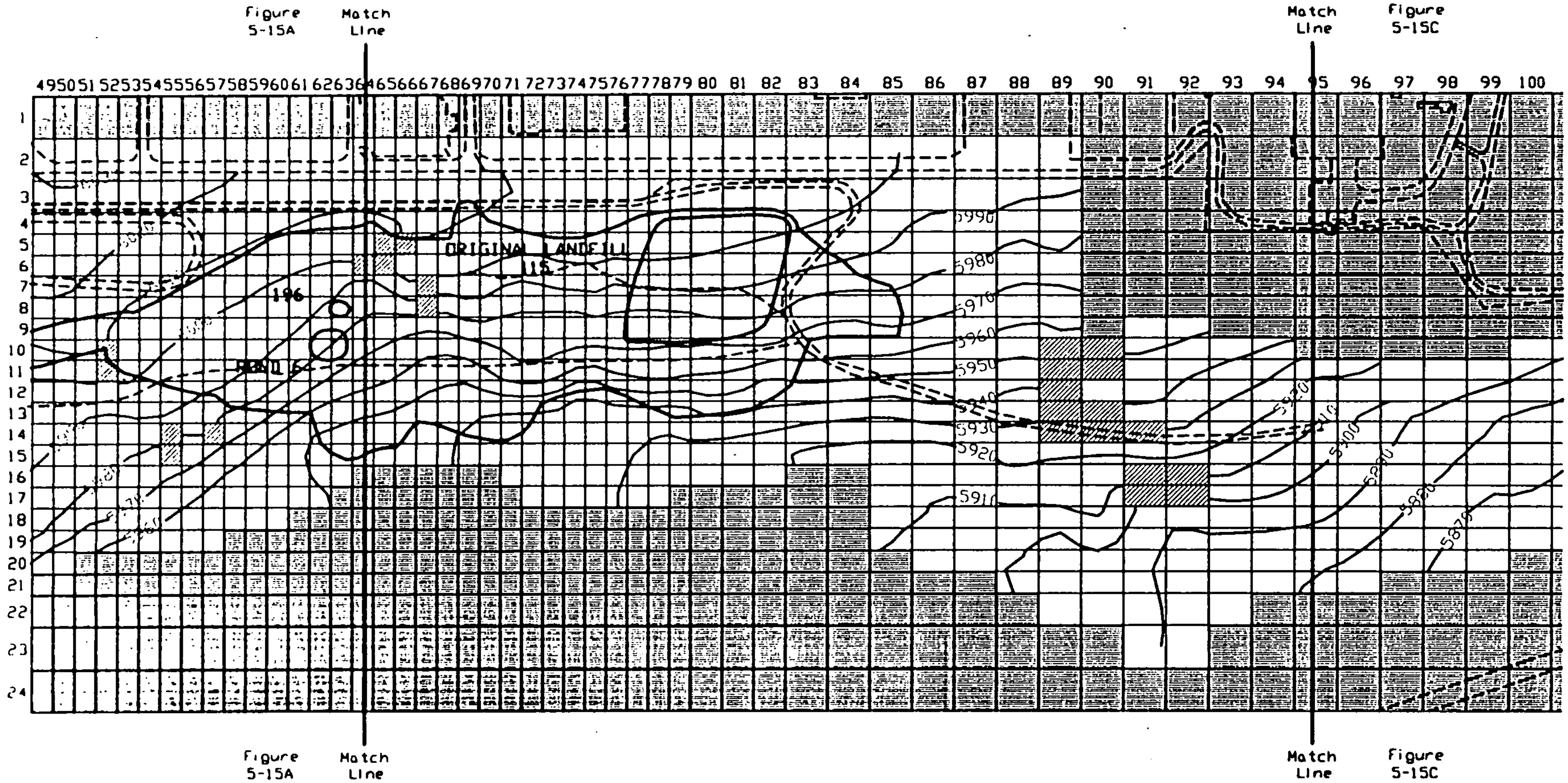
FIGURE 5-15A

Drawn — Date 8/9/95

Checked — Date

Approved — Date

FILE OU5-515A.DWG



Legend

- No Flow
- Dry Area
- Water Table Contour 10'
- Road
- Individual Hazardous Substance Site

N

200 feet

Drawn SAB Date 8/9/95
Checked DJJ Date 8-5-95
Approved ______ Date

FILE OU5-515B.DWG

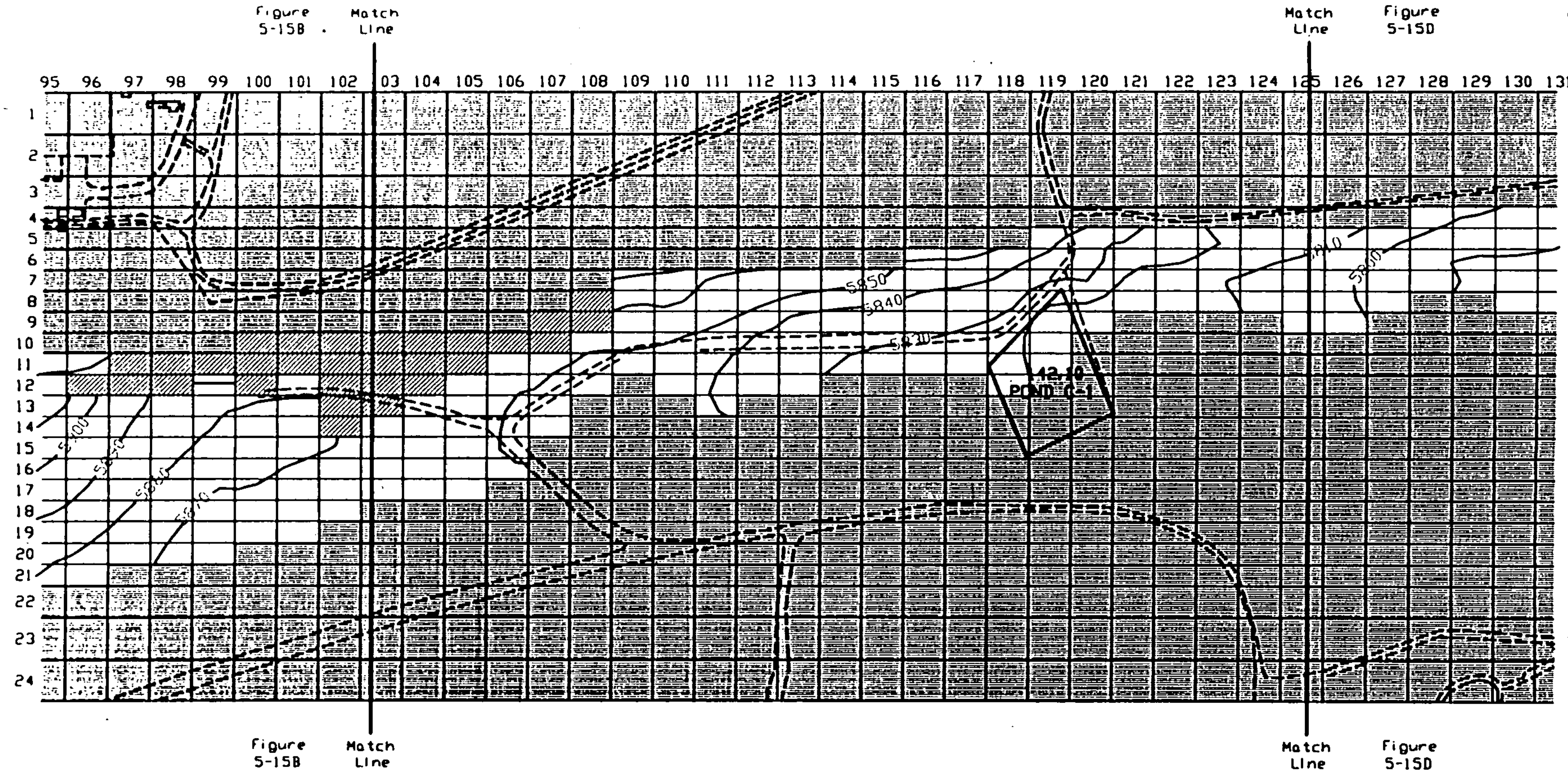
OU5 GROUNDWATER FLOW MODEL SIMULATED WATER TABLE

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-15B



Legend

No Flow

Dry Area

Water Table Contour 10'

Road

Individual Hazardous Substance Site

N

200 feet

OU5 GROUNDWATER FLOW MODEL SIMULATED WATER TABLE

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

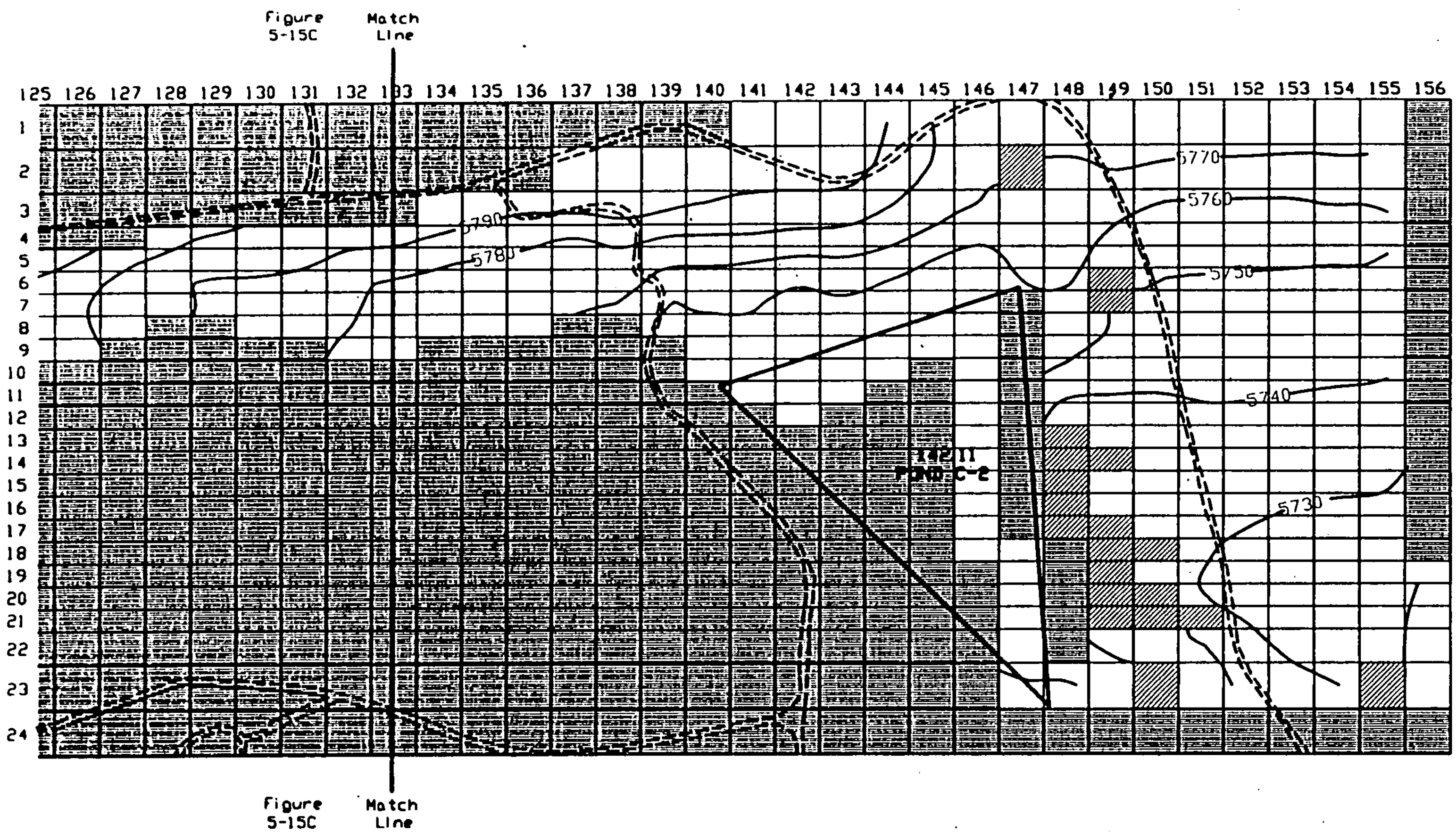
FIGURE 5-15C

FILE OU5-515C.DWG

Drawn NALL Date 8/9/95

Checked Date 8/9/95

Approved Date



Legend

No Flow	Water Table Contour 10'
Dry Area	Road
	Individual Hazardous Substance Site

N

200 feet

OU5 GROUNDWATER FLOW MODEL
SIMULATED WATER TABLE

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

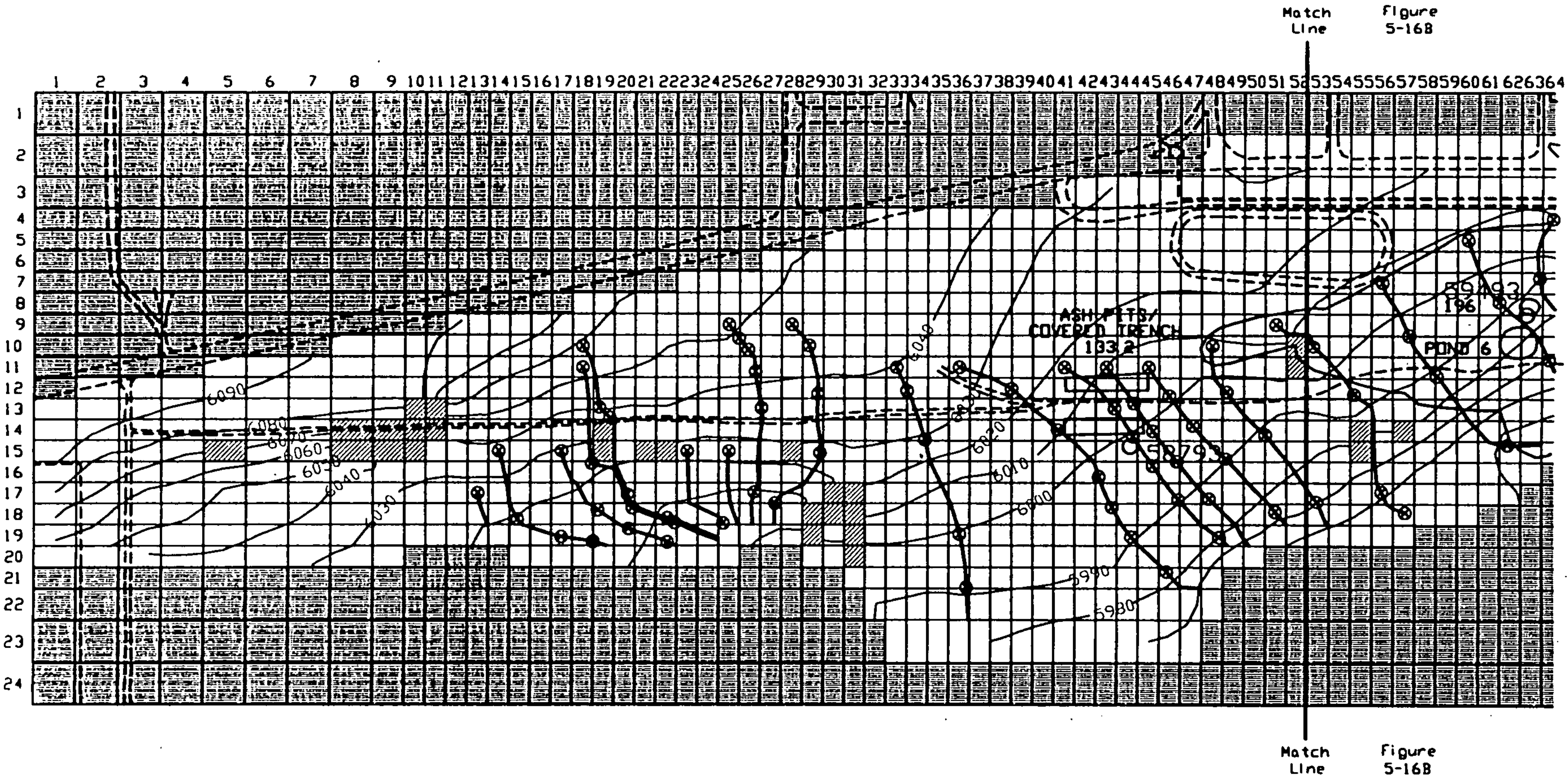
OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-15D

FILE OU5-515D.DWG

Drawn NAM Date 8/9/95
Checked [illegible] Date 8/9/95
Approved Date



Legend

- No Flow
- Dry
- Particle Track
- Particle Location on (0.25-Year Increment)
- Water Table Contour 10'
- Road
- Individual Hazardous Substance Site

58793
○ Monitoring Well

N
200 feet

Drawn	Date
Checked	Date
Approved	Date
FILE OU5-516A.DWG	

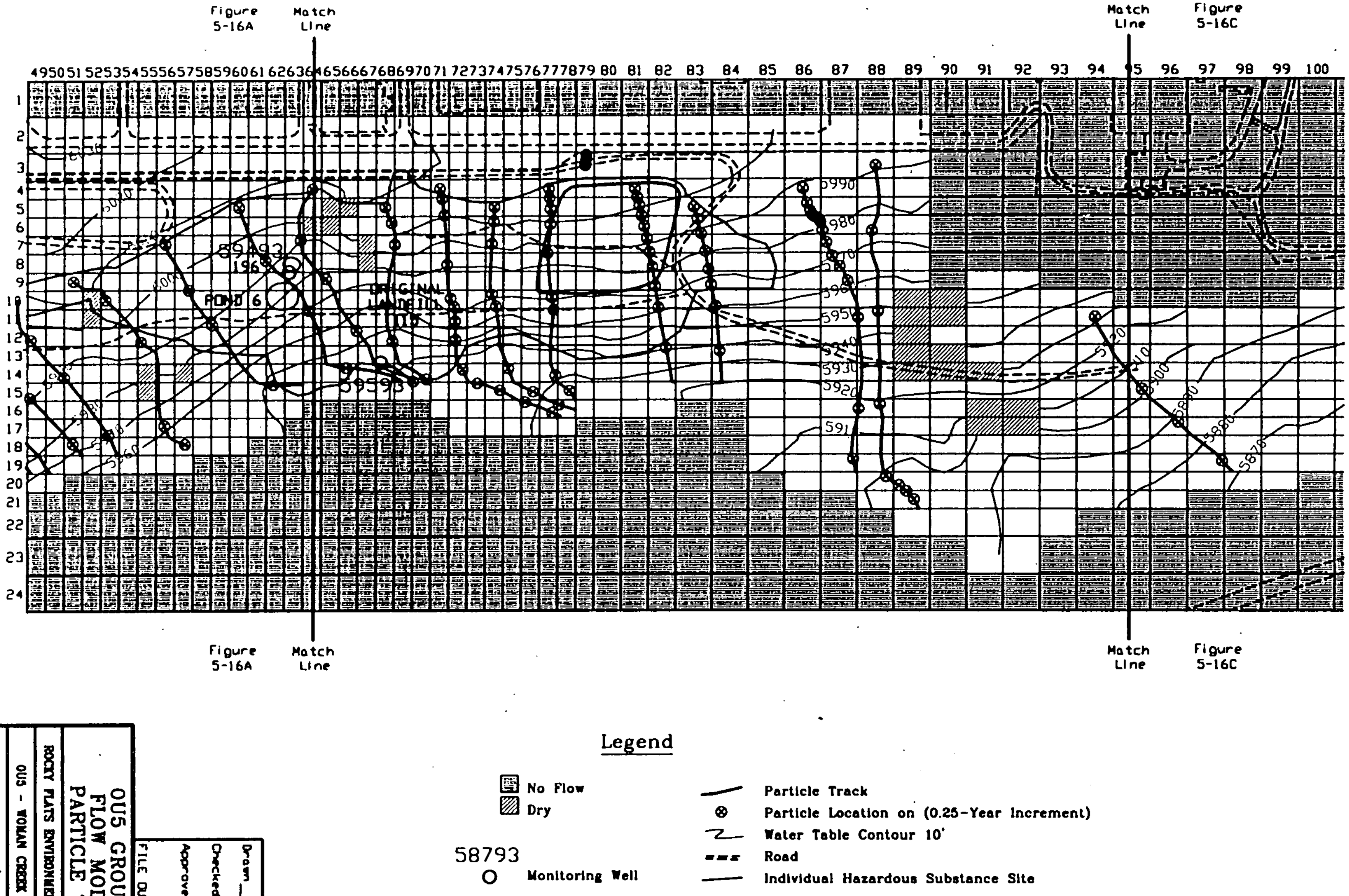
OU5 GROUNDWATER FLOW MODEL GRID PARTICLE TRACKING

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-16A



OU5 GROUNDWATER FLOW MODEL GRID PARTICLE TRACKING

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

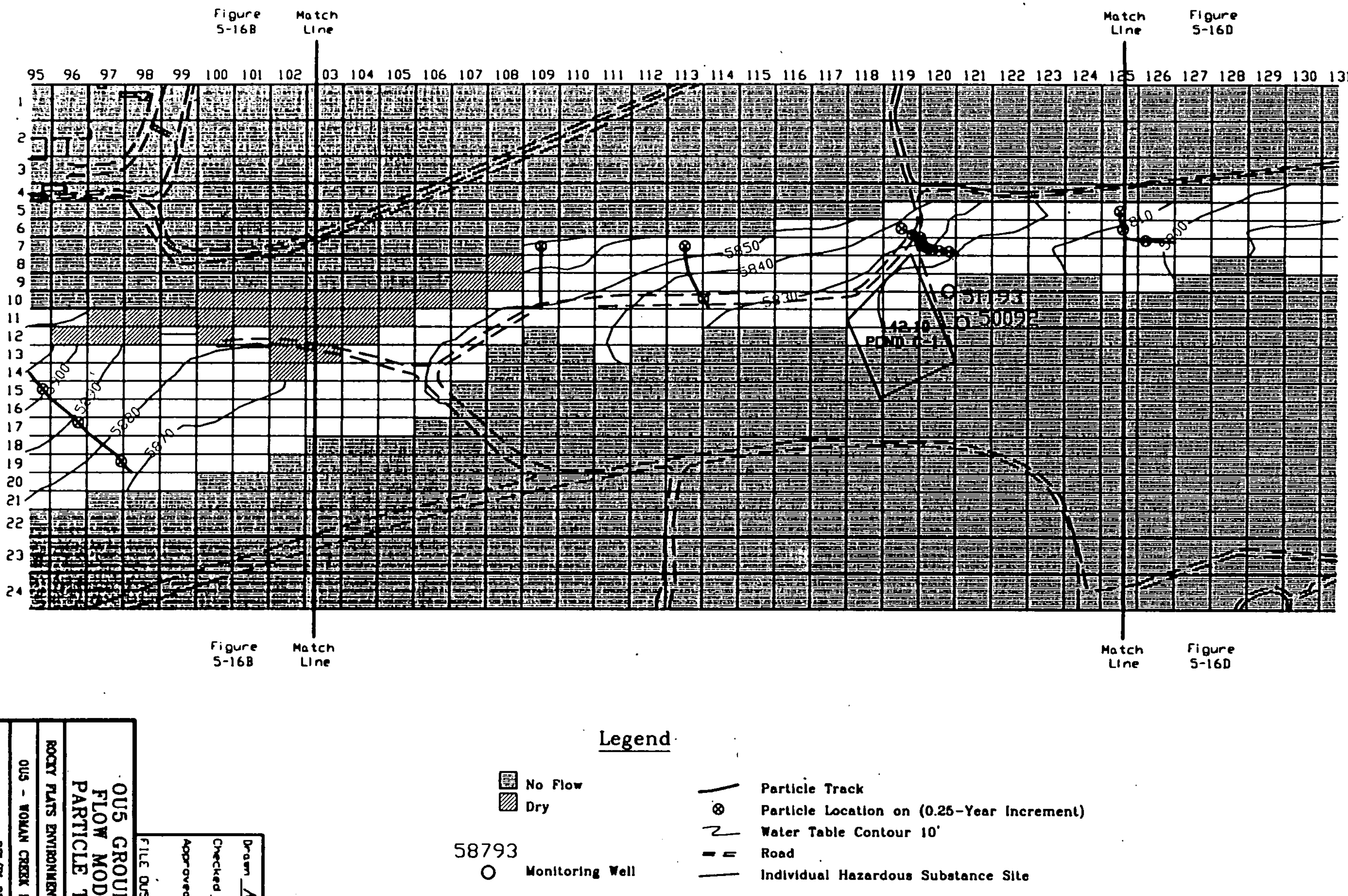
FIGURE 5-16B

FILE OU5-516B.DWG

Drawn ______ Date ______

Checked ______ Date ______

Approved ______ Date ______



Drawn NAm 8/9/95 Date
Checked [signature] 8-9-95 Date
Approved ____ Date

FILE OU5-516C.DWG

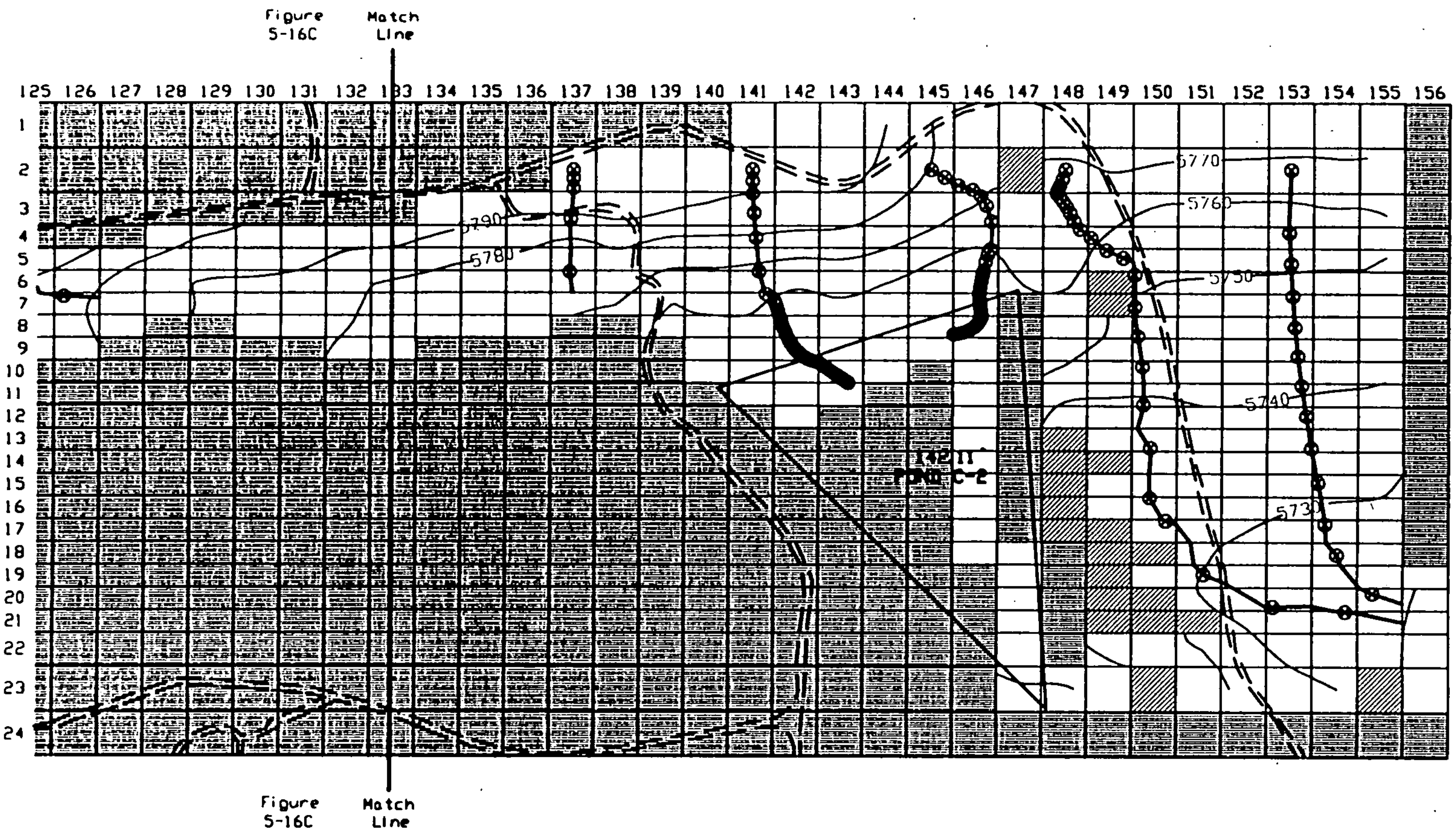
OU5 GROUNDWATER FLOW MODEL GRID PARTICLE TRACKING

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-16C



Legend

- No Flow
- Dry
- Particle Track
- ⊗ Particle Location on (0.25-Year Increment)
- Water Table Contour 10'
- Road
- Individual Hazardous Substance Site

N

200 feet

Drawn NAM Date 8/9/95
Checked [signature] Date 8-9-95
Approved ______ Date

FILE OU5-516D.DWG

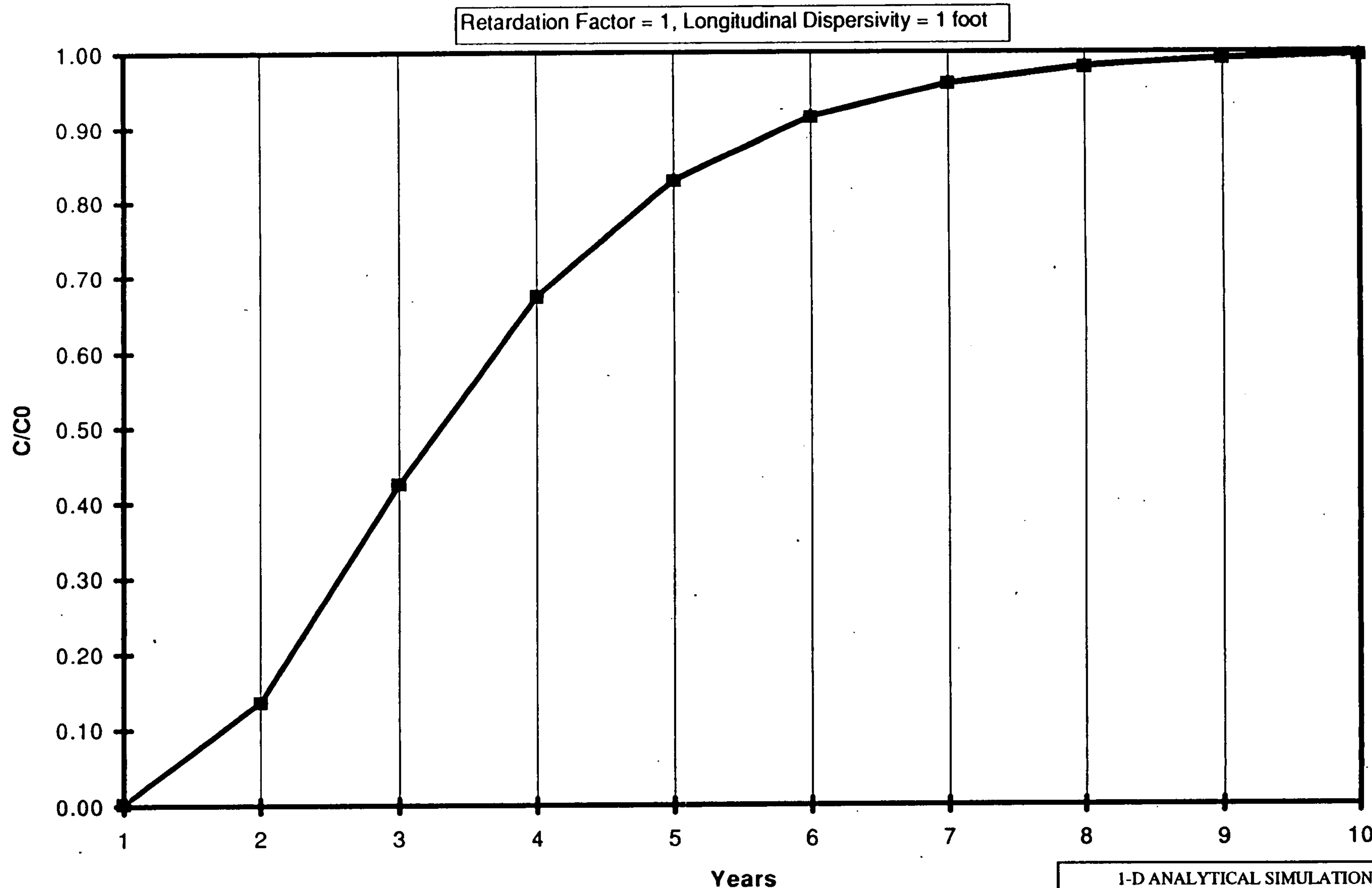
OU5 GROUNDWATER FLOW MODEL GRID PARTICLE TRACKING

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-16D



1-D ANALYTICAL SIMULATION OF CONTAMINANT TRANSPORT THROUGH THE VADOSE ZONE NORTH ASH PIT, IHSS 133.2

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

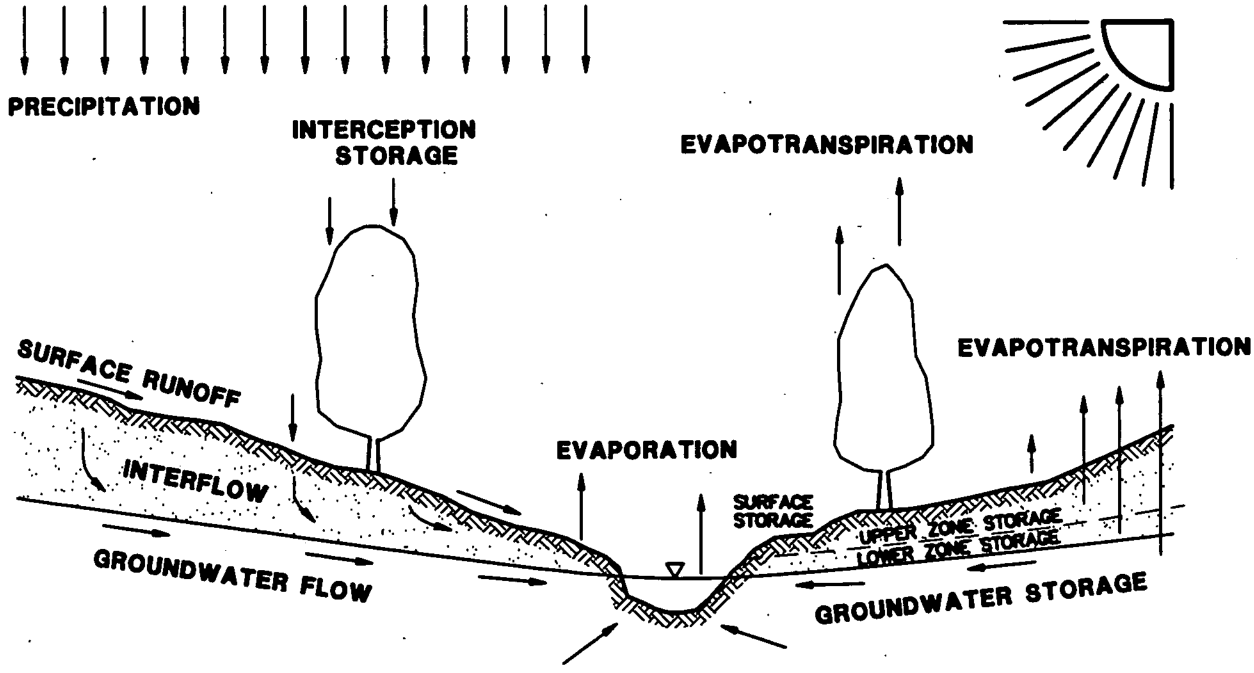
FIGURE 5-17

DRAWN JDy 7/27/95 DATE

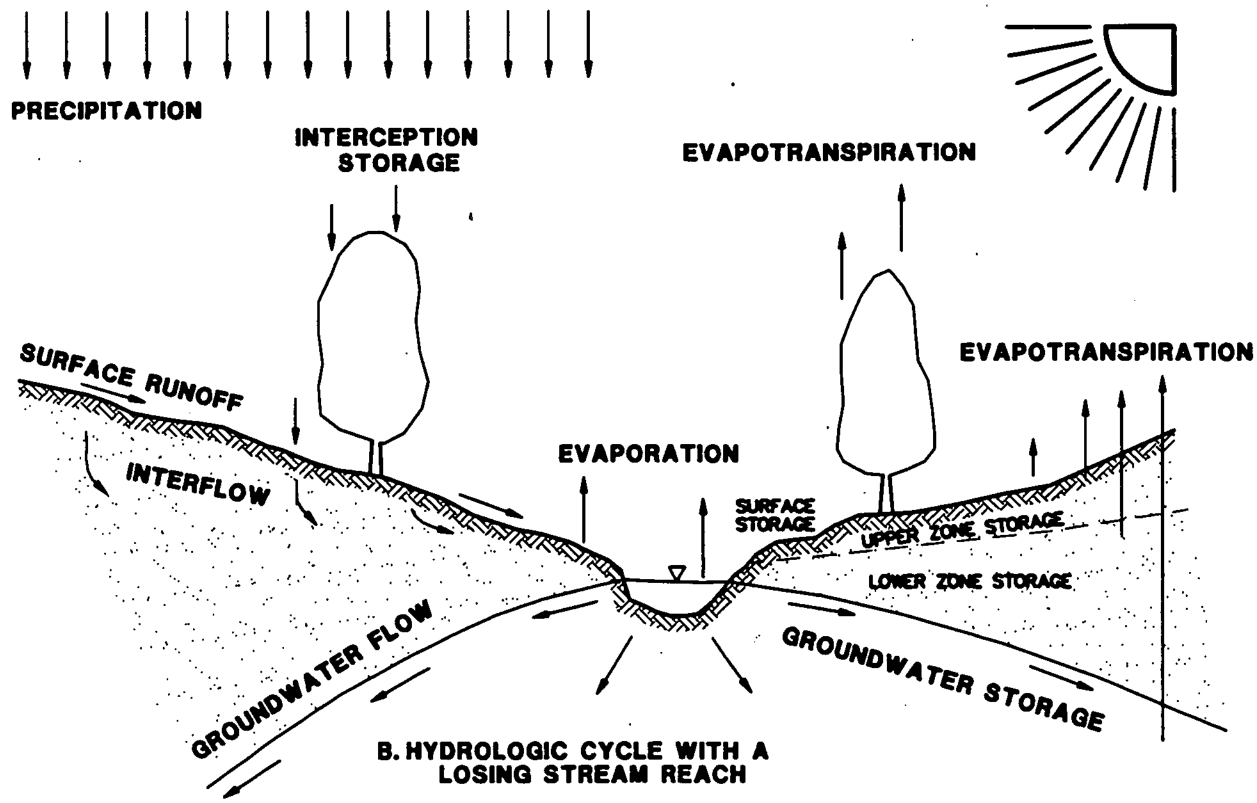
CHECKED TSJ 7/27/95 DATE

APPROVED ______ DATE

F5-17.DRW



A. HYDROLOGIC CYCLE WITH A GAINING STREAM REACH



B. HYDROLOGIC CYCLE WITH A LOSING STREAM REACH

HYDROLOGIC CYCLE WITH GAINING AND LOSING STREAM REACHES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-19

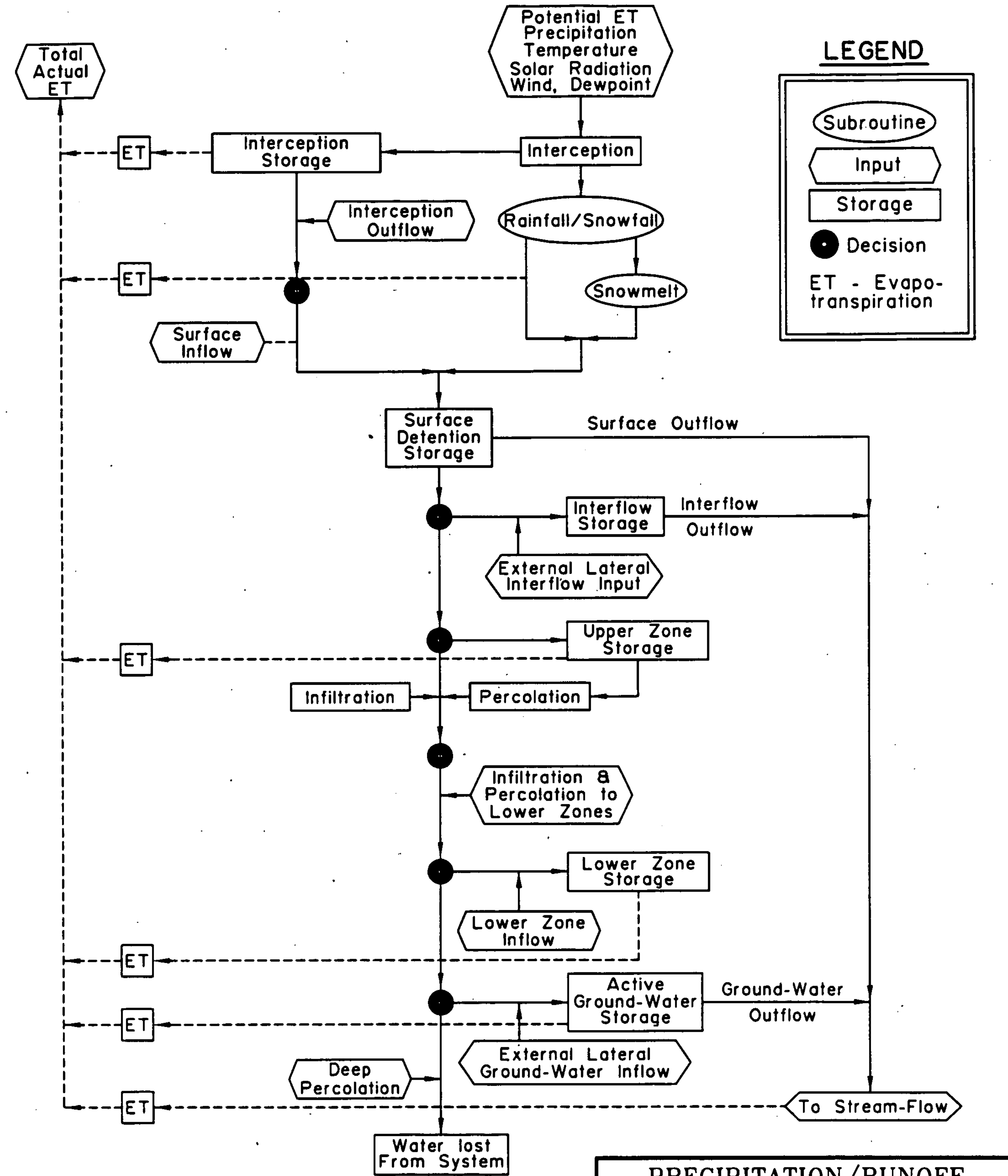
Drawn NAM 7/31/95 Date

Checked [signature] 7/31/95 Date

Approved ______ Date

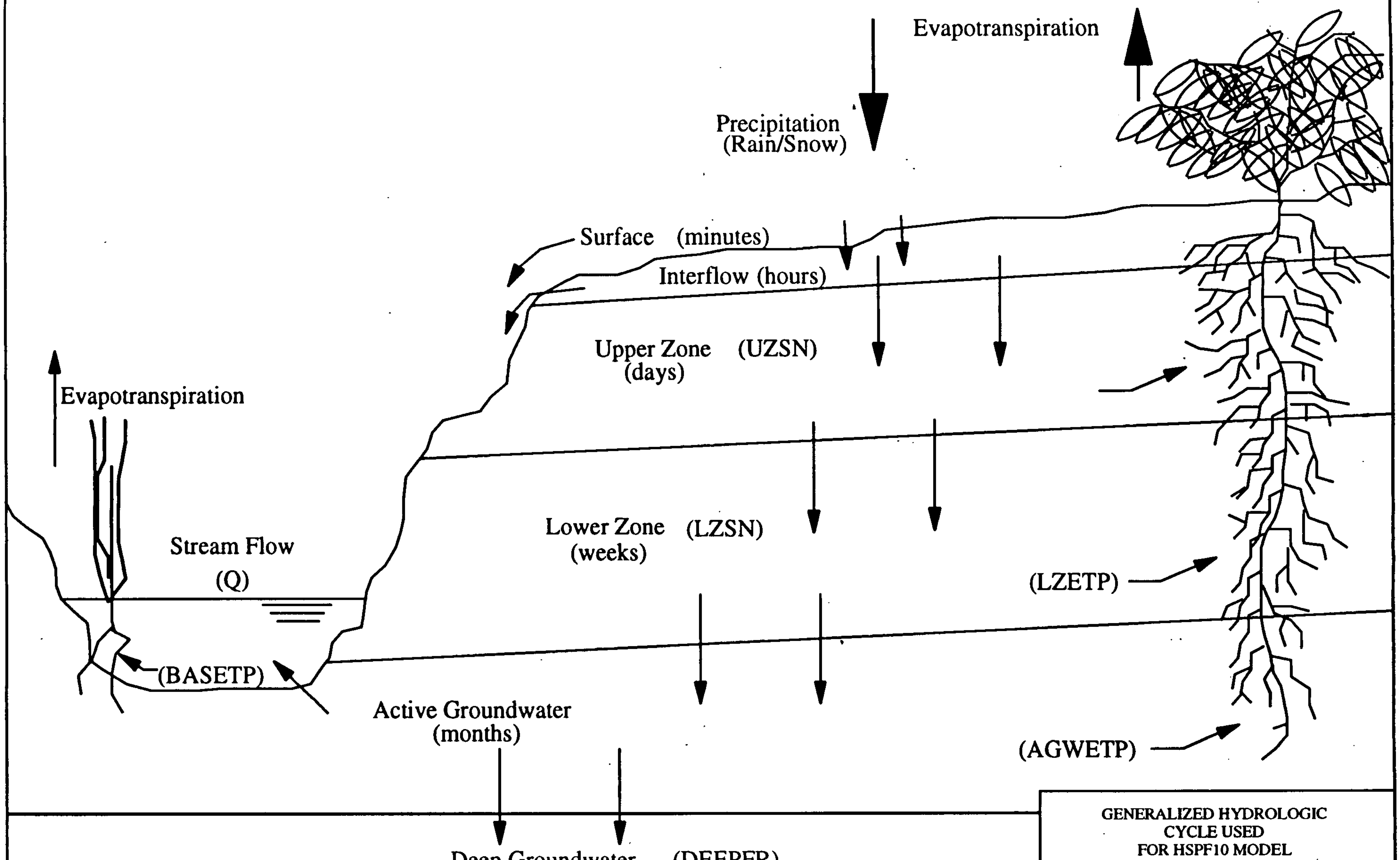
FILE OU5-5-19.DWG

Source: Modified From Bicknell and Others (1993).



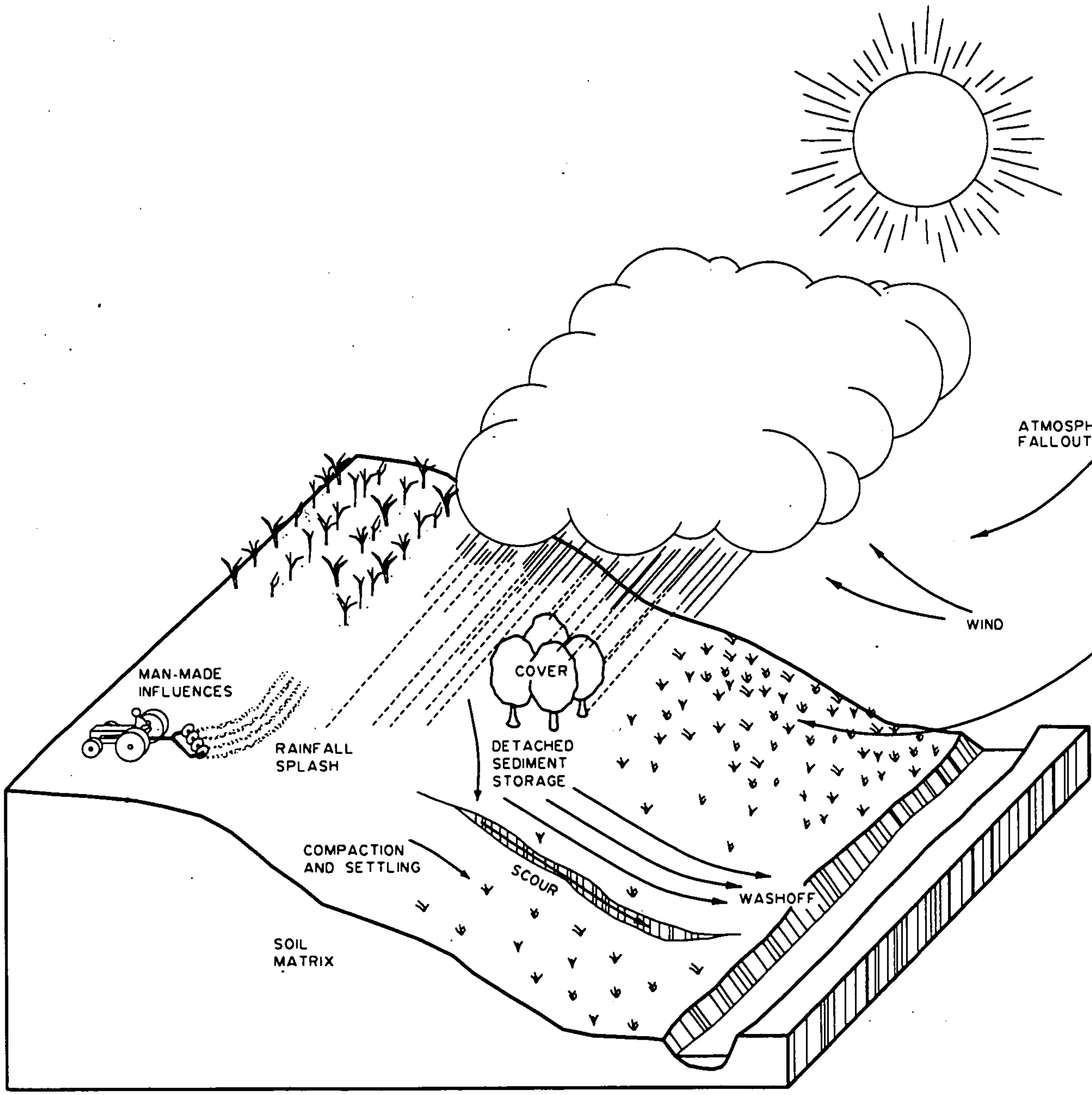
Source: Bicknell and Others (1993).

Drawn NAM 8/9/95 Date	**PRECIPITATION/RUNOFF PROCESSES USED IN HSPF10**
Checked TJ 8/9/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Approved Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
FILE OU5-5-20.DWG	FIGURE 5-20



NOTES: (hours) = General time-frame for flow to occur.
(BASETP) = Model variable name.
→ = Generalized flow direction.

DRAWN JDY 8/8/95 DATE	GENERALIZED HYDROLOGIC CYCLE USED FOR HSPF10 MODEL
CHECKED 7=7 8/8/95 DATE	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
APPROVED ____ DATE	OU5 - WOMAN CREEK PRIORITY DRAINAGE
F5-21.DRW	RFI/RI REPORT
	FIGURE 5-21



Source: Bicknell and Others (1993).

Drawn NAM 8/9/95 Date
Checked [signature] 8/9/95 Date
Approved ______ Date
FILE OU5-5-21.DWG

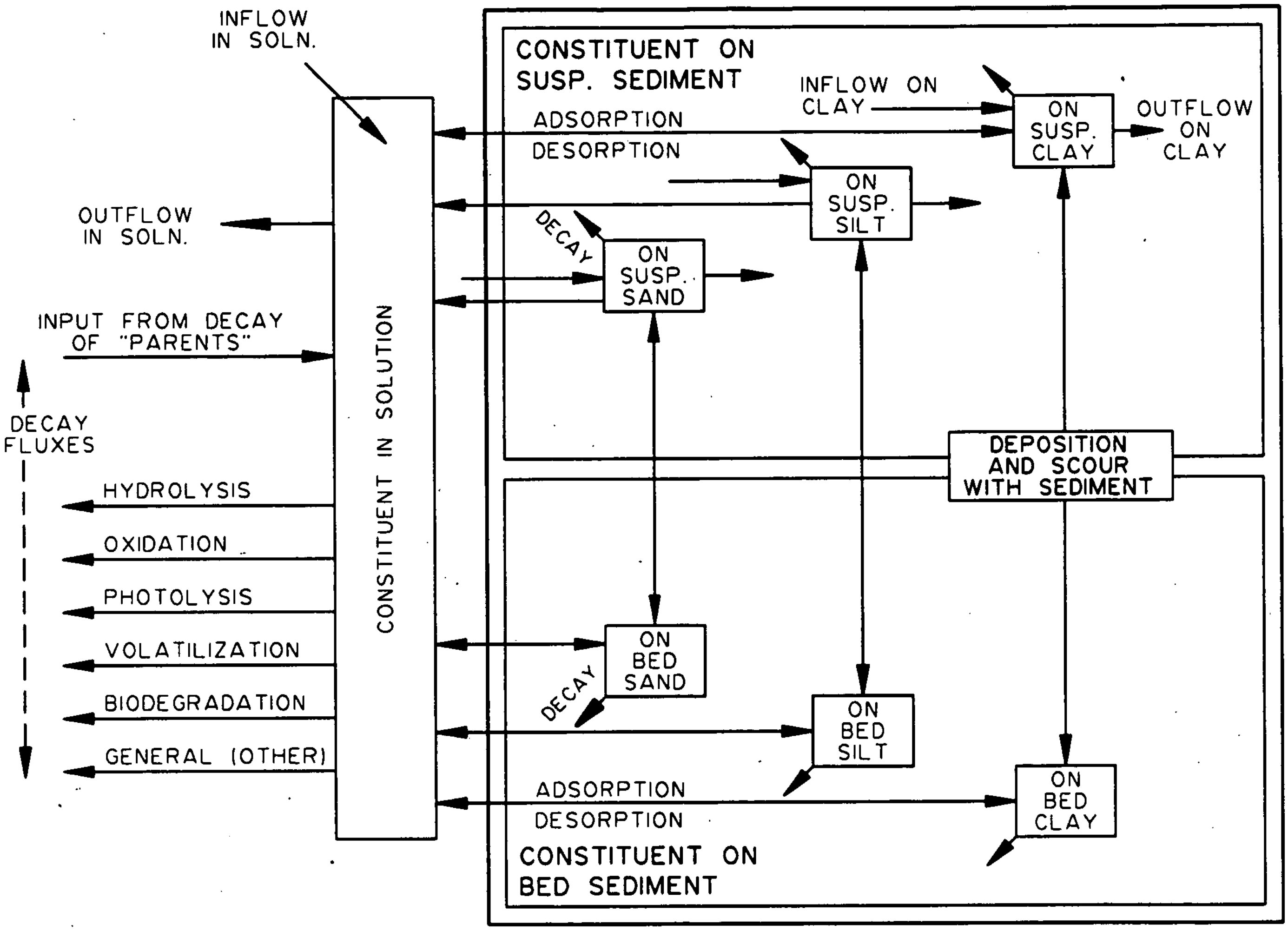
SOIL-EROSION PROCESSES USED IN HSPF10

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-22



Source: Bicknell and Others (1993).

Drawn NAM 7/31/95 Date	
Checked 7/31/95 Date	
Approved _______ Date	
FILE OU5-5-23.DWG	

POLLUTANT-FATE MECHANISMS MODELED IN HSPF10

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-23

Drawn NAM 7/31/95
Date
Checked TCQ 7/31/95
Date
Approved
Date
FILE OU5-5-25.DWG

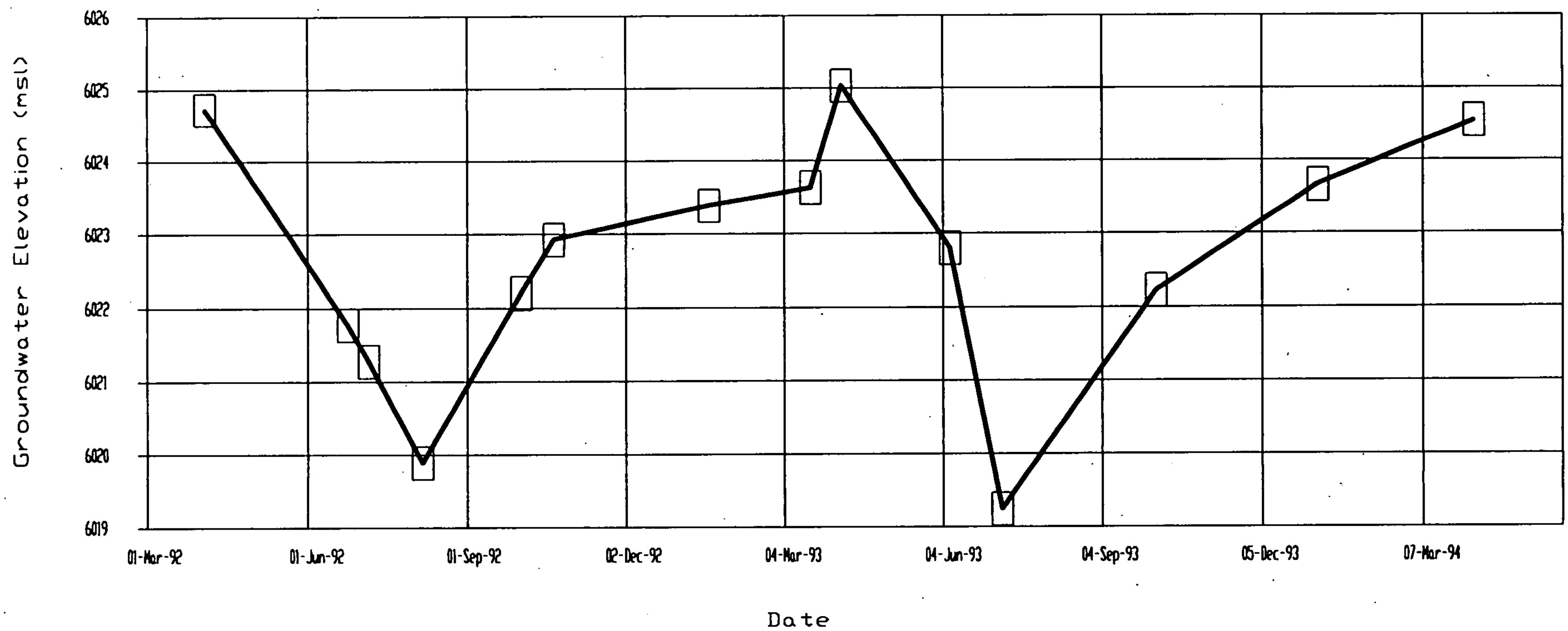
ANTELOPE SPRING CREEK GROUNDWATER INFLOW

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

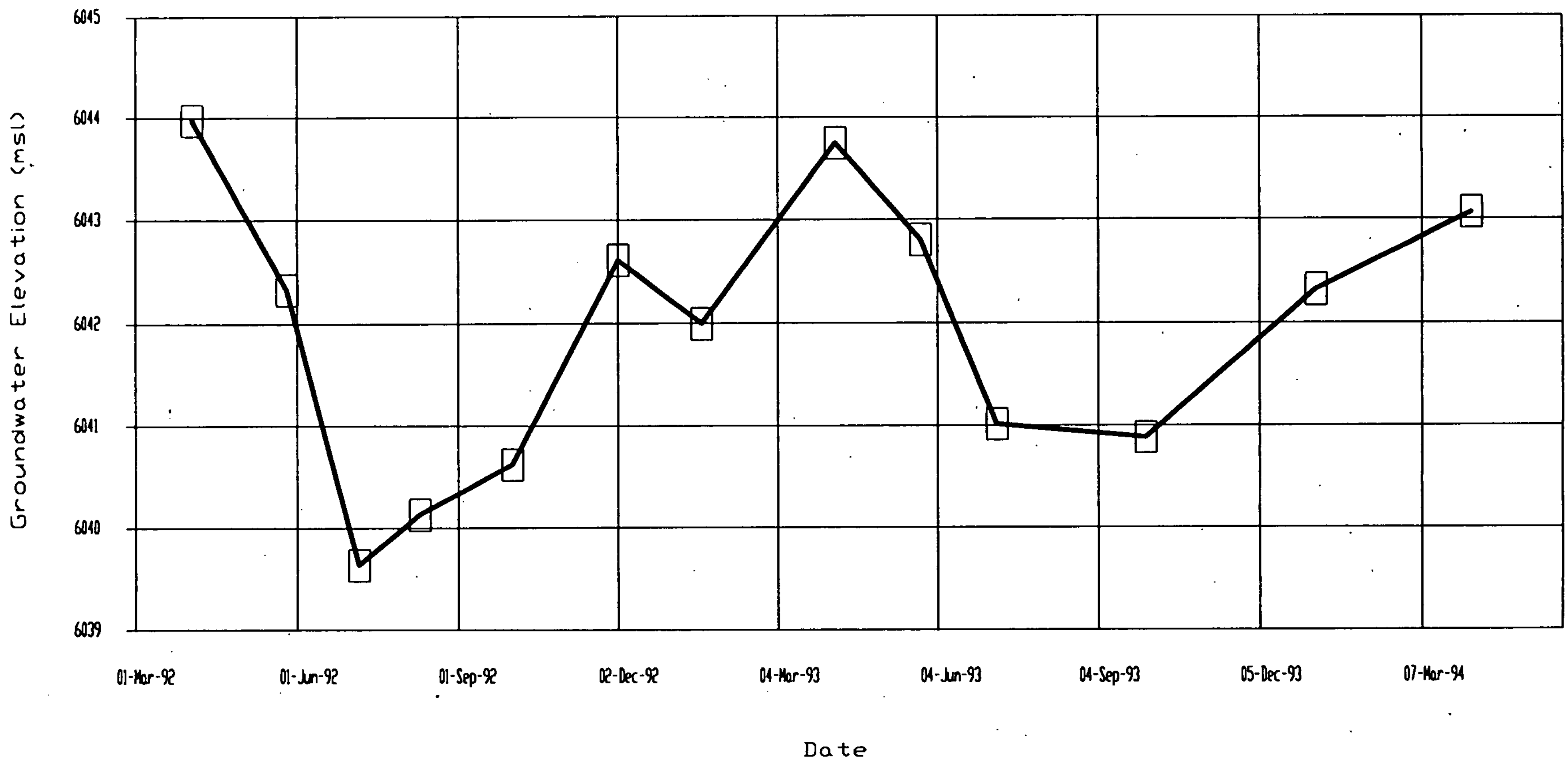
OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

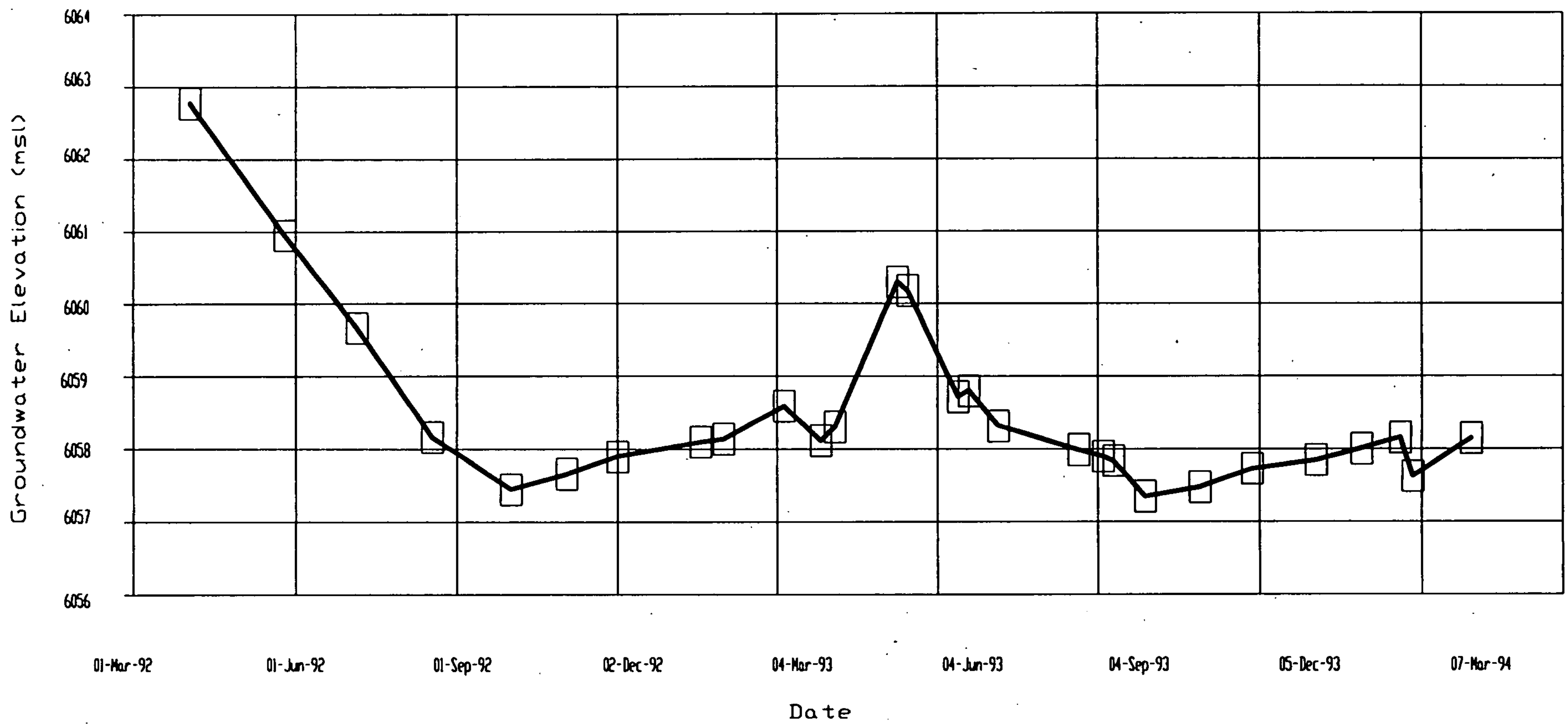
FIGURE 5-25



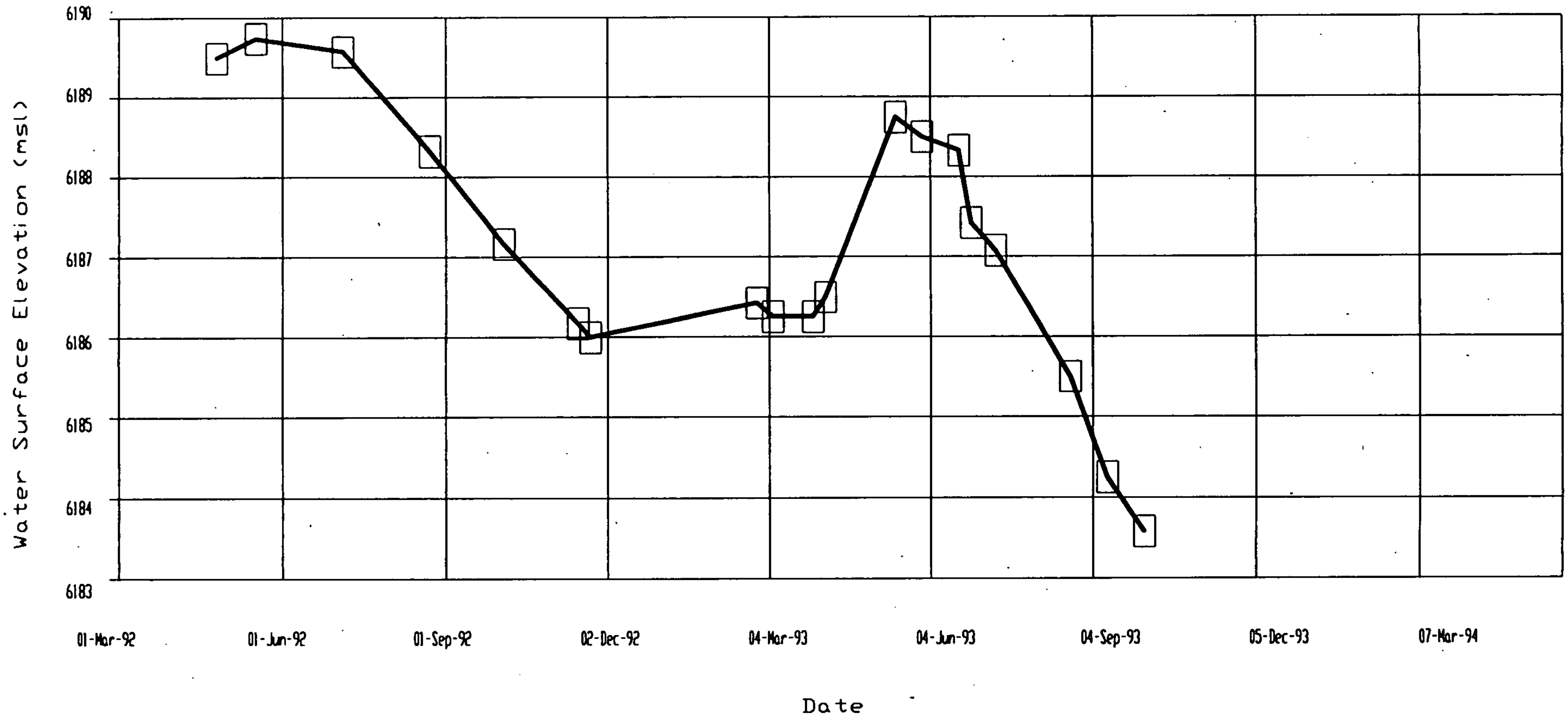
Drawn NAM 8/7/95 Date	**HYDROGRAPH of WELL 1989 near Antelope Spring Creek**
Checked [signature] 8/9/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Approved Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
FILE OU5-526a.DWG	FIGURE 5-26A



Drawn NAM 8/9/95 Date	**HYDROGRAPH of WELL 2689 NEAR WOMAN CREEK**
Checked 7Z17 8/9/95 Date	**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**
Approved Date	**OU5 - WOMAN CREEK PRIORITY DRAINAGE**
	RFI/RI REPORT
FILE OU5-526B.DWG	**FIGURE 5-26B**



Drawn NAM 8/9/95 Date	**HYDROGRAPH of WELL 5386 NEAR SOUTH WOMAN CREEK**
Checked 7/2/1 8/9/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Approved Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
FILE OU5-526C.DWG	FIGURE 5-26C



Drawn NAM 7/31/95 Date

Checked 7/31/95 Date

Approved Date

FILE OU5-527.DWG

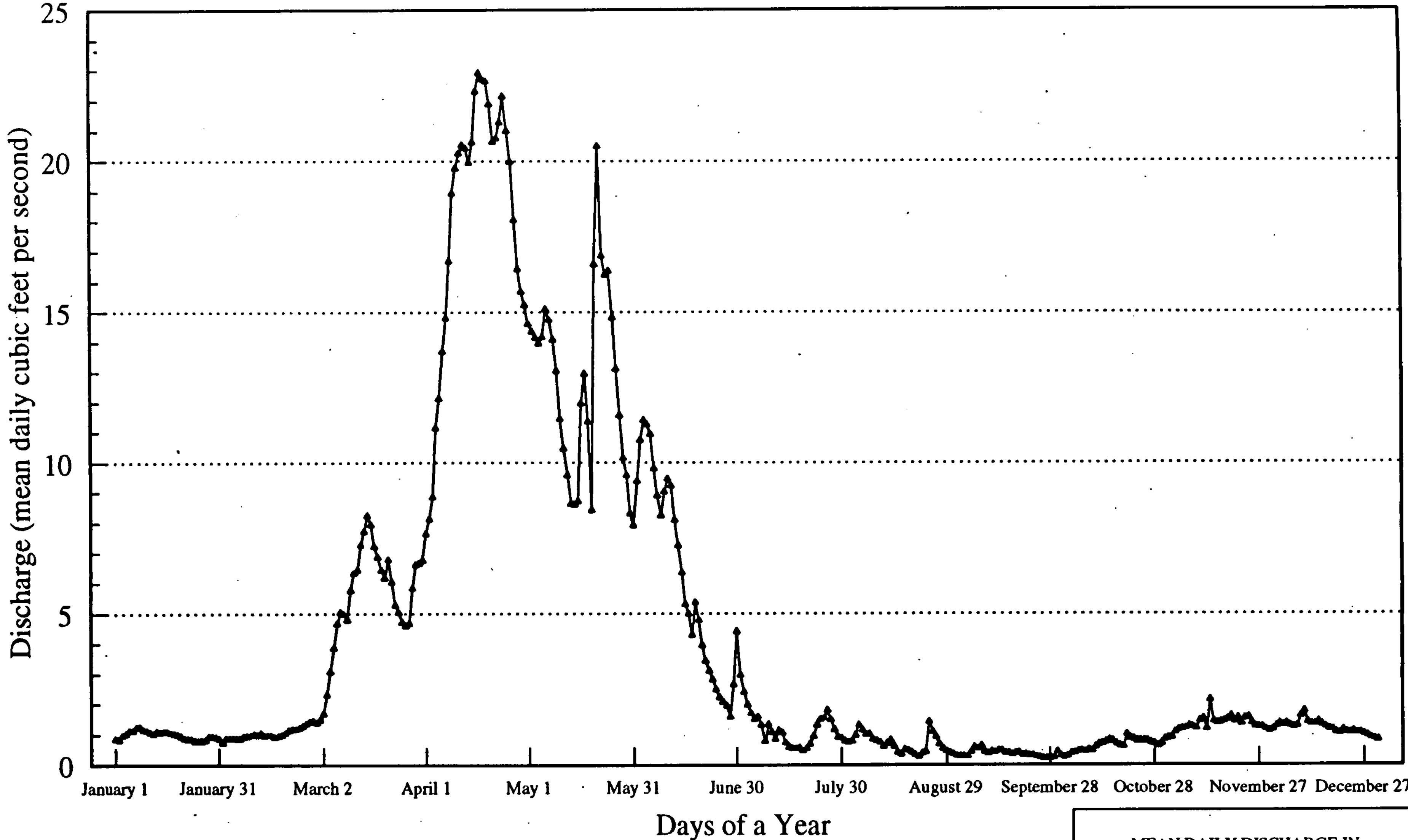
HYDROGRAPH of ROCKY FLATS LAKE WATER SURFACE

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-27



DRAWN	DATE
CHECKED	DATE
APPROVED	DATE
F5-28.DRW	

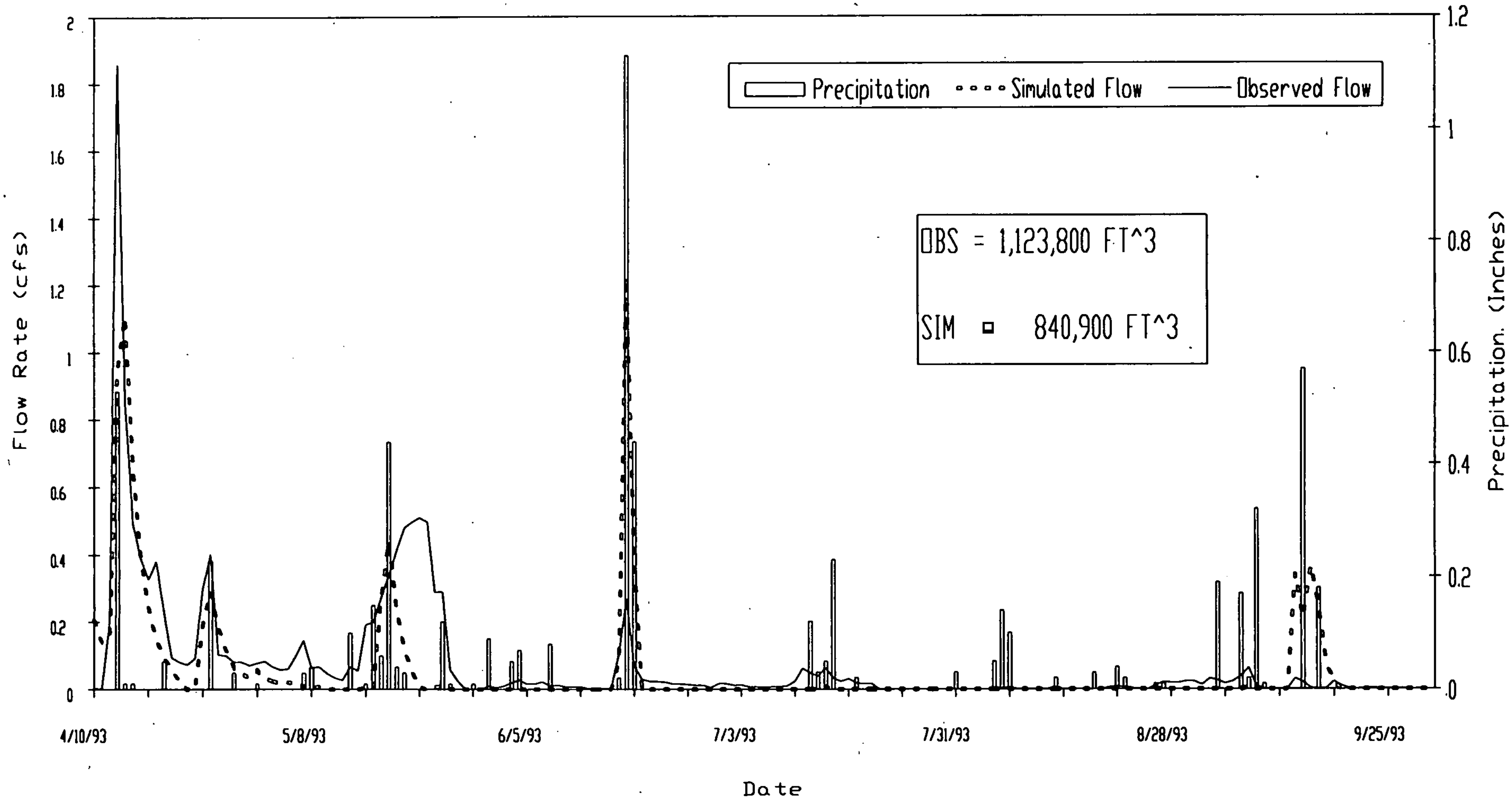
MEAN DAILY DISCHARGE IN COAL CREEK AT PLAINVIEW

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-28



Drawn NAM 8/9/95 Date
Checked [initials] 8/9/95 Date
Approved Date
FILE OU5-529a.DWG

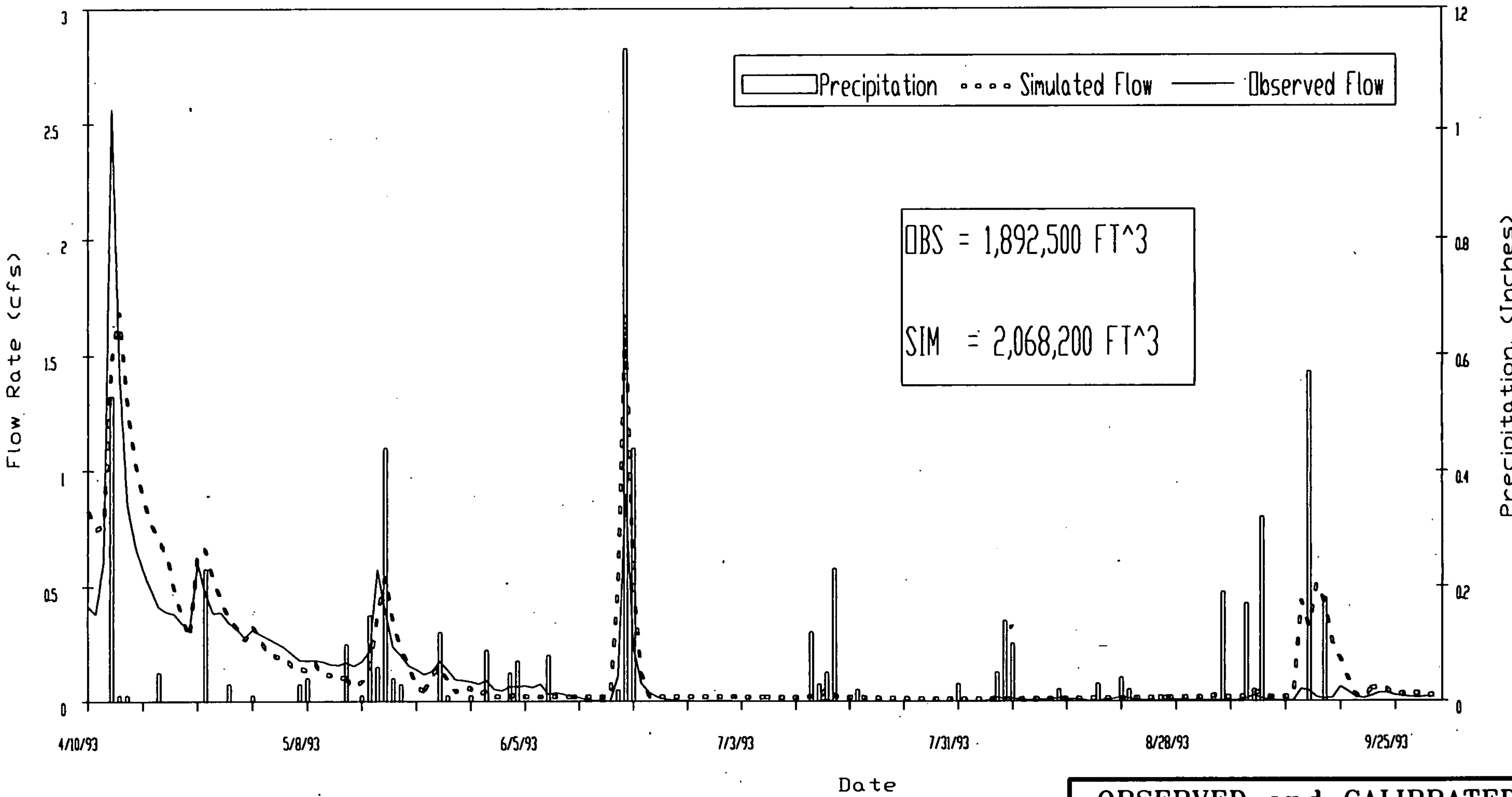
OBSERVED and CALIBRATED HYDROGRAPHS OUTFLOW of BASIN 2

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

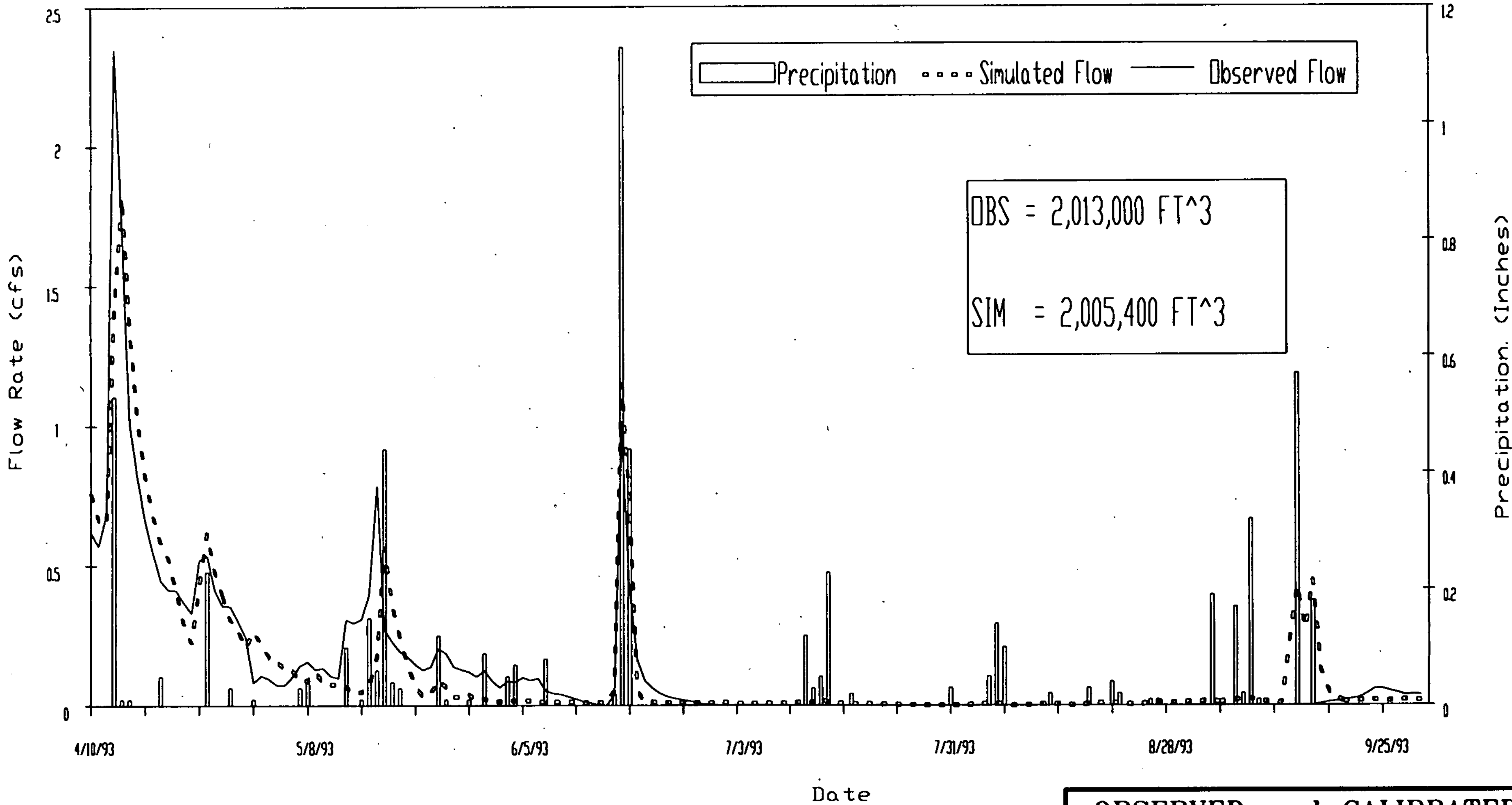
OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-29A



Drawn NAM 8/9/95 Date	**OBSERVED and CALIBRATED HYDROGRAPHS OUTFLOW of BASIN 4**
Checked 8/9/95 Date	**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**
Approved ______ Date	**OU5 - WOMAN CREEK PRIORITY DRAINAGE**
	RFI/RI REPORT
FILE OU5-529B.DWG	**FIGURE 5-29B**



Drawn NAM 8/9/95 Date
Checked 8/9/95 Date
Approved Date
FILE OU5-529C.DWG

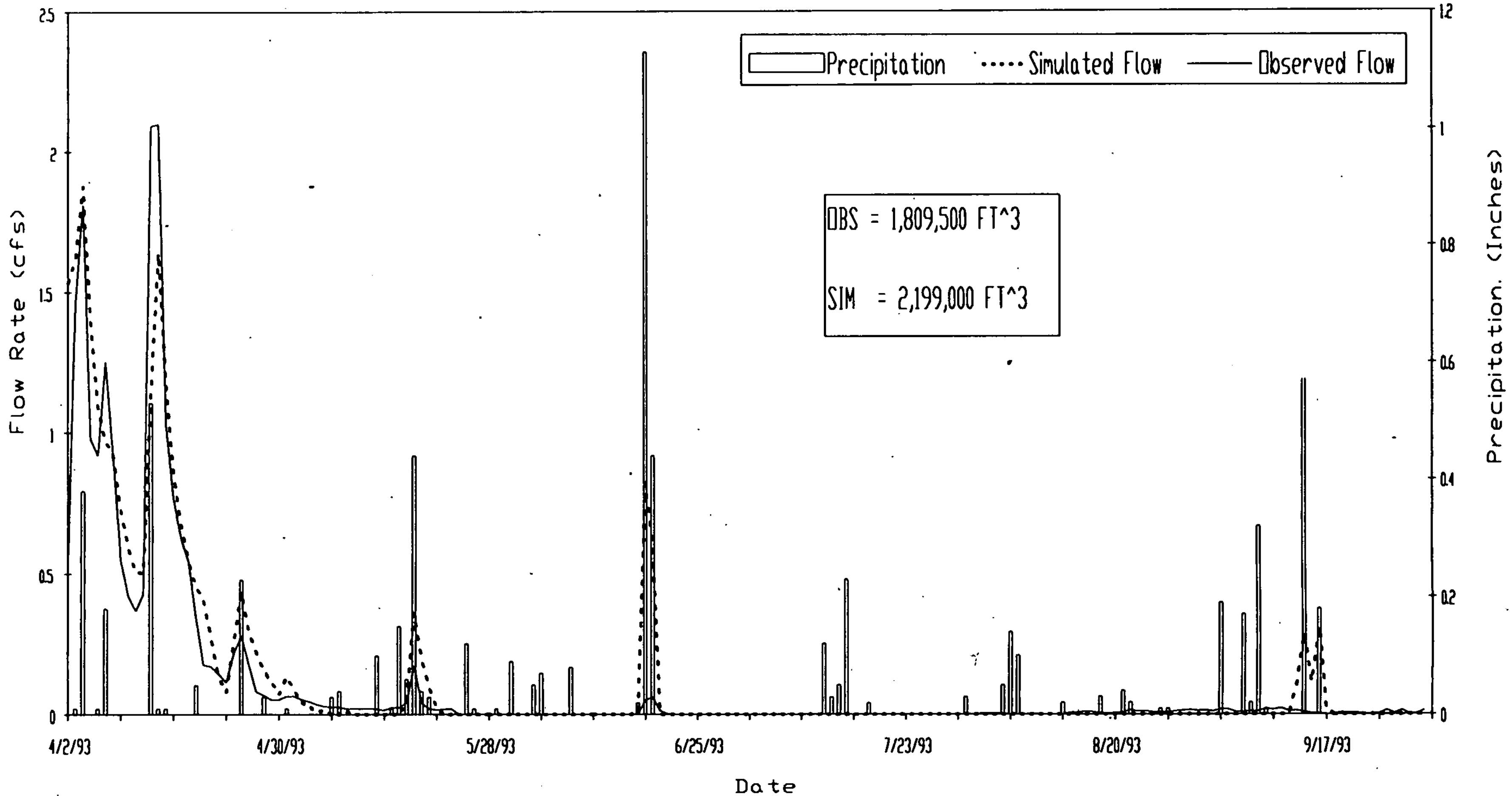
OBSERVED and CALIBRATED HYDROGRAPHS OUTFLOW of BASIN 5

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

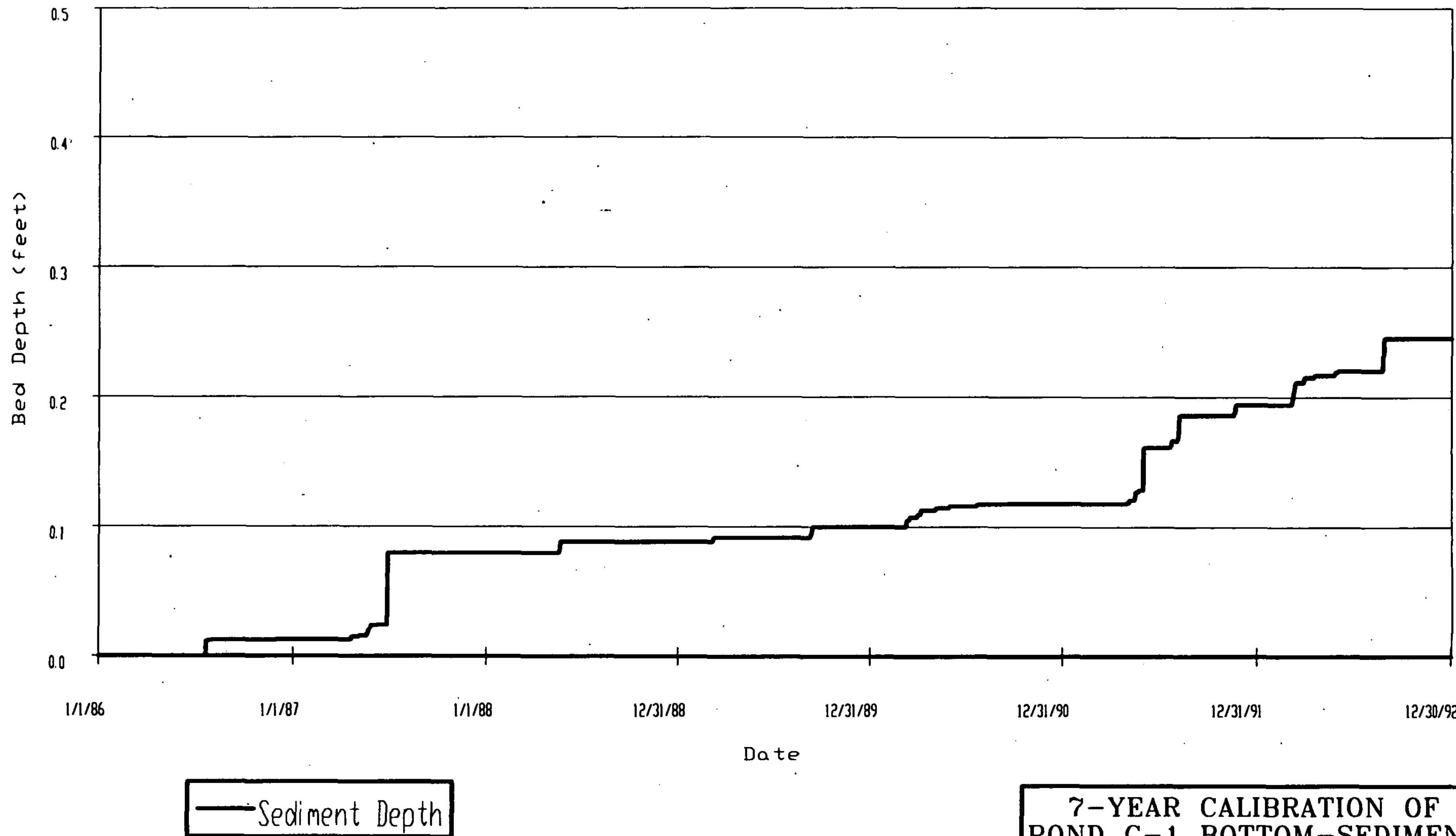
OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

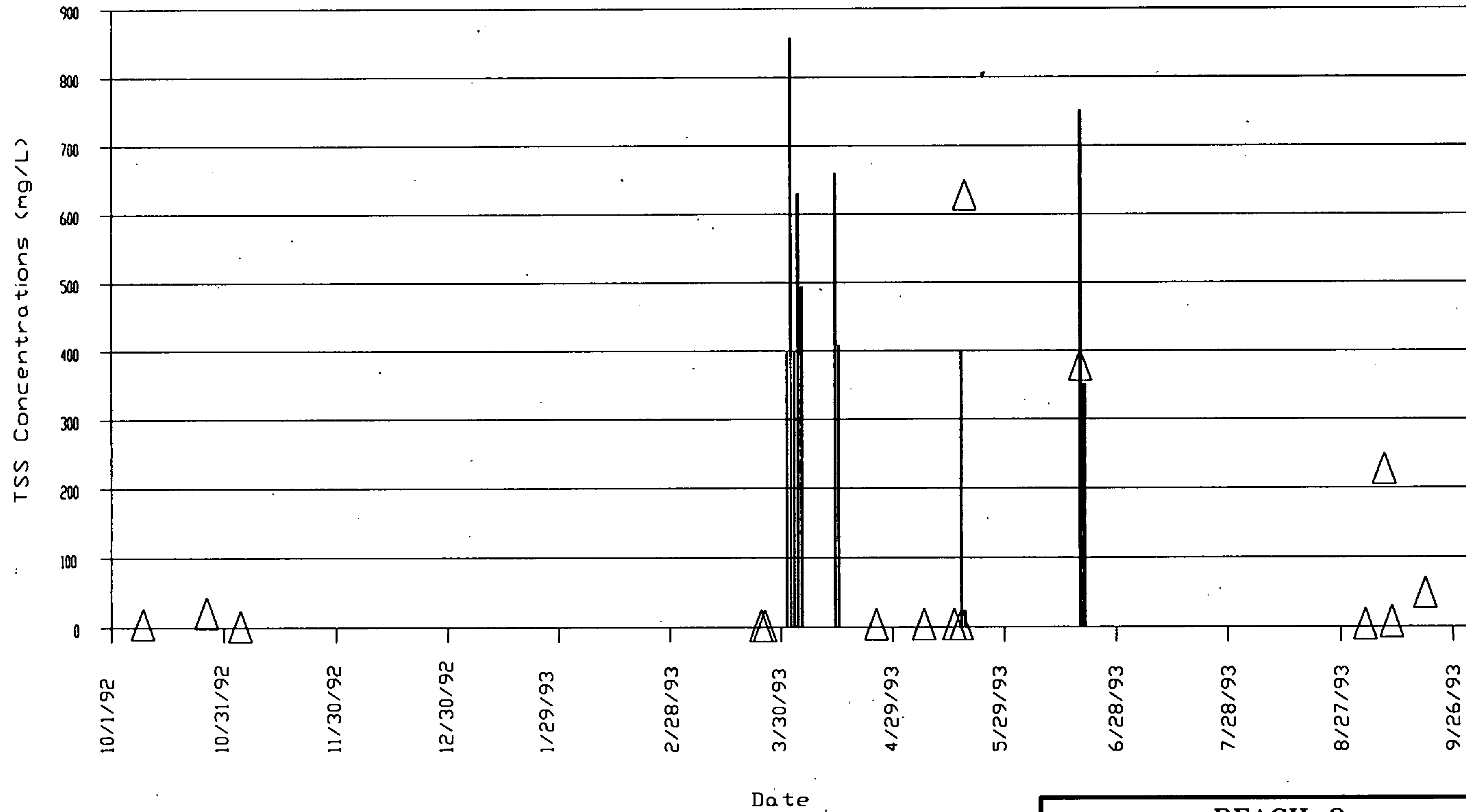
FIGURE 5-29C



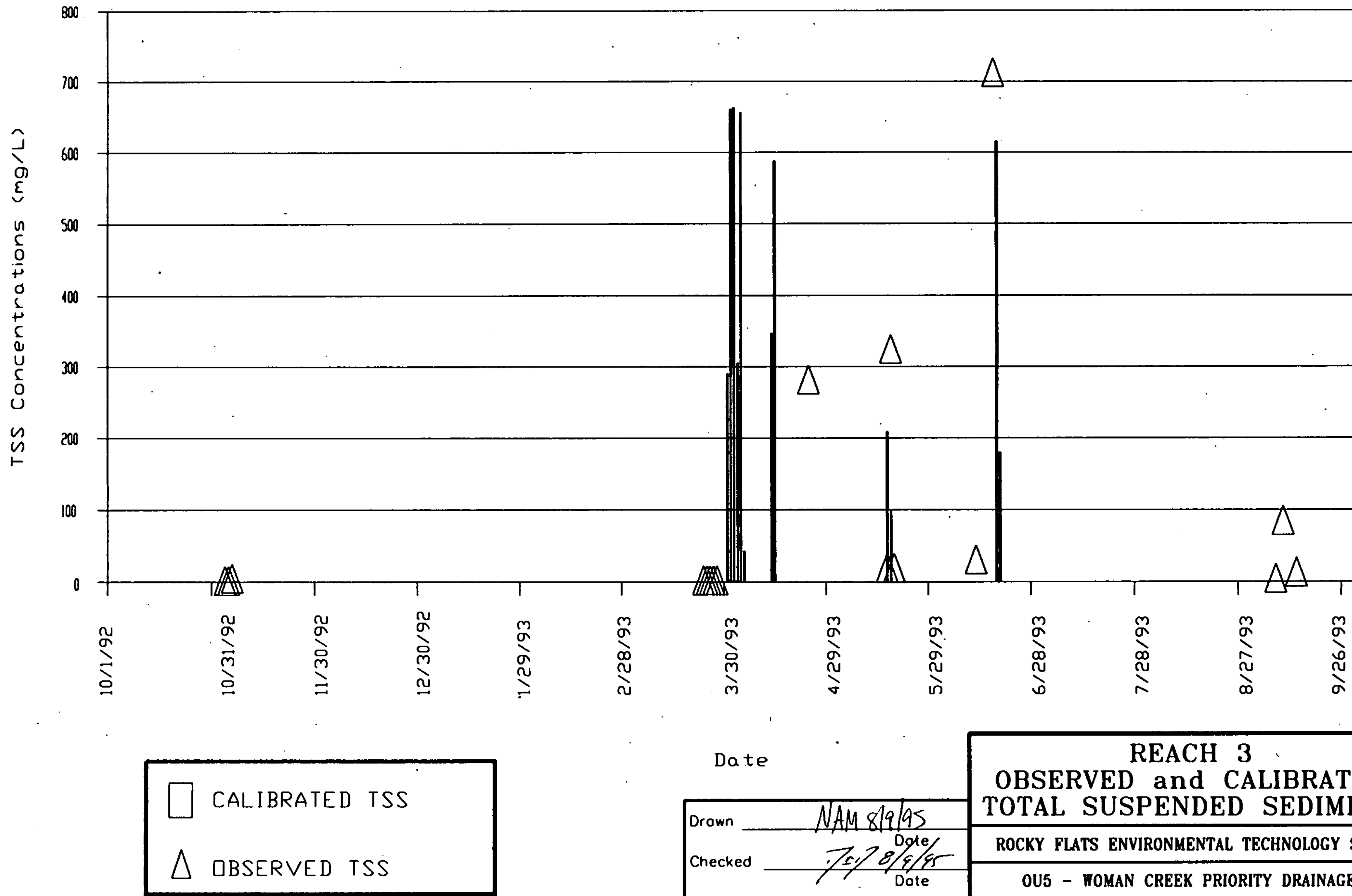
Drawn NAH 8/9/95 Date	**OBSERVED and CALIBRATED HYDROGRAPHS OUTFLOW of BASIN 6**
Checked 8/9/95 Date	**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**
Approved Date	**OU5 - WOMAN CREEK PRIORITY DRAINAGE**
	RFI/RI REPORT
FILE OU5-529D.DWG	**FIGURE 5-29D**



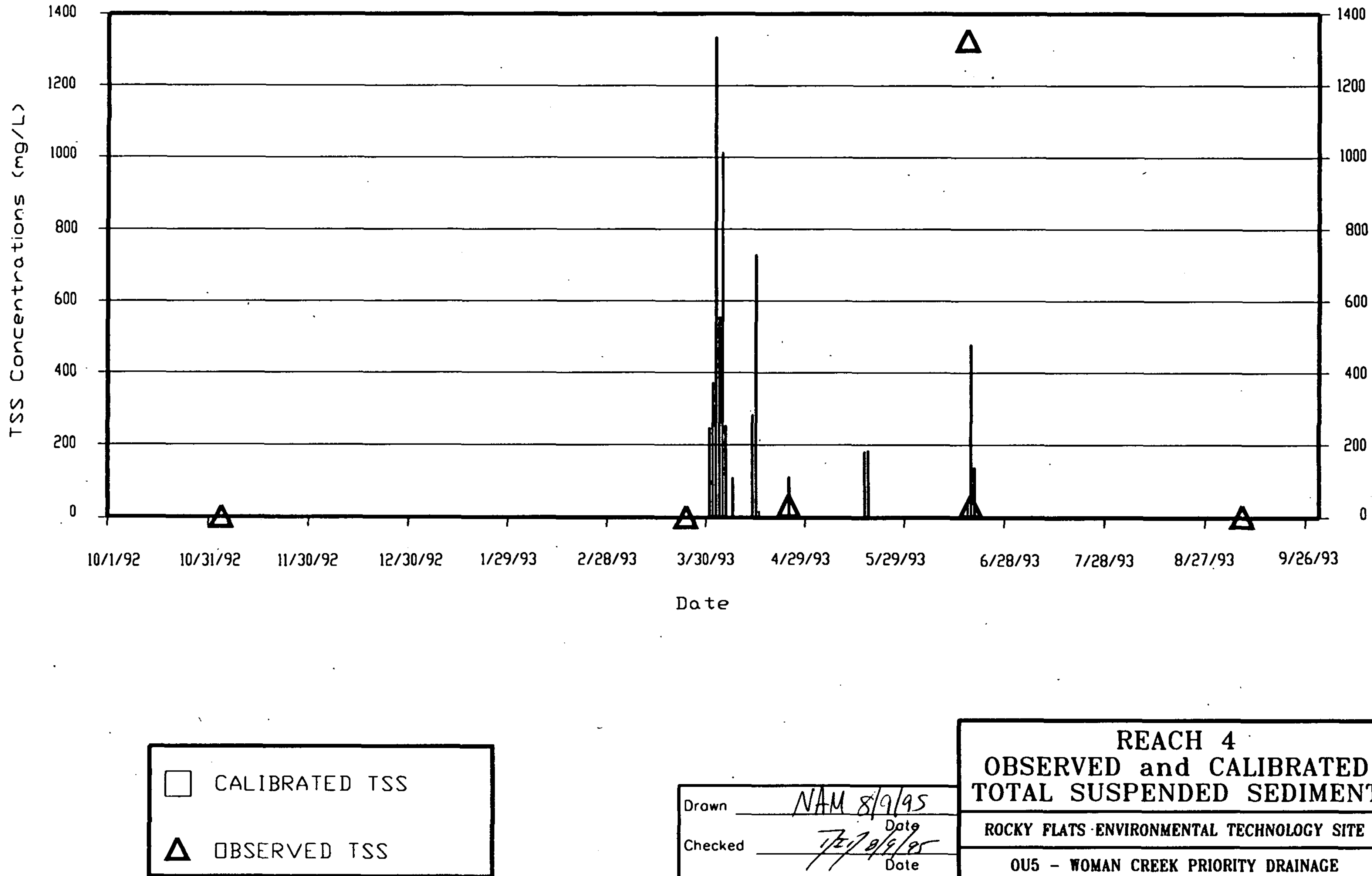
Drawn NAM 7/31/95 Date	**7-YEAR CALIBRATION OF POND C-1 BOTTOM-SEDIMENT DEPOSITION**
Checked 7/31/95 Date	**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**
Approved Date	**OU5 - WOMAN CREEK PRIORITY DRAINAGE**
	RFI/RI REPORT
FILE OU5-5-30.DWG	**FIGURE 5-30**



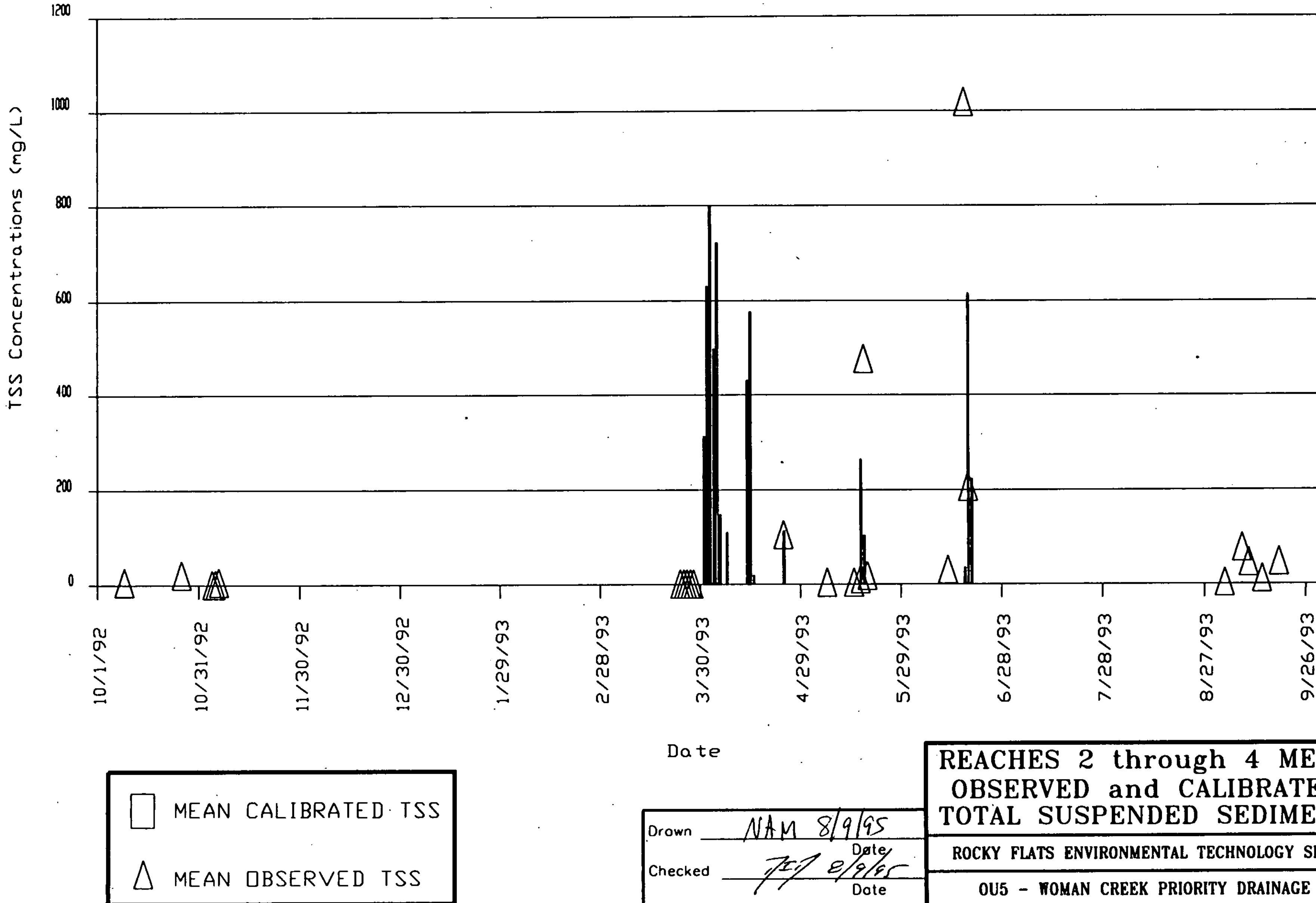
Drawn NAM 8/9/95 Date	**REACH 2 OBSERVED and CALIBRATED TOTAL SUSPENDED SEDIMENT**
Checked [initials] 8/9/95 Date	**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**
Approved Date	**OU5 - WOMAN CREEK PRIORITY DRAINAGE**
	RFI/RI REPORT
FILE OU5-531A.DWG	**FIGURE 5-31A**



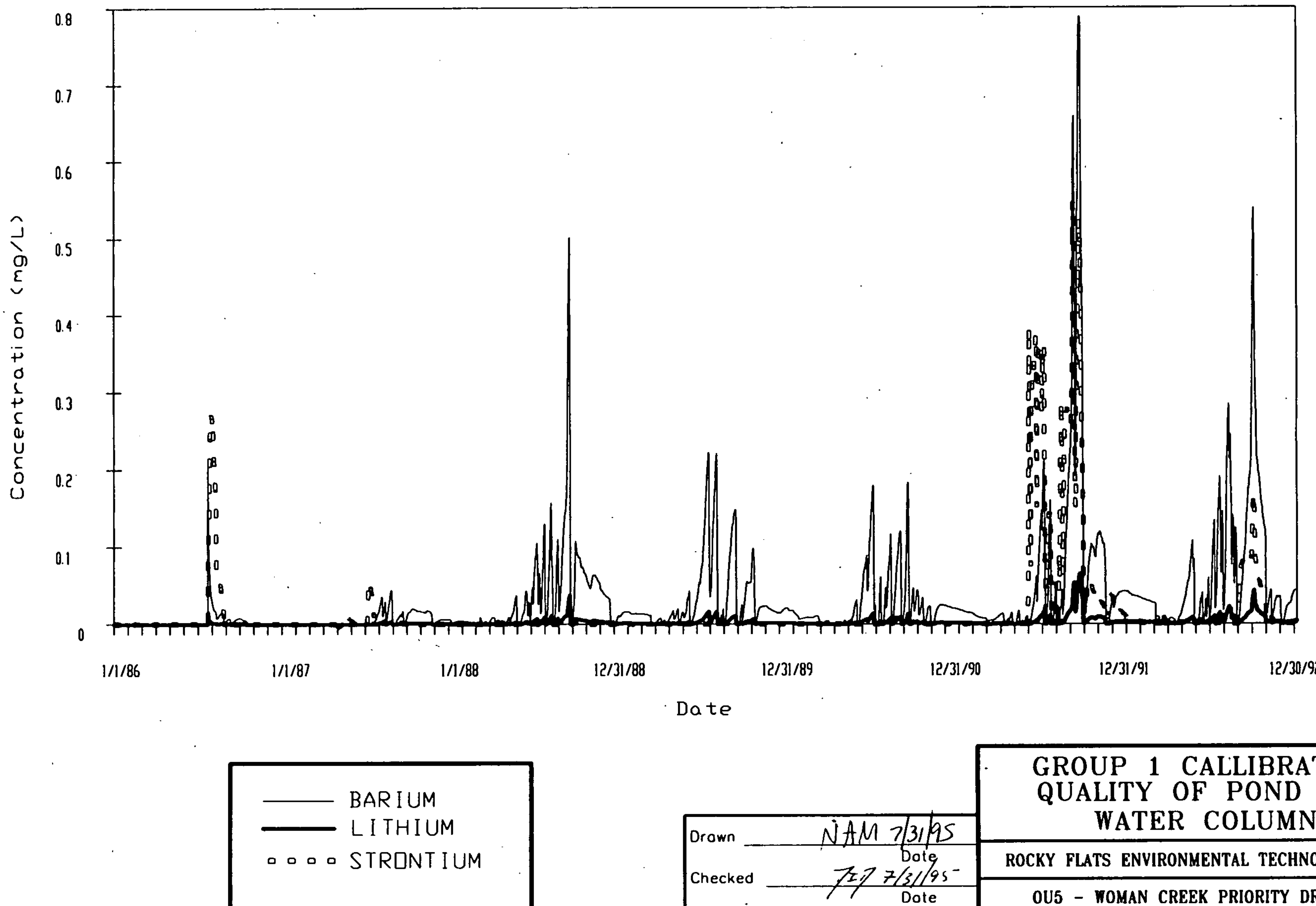
Drawn NAM 8/9/95 Date	**REACH 3 OBSERVED and CALIBRATED TOTAL SUSPENDED SEDIMENT**
Checked 8/9/95 Date	**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**
Approved Date	**OU5 - WOMAN CREEK PRIORITY DRAINAGE**
	RFI/RI REPORT
FILE OU5-531B.DWG	**FIGURE 5-31B**



Drawn NAM 8/9/95 Date	REACH 4 OBSERVED and CALIBRATED TOTAL SUSPENDED SEDIMENT
Checked 8/9/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Approved Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
FILE OU5-531C.DWG	FIGURE 5-31C



Drawn NAM 8/9/95 Date	REACHES 2 through 4 MEAN OBSERVED and CALIBRATED TOTAL SUSPENDED SEDIMENT
Checked 8/9/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Approved Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
FILE F5-31D.DWG	FIGURE 5-31D



Drawn NAM 7/31/95	Date
Checked 7/31/95	Date
Approved	Date
FILE OU5532A1.DWG	

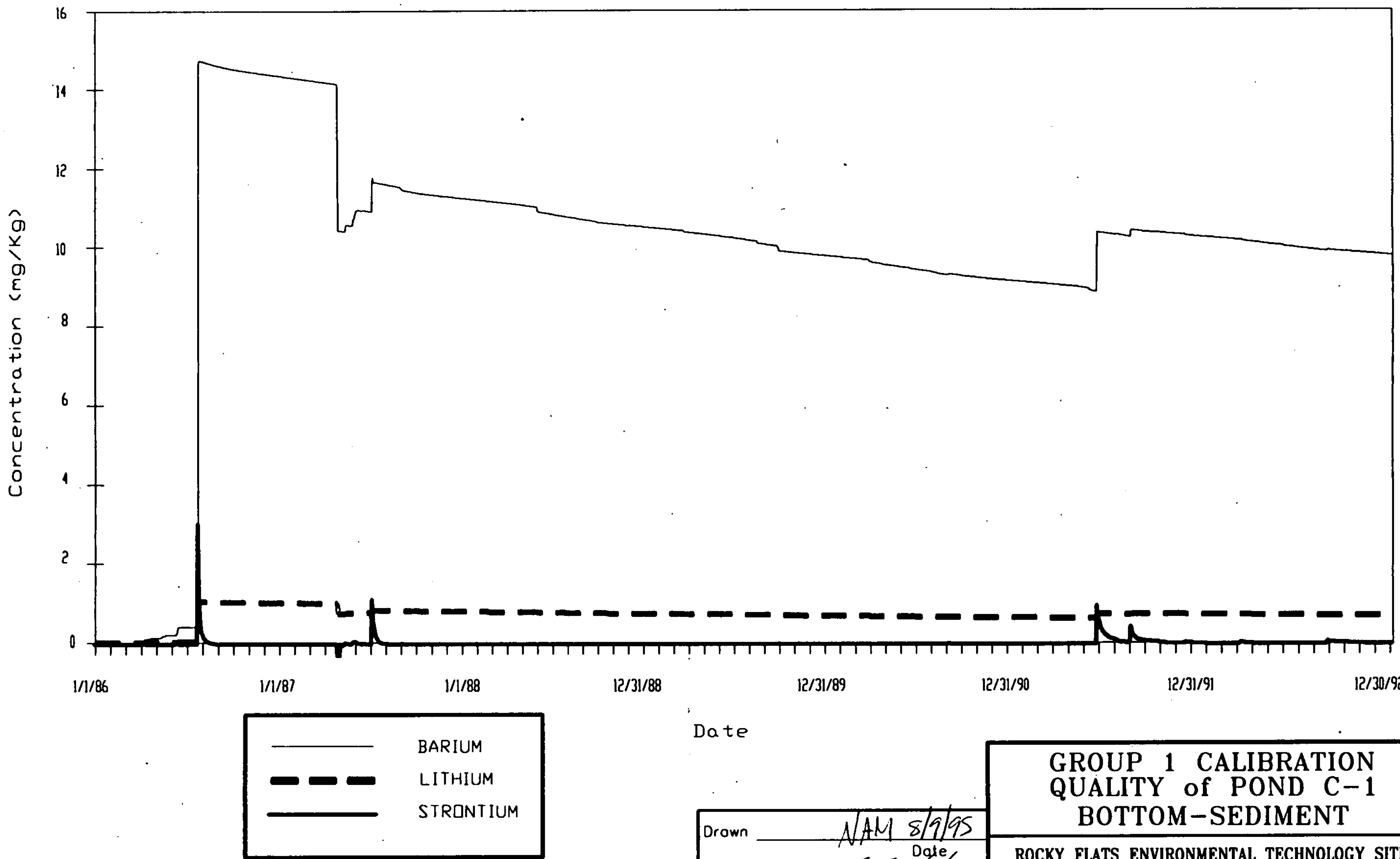
GROUP 1 CALLIBRATION QUALITY OF POND C-1 WATER COLUMN

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-32A1



Drawn NAM 8/9/95 Date

Checked 8/9/95 Date

Approved Date

FILE OU5532A2.DWG

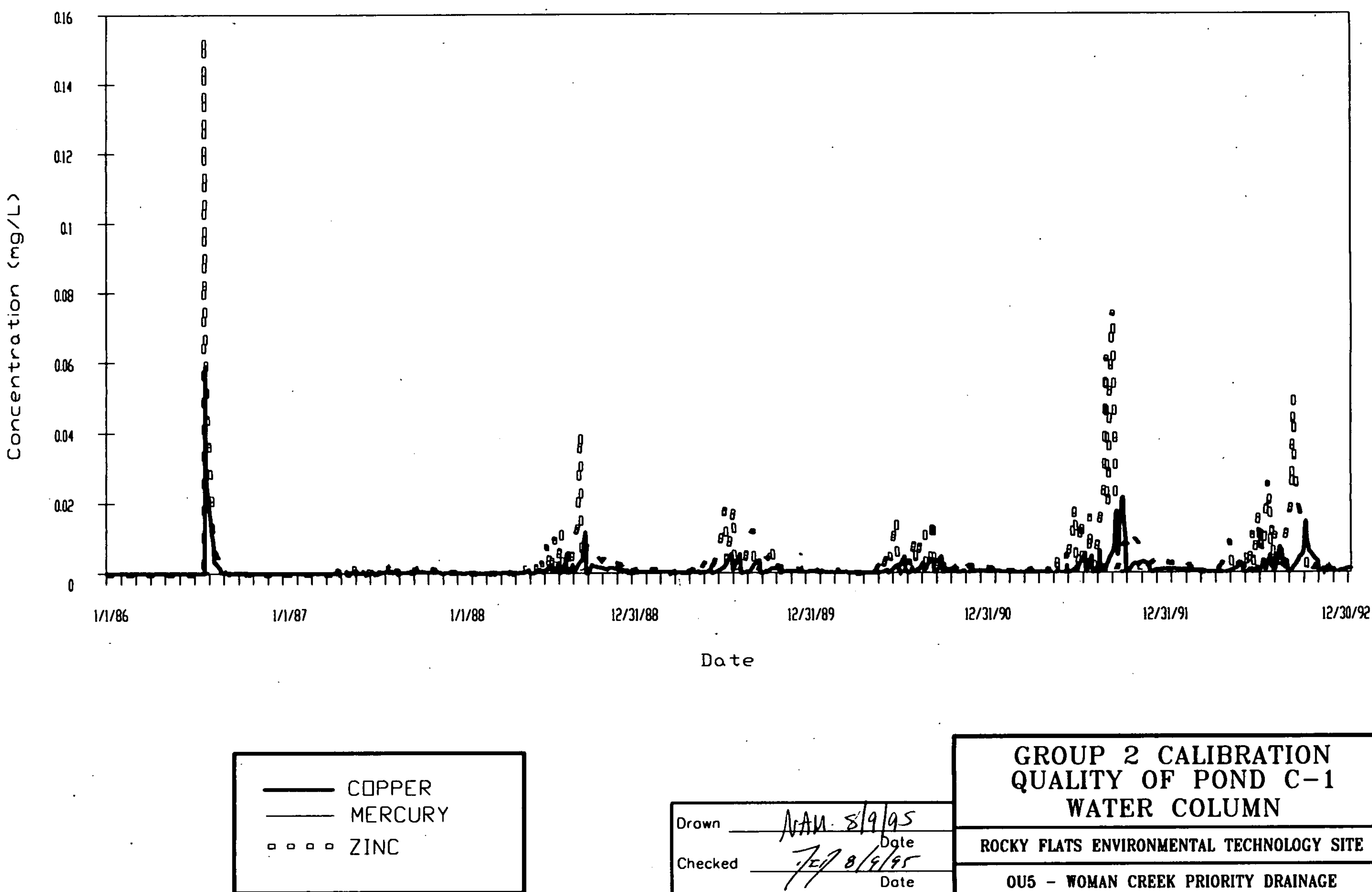
GROUP 1 CALIBRATION QUALITY of POND C-1 BOTTOM-SEDIMENT

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-32A2



Drawn NAH 8/9/95 Date

Checked [initials] 8/9/95 Date

Approved Date

FILE OU5532B1.DWG

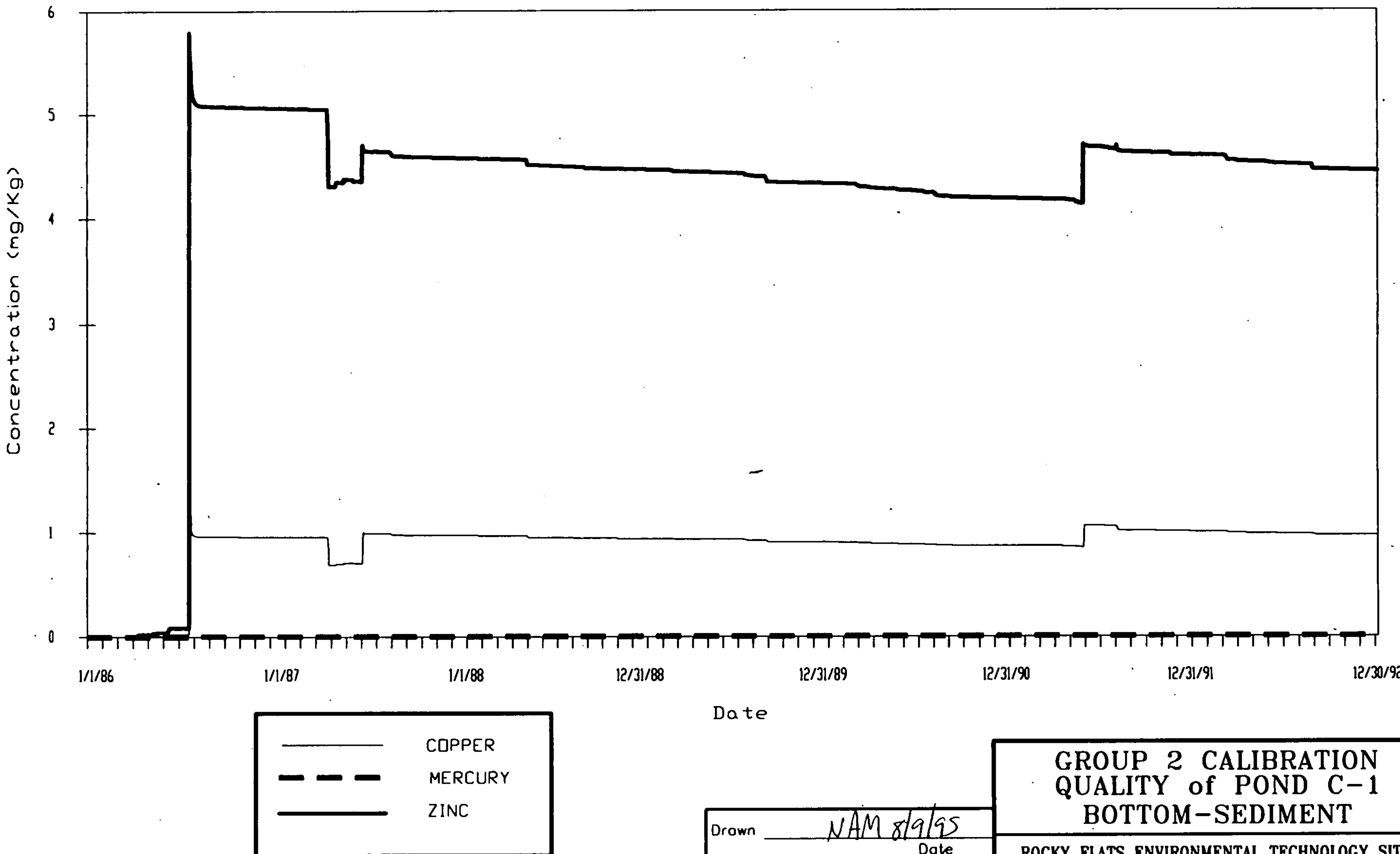
GROUP 2 CALIBRATION QUALITY OF POND C-1 WATER COLUMN

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-32B1



Drawn	NAM 8/9/95 Date
Checked	[illegible] 8/9/95 Date
Approved	Date
FILE OU5532B2.DWG	

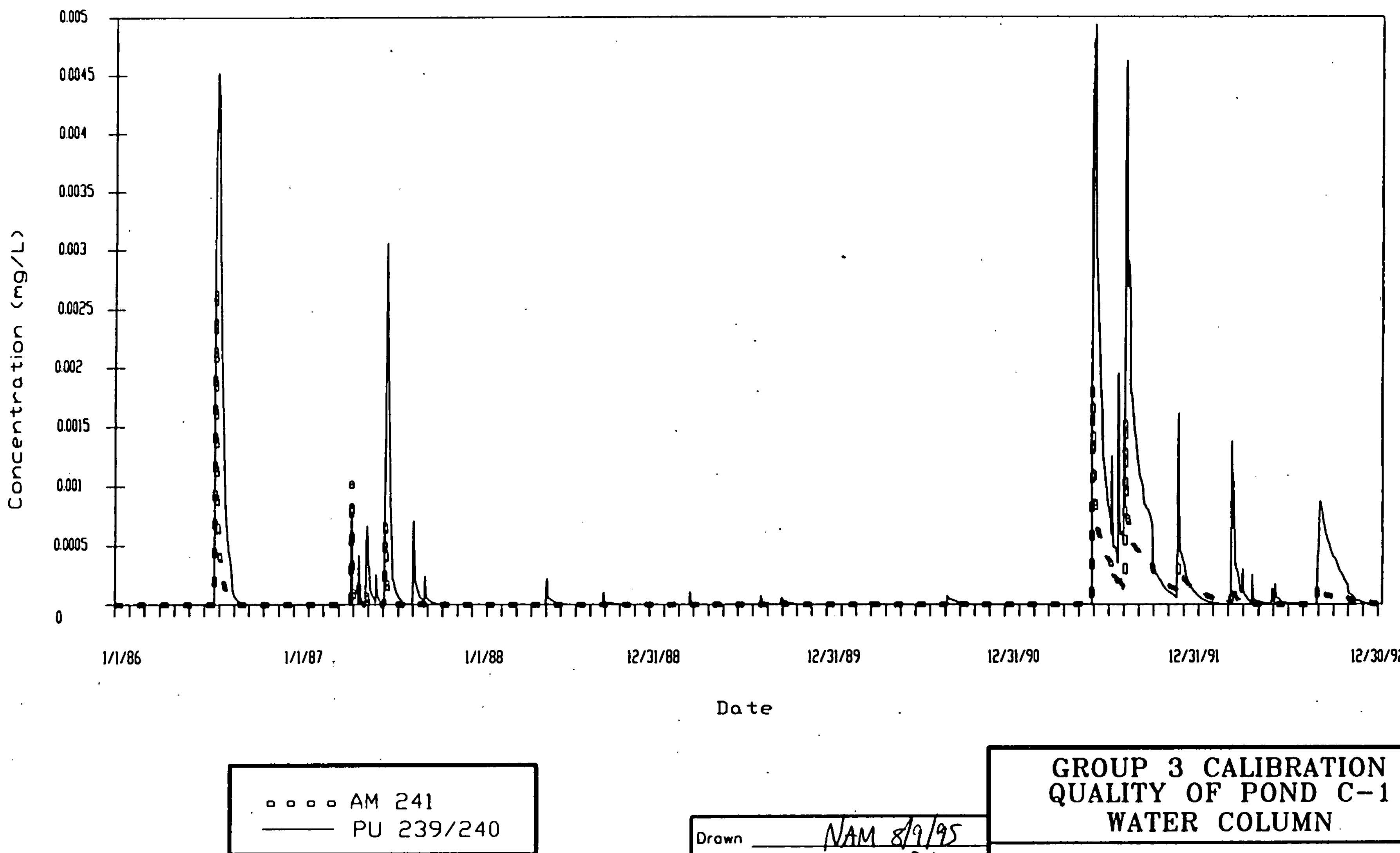
GROUP 2 CALIBRATION QUALITY of POND C-1 BOTTOM-SEDIMENT

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

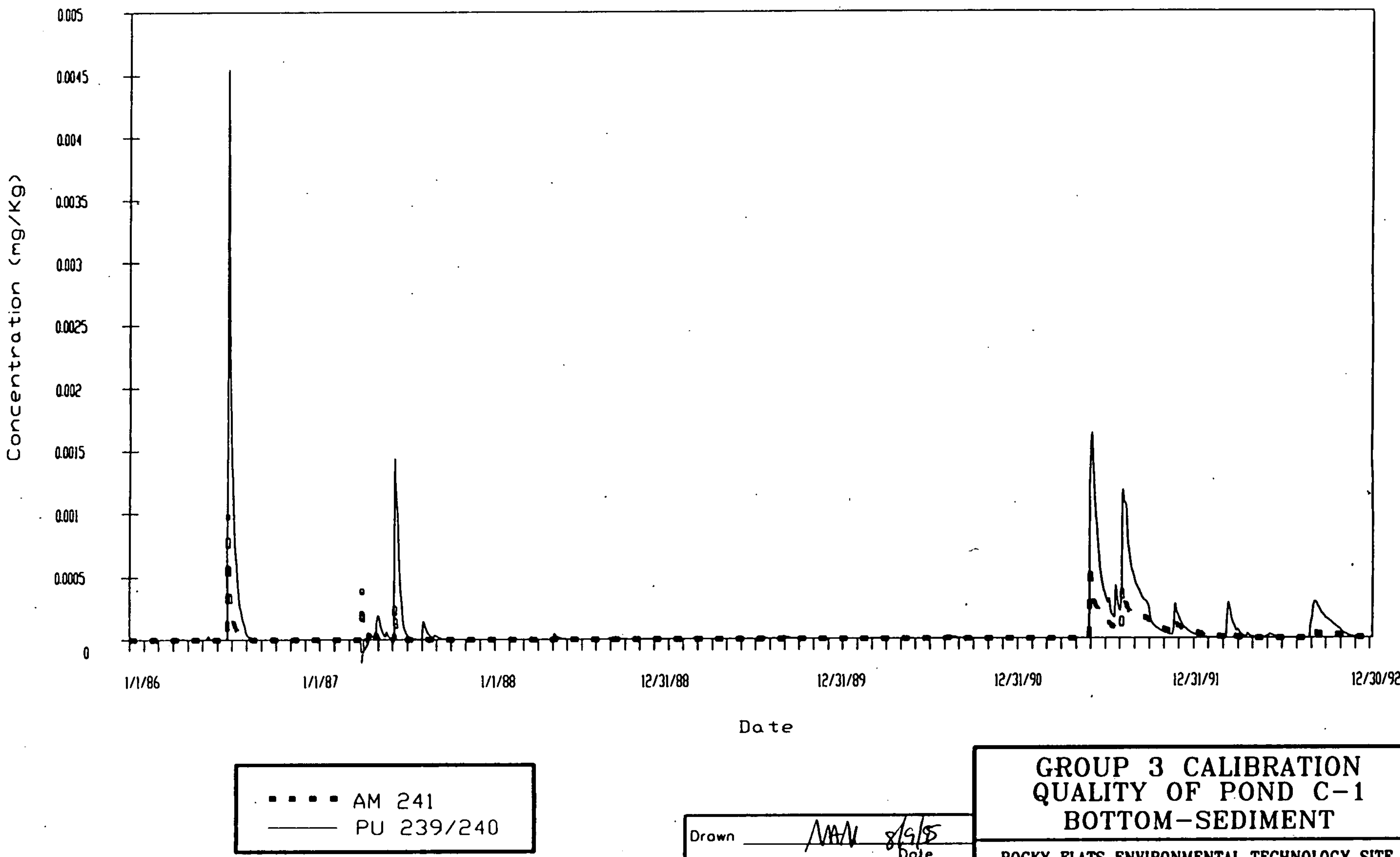
OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

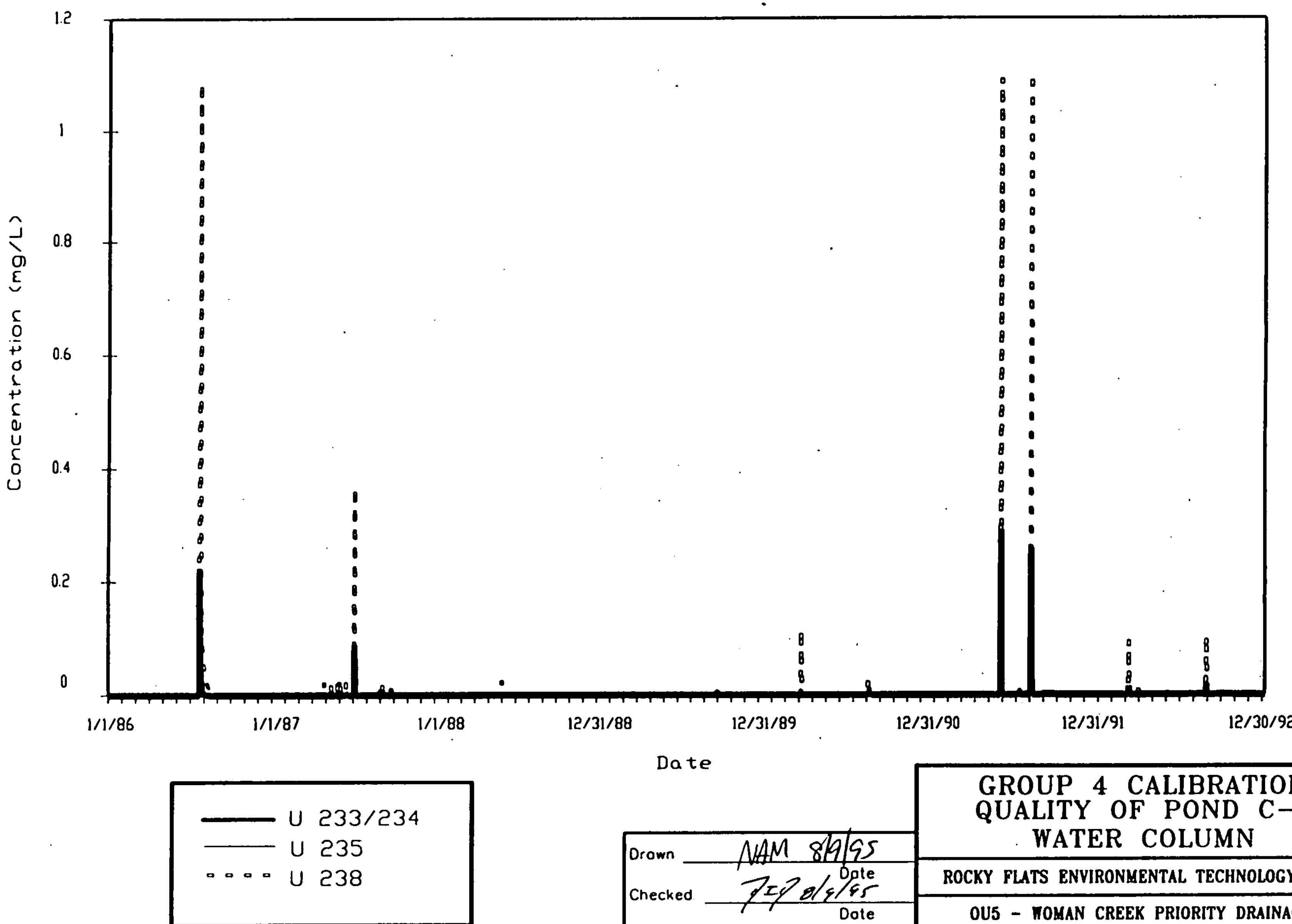
FIGURE 5-32B2



Drawn NAM 8/9/95 Date	GROUP 3 CALIBRATION QUALITY OF POND C-1 WATER COLUMN
Checked 8/9/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Approved Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
FILE OU5532C1.DWG	FIGURE 5-32C1



Drawn MAN 8/9/95 Date	GROUP 3 CALIBRATION QUALITY OF POND C-1 BOTTOM-SEDIMENT
Checked 8/9/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Approved Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
FILE OU5532C2.DWG	FIGURE 5-32C2



Drawn NAM 8/9/95 Date	
Checked 8/9/95 Date	
Approved Date	
FILE OU5532D1.DWG	

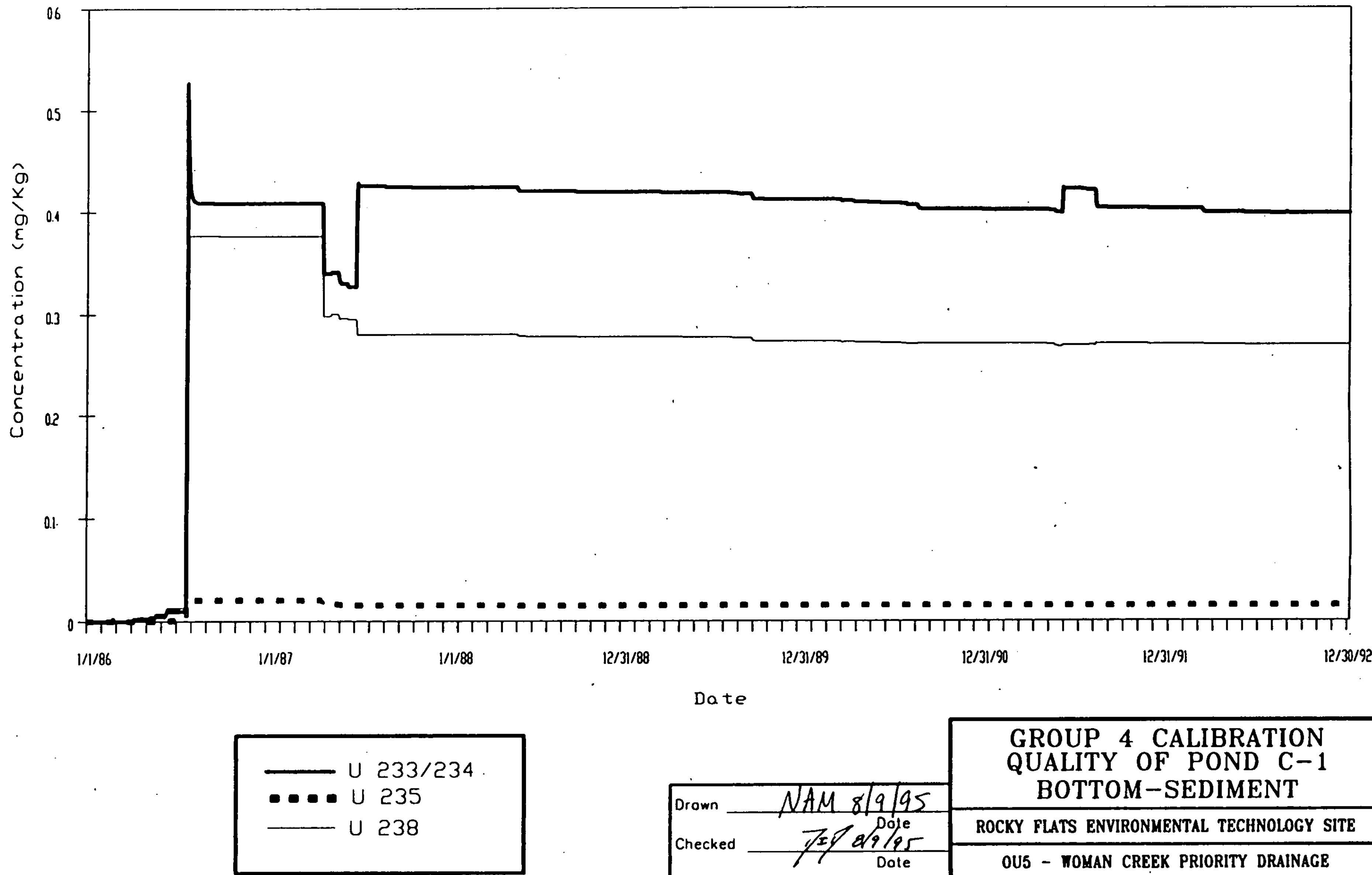
GROUP 4 CALIBRATION QUALITY OF POND C-1 WATER COLUMN

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

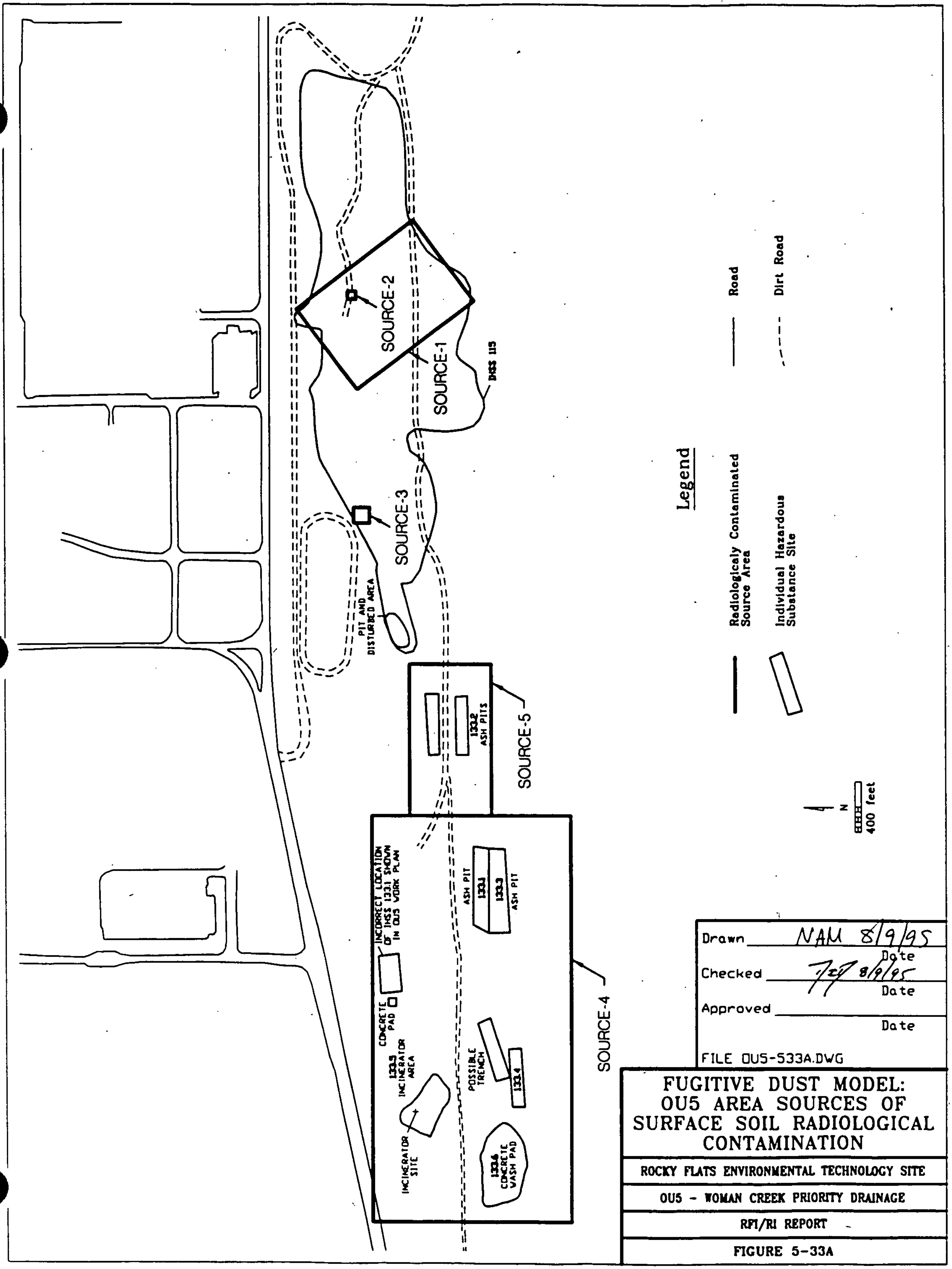
OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-32D1



Drawn NAM 8/9/95 Date	GROUP 4 CALIBRATION QUALITY OF POND C-1 BOTTOM-SEDIMENT
Checked [signature] 8/9/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Approved Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
FILE OU5532D2.DWG	FIGURE 5-32D2



Drawn NAM 8/9/95 Date
Checked 8/9/95 Date
Approved Date

FILE OU5-533A.DWG

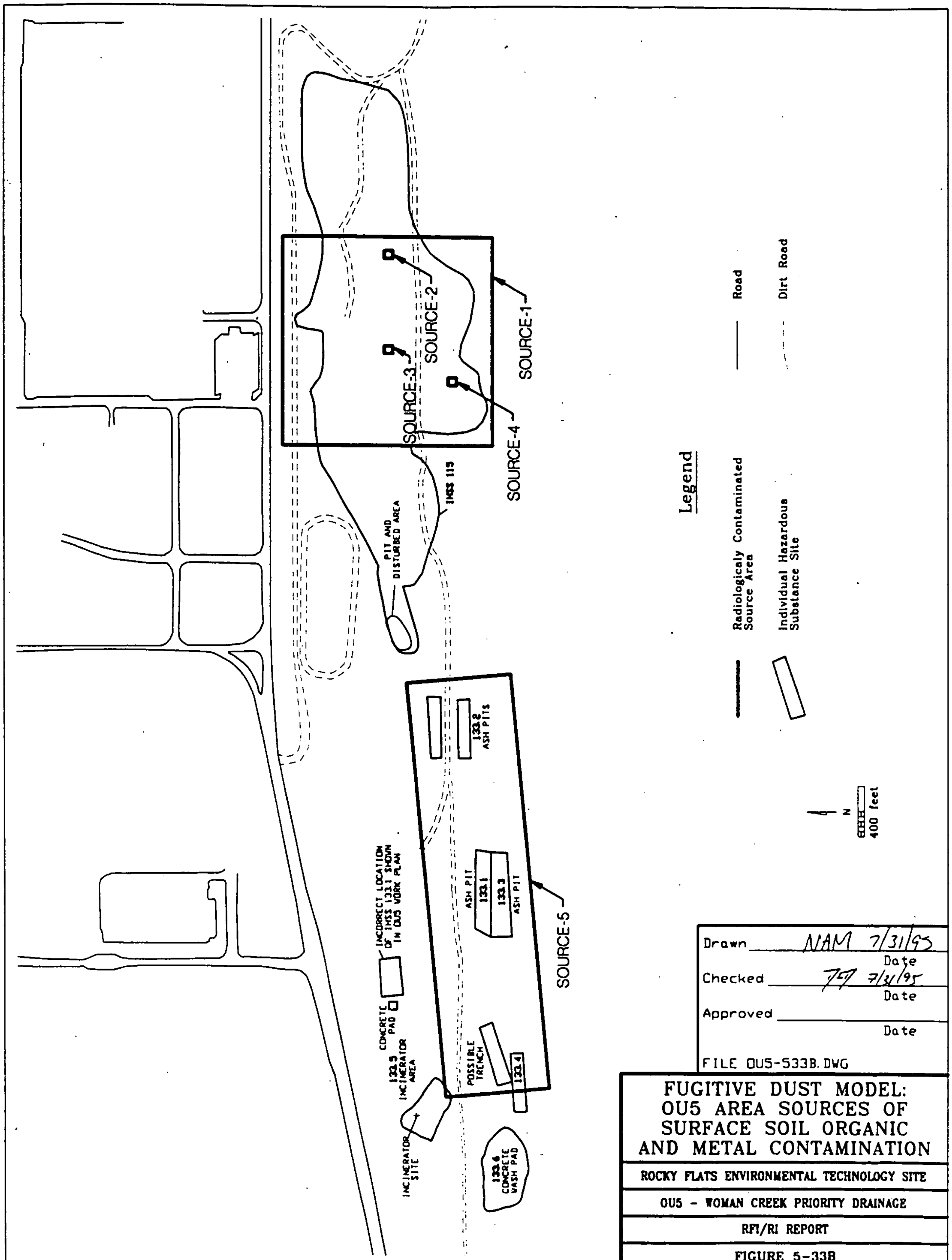
FUGITIVE DUST MODEL: OU5 AREA SOURCES OF SURFACE SOIL RADIOLOGICAL CONTAMINATION

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-33A



Drawn NAM 7/31/95 Date
Checked 7/31/95 Date
Approved Date
FILE OU5-533B.DWG

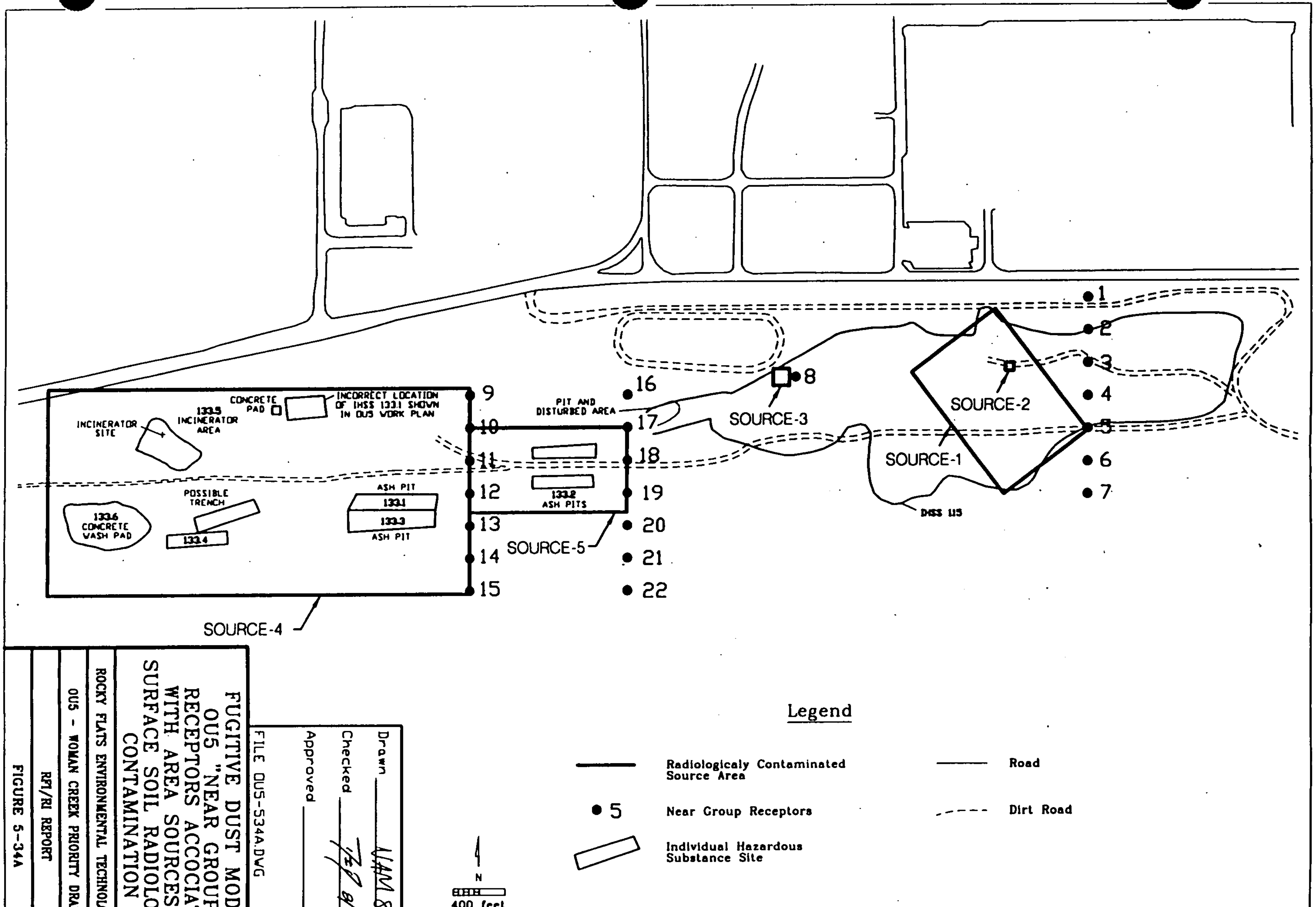
FUGITIVE DUST MODEL: OU5 AREA SOURCES OF SURFACE SOIL ORGANIC AND METAL CONTAMINATION

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-33B



Drawn NAM 8/9/95 Date

Checked [illegible] 8/9/95 Date

Approved ______ Date

FILE OU5-534A.DWG

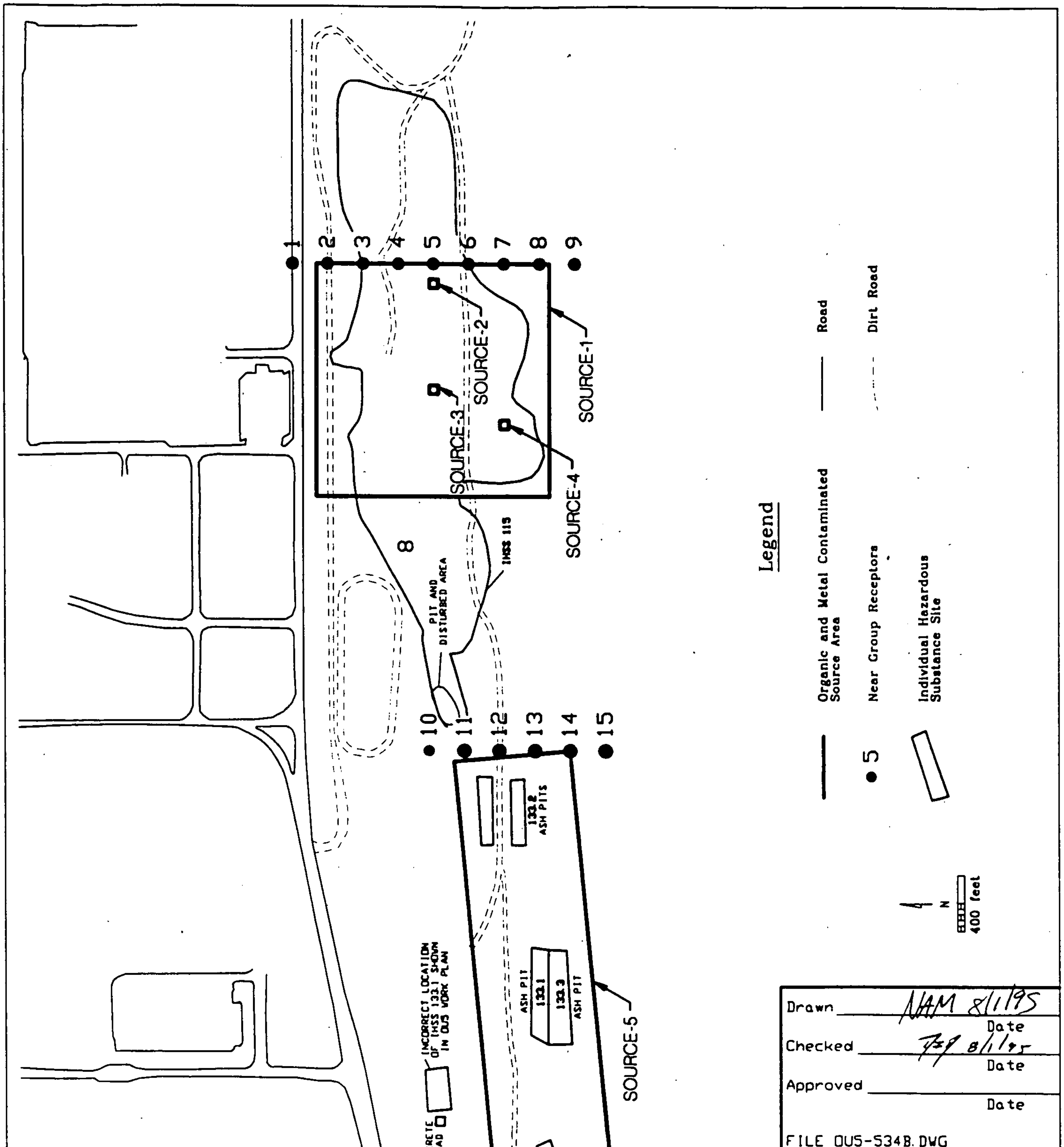
FUGITIVE DUST MODEL: OU5 "NEAR GROUP" RECEPTORS ACCOCIATED WITH AREA SOURCES OF SURFACE SOIL RADIOLOGICAL CONTAMINATION

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-34A



Drawn NAM 8/1/95 Date

Checked 8/1/95 Date

Approved ______ Date

FILE OU5-534B.DWG

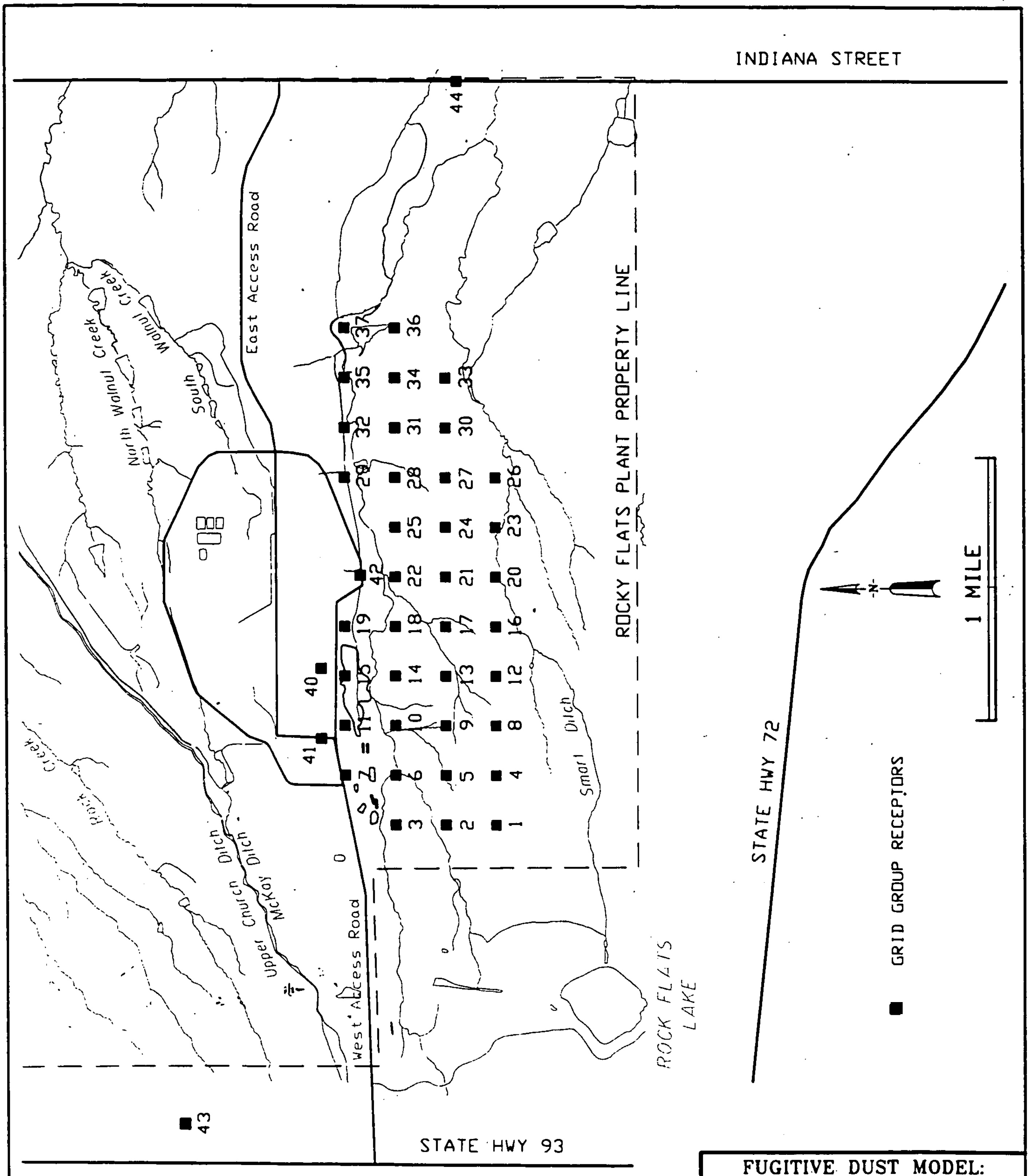
FUGITIVE DUST MODEL: OU5 "NEAR GROUP" RECEPTORS ASSOCIATED WITH AREA SOURCES OF SURFACE SOIL ORGANIC AND METAL CONTAMINATION

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-34B



FUGITIVE DUST MODEL: OU5 "GRID GROUP" RECEPTORS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-35

Drawn NAM 7/31/95 Date

Checked 7/31/95 Date

Approved ______ Date

FILE OU5-5-35.DWG

(After U.S.G.S. Quads, Louisville 1979, Golden, 1980; Lafayette 1979; and Arvada, 1980.)

Tables 5-1 through 5-43

70 pages

Table 5-1
Physical and Chemical Properties of Organic Compound COCs at OU 5

Compound	Density (g/ml)	Source	Water Solubility (mg/l)	Source	Vapor Pressure (mm Hg)	Source	Henry's Law Constant (atm-m^3/mole)	Source	K_{ow} (unitless)	Source	K_{oc} (ml/g)	Source
1,1-Dichloroethene	1.22	5	2.25E+03	2	6.00E+02	4	3.40E-02	2	62	3	65	2
1,2-Dichloroethene	1.26	1	6.00E+02	1	2.00E+02	1	3.80E-01	1	123	1	59	1
Acetone	0.792	5	1.00E+06	2	2.70E+02	4	2.06E-05	2	1	3	2	2
Aroclor-1254	1.505	1	5.70E-02	1	7.71E-05	1	2.70E-03	1	810,071	1	1,611,131	1
Benzo(a)anthracene	1.27	1	1.00E-02	1	5.00E-09	1	6.60E-07	1	407,380	1	1,380,384	1
Benzo(a)pyrene	1.27	1	1.00E-02	1	5.00E-09	1	2.40E-06	1	407,380	1	1,380,384	1
Benzo(b)fluoranthene	NF	1	1.40E-02	1	5.00E-07	1	1.20E-05	1	3,175,350	1	549,541	1
Dibenzo(a,h)anthracene	NF	5	5.00E-04	4	1.00E-10	4	7.33E-08	2	3,527,582	3	3,300,000	2
Fluoranthene	1.252	5	2.60E-01	4	5.00E-06	4	6.46E-06	2	121,486	3	38,000	2
Indeno(123-cd)pyrene	NF	1	6.20E-02	1	1.00E-10	1	6.86E-08	4	50,118,700	1	30,900	1
Pyrene	1.271	5	1.32E-01	4	2.50E-06	4	5.04E-06	2	100,474	3	38,000	2
Tetrachloroethene (PCE)	1.62	1	1.50E+02	1	1.40E+01	1	1.53E-02	1	398	1	300 - 360	1
Trichloroethene (TCE)	1.46	1	1.10E+03	1	5.80E+01	1	9.10E-03	1	338	1	100 - 150	1

Note: NF = Not found

Sources:
1 - OU 6 RFI/RI Report (DOE, 1996).
2 - RFETS PPRG Report (DOE, 1995).
3 - Kow values used in calculating RFETS subsurface soil action levels.
4 - Superfund Public Health Evaluation Manual (EPA, 1986).
5 - Hawley's condensed Chemical Dictionary (Sax and Lewis, 1987).

Table 5-2
Biodegradation Rates for Organic Compound COCs

Compounds	Groundwater Half-Lives	Soil Half-Lives	Surface Water Half-Lives
1,1-Dichloroethene	NA	NA	NA
1,2-Dichloroethene	8 weeks - 95 months	4 weeks - 6 months	4 weeks - 6 months
Acetone	NA	NA	NA
Aroclor-1254	NA	NA	NA
Benzo(a)anthracene	204 days - 3.73 years	102 days - 1.86 years	1 hour - 3 hours
Benzo(a)pyrene	114 days - 2.9 years	57 days - 1.45 years	0.37 hours - 1.1 hours
Benzo(b)fluoranthene	1.97 years - 3.34 years	360 days - 1.67 years	8.7 hours - 720 hours
Dibenzo(a,h)anthracene	NA	NA	NA
Fluoranthene	NA	NA	NA
Indeno(123-cd)pyrene	3.29 years - 4.0 years	1.64 years - 20 years	125 days - 250 days
Pyrene	NA	NA	NA
Tetrachloroethene (PCE)	12 months - 2 years	6 months - 1 year	6 months - 1 year
Trichloroethene (TCE)	10.7 months - 4.5 years	6 months - 1 year	6 months - 1 year

Source: OU 6 RFI/RI Report (DOE, 1996)

Table 5-3
Physical and Chemical Properties of Inorganic Compound COCs at OU 5

Chemical	Formula	Molecular Weight (g/mole)	Water Solubility	Specific Gravity	K_d	Source
Aluminum	Al	27.0	Insoluble	2.70	35	1
Antimony	Sb	121.7	Insoluble	6.68	NA	
Barium	Ba	137.3	Decomposes	3.51	15	1
Beryllium	Be	9.0	Insoluble	1.85	NA	
Cadmium	Cd	112.4	Insoluble	8.65	80	1
Copper	Cu	63.5	Insoluble	8.96	NA	
Lithium	Li	6.9	Decomposes	0.53	NA	
Manganese	Mn	54.9	Decomposes	7.21	NA	
Molybdenum	Mo	95.9	Insoluble	10.22	NA	
Nickel	Ni	58.7	Insoluble	8.90	400	1
Silver	Ag	107.9	Insoluble	10.5	4.7	2
Strontium	Sr	87.6	Decomposes	2.60	3.3	2
Vanadium	V	50.9	Insoluble	5.96	NA	
Zinc	Zn	65.4	Insoluble	7.13	2.8	2

Sources:
1 - Values for sand from Thibault et al., 1990.
2 - K_d values found in OU 6 RFI/RI Report (DOE, 1996).

NA = Information not available.

Table 5-4
Radioactive Half-Lives for Radionuclide COCs

Element	Radioactive Half-Lives (years)
Americium-241	433
Plutonium-239	24,100
Plutonium-240	6,570
Radium-226	1,620
Uranium-233	15,900
Uranium-234	246,000
Uranium-235	704,000,000
Uranium-238	4,470,000,000

Source: OU 6 RFI/RI Report (DOE, 1996)

Table 5-5

Initial Recharge Rates OU 5 Groundwater Flow Model

Zone	Vegetation Type	Initial Recharge Rate ft/day	Initial Recharge Rate in/yr
1	Riparian Woodland	-5.2E-03	-22.76
2	Short Upland Shrub	-3.0E-03	-13.04
3	Open Water	-2.7E-03	-11.65
4	Tall Marsh, Bottom Land Shrub	-2.3E-03	-10.26
5	Wet Meadow, Short Marsh	-1.7E-03	-7.48
6	Mesic Mixed Grassland, Short Grassland	1.6E-03	7.17
7	Reclaimed Grassland	1.6E-03	7.17
8	Xeric Mixed Grassland	1.9E-03	8.50
9	Disturbed Area/Barren Lands/Annual Grass/Forb	2.1E-03	9.39

Table 5-6

Monthy Precipitation at Rocky Flats Plant

Year	Month	Rain and Snowmelt Inches
1993	May	1.13
1993	June	1.79
1993	July	0.48
1993	August	0.42
1993	September	1.58
1993	October	1.41
1993	November	1.27
1993	December	0.35
1994	January	0.45
1994	February	0.77
1994	March	1.05
1994	April	4.03
Total		14.73

From EG&G, Monthly Environmental Monitoring Report, Rocky Flats Plant. Reports May - ER-4180110-219 through April, 1994 - ER-4180110-222.

Table 5-7
Estimated Consumptive Use Rates OU 5 Groundwater Flow Model

Zone No. [1]	Plant Subcommunity	K	Consumptive-Use [2] F [3]	Uc	Soil Moisture Correction	Corrected Uc	Dominant Plants	Basis for K
Community: Xeric Zone								
323	Xeric Mixed Grassland	0.70	26.95973308	18.87	0.33	6.23	narrow leaf sedge, blue gramma, Kentucky blue grass, sage	Shultz, 1976, sage brush
Community: Mesic Zone								
322	Mesic Mixed Grassland	0.85	26.95973308	22.92	0.33	7.56	western wheatgrass	USDA, 1970, small grains
324	Reclaimed Grassland	0.85	26.95973308	22.92	0.33	7.56	smooth brome, wheat grasses, sweet clover	USDA, 1970, small grains
410	Disturbed Area-Annual Grass/Forb	0.85	26.95973308	22.92	0.33	7.56	annual sunflower, sweet clover	USDA, 1970, Ladono Whitecover
420	Disturbed Area-Barren Lands	0.60	26.95973308	16.18	0.33	5.34	roads	Less than sage brush
Community: Hydric Zone								
110	Riparian Woodland	1.35	26.95973308	36.40	1.03	37.49	cottonwoods, willows	Shultz, 1976, cottonwood, willows
220	Short Upland Shrub (Snowberry)	1.00	26.95973308	26.96	1.03	27.77	snowberry, canada bluegrass	Shultz, 1976, small willows
10	Wet Meadow (Grasses)	0.80	26.95973308	21.57	1.03	22.21	prairie shortgrass, sedges	Shultz, 1976, light vegetation
30	Tall Marsh (Cattails)	0.90	26.95973308	24.26	1.03	24.99	cattails, bulrushes	Shultz, 1976, seeped areas
40	Open Water	0.95	26.95973308	25.61	1.03	26.38	impoundments	Shultz, 1976, water surfaces

Notes:
1. Zone numbers refer to DOE (1992c).
2. Calculated from Uc=K*F
3. F = Consumptive Use Factor = sum of the monthly consumptive use factors for each month during the growing season, May 15 - September 30, 1993.

Table 5-8

Calibration Results, Primary Target Wells
OU 5 Groundwater Flow Model

Well	X_Grid	Y_Grid	Column	Row	Observed	Calculated	(CAL.-OBS.)
5686	2220	1308	36	23	5982.3	5982	-0.25
6586	9501	469	132	7	5781.7	5782	0.23242
7086	4003	859	72	15	5935.6	5935.3	-0.2666
51193	8379	575	120	9	5812	5812	-0.02002
58793	2605	838	44	15	5998.7	5998.9	0.26855
59493	3536	526	63	9	5985.2	5985.3	0.10449
59593	3786	773	68	13	5942.7	5943	0.26563

Number of Active Observation Points = 7
Mean of Residuals = 0.047782
Standard Deviation of Residuals (SDEV) = 0.232957
Mean of Absolute Residuals (MA) = .201102
Root Mean Squared Residuals (RMS) = 0.220905
Correlation Coefficient = 0.999997

Table 5-9
Calibration Results, Secondary Wells and Wellpoints
OU 5 Groundwater Flow Model

Well	X_Grid	Y_Grid	Column	Row	Observed	Calculated	(CAL.-OBS.)
5886	5435	1266	91	23	5891.6	5891.5	-0.1001
6886	5582	1196	92	22	5886.7	5887.2	0.45654
5786	3572	791	63	14	5947	5948.4	1.356
6486	7610	678	113	12	5833.4	5834.3	0.84912
59093	1327	999.8	19	18	6010	6012.2	2.1162
59393	3489	794.8	62	14	5947.2	5951.2	3.9731
59793	4128	797.4	75	14	5932.1	5934.6	2.4805
63093	1751	992.8	27	18	5998.7	6005.2	6.4565
59993	4132	799.9	75	14	5935.3	5934.3	-0.94678
60293	3847	753.9	69	13	5942.4	5942.2	-0.27393
60593	2973	673.7	51	11	6002	6000.9	-1.1235
60693	2896	664.9	50	11	6008.1	6001.6	-6.54
60893	3585	506.7	64	8	5985.1	5983	-2.0303
62593	1457	730.4	21	13	6043.6	6040.9	-2.7148
62693	1926	723	31	12	6037.9	6037.9	-7.76E-02
62793	4304	803	78	14	5935.6	5930.4	-5.2026
62893	4700	385.9	83	6	5994	5991.8	-2.1597
63593	2603	836.2	44	15	5997.3	5999.1	1.7725
63693	2608	848	44	15	5996.9	5998.5	1.6641
63793	2611	835.4	44	15	5998.3	5998.9	0.63037
63893	3536	521.9	63	8	5982.3	5985.6	3.3853
63993	3115	528.4	54	9	6001.4	6004.7	3.3301
64093	3124	532.1	54	9	6002.4	6004.1	1.7188
51293	314.8	1103	4	20	6041	6040.5	-0.5
51393	1057	1036	13	19	6020	6020.1	0.12646
51693	2102	1203	34	22	5986	5989	2.9878
52193	2102	1105	34	20	5998	5996.4	-1.5933
53993	7058	736	107	13	5848	5848	0
54093	7052	708.1	107	12	5849	5848.6	-0.35449
54193	7046	681	107	12	5857	5851.3	-5.6982
54693	9123	412.8	128	6	5792	5793.2	1.2485
51493	1717	1067	26	19	6000.7	6000.5	-0.2002
51593	2102	1290	34	23	5985.7	5986.2	0.47461
51793	2104	1184	34	22	5989.6	5990.5	0.87109
51893	2105	1165	34	21	5993.6	5992	-1.6172
51993	2103	1145	34	21	5994.3	5993.5	-0.771
52093	2103	1125	34	20	5996.4	5995	-1.4038
52593	2671	1314	45	23	5970.9	5970	-0.8999
52693	3505	806.2	62	14	5946.2	5949	2.8433
52793	4003	908.4	72	16	5935.1	5935	-6.49E-02
52893	4002	831.8	72	15	5936.4	5935.7	-0.74121
52993	4002	787.4	72	14	5936.7	5937	0.2959
53093	4005	755.9	72	13	5937.7	5939.2	1.4707
53293	4004	692.9	72	12	5956.2	5956.6	0.396
53393	4736	850.2	84	15	5916	5917.5	1.5
53493	5174	1154	88	21	5898.8	5899.5	0.7002
53593	5950	1127	96	21	5875.3	5876.8	1.4502
54393	7034	640.9	107	11	5858.6	5855	-3.5596
54493	7025	607.7	107	10	5863.6	999.99	dry cell
54793	9876	506.1	135	8	5773	5773	0

Number of Active Observation Points = 49
Root Mean Squared Residuals (RMS) = 2.357743
Mean of Residuals (M) = 0.1220504
Correlation Coefficient = 0.9993236
Standard Deviation of Residuals (SDEV) = 2.378982
Probability of Un-Correlation = 0
Mean of Absolute Residuals (MA) = 1.696468

Table 5-10

Hydraulic Conductivities
OU 5 Groundwater Flow Model

Zone	Hydraulic Conductivity ft/day	Effective Porosity	Zone	Hydraulic Conductivity ft/day	Effective Porosity
1	1.43E-02	0.01	14	5.14E-01	0.03
2	3.57E-02	0.01	15	6.29E-01	0.03
3	5.29E-02	0.01	16	8.23E-01	0.04
4	7.14E-02	0.01	17	8.57E-01	0.04
5	7.40E-02	0.01	18	9.29E-01	0.04
6	1.57E-01	0.01	19	1.00E+00	0.04
7	1.65E-01	0.01	20	2.86E+00	0.12
8	2.27E-01	0.01	21	4.94E+00	0.15
9	2.86E-01	0.01	22	7.14E+00	0.18
10	3.57E-01	0.02	23	1.00E+01	0.18
11	3.70E-01	0.02	24	1.43E+01	0.18
12	4.29E-01	0.02	25	2.86E+01	0.19
13	5.00E-01	0.03			

Table 5-11

Recharges Rates from Calibration of OU 5 Groundwater Model

Zone	Recharge Rate (Feet per Day)
1	-0.000742856
2	-0.000442857
3	-0.000385714
4	-0.000342857
5	-0.000242857
6	0.000228571
7	0.000242857
8	0.000271428
9	0.0003

Table 5-12

Volumetric Budget
OU 5 Groundwater Flow Model

Inflow, Cubic Feet/Day	
From Constant Head Cells =	15,556
Recharge =	8,920
Total Inflow =	24,476
Outflow, Cubic Feet/Day	
To Constant Head Cells =	22,670
Negative Recharge (phreatophytes) =	1,852.8
Total Outflow =	24,522
Inflow - Outflow, Cubic Feet/Day	-46.502
Percent Discrepancy	-0.19

Table 5-13
Summary of Screening for Target Well Selection
OU 5 Solute Transport Model

Well Number	Chemical of Concern	Units	Background Mean	Mean Plus 2 St. Dev.	Well Maximum	Mean	Target Well?
	Aluminum	ug/l	72.24	231.57	9	9	No
	Americium-241	pCi/l	0.02	0.1	NA	NA	No
	Barium	ug/l	84.23	154.76	156	156	Yes
	Beryllium	ug/l	2.33	5.1	0.5	0.5	No
	Manganese	ug/l	22.91	128.92	0.5	0.5	No
50092	Plutonium-239/240	pCi/l	0.01	0.01	NA	NA	No
	Radium-226	pCi/l	0.26	0.48	0.55	0.47	Yes
	Uranium-233/234	pCi/l	6.1	19.08	5.9	5.16	No
	Uranium-235	pCi/l	0.23	0.65	0.39	0.33	No
	Uranium-238	pCi/l	4.31	13.65	3.5	3.19	No
	Vanadium	ug/l	13.03	45.06	NA	NA	No
	Aluminum	ug/l	72.24	231.57	100	41.4	No
	Americium-241	pCi/l	0.02	0.1	0.004	0.002	No
	Barium	ug/l	84.23	154.76	257	236.63	Yes
	Beryllium	ug/l	2.33	5.1	2.5	1.5	No
	Manganese	ug/l	22.91	128.92	3005	2900	Yes
51193	Plutonium-239/240	pCi/l	0.01	0.01	0.0005	-0.002	No
	Radium-226	pCi/l	0.26	0.48	NA	NA	No
	Uranium-233/234	pCi/l	6.1	19.08	0.49	0.36	No
	Uranium-235	pCi/l	0.23	0.65	0.09	0.06	No
	Uranium-238	pCi/l	4.31	13.65	0.59	0.34	No
	Vanadium	ug/l	13.03	45.06	25	13.5	No
	Aluminum	ug/l	72.24	231.57	100	73.33	No
	Americium-241	pCi/l	0.02	0.1	0.018	0.008	No
	Barium	ug/l	84.23	154.76	156	155	Yes
	Beryllium	ug/l	2.33	5.1	2.5	1.83	No
	Manganese	ug/l	22.91	128.92	515	490.67	Yes
58793	Plutonium-239/240	pCi/l	0.01	0.01	0.002	0.001	No
	Radium-226	pCi/l	0.26	0.48	0.55	0.55	Yes
	Uranium-233/234	pCi/l	6.1	19.08	0.87	0.55	No
	Uranium-235	pCi/l	0.23	0.65	0.04	0.01	No
	Uranium-238	pCi/l	4.31	13.65	1.1	0.67	No
	Vanadium	ug/l	13.03	45.06	25	17.5	No
	Aluminum	ug/l	72.24	231.57	100	43	No
	Americium-241	pCi/l	0.02	0.1	0.005	0.001	No
	Barium	ug/l	84.23	154.76	647	486.67	Yes
	Beryllium	ug/l	2.33	5.1	2.5	1.17	No
	Manganese	ug/l	22.91	128.92	10500	6130	Yes
59493	Plutonium-239/240	pCi/l	0.01	0.01	0.002	0.002	No
	Radium-226	pCi/l	0.26	0.48	1.03	1.03	Yes
	Uranium-233/234	pCi/l	6.1	19.08	2.1	1.99	No
	Uranium-235	pCi/l	0.23	0.65	0.16	0.08	No
	Uranium-238	pCi/l	4.31	13.65	1.9	1.72	No
	Vanadium	ug/l	13.03	45.06	25	11.03	No
	Aluminum	ug/l	72.24	231.57	37.7	22.23	No
	Americium-241	pCi/l	0.02	0.1	0.006	0.006	No
	Barium	ug/l	84.23	154.76	139	121	No
	Beryllium	ug/l	2.33	5.1	0.5	0.5	No
	Manganese	ug/l	22.91	128.92	761	575.67	Yes
59593	Plutonium-239/240	pCi/l	0.01	0.01	0.001	0.001	No
	Radium-226	pCi/l	0.26	0.48	0.56	0.56	Yes
	Uranium-233/234	pCi/l	6.1	19.08	3.5	2.57	No
	Uranium-235	pCi/l	0.23	0.65	0.37	0.2	No
	Uranium-238	pCi/l	4.31	13.65	3.6	2.23	No
	Vanadium	ug/l	13.03	45.06	2.5	2.17	No

Table 5-14
Target Concentrations OU 5 Solute Transport Model

Constituent	Well Number	Background Mean Concentration (BM)	Well Mean Concentration (WM)	Target Concentration (BM-WM)
Barium	50092	84.23	156	71.77
in ug/l	51193	84.23	236.63	152.40
	58793	84.23	155	70.77
	59493	84.23	486.67	402.44
	59593	84.23	121	36.77
Manganese	51193	22.91	2,900	2,877.09
in ug/l	58793	22.91	490.67	467.76
	59493	22.91	6,130	6,107.09
	59593	22.91	575.67	552.76
Radium-226	50092	0.26	0.47	0.21
in pCi/l	58793	0.26	0.55	0.29
	59493	0.26	1.03	0.77
	59593	0.26	0.56	0.30

Table 5-15
Calibration Results OU 5 Solute Transport Models

Chemical of Concern	Well Number	Target Concentration ug/l and pCi/l	Computed Concentration ug/l and pCi/l	Distribution Coefficient ml/g	Source Concentration ug/l and pCi/l
Barium	58793	70.77	72.39	0.624	2912.5
	59493	402.44	402.43	0.624	47859
	59593	NA	171.6	0.624	47859
	51193	152.4	152.4	0.624	152.49
	50092	71.77	71.77	0.624	93.868
Manganese	58793	467.76	510.1	3.059	291030
	59493	6107.09	6113.8	3.059	973180
	59593	552.76	558.1	3.059	973180
	51193	2877.09	2877.09	3.059	3663
	50092	NA	NA	NA	NA
Radium-226	58793	0.29	29.79	0.687	12.679
	59493	0.77	76.54	0.687	106.72
	59593	0.3	35.25	0.687	106.72
	51193	NA	NA	NA	NA
	50092	0.21	0.21	0.687	0.29345

Table 5-16
Thirty-Year Future Concentrations at Woman Creek
OU 5 Groundwater Modeling

Constituent	Location of Greatest 30-Year Concentration: Column	Row	Greatest 30-Year Concentration pCi/L or ug/L
Radium-226	120	11	0.27
Barium	70	15	93
Manganese	120	9	3451

Table 5-17
Worst-Case Future Concentrations at Woman Creek
OU 5 Groundwater Modeling

Constituent	Location of Worst-Case Concentration: Column	Row	Steady-State Concentration pCi/L or ug/L	Uncertainty Ratio	Worst-Case Concentration pCi/L or ug/L
Radium-226	49	20	0.26	10	2.6
Barium	70	15	93	1.71	159
Manganese	49	20	5911	1.1	6517

Table 5-18
Geometric Properties of HSPF10 Sub-Basins and Stream Reaches

Sub-Basin	Calibration Basin Area (Acres)	Simulation Basin Area (Acres)	Reach Length (Feet)	Comments
Basin 1	364.2	364.2	None	Located west of South Boulder Diversion Canal (SBDC)
Basin 2	301.0	301.0	5,801	Extends eastward to the west boundary of RFETS (GS05)
Basin 3	494.4	557.8	5,961	Extends eastward to the confluence with Antelope Spring Creek
Basin 4	51.3	97.2	1,806	Extends eastward to GS17 (inflow to Pond C-1)
Basin 5	50.1	82.3	1,033	Extends through Pond C-1 to GS07 (outflow of Pond C-1)
Basin 6	603.4	643.9	10,392	Extends eastward to Indiana Street (GS02)
Totals	1,864.4	2,046.4	24,993	

Table 5-19

Monthly and Annual Precipitation at Rocky Flats Environmental Technology Site (inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1971						0.22	1.11	0.35	3.17	0.55	0.15	0.40	
1972	0.93	0.08	0.83	1.58	0.97	0.95	1.59	2.47	1.42	0.91	2.00	1.05	14.78
1973	1.05	0.15	2.04	4.73	4.71	0.66	1.53	0.54	2.74	0.65	1.30	1.48	21.58
1974	1.12	1.11	0.89	3.05	0.08	1.99	1.00	0.22	1.41	1.91	1.15	0.38	14.31
1975	0.38	0.84	1.42	1.31	3.73	1.11	0.83	1.22	0.80	0.68	0.85	0.21	13.38
1976	0.13	0.04	0.34	2.16	1.93	0.90	1.53	1.46	4.49	0.66	0.21	0.10	13.95
1977	0.06	0.47	0.08	1.80	0.46	1.13	2.73	1.04	0.12	0.40	0.34	0.09	8.72
1978	0.35	0.33											
1979													
1980													
						No published data found for this time period							
1981													
1982													
1983	0.02	0.19	4.64	2.21	3.97	2.76	2.10	3.46	0.01	0.34	2.47	0.42	22.59
1984	0.36	0.65	0.84	1.42	0.56	0.91	0.77	1.69	0.16	3.68	0.00	0.28	11.32
1985	0.41	0.77	0.64	1.69	2.92	1.73	3.38	0.11	1.24	0.00	1.26	0.08	14.23
1986	0.06	0.93	0.00	2.68	2.23	2.03	1.46	1.58	0.84	0.98	0.98	1.26	15.03
1987	0.43	1.19	1.35	0.91	2.40	5.72	0.57	2.09	0.64	1.06	1.10	0.71	18.17
1988	0.27	0.55	1.10	1.22	2.20	0.95	1.66	1.60	1.36	0.09	0.40	0.54	11.94
1989	0.53	0.11	0.21	0.51	2.20	0.02	1.74	1.90	2.69	0.39	0.11	0.31	10.72
1990	0.28	0.17	2.16	1.33	1.82	0.12	3.16	1.41	2.00	0.80	0.64	0.02	13.91
1991	0.19	0.04	0.41	1.50	3.77	2.30	2.47	2.45	0.84	0.31	1.72	0.17	16.17
1992	0.31	0.00	3.37	0.53	1.51	2.21	1.10	2.97	0.00	0.59	1.00	0.11	13.70
1993	0.03	0.27	1.52	1.45	1.13	1.79	0.48	0.42	1.58	1.41	1.27	0.35	11.70
1994	0.45	0.77	1.05	4.03	1.37	1.12	0.4	1.5	0.68	0.96	1.08	0.16	13.57
Median	0.35	0.33	0.97	1.54	1.93	1.13	1.53	1.54	1.04	0.67	1.04	0.30	13.93
Mean	0.39	0.46	1.27	1.90	2.00	1.51	1.56	1.50	1.38	0.86	0.95	0.43	14.43
Std. Dev.	0.33	0.39	1.19	1.12	1.36	1.28	0.88	0.93	1.19	0.82	0.67	0.42	3.50
Maximum	1.12	1.19	4.64	4.73	4.71	5.72	3.38	3.46	4.49	3.68	2.47	1.48	22.59
Minimum	0.02	0.00	0.00	0.51	0.00	0.02	0.40	0.11	0.00	0.00	0.00	0.02	8.72
N	18	18	17	17	18	18	18	18	18	18	18	18	17

Source: EG&G Rocky Flats, Inc.

Note: Blank space means no data available.

Table 5-20
Summary of Chemicals of Concern by Medium

Group	Chemical of Concern	Surface Soil	Ground-Water	Surface Water	Pond Sediment	Stream Sediment
			Metals			
1	Barium		X	X		
	Lithium			X		
	Strontium			X		
2	Copper	X				X
	Mercury	X			X	X
	Zinc				X	X
			Radionuclides			
3	Americium-241		X	X	X	X
	Plutonium-239/240		X		X	X
4	Uranium-233/234	X	X	X	X	
	Uranium-235	X	X		X	
	Uranium-238	X	X	X	X	

Source: DOE, 1995a

Table 5-21

OU5 Surface-Water Gauge Stations (GS) for Woman Creek Drainage Basin

Site	Purpose/Location[1]	Equipment	Flow Equation[2]
GS05	West boundary of RFETS on Woman Creek	9" Parshall Flume Flow Recorder	$CFS = 3.1667(FT^{1.5128})$
GS06	West boundary of RFETS on South Woman Creek	9" Parshall Flume Flow Recorder	$CFS = 3.1667(FT^{1.5128})$
GS17	Flow into Pond C-1 and seepage from SID	9" Parshall Flume Flow Recorder	$CFS = 3.1667(FT^{1.5128})$
GS07	Discharge from Pond C-1	9" Parshall Flume 90° V-Notch Weir Flow Recorder	$CFS = 3.1667(FT^{1.5128})$
GS01	Indiana Street	Rated Culvert 43" X 78" CMP Flow Recorder	$CFS = 11.05(FT^5)+30.87(FT^4)+26.63(FT^3)+10.35(FT^2)+0.22(FT)+0.00019$
GS02	Indiana Street	Rated Culvert 36" CMP Flow Recorder	$CFS = 0.06067(FT^3)+5.0093(FT^2)+1.0656(FT)$

NOTES:
1) Locations are shown on Figure 5.3.2-2
2) Source: EG&G, 1994d
CMP = corrugated metal pipe; CFS = cubic feet per second; FT = feet (depth of flow)

Table 5-22

Woman Creek Observed Total Suspended Sediment Concentrations

Date	Sample Location	Concentration (mg/L)				
		Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
10/9/92	GS05	5				
10/26/92	GS05	21				
	GS07				10	
11/4/92	SW107	2				
	SW506	2				
	SW040		2			
	SW033		2			
	SW034		5			
	SW501			2		
	SW029				5.5	
	SW026					2
3/24/93	SW107	2				
	SW127	2				
	SW040		2			
	SW041		2			
	SW506		2			
	SW033		2			
	SW034		2			
	SW501			2		
	SW029				17	
	SW026					2
4/13/93	GS07				15	
	GS01					2
	GS02					44
4/24/93	GS05	4				
	GS16		281			
	GS17			33		
5/7/93	GS05	4				
5/15/93	GS05	4				

Table 5-22 (continued)

Date	Sample Location	Concentration (mg/L)				
		Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
5/17/93	GS05	4				
	GS06	628				
	GS18		19			
	GS16		325			
	GS18		19			
6/12/93	GS16		31			
6/17/93	GS16		713			
	GS18		49			
	GS17			1326		
	GS02					10
6/18/93	GS06	378				
	GS17			32		
	GS14					7
9/2/93	GS05	4				
9/7/93	GS05	4				
	GS05	228				
	GS16		5			
	GS17			4		
9/9/93	GS06	8				
	GS16		85			
9/13/93	GS16		13			
9/18/93	GS05	48				

Table 5-23
OU5 HSPF10 Model Water-Quality Partition Coefficients and Other Values [1)]

	Partitian Coefficients (ml/g); pH range 5 - 9				
COC	Sand (<10% clay)[2)]	Silt (10-30% clay)[2)]	Clay (>30% clay)[2)]	1/2 life T (yr)	1st Order Decay Coeff. .693/T
Barium	530.0	2800.0	16000.0		
Copper	41.9	92.2	336		
Lithium	0.0	0.2	0.8		
Mercury	322.0	580.0	5280.0		
Strontiu	24.3	100.0	124.0		
Zinc	12.7	939.0	1460.0		
Am_{241}	82.0	200.0	1000.0	458	$1.5x10^{-3}$
$Pu_{239/240}$	10.0	100.0	250.0	$2.41x10^{4}/6.57x10^{3}$	$2.9x10^{-5}/1.1x10^{-4}$
$U_{233/234}$	0.0	50.0	500.0	$1.59x10^{5}/2.45x10^{5}$	$4.0x10^{-6}/2.8x10^{-6}$
U_{235}	0.0	50.0	500.0	$7.0x10^{8}$	$9.8x10^{-10}$
U_{238}	0.0	50.0	500.0	$4.47x10^{9}$	$1.55x10^{-10}$

1) Source: D. L. Strenge and S.R. Peterson, 1989.
2) Estimated values based on values given for soil composition with the given total weight percent of clay, organic matter, and iron and aluminum oxyhydroxides.

TABLE 5-24
Woman Creek Water-Budget Calibration Results [1)]

Location	Mass Volume (cubic feet) Observed	Mass Volume (cubic feet) Simulated	Percent Difference
GS05 (Basin 2)	1,123,800	840,900	-0.25
GS17 (Basin 4)	1,892,500	2,068,200	0.09
GS07 (Basin 5)	2,013,000	2,005,400	-0.00
GS02 (Basin 6)	1,809,500	2,199,000	0.22
Mean Results	1,709,700.00	1,778,375.00	0.04

1) Calibration period: April 1993 through September 1993

Table 5-25
Comparison of Observed and Simulated Calibration Results for Pond C-1 Water-Column Quality[1)]

	Constituents (COCs)	Observed COC Concentrations [2)]	7-Year simulation results [3)] Median	Mean	Maximum	7-Year Results as % of Observed Median	Mean	Maximum
Group 1 (mg/L)	Reach 5							
	Barium	**0.0900**	0.0110	**0.0344**	0.7880	12.22%	**38.22%**	875.56%
	Lithium	**0.0060**	0.0008	**0.0026**	0.0650	13.17%	**43.33%**	1083.33%
	Strontium	**0.2750**	0.0000	**0.0161**	0.5480	0.01%	**5.85%**	199.27%
Group 2 (mg/L)	Reach 5							
	Copper	**0.0030**	0.0003	**0.0010**	0.0588	9.63%	**34.11%**	1961.06%
	Mercury	**0.0000**	0.0000	**0.0000**	0.0003	NA	**NA**	NA
	Zinc	**0.0070**	0.0010	**0.0034**	0.1562	14.40%	**49.13%**	2231.59%
Group 3 (pCi/L)	Reach 5							
	Americium-241	**0.0040**	0.0009	**0.0012**	0.0056	22.43%	**30.31%**	140.45%
	Plutonium-239/240	**0.0010**	0.0000	**0.0000**	0.0043	0.10%	**0.94%**	434.58%
Group 4 (pCi/L)	Reach 5							
	Uranium-233/234	**0.9000**	0.0239	**0.0288**	0.2940	2.66%	**3.20%**	32.67%
	Uranium-235	**NA**	0.0000	**0.0000**	0.0160	NA	**NA**	NA
	Uranium-238	**0.6000**	0.0002	**0.0019**	0.8750	0.03%	**0.32%**	145.83%
					Mean	**8.29%**	**22.82%**	**789.37%**

1) Simulation period is 1986 through 1992 (7 years).
2) Observed COC concentrations are composite values from OU5 field sampling data.
3) Simulation source-terms were calculated with the SID in-place.

Table 5-26
Comparison of Observed and Simulated Calibration Results for Pond C-1 and Woman Creek Bottom-Sediment Quality[1)]

	Constituents (COCs)	Observed COC Concentrations [2)]	7-Year Simulation Results [3)]	30-Year Extrapolated Results [3)]	SID Inclusion Ratio [4)]	30-Year Simulated Results [3)]	7-Year, w/ SID, results as % of observed	30-Year, w/o SID, results as % of observed
Group 1 (mg/Kg)	Reach 5							
	Barium	NA	9.800	41.993	1.850	77.687	NA	NA
	Lithium	NA	0.680	2.914	1.860	5.420	NA	NA
	Strontium	NA	0.017	0.073	1.800	0.131	NA	NA
Group 2 (mg/Kg)	Reach 5							
	Copper	0.2430	0.865	3.707	2.077	7.698	355.97%	3168.09%
	Mercury	1.3310	NA	NA	NA	NA	NA	NA
	Zinc	0.7590	4.160	17.826	1.800	32.086	548.09%	4227.42%
	Reach 4							
	Copper	14.5000	0.955	4.092	2.077	8.499	6.59%	58.62%
	Mercury	0.1000	NA	NA	NA	NA	NA	NA
	Zinc	44.2000	4.470	19.154	1.800	34.477	10.11%	78.00%
	Reach 3							
	Copper	9.3900	1.256	5.382	2.077	11.178	13.38%	119.05%
	Mercury	0.1100	NA	NA	NA	NA	NA	NA
	Zinc	35.0000	5.660	24.253	1.800	43.656	16.17%	124.73%
Group 3 (pCi/gm)	Reach 5							
	Americium-241	0.1030	0.0000	0.0001	1.7650	0.0002	0.02%	0.15%
	Plutonium-239/240	0.6840	0.0001	0.0003	1.9180	0.0005	0.01%	0.07%
	Reach 4							
	Americium-241	0.0080	0.0003	0.0015	1.7650	0.0026	4.25%	32.14%
	Plutonium-239/240	0.0390	0.0015	0.0064	1.9180	0.0123	3.85%	31.61%
	Reach 3							
	Americium-241	0.0061	0.0002	0.0010	1.7650	0.0018	3.93%	29.76%
	Plutonium-239/240	0.0071	0.0013	0.0056	1.9180	0.0107	18.31%	150.48%
Group 4 (pCi/gm)	Reach 5							
	Uranium-233/234	2.0890	0.260	1.114	6.771	7.544	12.45%	361.11%
	Uranium-235	0.0920	0.010	0.043	24.362	1.044	10.87%	1134.69%
	Uranium-238	1.7620	0.380	1.628	23.919	38.947	21.57%	2210.40%
						Mean	68.37%	781.75%

1) Simulation period is 1986 through 1992 (7 years).
2) Observed COC concentrations are composite values from OU5 field sampling data.
3) Simulation source-terms were calculated with the SID in-place.
4) Indicates the increased concentration of each COC when the area north of the SID is included.

Table 5-27A
Statistical Summary of Group 1, 30-Year Simulation
Water-Column Quality

Reach 5

	Barium (mg/L)		Lithium (mg/L)		Strontium (mg/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	0.234	0.118	0.031	0.010	0.082	0.020
Standard Error	0.009	0.007	0.002	0.001	0.005	0.002
Median	0.226	0.113	0.029	0.009	0.079	0.018
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	0.050	0.036	0.010	0.003	0.024	0.012
Sample Variance	0.002	0.001	0.0001	0.00001	0.001	0.0001
Kurtosis	2.01	3.07	1.29	3.35	0.123	3.05
Skewness	1.26	1.49	1.26	1.65	0.561	1.42
Range	0.220	0.170	0.042	0.016	0.104	0.057
Minimum	0.162	0.063	0.018	0.005	0.044	0.003
Maximum	0.383	0.233	0.059	0.021	0.148	0.060
Sum	6.79	3.43	0.892	0.278	2.39	0.577
Count	29	29	29	29	29	29
Confidence Level (95%)	0.018	0.013	0.004	0.001	0.009	0.004

Reach 6

	Barium (mg/L)		Lithium (mg/L)		Strontium (mg/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	0.719	0.009	0.119	0.001	0.143	0.002
Standard Error	0.164	0.001	0.027	0.0001	0.056	0.0002
Median	0.498	0.008	0.085	0.001	0.056	0.001
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	0.884	0.003	0.145	0.0003	0.302	0.001
Sample Variance	0.782	0.00001	0.021	0.00000	0.091	0.00000
Kurtosis	17.8	3.14	11.7	3.53	25.6	3.84
Skewness	3.92	1.59	3.19	1.73	4.94	1.56
Range	4.74	0.014	0.719	0.001	1.66	0.005
Minimum	0.103	0.005	0.013	0.0003	0.013	0.0002
Maximum	4.84	0.018	0.732	0.002	1.67	0.005
Sum	20.9	0.264	3.45	0.021	4.14	0.048
Count	29	29	29	29	29	29
Confidence Level (95%)	0.322	0.001	0.053	0.0001	0.110	0.0004

Table 5-27A
Statistical Summary of Group 1, 30-Year Simulation
Water-Column Quality

Reach 3

	Barium (mg/L)		Lithium (mg/L)		Strontium (mg/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	0.0001	0	0.000008	0	0.0001	0
Standard Error	0.000004	0	0.000000	0	0.000007	0
Median	0.0001	0	0.000009	0	0.0001	0
Mode	n/a	0	n/a	0	n/a	0
Standard Deviation	0.0000	0	0.000002	0	0.00004	0
Sample Variance	0.000000	0	0.000000	0	0.000000	0
Kurtosis	-0.687	n/a	-0.686	n/a	0.591	n/a
Skewness	-0.565	n/a	-0.564	n/a	0.366	n/a
Range	0.0001	0	0.000005	0	0.0002	0
Minimum	0.0001	0	0.000005	0	0.00006	0
Maximum	0.0002	0	0.00001	0	0.0002	0
Sum	0.003	0	0.0002	0	0.004	0
Count	29	29	29	29	29	29
Confidence Level (95%)	0.000008	n/a	0.000001	n/a	0.00001	n/a

Reach 4

	Barium (mg/L)		Lithium (mg/L)		Strontium (mg/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	0.00003	0	0.000002	0	0.00005	0
Standard Error	0.000001	0	0.000000	0	0.000003	0
Median	0.00003	0	0.000002	0	0.00005	0
Mode	n/a	0	n/a	0	n/a	0
Standard Deviation	0.000006	0	0.000000	0	0.00001	0
Sample Variance	0.000000	0	0.000000	0	0.000000	0
Kurtosis	-0.244	n/a	-0.236	n/a	1.38	n/a
Skewness	-0.065	n/a	-0.059	n/a	0.848	n/a
Range	0.00002	0	0.000002	0	0.00007	0
Minimum	0.00002	0	0.000001	0	0.00002	0
Maximum	0.00004	0	0.000003	0	0.00009	0
Sum	0.001	0	0.00006	0	0.001	0
Count	29	29	29	29	29	29
Confidence Level (95%)	0.000002	n/a	0.000000	n/a	0.000005	n/a

Table 5-27B

Statistical Summary of Group 1, 30-Year Simulation

Sediment-Associated Quality

Reach 3

	Barium (mg/KG)		Lithium (mg/KG)		Strontium (mg/KG)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	17.3	17.6	1.22	1.25	1.27	1.06
Standard Error	0.125	0.113	0.009	0.008	0.051	0.048
Median	17.4	17.7	1.2	1.3	1.2	1.1
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	0.674	0.610	0.048	0.043	0.275	0.261
Sample Variance	0.455	0.372	0.002	0.002	0.076	0.068
Kurtosis	-1.0	-0.719	-1.0	-0.710	-0.031	0.028
Skewness	-0.065	-0.234	-0.065	-0.238	0.777	0.073
Range	2.4	2.2	0.167	0.157	0.997	1.1
Minimum	16.2	16.6	1.1	1.2	0.883	0.500
Maximum	18.5	18.8	1.3	1.3	1.9	1.6
Sum	501	511	35.4	36.1	36.9	30.8
Count	29	29	29	29	29	29
Confidence Level (95%)	0.245	0.222	0.017	0.016	0.100	0.095

Reach 4

	Barium (mg/KG)		Lithium (mg/KG)		Strontium (mg/KG)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	14.1	14.4	0.999	1.02	1.50	1.40
Standard Error	0.118	0.100	0.008	0.007	0.042	0.045
Median	14.2	14.4	1.00	1.02	1.47	1.40
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	0.637	0.537	0.045	0.038	0.224	0.242
Sample Variance	0.405	0.289	0.002	0.001	0.050	0.058
Kurtosis	-0.144	-0.672	-0.156	-0.678	-0.039	0.049
Skewness	-0.081	-0.148	-0.081	-0.138	0.602	-0.072
Range	2.64	1.95	0.187	0.137	0.865	1.02
Minimum	12.6	13.4	0.894	0.948	1.14	0.884
Maximum	15.3	15.3	1.08	1.09	2.01	1.90
Sum	410	419	29.0	29.6	43.6	40.7
Count	29	29	29	29	29	29
Confidence Level (95%)	0.232	0.196	0.016	0.014	0.081	0.088

Table 5-27B
Statistical Summary of Group 1, 30-Year Simulation
Sediment-Associated Quality

Reach 5

	Barium (mg/KG)		Lithium (mg/KG)		Strontium (mg/KG)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	15.4	15.7	0.699	0.684	0.091	0.026
Standard Error	0.281	0.343	0.009	0.012	0.005	0.003
Median	15.0	15.1	0.699	0.678	0.085	0.023
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	1.51	1.85	0.046	0.063	0.026	0.016
Sample Variance	2.29	3.42	0.002	0.004	0.001	0.000
Kurtosis	2.62	3.68	-1.05	-0.065	0.336	3.41
Skewness	1.40	1.72	-0.031	0.016	0.588	1.48
Range	7.07	8.80	0.170	0.270	0.114	0.079
Minimum	13.2	13.2	0.612	0.541	0.049	0.003
Maximum	20.3	22.0	0.783	0.811	0.163	0.082
Sum	448	456	20.3	19.8	2.64	0.756
Count	29	29	29	29	29	29
Confidence Level (95%)	0.550	0.673	0.017	0.023	0.010	0.006

Reach 6

	Barium (mg/KG)		Lithium (mg/KG)		Strontium (mg/KG)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	9.82	9.90	0.693	0.698	0.547	0.426
Standard Error	0.075	0.065	0.005	0.005	0.022	0.016
Median	9.90	9.97	0.699	0.704	0.510	0.419
Mode	n/a	10.0	n/a	n/a	n/a	n/a
Standard Deviation	0.402	0.348	0.029	0.025	0.118	0.087
Sample Variance	0.162	0.121	0.001	0.001	0.014	0.008
Kurtosis	-0.078	-0.045	-0.024	0.007	-0.977	0.859
Skewness	-0.799	-0.410	-0.825	-0.431	0.450	0.862
Range	1.40	1.42	0.103	0.102	0.394	0.351
Minimum	8.93	9.07	0.627	0.639	0.378	0.295
Maximum	10.3	10.5	0.730	0.742	0.771	0.646
Sum	285	287	20.1	20.2	15.9	12.4
Count	29	29	29	29	29	29
Confidence Level (95%)	0.146	0.127	0.011	0.009	0.043	0.032

Table 5-28A
Statistical Summary of Group 2, 30-Year Simulation
Water-Column Quality

Reach 3

	Copper (ug/L)		Mercury (ug/L)		Zinc (ug/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	0.088	0	0.000000	0	0.00005	0
Standard Error	0.004	0	0.000000	0	0.00000	0
Median	0.088	0	0.000000	0	0.00005	0
Mode	n/a	0	n/a	0	n/a	0
Standard Deviation	0.022	0	0.000000	0	0.000009	0
Sample Variance	0.0005	0	0.000000	0	0.000000	0
Kurtosis	-0.274	n/a	-0.701	n/a	-0.675	n/a
Skewness	0.685	n/a	-0.577	n/a	-0.574	n/a
Range	0.075	0	0.000000	0	0.00003	0
Minimum	0.056	0	0.000000	0	0.00003	0
Maximum	0.131	0	0.000000	0	0.00006	0
Sum	2.54	0	0.000002	0	0.001	0
Count	29	29	29	29	29	29
Confidence Level (95%)	0.008	n/a	0.000000	n/a	0.000003	n/a

Reach 4

	Copper (ug/L)		Mercury (ug/L)		Zinc (ug/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	0.028	0	0.000000	0	0.00001	0
Standard Error	0.001	0	0.000000	0	0.000000	0
Median	0.027	0	0.000000	0	0.00001	0
Mode	n/a	0	n/a	0	n/a	0
Standard Deviation	0.007	0	0.000000	0	0.000002	0
Sample Variance	0.00005	0	0.000000	0	0.000000	0
Kurtosis	-0.481	n/a	-0.106	n/a	0.024	n/a
Skewness	0.626	n/a	-0.077	n/a	-0.014	n/a
Range	0.024	0	0.000000	0	0.000009	0
Minimum	0.017	0	0.000000	0	0.000006	0
Maximum	0.041	0	0.000000	0	0.00002	0
Sum	0.801	0	0.000000	0	0.000303	0
Count	29	29	29	29	29	29
Confidence Level (95%)	0.003	n/a	0.000000	n/a	0.000001	n/a

Table 5-28A
Statistical Summary of Group 2, 30-Year Simulation
Water-Column Quality

Reach 5

	Copper (ug/L)		Mercury (ug/L)		Zinc (ug/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	25.1	9.17	0.00006	0.00002	0.048	0.016
Standard Error	1.75	0.651	0.00000	0.00000	0.003	0.001
Median	25.3	9.18	0.00005	0.00002	0.044	0.015
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	9.40	3.51	0.00002	0.00001	0.017	0.006
Sample Variance	88.3	12.3	0.00000	0.00000	0.0003	0.00004
Kurtosis	0.387	0.428	2.67	4.94	2.52	4.74
Skewness	0.404	0.275	1.53	1.96	1.50	1.92
Range	40.2	15.5	0.00009	0.00004	0.075	0.031
Minimum	8.83	2.60	0.00003	0.00001	0.027	0.007
Maximum	49.0	18.1	0.00012	0.00005	0.102	0.038
Sum	728	266	0.002	0.001	1.40	0.451
Count	29	29	29	29	29	29
Confidence Level (95%)	3.42	1.28	0.00001	0.00000	0.006	0.002

Reach 6

	Copper (ug/L)		Mercury (ug/L)		Zinc (ug/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	82.6	0.688	0.000	0.000	0.174	0.001
Standard Error	15.3	0.049	0.000	0.000	0.037	0.000
Median	65.4	0.696	0.000	0.000	0.134	0.001
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	82.6	0.266	0.0002	0.0000	0.198	0.001
Sample Variance	6,823	0.071	0.0000	0.0000	0.039	0.000
Kurtosis	12.5	0.333	11.0	4.79	10.8	4.54
Skewness	3.14	0.296	3.08	1.95	3.06	1.90
Range	428	1.15	0.001	0.000	0.980	0.002
Minimum	11.3	0.203	0.00002	0.00000	0.018	0.001
Maximum	439	1.35	0.001	0.000	0.998	0.003
Sum	2,394	20.0	0.006	0.000	5.03	0.035
Count	29	29	29	29	29	29
Confidence Level (95%)	30.1	0.097	0.0001	0.00000	0.072	0.0002

Table 5-28B
Statistical Summary of Group 2, 30-Year Simulation
Sediment-Associated Quality

Reach 3

	Coppper (mg/KG)		Mercury (mg/KG)		Zinc (mg/KG)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	101,010	91,483	0.004	0.004	3.43	3.88
Standard Error	1,549	1,667	0.000	0.000	0.087	0.097
Median	101,574	92,800	0.004	0.005	3.40	3.96
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	8,339	8,977	0.001	0.001	0.469	0.522
Sample Variance	69,546,829	80,592,166	0.000	0.000	0.220	0.272
Kurtosis	-0.30	-1.23	-0.357	-1.12	-0.146	-1.17
Skewness	-0.19	-0.20	0.023	-0.036	-0.065	-0.151
Range	33,123	28,216	0.002	0.002	1.90	1.85
Minimum	84,959	76,084	0.003	0.003	2.43	3.01
Maximum	118,083	104,300	0.005	0.006	4.33	4.86
Sum	2,929,281	2,652,994	0.115	0.130	99.4	112
Count	29	29	29	29	29	29
Confidence Level (95%)	3,035	3,267	0.0002	0.0002	0.171	0.190

Reach 4

	Coppper (mg/KG)		Mercury (mg/KG)		Zinc (mg/KG)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	16,227	13,915	0.004	0.004	3.39	3.67
Standard Error	326	236	0.0001	0.0001	0.051	0.059
Median	15,918	13,547	0.004	0.004	3.41	3.63
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	1,754	1,271	0.0004	0.0005	0.275	0.319
Sample Variance	3,075,998	1,614,545	0.0000	0.0000	0.075	0.102
Kurtosis	-0.963	1.77	-0.236	1.130	-0.410	1.13
Skewness	0.271	1.12	-0.183	-0.509	-0.249	-0.552
Range	6,576	5,828	0.002	0.002	1.04	1.53
Minimum	13,082	12,039	0.003	0.003	2.85	2.75
Maximum	19,658	17,867	0.005	0.005	3.89	4.27
Sum	470,593	403,546	0.112	0.121	98.4	106
Count	29	29	29	29	29	29
Confidence Level (95%)	638	462	0.0001	0.0002	0.100	0.116

Table 5-28B
Statistical Summary of Group 2, 30-Year Simulation
Sediment-Associated Quality

Reach 5

	Coppper (mg/KG)		Mercury (mg/KG)		Zinc (mg/KG)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	1,001	992	0.003	0.004	2.84	3.19
Standard Error	66.0	68.6	0.000	0.000	0.056	0.059
Median	986	968	0.003	0.004	2.77	3.16
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	355	370	0.000	0.001	0.301	0.316
Sample Variance	126,159	136,546	0.000	0.000	0.091	0.100
Kurtosis	-0.591	-0.115	0.655	-0.928	0.580	-0.663
Skewness	0.260	0.720	0.683	0.264	0.638	0.328
Range	1,307	1,315	0.002	0.002	1.32	1.19
Minimum	381	507	0.003	0.003	2.34	2.58
Maximum	1,688	1,822	0.005	0.005	3.66	3.77
Sum	29,039	28,760	0.101	0.113	82.3	92.4
Count	29	29	29	29	29	29
Confidence Level (95%)	129	134	0.0002	0.0002	0.110	0.115

Reach 6

	Coppper (mg/KG)		Mercury (mg/KG)		Zinc (mg/KG)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	11,242	8,338	0.002	0.002	1.82	2.02
Standard Error	283	287	0.0000	0.0001	0.033	0.032
Median	11,627	8,115	0.002	0.002	1.85	2.00
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	1,524	1,546	0.0003	0.0003	0.176	0.170
Sample Variance	2,322,356	2,391,057	0.0000	0.0000	0.031	0.029
Kurtosis	-0.411	20.4	-0.826	-0.821	-0.550	-0.686
Skewness	-0.335	4.19	0.178	0.143	0.123	0.168
Range	5,901	8,800	0.001	0.001	0.698	0.660
Minimum	7,933	6,973	0.001	0.001	1.51	1.69
Maximum	13,834	15,773	0.002	0.002	2.21	2.35
Sum	326,025	241,801	0.051	0.055	52.7	58.5
Count	29	29	29	29	29	29
Confidence Level (95%)	555	563	0.0001	0.0001	0.064	0.062

Table 5-29A
Statistical Summary of Group 3, 30-Year Simulation
Water-Column Quality

Reach 3

	Am241 (pCi/L)		Pu239/240 (pCi/L)	
	mean	*median*	*mean*	*median*
Mean	0.0002	0	0.00004	0
Standard Error	0.0000	0	0.00000	0
Median	0.0002	0	0.00004	0
Mode	n/a	0	n/a	0
Standard Deviation	0.00005	0	0.00001	0
Sample Variance	0.00000	0	0.00000	0
Kurtosis	-0.308	n/a	-0.658	n/a
Skewness	0.684	n/a	-0.573	n/a
Range	0.0002	0	0.00002	0
Minimum	0.0001	0	0.00002	0
Maximum	0.0003	0	0.00005	0
Sum	0.006	0	0.001	0
Count	29	29	29	29
Confidence Level (95%)	0.00002	n/a	0.00000	n/a

Reach 4

	Am241 (pCi/L)		Pu239/240 (pCi/L)	
	mean	*median*	*mean*	*median*
Mean	0.00004	0	0.000009	0
Standard Error	0.00000	0	0.000000	0
Median	0.00004	0	0.000009	0
Mode	n/a	0	n/a	0
Standard Deviation	0.00001	0	0.000002	0
Sample Variance	0.00000	0	0.000000	0
Kurtosis	-0.353	n/a	-0.217	n/a
Skewness	0.633	n/a	-0.156	n/a
Range	0.00004	0	0.000008	0
Minimum	0.00003	0	0.000005	0
Maximum	0.00007	0	0.00001	0
Sum	0.001	0	0.0003	0
Count	29	29	29	29
Confidence Level (95%)	0.000004	n/a	0.000001	n/a

Table 5-29A
Statistical Summary of Group 3, 30-Year Simulation
Water-Column Quality

Reach 5

	Am241 (pCi/L)		Pu239/240 (pCi/L)	
	mean	*median*	*mean*	*median*
Mean	0.134	0.047	0.005	0.002
Standard Error	0.002	0.001	0.000	0.000
Median	0.134	0.046	0.005	0.002
Mode	n/a	n/a	n/a	n/a
Standard Deviation	0.010	0.003	0.002	0.001
Sample Variance	0.000	0.000	0.000	0.000
Kurtosis	0.190	-0.121	3.31	8.79
Skewness	0.087	0.074	1.70	2.70
Range	0.042	0.013	0.009	0.004
Minimum	0.113	0.040	0.003	0.001
Maximum	0.155	0.053	0.012	0.005
Sum	3.88	1.35	0.159	0.050
Count	29	29	29	29
Confidence Level (95%)	0.004	0.001	0.001	0.000

Reach 6

	Am241 (pCi/L)		Pu239/240 (pCi/L)	
	mean	*median*	*mean*	*median*
Mean	0.519	0.004	0.020	0.000
Standard Error	0.119	0.000	0.004	0.000
Median	0.360	0.004	0.015	0.000
Mode	n/a	n/a	n/a	n/a
Standard Deviation	0.640	0.000	0.022	0.000
Sample Variance	0.409	0.0000	0.0005	0.0000
Kurtosis	18.7	0.145	10.2	8.87
Skewness	4.05	0.110	2.97	2.73
Range	3.47	0.001	0.106	0.000
Minimum	0.068	0.003	0.002	0.000
Maximum	3.54	0.004	0.108	0.000
Sum	15.0	0.104	0.568	0.004
Count	29	29	29	29
Confidence Level (95%)	0.233	0.000	0.008	0.000

Table 5-29B
Statistical Summary of Group 3, 30-Year Simulation
Sediment-Associated Quality

Reach 3

	Am241 (pCi/g)		Pu239/240 (pCi/g)	
	mean	*median*	*mean*	*median*
Mean	0.184	0.167	0.003	0.003
Standard Error	0.003	0.003	0.000	0.000
Median	0.185	0.169	0.003	0.003
Mode	n/a	n/a	n/a	n/a
Standard Deviation	0.015	0.016	0.000	0.000
Sample Variance	0.000	0.000	0.000	0.000
Kurtosis	-0.299	-1.226	-0.041	-1.24
Skewness	-0.201	-0.200	-0.131	0
Range	0.060	0.051	0.002	0.001
Minimum	0.155	0.139	0.002	0.003
Maximum	0.215	0.190	0.004	0.004
Sum	5.34	4.85	0.083	0.094
Count	29	29	29	29
Confidence Level (95%)	0.005	0.006	0.000	0.000

Reach 4

	Am241 (pCi/g)		Pu239/240 (pCi/g)	
	mean	*median*	*mean*	*median*
Mean	0.012	0.010	0.003	0.004
Standard Error	0.000	0.000	0.000	0.000
Median	0.012	0.010	0.003	0.004
Mode	n/a	n/a	n/a	n/a
Standard Deviation	0.002	0.002	0.000	0.000
Sample Variance	0.000	0.000	0.000	0.000
Kurtosis	7.15	5.92	0.278	0.015
Skewness	2.02	1.97	-0.665	-0.392
Range	0.012	0.008	0.001	0.001
Minimum	0.009	0.009	0.003	0.003
Maximum	0.021	0.017	0.004	0.004
Sum	0.361	0.304	0.100	0.108
Count	29	29	29	29
Confidence Level (95%)	0.001	0.001	0.000	0.000

Table 5-29B
Statistical Summary of Group 3, 30-Year Simulation
Sediment-Associated Quality

Reach 5

	Am241 (pCi/g)		Pu239/240 (pCi/g)	
	mean	*median*	*mean*	*median*
Mean	0.150	0.132	0.003	0.003
Standard Error	0.003	0.003	0.000	0.000
Median	0.151	0.134	0.003	0.003
Mode	n/a	n/a	n/a	n/a
Standard Deviation	0.015	0.014	0.0003	0.0003
Sample Variance	0.0002	0.0002	0.0000	0.0000
Kurtosis	0.107	-0.754	0.514	-0.840
Skewness	-0.549	-0.169	0.673	0.083
Range	0.064	0.051	0.001	0.001
Minimum	0.111	0.105	0.002	0.003
Maximum	0.174	0.156	0.003	0.004
Sum	4.35	3.82	0.079	0.088
Count	29	29	29	29
Confidence Level (95%)	0.006	0.005	0.0001	0.0001

Reach 6

	Am241 (pCi/g)		Pu239/240 (pCi/g)	
	mean	*median*	*mean*	*median*
Mean	0.135	0.100	0.002	0.002
Standard Error	0.003	0.004	0.000	0.000
Median	0.140	0.097	0.002	0.002
Mode	n/a	n/a	n/a	n/a
Standard Deviation	0.018	0.020	0.000	0.000
Sample Variance	0.000	0.000	0.000	0.000
Kurtosis	-0.413	21.526	-0.447	-0.534
Skewness	-0.332	4.354	0.175	0.076
Range	0.071	0.111	0.001	0.001
Minimum	0.095	0.084	0.001	0.002
Maximum	0.166	0.195	0.002	0.002
Sum	3.91	2.89	0.051	0.055
Count	29	29	29	29
Confidence Level (95%)	0.007	0.007	0.000	0.000

Table 5-30A
Statistical Summary of Group 4, 30-Year Simulation
Water-Column Quality

Reach 3

	U233/234 (pCi/L)		U235 (pCi/L)		U238 (pCi/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	0.010	0	0.002	0	0.104	0
Standard Error	0.0003	0	0.0001	0	0.004	0
Median	0.010	0	0.002	0	0.109	0
Mode	n/a	0	n/a	0	n/a	0
Standard Deviation	0.002	0	0.0004	0	0.019	0
Sample Variance	0.0000	0	0.0000	0	0.0004	0
Kurtosis	-0.734	n/a	-0.734	n/a	-0.734	n/a
Skewness	-0.555	n/a	-0.555	n/a	-0.555	n/a
Range	0.006	0	0.001	0	0.066	0
Minimum	0.006	0	0.001	0	0.065	0
Maximum	0.012	0	0.002	0	0.132	0
Sum	0.286	0	0.056	0	3.02	0
Count	29	29	29	29	29	29
Confidence Level (95%)	0.001	n/a	0.0001	n/a	0.007	n/a

Reach 4

	U233/234 (pCi/L)		U235 (pCi/L)		U238 (pCi/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	0.002	0	0.0003	0	0.019	0
Standard Error	0.000	0	0.0000	0	0.001	0
Median	0.002	0	0.0004	0	0.019	0
Mode	n/a	0	n/a	0	n/a	0
Standard Deviation	0.0004	0	0.0001	0	0.004	0
Sample Variance	0.00000	0	0.00000	0	0.00002	0
Kurtosis	-0.109	n/a	-0.110	n/a	-0.110	n/a
Skewness	-0.035	n/a	-0.036	n/a	-0.036	n/a
Range	0.002	0	0.0003	0	0.016	0
Minimum	0.001	0	0.0002	0	0.012	0
Maximum	0.003	0	0.0005	0	0.028	0
Sum	0.052	0	0.010	0	0.543	0
Count	29	29	29	29	29	29
Confidence Level (95%)	0.0001	n/a	0.00003	n/a	0.001	n/a

Table 5-30A
Statistical Summary of Group 4, 30-Year Simulation
Water-Column Quality

Reach 5

	U233/234 (pCi/L)		U235 (pCi/L)		U238 (pCi/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	3.91	1.38	0.260	0.080	13.6	4.26
Standard Error	0.082	0.026	0.018	0.006	0.976	0.368
Median	3.82	1.35	0.250	0.076	13.0	3.95
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	0.442	0.141	0.095	0.031	5.26	1.98
Sample Variance	0.195	0.020	0.009	0.001	27.6	3.94
Kurtosis	0.859	0.256	2.51	3.71	3.54	4.91
Skewness	1.11	0.520	1.49	1.59	1.69	1.99
Range	1.69	0.588	0.415	0.147	23.8	9.21
Minimum	3.37	1.12	0.141	0.035	7.44	2.05
Maximum	5.06	1.71	0.555	0.182	31.2	11.3
Sum	113	40.0	7.53	2.32	395	124
Count	29	29	29	29	29	29
Confidence Level (95%)	0.161	0.051	0.034	0.011	1.91	0.722

Reach 6

	U233/234 (pCi/L)		U235 (pCi/L)		U238 (pCi/L)	
	mean	*median*	*mean*	*median*	*mean*	*median*
Mean	14.6	0.104	0.938	0.006	49.3	0.322
Standard Error	3.09	0.002	0.197	0.000	10.5	0.029
Median	10.2	0.103	0.707	0.006	37.9	0.293
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	16.7	0.011	1.06	0.002	56.8	0.155
Sample Variance	278	0.0001	1.12	0.0000	3226	0.024
Kurtosis	16.8	1.57	9.50	3.86	11.1	5.33
Skewness	3.76	0.723	2.91	1.68	3.10	2.14
Range	89.3	0.052	5.10	0.012	281	0.734
Minimum	2.10	0.083	0.094	0.002	5.30	0.139
Maximum	91.4	0.135	5.20	0.014	287	0.873
Sum	424	3.02	27.2	0.176	1430	9.33
Count	29	29	29	29	29	29
Confidence Level (95%)	6.06	0.004	0.386	0.001	20.7	0.056

Table 5-30B
Statistical Summary of Group 4, 30-Year Simulation
Sediment-Associated Quality

Reach 3

	U233/234 (pCi/G)		U235 (pCi/G)		U238 (pCi/G)	
	mean	*median*	*mean*	*median*		
Mean	1.50	1.53	0.294	0.300	15.8	16.1
Standard Error	0.011	0.010	0.002	0.002	0.114	0.104
Median	1.51	1.54	0.296	0.302	15.9	16.2
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	0.058	0.053	0.011	0.010	0.615	0.560
Sample Variance	0.003	0.003	0.000	0.000	0.379	0.314
Kurtosis	-1.04	-0.726	-1.04	-0.73	-1.04	-0.726
Skewness	-0.063	-0.236	-0.063	-0.236	-0.063	-0.236
Range	0.204	0.193	0.040	0.038	2.15	2.03
Minimum	1.40	1.44	0.275	0.282	14.8	15.1
Maximum	1.61	1.63	0.315	0.320	16.9	17.2
Sum	43.4	44.3	8.53	8.70	458	467
Count	29	29	29	29	29	29
Confidence Level (95%)	0.021	0.019	0.004	0.004	0.224	0.204

Reach 4

	U233/234 (pCi/G)		U235 (pCi/G)		U238 (pCi/G)	
	mean	*median*	*mean*	*median*		
Mean	1.22	1.26	0.240	0.247	12.9	13.3
Standard Error	0.012	0.012	0.002	0.002	0.130	0.131
Median	1.23	1.27	0.242	0.249	13.0	13.3
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	0.067	0.067	0.013	0.013	0.701	0.706
Sample Variance	0.004	0.004	0.000	0.000	0.492	0.498
Kurtosis	-0.72	-0.066	-0.72	-0.07	-0.72	-0.066
Skewness	-0.033	0.054	-0.033	0.054	-0.033	0.054
Range	0.256	0.278	0.050	0.055	2.69	2.93
Minimum	1.10	1.13	0.215	0.222	11.6	11.9
Maximum	1.35	1.41	0.266	0.276	14.3	14.8
Sum	35.5	36.5	6.96	7.16	374	385
Count	29	29	29	29	29	29
Confidence Level (95%)	0.024	0.024	0.005	0.005	0.255	0.257

Table 5-30B
Statistical Summary of Group 4, 30-Year Simulation
Sediment-Associated Quality

Reach 5

	U233/234 (pCi/G)		U235 (pCi/G)		U238 (pCi/G)	
	mean	*median*	*mean*	*median*		
Mean	3.65	3.35	0.128	0.143	6.86	7.70
Standard Error	0.048	0.044	0.002	0.002	0.116	0.108
Median	3.69	3.37	0.128	0.145	6.86	7.77
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	0.260	0.234	0.012	0.011	0.627	0.583
Sample Variance	0.067	0.055	0.000	0.000	0.393	0.340
Kurtosis	-0.007	-0.689	0.594	-0.244	0.551	-0.264
Skewness	-0.548	-0.196	0.492	-0.254	0.482	-0.268
Range	1.06	0.848	0.052	0.045	2.77	2.39
Minimum	2.99	2.90	0.108	0.120	5.80	6.42
Maximum	4.06	3.75	0.160	0.164	8.57	8.81
Sum	106	97.0	3.71	4.16	199	223
Count	29	29	29	29	29	29
Confidence Level (95%)	0.094	0.085	0.004	0.004	0.228	0.212

Reach 6

	U233/234 (pCi/G)		U235 (pCi/G)		U238 (pCi/G)	
	mean	*median*	*mean*	*median*		
Mean	0.861	0.861	0.167	0.169	8.97	9.07
Standard Error	0.007	0.006	0.001	0.001	0.069	0.059
Median	0.866	0.869	0.169	0.170	9.05	9.11
Mode	n/a	n/a	n/a	n/a	n/a	n/a
Standard Deviation	0.037	0.030	0.007	0.006	0.369	0.319
Sample Variance	0.001	0.001	0.000	0.000	0.136	0.102
Kurtosis	0.016	-0.001	0.028	-0.024	0.028	-0.024
Skewness	-0.797	-0.432	-0.835	-0.425	-0.835	-0.424
Range	0.134	0.125	0.024	0.025	1.30	1.32
Minimum	0.775	0.790	0.152	0.155	8.14	8.32
Maximum	0.91	0.915	0.176	0.180	9.44	9.64
Sum	25.0	25.0	4.85	4.90	260	263
Count	29	29	29	29	29	29
Confidence Level (95%)	0.013	0.011	0.003	0.002	0.134	0.116

Table 5-31A

Fugitive Dust Model: OU 5 Area Sources for Radionuclides

Source number	x-coordinate of center (meters)	y-coordinate of center (meters)	x-dimension of rectangle (meters)	y-dimension of rectangle (meters)	height of emission (meters)	angle of rotation	No. of samples	Radionuclide levels (pCi/g) Am-241	Pu-239/240	U-233/234	U-235	U-238
1	24,958.40	14,569.32	142.28	97.45	0	-52.76	18	0.023	0.096	12.322	2.505	106.938
2	24,967.69	14,601.44	7.62	7.62	0	0	1	-0.19 (0)	-0.13 (0)	2,800	670	38,000
3	24,754.33	14,492.30	15.24	15.24	0	0	1	0.084	0.009	200	46	2,000
4	24,265.27	14,487.14	392.88	192.02	0	0	17-22	0.02	0.06	7.19	0.39	27.23
5	24,535.63	14,506.80	147.84	78.94	0	0	17-22	0.02	0.06	7.19	0.39	27.23

Source of sample results: DOE, 1994a; RFEDS

Table 5-31B

Fugitive Dust Model: OU 5 Area Sources for Organic Chemicals of Concern

Source number	x-coordinate of center (meters)	y-coordinate of center (meters)	x-dimension of rectangle (meters)	y-dimension of rectangle (meters)	height of emission (meters)	angle of rotation	No. of samples	Contaminant levels (ug/g) Arochlor-1254	Benzo(a) anthracene	Benzo(b) fuor-anthene	Benzo(a) pyrene
1	24925.23	14569.03	201.17	201.17	0	0	15-36	7.13E-01	6.75E-01	7.57E-01	5.20E-01
2	25009	14568	7.62	7.62	0	0	0-1	0	4.50E01	4.90E01	4.30E01
3	24917	14568	7.62	7.62	0	0	0-1	0	0	0	0
4	24887	14507	7.62	7.62	0	0	0-1	0	0	0	0
5	24398.17	14482.19	402.34	100.58	0	5.36	0-9	0	0	6.92E-03	8.28E-02

Source of sample results: DOE, 1994a; RFEDS

Table 5-31B (Continued)

Source number	x-coordinate of center (meters)	y-coordinate of center (meters)	x-dimension of rectangle (meters)	y-dimension of rectangle (meters)	height of emission (meters)	angle of rotation	No. of samples	Contaminant levels (ug/g) Dibenzo (a,h) anthracene	Fluor-anthene	Indeno (1,2,3-c,d) pyrene	Pyrene
1	24,925.23	14,569.03	201.17	201.17	0	0	15-36	2.71E-01	8.37E-01	3.00E-01	1.02E00
2	25,009	14,568	7.62	7.62	0	0	0-1	7.00E00	1.40E02	3.2E01	1.20E02
3	24,917	14,568	7.62	7.62	0	0	0-1	1.10E00	1.20E01	3.10E00	0
4	24,887	14,507	7.62	7.62	0	0	0-1	0	0	0	0
5	24,398.17	14,482.19	402.34	100.58	0	5.36	0-9	1.11E-02	8.10E-02	1.161E-02	9.40E-02

Source of sample results: DOE, 1994a; RFEDS

Table 5-31C

Fugitive Dust Model: OU 5 Area Sources for Metals Chemicals of Concern

Source number	x-coordinate of center (meters)	y-coordinate of center (meters)	x-dimension of rectangle (meters)	y-dimension of rectangle (meters)	height of emission (meters)	angle of rotation	No. of samples	Contaminant levels (mg/g)		
								Copper	Mercury	Silver
1	24925.23	14569.03	201.17	201.17	0	0	20-36	3.15E-02	1.32E-04	1.05E-03
2	25009	14568	7.62	7.62	0	0	0-1	0	0	0
3	24917	14568	7.62	7.62	0	0	0-1	0	0	0
4	24887	14507	7.62	7.62	0	0	0-1	0	0	1.26E-02
5	24398.17	14482.19	402.34	100.58	0	5.36	10	1.62E-02	7.10E-05	1.53E-03

Source of sample results: DOE, 1994a; RFEDS

Table 5-32

Fugitive Dust Model: OU 5 Source Input Parameters
Particle Size Distributions and Densities

Particle size class	Grain size distribution (Percent finer by weight)	Particle size distribution (Fraction within 100 çm range)	Particle density (g/cm ^{3})
≤10 çm	19	0.500	1.385
≤30 çm	28	0.237	
≤100 çm	38	0.263	

Source: DOE, 1994a

Table 5-33

Fugitive Dust Model: OU 5 Source Multipliers and Orders of Magnitude of Output Results

Radionuclide Constituent	Source multiplier	Order of magnitude of output results (pCi/m^3 for concentration; pCi/m^2-s for deposition)
Uranium-233/234	E+01	E-07
Uranium-235	E+01	E-07
Uranium-238	E-01	E-05
Organic Constituent	**Source multiplier**	**Order of magnitude of output results (ug/m^3 for concentration; ug/m^2-s for deposition)**
Aroclor-1254	E+03	E-09
Benzo(a)anthracene	E+03	E-09
Benzo(a)pyrene	E+03	E-09
Benzo(b)fluoranthene	E+03	E-09
Dibenzo(a,h)anthracene	E+03	E-09
Fluoranthene	E+03	E-09
Indeno(1,2,3-c,d)pyrene	E+03	E-09
Pyrene	E+03	E-09
Metal Constituent	**Source multiplier**	**Order of magnitude of output results (mg/m^3 for concentration; mg/m^2-s for deposition)**
Copper	E+03	E-09
Mercury	E+05	E-11
Silver	E+05	E-11

Table 5-34

Fugitive Dust Model: Determination of Card 14A Input Parameters for Americium-241

Wind erosion potential equation: $P(u) = 58(u^* - u^*_t)^2 - 25(u^* - u^*_t)$, where friction velocity, $u^* = 0.062$ x 10-m wind speed, u, threshold friction velocity, $u^*_t = 1.17$ m/s		Coefficients in wind erosion potential equation, P(u)		
		0.222952	-6.86464	50.1462
Divide coefficients in P(u) equation by 3,600 s/hr to obtain coefficients for hourly emission rate equation, E_{PM}		Coefficients in fugitive particulate matter emission rate equation, E_{PM}		
		6.19311E-05	-1.90684E-03	1.39295E-02
Multiply coefficients in E_{PM} equation by a selected multiplier (Table GM-5.5.5-3); for Am-241, 1.00E+04		Coefficients in fugitive particulate matter emission rate equation, E_{PM}		
		6.19311E-01	-1.90684E+01	1.39295E+02
Multiply coefficients in E_{PM} equation by constituent concentrations in soil		Coefficients in contaminant emission rate equation, $E_{contaminant}$ Card 14A coefficients		
Source number	Americium-241 concentration in soil (pCi/g)	G_1	G_2	G_3
1	2.30E-02	1.42442E-02	-4.38574E-01	3.20379E+00
2	0.00E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	8.40E-02	5.20221E-02	-1.60175E+00	1.17008E+01
4	2.00E-02	1.23862E-02	-3.81369E-01	2.78590E+00
5	2.00E-02	1.23862E-02	-3.81369E-01	2.78590E+00

Table 5-35A

Fugitive Dust Model: "Near Group" Receptors for Area Sources of Radionuclides

Receptor number	Description	x-coordinate (meters)	y-coordinate (meters)
1	East of Sources 1 & 2	25,040.30	14,666.03
2	East of Sources 1 & 2	25,040.30	14,635.55
3	East of Sources 1 & 2	25,040.30	14,605.07
4	East of Sources 1 & 2	25,040.30	14,574.59
5	East of Sources 1 & 2	25,040.30	14,544.11
6	East of Sources 1 & 2	25,040.30	14,513.63
7	East of Sources 1 & 2	25,040.30	14,483.15
8	East of Source 3	24,767.90	14,592.64
9	East of Source 4	24,461.94	14,576.85
10	East of Source 4	24,461.94	14,546.37
11	East of Source 4	24,461.94	14,515.89
12	East of Source 4	24,461.94	14,485.41
13	East of Source 4	24,461.94	14,454.93
14	East of Source 4	24,461.94	14,424.45
15	East of Source 4	24,461.94	14,393.97
16	East of Source 5	24,601.01	14,576.85
17	East of Source 5	24,601.01	14,546.37
18	East of Source 5	24,601.01	14,515.89
19	East of Source 5	24,601.01	14,485.41
20	East of Source 5	24,601.01	14,454.93
21	East of Source 5	24,601.01	14,424.45
22	East of Source 5	24,601.01	14,393.97
23	OU5 Sampler 102	23,781.61	14,580.18
24	OU5 Sampler 100	25,131.49	14,537.28
25	OU5 Sampler 101	24,642.66	14,489.62

Table 5-35B

Fugitive Dust Model: "Near Group" Receptors For Area Sources of Organic and Metal Constituents

Receptor number	Description	x-coordinate (meters)	y-coordinate (meters)
1	East of Sources 1,2,3&4	25,026.81	14,690.37
2	East of Sources 1,2,3&4	25,026.81	14,659.89
3	East of Sources 1,2,3&4	25,026.81	14,629.41
4	East of Sources 1,2,3&4	25,026.81	14,598.93
5	East of Sources 1,2,3&4	25,026.81	14,568.45
6	East of Sources 1,2,3&4	25,026.81	14,537.97
7	East of Sources 1,2,3&4	25,026.81	14,507.49
8	East of Sources 1,2,3&4	25,026.81	14,477.01
9	East of Sources 1,2,3&4	25,026.81	14,446.53
10	East of Source 5	24,603.15	14,572.82
11	East of Source 5	24,603.15	14,542.34
12	East of Source 5	24,603.15	14,511.86
13	East of Source 5	24,603.15	14,481.38
14	East of Source 5	24,603.15	14,450.90
15	East of Source 5	24,603.15	14,420.42

Table 5-35C

Fugitive Dust Model: OU 5 "Grid Group" Receptors

Receptor number	Description	x-coordinate (meters)	y-coordinate (meters)
1	Grid receptor	24,079	13,716
2	Grid receptor	24,079	14,021
3	Grid receptor	24,079	14,326
4	Grid receptor	24,384	13,716
5	Grid receptor	24,384	14,021
6	Grid receptor	24,384	14,326
7	Grid receptor	24,384	14,630
8	Grid receptor	24,689	13,716
9	Grid receptor	24,689	14,021
10	Grid receptor	24,689	14,326
11	Grid receptor	24,689	14,630
12	Grid receptor	24,994	13,716
13	Grid receptor	24,994	14,021
14	Grid receptor	24,994	14,326
15	Grid receptor	24,994	14,630
16	Grid receptor	25,298	13,716
17	Grid receptor	25,298	14,021
18	Grid receptor	25,298	14,326
19	Grid receptor	25,298	14,630
20	Grid receptor	25,603	13,716
21	Grid receptor	25,603	14,021
22	Grid receptor (maximum AOC3 receptor)	25,603	14,326
23	Grid receptor	25,908	13,716
24	Grid receptor	25,908	14,201
25	Grid receptor	25,908	14,326
26	Grid receptor	26,213	13,716
27	Grid receptor	26,213	14,201

Table 5-35C (Continued)

28	Grid receptor	26,213	14,326
29	Grid receptor	26,213	14,630
30	Grid receptor	26,518	14,021
31	Grid receptor	26,518	14,326
32	Grid receptor	26,518	14,630
33	Grid receptor	26,822	14,021
34	Grid receptor	26,822	14,326
35	Grid receptor	26,822	14,630
36	Grid receptor	27,127	14,326
37	Grid receptor	27,127	14,630
40	RAAMP sampler 13	25,039.05	14,700.44
41	RAAMP sampler 14	24,608.47	14,774.94
42	RAAMP sampler 23	25,611.67	14,536.11
43	RAAMP sampler 32	22,250	15,621
44	RAAMP sampler 38	28,624.85	13,949.07

Table 5-36

Comparison of OU 5 Ambient Air Data with Fugitive Dust Model Results

OU5 Sampler	Ambient data +/- error (pCi/m ^{3})	FDM value (pCi/m ^{3})
	Americium-241	
S102	1.80E-05+/-0.48E-05	0
S101	1.68E-05+/-0.56E-05	1.69E-07
S100	1.14E-05+/-0.37E-05	9.43E-09
	Plutonium-239/240	
S102	9.53E-07+/-7.04E-07	0
S101	1.27E-06+/-1.23E-06	5.34E-07
S100	0+/-7.19E-07	3.60E-08
	Uranium-233/234	
S102	5.50E-05+/-2.77E-05	0
S101	8.06E-05+/-2.75E-05	6.48E-05
S100	9.06E-05+/-3.02E-05	1.31E-05
	Uranium-235	
S102	2.98E-06+/-6.01E-06	0
S101	5.06E-06+/-6.67E-06	5.32E-06
S100	5.83E-06+/-6.74E-06	2.83E-06
	Uranium-238	
S102	5.95E-05+/-2.86E-05	0
S101	7.51E-05+/-2.59E-05	3.06E-04
S100	7.06E-05+/-2.58E-05	1.51E-04

Notes: See text Section 5.3.3.5 Verification. Ambient data represent the period December 30, 1992 through January 26, 1993. FDM values represent the period January 1, 1993 through January 31, 1993.

Table 5-37A

Fugitive Dust Model Results for Selected OU 5 Receptors
Maximum Annual (1990) Averages
Radionuclides

Receptor	Uranium-233/234	Uranium-235	Uranium-238
Maximum AOC1 exposure	6.56E-05	1.55E-05	8.78E-04
Maximum AOC2 exposure	6.05E-05	8.28E-06	3.58E-04
Maximum AOC3 exposure	3.65E-06	4.80E-07	2.52E-05

Receptor	Uranium-233/234	Uranium-235	Uranium-238
Maximum AOC1 exposure	4.45E-06	1.06E-06	5.98E-05
Maximum AOC2 exposure	4.54E-06	6.46E-07	2.79E-05
Maximum AOC3 exposure	1.57E-07	2.11E-08	1.11E-06

Note: Area of Concern 1 (AOC1) is IHSS 115, the old landfill. AOC2 is IHSS 133, the ash pits. AOC3 is Woman Creek drainage.

Table 5-37B

Fugitive Dust Model Results for Selected OU 5 Receptors
Maximum Annual (1990) Averages
Organic Chemicals of Concern

	Annual average ambient air concentration (ug/m ^{3})			
Receptor	Aroclor-1254	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(a)pyrene
Maximum AOC1 exposure	3.78E-06	1.74E-05	1.89E-05	1.60E-05
Maximum AOC2 exposure	0	0	4.00E-08	4.86E-07
Maximum AOC3 exposure	1.61E-07	1.65E-07	1.85E-07	1.41E-07

	Annual average deposition (ug/m ^{2}-s)			
Receptor	Aroclor-1254	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(a)pyrene
Maximum AOC1 exposure	2.82E-07	1.38E-06	1.05E-06	1.28E-06
Maximum AOC2 exposure	0	0	2.08E-09	3.51E-08
Maximum AOC3 exposure	7.41E-09	7.61E-09	8.54E-09	6.48E-09

Table 5-37B (Continued)

Receptor	Dibenzo(a,h)anthracene	Fluoranthene	Indeno(1,2,3-c,d)pyrene	Pyrene
	Annual average ambient air concentration (ug/m^3)			
Maximum AOC1 exposure	3.51E-06	4.82E-05	1.15E-05	4.27E-05
Maximum AOC2 exposure	6.50E-08	4.72E-07	9.45E-08	5.59E-07
Maximum AOC3 exposure	6.47E-08	2.43E-07	7.95E-08	2.77E-07
	Annual average deposition (ug/m^2-s)			
Receptor	Dibenzo(a,h)anthracene	Fluoranthene	Indeno(1,2,3-c,d)pyrene	Pyrene
Maximum AOC1 exposure	2.74E-07	3.87E-06	6.36E-07	3.42E-06
Maximum AOC2 exposure	4.68E-09	3.40E-08	4.90E-09	4.03E-08
Maximum AOC3 exposure	2.98E-09	1.12E-08	3.67E-09	1.28E-08

Note: Area of Concern 1 (AOC1) is IHSS 115, the old landfill. AOC2 is IHSS 133, the ash pits. AOC3 is Woman Creek drainage.

Table 5-37C

Fugitive Dust Model Results for Selected OU 5 Receptors
Maximum Annual (1990) Averages
Metal Chemicals of Concern

	Annual average ambient air concentration (mg/m^3)		
Receptor	Copper	Mercury	Silver
Maximum AOC1 exposure	1.70E-07	7.17E-12	5.74E-11
Maximum AOC2 exposure	9.57E-08	4.17E-12	0
Maximum AOC3 exposure	9.49E-09	4.03E-11	2.44E-10

	Annual average deposition (mg/m^2-s)		
Receptor	Copper	Mercury	Silver
Maximum AOC1 exposure	1.26E-08	5.3E-13	4.27E-12
Maximum AOC2 exposure	6.90E-09	3.0E-13	0
Maximum AOC3 exposure	4.29E-10	1.82E-12	1.12E-11

Note: Area of Concern 1 (AOC1) is IHSS 115, the old landfill.. AOC2 is IHSS 133, the ash pits. AOC3 is Woman Creek drainage.

Table 5-38A

Fugitive Dust Model Results for Selected OU 5 Receptors
Maximum 1990 24-Hour Averages
Radionuclides

Receptor	Uranium-233/234	Uranium-235	Uranium-238
Maximum AOC1 exposure	2.27E-02	5.41E-03	3.06E-01
Maximum AOC2 exposure	1.86E-02	2.58E-03	1.11E-01
Maximum AOC3 exposure	1.21E-03	1.65E-04	8.63E-03

Receptor	Uranium-233/234	Uranium-235	Uranium-238
Maximum AOC1 exposure	1.54E-03	3.68E-04	2.08E-02
Maximum AOC2 exposure	1.38E-03	1.99E-04	8.56E-03
Maximum AOC3 exposure	5.10E-05	7.14E-06	3.72E-04

Note: Area of Concern 1 (AOC1) is IHSS 115, the old landfill. AOC2 is IHSS 133, the ash pits. AOC3 is Woman Creek drainage.

Table 5-38B

Fugitive Dust Model Results for Selected OU 5 Receptors
Maximum 1990 24-Hour Averages
Organic Chemicals of Concern

	24-hour average ambient air concentration (ug/m^3)			
Receptor	Aroclor-1254	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(a)pyrene
Maximum AOC1 exposure	1.18E-03	5.01E-03	5.46E-03	4.60E-03
Maximum AOC2 exposure	0	0	1.26E-05	1.53E-04
Maximum AOC3 exposure	5.65E-05	5.79E-05	6.51E-05	4.92E-05

	24-hour average deposition (ug/m^2-s)			
Receptor	Aroclor-1254	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(a)pyrene
Maximum AOC1 exposure	8.73E-05	3.92E-04	2.96E-04	3.61E-04
Maximum AOC2 exposure	0	0	6.44E-07	1.09E-05
Maximum AOC3 exposure	2.57E-06	2.64E-06	2.97E-06	2.23E-06

Table 5-38B (Continued)

Receptor	Dibenzo(a,h)anthracene	Fluoranthene	Indeno(1,2,3-c,d)pyrene	Pyrene
	24-hour average ambient air concentration (ug/m^3)			
Maximum AOC1 exposure	1.03E-03	1.37E-02	3.28E-03	1.22E-02
Maximum AOC2 exposure	2.04E-05	1.49E-04	2.96E-05	1.75E-04
Maximum AOC3 exposure	2.27E-05	8.51E-05	2.79E-05	9.70E-05
	24-hour average deposition (ug/m^2-s)			
Receptor	Dibenzo(a,h)anthracene	Fluoranthene	Indeno(1,2,3-c,d)pyrene	Pyrene
Maximum AOC1 exposure	7.89E-05	1.09E-03	1.79E-04	9.62E-04
Maximum AOC2 exposure	1.46E-06	1.06E-05	1.51E-06	1.25E-05
Maximum AOC3 exposure	1.03E-06	3.88E-06	1.27E-06	4.41E-06

Note: Area of Concern 1 (AOC1) is IHSS 115, the old landfill. AOC2 is IHSS 133, the ash pits. AOC 3 is the Woman Creek drainage.

Table 5-38C

Fugitive Dust Model Results for Selected OU 5 Receptors
Maximum 1990 24-Hour Averages
Metal Chemicals of Concern

	24-hour average ambient air concentration (mg/m^3)		
Receptor	Copper	Mercury	Silver
Maximum AOC1 exposure	5.31E-05	2.23E-09	1.80E-08
Maximum AOC2 exposure	3.00E-05	1.31E-09	0
Maximum AOC3 exposure	3.25E-06	1.38E-08	8.66E-08

	24-hour average deposition (mg/m^2-s)		
Receptor	Copper	Mercury	Silver
Maximum AOC1 exposure	3.90E-06	1.64E-10	1.32E-09
Maximum AOC2 exposure	2.14E-06	9.35E-11	0
Maximum AOC3 exposure	1.45E-07	6.13E-10	3.90E-09

Note: Area of Concern 1 (AOC1) is IHSS 115, the old landfill. AOC2 is IHSS 133, the ash pits. AOC 3 is the Woman Creek drainage.

Table 5-39A

Fugitive Dust Model Results for Selected OU 5 Receptors
Maximum 1990 1-Hour Averages
Radionuclides

Receptor	Uranium-233/234	Uranium-235	Uranium-238
Maximum AOC1 exposure	1.78E-01	4.26E-02	2.41E00
Maximum AOC2 exposure	6.96E-02	9.51E-03	4.07E-01
Maximum AOC3 exposure	4.89E-03	7.93E-04	4.32E-02

Receptor	Uranium-233/234	Uranium-235	Uranium-238
Maximum AOC1 exposure	1.22E-02	2.92E-03	1.66E-01
Maximum AOC2 exposure	5.25E-03	7.49E-04	3.21E-02
Maximum AOC3 exposure	2.13E-04	3.63E-05	1.98E-03

Note: Area of Concern 1 (AOC1) is IHSS 115, the old landfill. AOC2 is IHSS 133, the ash pits. AOC3 is Woman Creek drainage.

Table 5-39B

Fugitive Dust Model Results for Selected OU 5 Receptors
Maximum 1990 1-Hour Averages
Organic Chemicals of Concern

	1-hour average ambient air concentration (ug/m^3)			
Receptor	Aroclor-1254	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(a)pyrene
Maximum AOC1 exposure	5.58E-03	2.18E-02	2.37E-02	2.02E-02
Maximum AOC2 exposure	0	0	4.73E-05	5.70E-04
Maximum AOC3 exposure	3.57E-04	3.94E-04	4.40E-04	3.14E-04

	1-hour average deposition (ug/m^2-s)			
Receptor	Aroclor-1254	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(a)pyrene
Maximum AOC1 exposure	4.35E-04	1.76E-03	1.35E-03	1.63E-03
Maximum AOC2 exposure	0	0	2.51E-06	4.16E-05
Maximum AOC3 exposure	1.65E-05	1.82E-05	2.03E-05	1.45E-05

Table 5-39B (Continued)

Receptor	1-hour average ambient air concentration (ug/m^3)			
	Dibenzo(a,h)anthracene	Fluoranthene	Indeno(1,2,3-c,d)pyrene	Pyrene
Maximum AOC1 exposure	4.28E-03	6.11E-02	1.45E-02	5.39E-02
Maximum AOC2 exposure	7.62E-05	5.55E-04	1.11E-04	6.50E-04
Maximum AOC3 exposure	1.45E-03	6.05E-04	1.93E-04	6.60E-04

Receptor	1-hour average deposition (ug/m^2-s)			
	Dibenzo(a,h)anthracene	Fluoranthene	Indeno(1,2,3-c,d)pyrene	Pyrene
Maximum AOC1 exposure	3.40E-04	4.99E-03	8.27E-04	4.39E-03
Maximum AOC2 exposure	5.56E-06	4.05E-05	5.88E-06	4.74E-05
Maximum AOC3 exposure	6.70E-06	2.80E-05.	8.91E-06	3.05E-05

Note: Area of Concern 1 (AOC1) is IHSS 115, the old landfill. AOC2 is IHSS 133, the ash pits. AOC 3 is the Woman Creek drainage.

Table 5-39C

Fugitive Dust Model Results for Selected OU 5 Receptors
Maximum 1990 1-Hour Averages
Metal Chemicals of Concern

	1-hour average ambient air concentration (mg/m^3)		
Receptor	Copper	Mercury	Silver
Maximum AOC1 exposure	2.46E-04	1.03E-08	8.24E-08
Maximum AOC2 exposure	1.12E-04	4.88E-09	0
Maximum AOC3 exposure	1.59E-05	6.70E-08	5.32E-07
	1-hour average deposition (mg/m^2-s)		
Receptor	Copper	Mercury	Silver
Maximum AOC1 exposure	1.92E-05	8.06E-10	6.42E-09
Maximum AOC2 exposure	8.15E-06	3.56E-10	0
Maximum AOC3 exposure	7.34E-07	3.08E-09	2.45E-08

Note: Area of Concern 1 (AOC1) is IHSS 115, the old landfill. AOC2 is IHSS 133, the ash pits. AOC 3 is the Woman Creek drainage.

Table 5-40

Indoor Air Model Input Data Requirements

Johnson-Ettinger Equations Symbol Building Characteristic	Units	Range of Values Commercial Office Building
Building size	m^2	557 (464-650)
Basement size	m^2	373 (311-436)
A_B = area of building basement floor and walls below grade	m^2	562 (483-639)
V = building volume	m^3	1,359 (1,113-1,586)
ACH = building air changes per hour	dimensionless	0.5 (0.04-1.5)
Q_{bldg} = building ventilation rate	m^3/hr	24,000 (680)
X_{crack} = total floor/wall seam perimeter distance	cm	7,730 (7,057-8,350)
Z_{crack} = depth of crack below surface	cm	244
r_{crack} = width of crack	cm	1.9
ΔP = building pressure difference relative to ambient pressure	Pa (10 g/cm-s ^{2})	1 (1-10)
k_v = soil permeability to vapor flow	darcy (10^{-8} cm^2)	10 (0.01-100)

Sources: DOE, 1994b; EPA, 1992a; Johnson and Ettinger, 1991; Nihiser, pers. comm. 1993

Table 5-41

Maximum Concentrations of VOCs Identified in the IHSS 115 Soil-Gas Survey

Constituent	Maximum Concentration (çg/L)
tetrachloroethene (PCE) (tetrachloroethylene, perchlorethylene)	7.6
1,1,1-trichloroethane (TCA)	13.0
trichloroethene (TCE) (trichloroethylene)	28.0

Source: DOE, 1994a

Table 5-42

Vapor Viscosities of VOCs Identified in IHSS 115 Soil-Gas Survey

Constituent	Vapor Viscosity (g/cm-s) at temperature
tetrachloroethene (PCE) (tetrachloroethylene, perchlorethylene)	0.01932 at 15°C 0.00798 at 30°C
1,1,1-trichloroethane (TCA)	0.00566 at 20°C 0.00532 at 25°C
trichloroethene (TCE) (trichloroethylene)	0.00903 at 15°C 0.00725 at 30°C

Source: Dean, 1992

Table 5-43

**Results of Indoor Air Modeling for
OU 5 Human Health Risk Assessment**

Constituent	Concentration in Basement Area (çg/m^3) Commercial Office Building
tetrachloroethene (PCE) (tetrachloroethylene, perchlorethylene)	0.018 (0.0056 - 0.25)
1,1,1-trichloroethane (TCA)	0.067 (0.021 - 0.92)
trichloroethene (TCE) (trichloroethylene)	0.23 (0.071 - 3.2)

6.0 HUMAN HEALTH RISK ASSESSMENT

The human health risk assessment (HHRA) for OU 5 is summarized in this section. The HHRA represents a portion of the BRA associated with the RFI/RI. This section presents the methodology and results of the HHRA.

6.1 INTRODUCTION

6.1.1 Purpose

The purpose of the OU 5 HHRA is to develop a quantitative description and assessment of the human health risks posed by the COCs at OU 5. This HHRA is incorporated in its entirety as part of the BRA for OU 5. The resulting analysis of the human health risks posed by OU 5 responds to and fulfills the requirements of Attachment 2, Section VII.D, Interagency Agreement. These agreements among the DOE, EPA and CDPHE require an analysis acceptable to both EPA and CDPHE. Pursuant to this requirement, the method of evaluation is consistent with the EPA RAGS (EPA, 1989).

6.1.2 Scope

This HHRA contains information pertinent to potential human health risks associated with OU 5. COCs are identified and an exposure assessment links the COCs to potentially exposed receptors through current or future land uses and the associated exposures. COC intakes are calculated, compared with EPA guidance, and potential health risks are estimated. Uncertainty analysis is then performed on the evaluations and results are documented.

6.1.3 Delineation of OU 5 Contaminant Source Areas

A source area is defined as an IHSS or group of IHSSs where concentrations or activities of potential chemicals of concern (PCOCs) in any medium exceed an upper-bound estimate of the background range. The upper-bound estimate of the background range for metals and radionuclides is defined as the background mean plus two standard deviations; all detected organics are considered to be above background levels.

Six OU 5 source areas were agreed to by EPA, CDPHE and DOE, and generally coincide with the OU 5 IHSSs, with the exception of IHSS 209. IHSS 209 is not considered a source area because only calcium exceeded the criterion of the mean plus two standard deviations. In addition, calcium is an essential nutrient with no ARARs available. The following six physical areas are largely determined by the extent of the potential contamination:

(1) IHSS 115/196 Source Area. This source area includes the area of IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Pond). It also includes the additional area of a small margin around IHSS 115 to include associated data points.

(2) IHSS 133 Source Area. This source area includes the area encompassing all of the 133 IHSSs. This includes the Ash Pits (IHSS 133.1, 133.2, 133.3, and 133.4), the Incinerator (IHSS 133.5), and the Concrete Wash Pad (IHSS 133.6).

(3) Surface Disturbance South of IHSS 133 Source Area. This source area is located approximately 1000 ft south of the ash pits (IHSS 133), and includes areas of former excavations and associated surface-soil sampling locations.

(4) SID and Pond C-2 Source Area. This source area includes the SID up to the Original Landfill (IHSS 115) boundary and the Pond C-2 (IHSS 142.11). The SID terminates into Pond C-2.

(5) Surface Disturbance West of IHSS 209 Source Area. This source area includes the Surface Disturbance area located approximately 1150 ft west of IHSS 209.

(6) Woman Creek and Pond C-1 Source Area. This source area includes Woman Creek to the west boundary of the OU 5 study area and Pond C-1 (IHSS 142.10) located along the Woman Creek drainage.

6.1.4 Determination of OU 5 Areas of Concern

AOCs are defined as one or several source areas that are in close proximity and can be evaluated as a unit in the HHRA. Of the six source areas identified in OU 5, the IHSS 115/196 Source Area and the IHSS 133 Source Area are generally physically separated and are treated individually as AOCs. The

SID and Pond C-2 Source Area and the Woman Creek and Pond C-1 Source Areas are interrelated and are treated together as one AOC.

The source area south of IHSS 133 did not exceed the CDPHE risk-based conservative screen criterion and, therefore, is not considered an AOC (DOE, 1994d). The source area west of IHSS 209 slightly exceeded the CDPHE conservative screen criterion due to plutonium-239/240 in one surface-soil sample. The remaining samples are significantly less than the risk-based concentration (RBC) and subsequent sampling was not able to reproduce the plutonium-239/240 concentration that exceeded the CDPHE conservative screen. Because the criterion was only slightly exceeded and due to a single sample of one PCOC, this source area is not identified as an AOC.

In summary, the OU 5 AOCs are shown in Figure 6-1 and are identified as:

- AOC1 is identical to the IHSS 115/196 Source Area.
- AOC2 is identical to the IHSS 133 Source Area.
- AOC3 contains the SID, Pond C-1, and Pond C-2, and Woman Creek Source Areas.

6.1.5 Section Organization

The HHRA identifies the OU 5 source areas and AOCs in Section 6.1, and is organized into the following seven major sections:

- Section 6.2 presents the COC methodology and its application in the identification and selection of COCs.
- Section 6.3 provides a description of how scenarios and pathways are identified and selected for quantitative analysis. It discusses each current and future land use and potential receptors that could be exposed to the COCs in the context of the land uses.
- Section 6.4 presents pathway-specific information such as intake equations, modeling data, exposure factors, concentrations terms, and resulting receptor intakes.

- Section 6.5 presents the COC toxicity information including carcinogenic and noncarcinogenic effects.

- Section 6.6 provides the methodology and application of combining the results of the exposure assessment and the toxicity assessment. It includes the numerical estimates by scenario and receptor of potential health effects, and the OU 5 uncertainty analysis.

- Section 6.7 presents an estimate of the total radiation doses for 1 year for receptors exposed to radionuclides by exposure pathways.

- Section 6.8 presents a summary of the entire HHRA.

6.2 CHEMICALS OF CONCERN IDENTIFICATION

The HHRA evaluates potential human health risks for applicable receptors under current and potential future land-use conditions, assuming no remedial action takes place at OU 5. COCs are metals or radionuclides whose concentration or activity statistically exceeds background concentrations or activities; and organic compounds that are not naturally occurring, but that could pose a human health risk under the assumed exposure conditions. COCs are identified on an OU-wide basis for each medium (e.g., groundwater and soil), through which exposure to chemicals could occur. The identification of COCs will also help focus the efforts of environmental transport modeling, description of the nature and extent of contamination, and remedy selection.

6.2.1 Selection Process for Chemicals of Concern

COCs are selected at OU 5 for surface soil, subsurface soil, groundwater, surface water, seep water, pond sediment, seep sediment, and stream sediment. These media were sampled during the Phase I RFI/RI, in accordance with the OU 5 Work Plan, as amended (DOE, 1992a). COCs are identified on an OU-wide basis, by pooling analytical results for samples collected from the various sampling locations for each medium.

The process for selection of COCs is shown in Figure 6-2 and includes the following elements:

- Evaluation of data
- Comparison to background concentrations
- Application of professional judgement
- Elimination of essential nutrients and major ions
- Evaluation of detection frequency
- Concentration/toxicity screen
- Evaluation of risk-based concentrations for infrequently detected analytes and identification of special-case COCs

6.2.2 Evaluation of Data

The preliminary step in the process for selection of COCs is the evaluation of analytical data for samples collected from each environmental medium. Analytical data from environmental samples collected during the OU 5 field sampling program and the sitewide sampling programs were used to characterize potential contamination at OU 5. The samples used in this evaluation were collected between October 1992 and November 1993; however, sampling was ongoing as data gaps were identified. The number of samples, sampling locations, and other features of the sampling and analytical program are discussed in the OU 5 Work Plan (DOE, 1992a), various TMs, and summarized in TM15
(DOE, 1994a). Samples were collected from the following media:

- Surface soil
- Subsurface soil
- Groundwater

- Seep water (or groundwater associated with seep)
- Pond sediment
- Seep sediment
- Stream sediment

The data set is described in Appendix A of TM11 (DOE, 1995a), and was used to determine the OU 5 PCOCs. These data are also described in Section 4.0. The COC selection process is intended to identify the chief environmental constituents in each medium that could have adverse impacts on public health. The risk assessment focuses on OU 5 constituents that are potentially significant health hazards. Inorganic constituents whose concentrations are below background levels or that are essential nutrients or major ions are excluded from the risk assessment. Organic constituents that would contribute insignificantly to overall risk are identified and discussed in TM11 (DOE, 1995a) but are not included in this quantitative risk assessment.

6.2.3 Comparison to Background Concentrations

The evaluation of analytical data for the development of PCOCs is presented in TM11 (DOE, 1995a). Analytical results for metals and radionuclides were compared to background levels derived from data for subsurface soils, groundwater, seeps/springs, and stream sediments reported in the BGCR (DOE, 1993a) and from background surface-soil samples collected in the Rock Creek area during the 1991 OU 1 Phase III investigation and the 1993 OU 2 Phase II investigation. Metals and radionuclides whose concentrations did not statistically exceed background levels were eliminated from further consideration as PCOCs.

TM11 presents the background comparison methodology in detail, and contains summary tables of statistical results for metals and radionuclides in all media. Organic constituents were assumed to be anthropogenic in origin and are not attributable to background; therefore, any organic constituent detected is initially considered a PCOC.

6.2.4 Application of Professional Judgment

The spatial and temporal distribution, and the pattern of geochemical characteristics of certain metals and radionuclides identified as being above background levels were carefully evaluated using professional judgement to support a conclusion as to whether these constituents were likely to be naturally occurring or due to environmental contamination. The evaluation and professional judgment are briefly described here and in more detail in TM11, which contains discussions of professional judgement as it was applied to each medium.

Based on the known histories of the OU 5 IHSSs, as well as the operational history of RFETS, none of the radionuclides identified as PCOCs are eliminated through this process. The primary radionuclides identified as PCOCs, americium-241, plutonium-239/240, and the uranium isotopes, are expected as site contaminants. Much of the spatial and temporal distribution and geochemical characteristics of certain metals in each of the environmental media applicable to OU 5 is based on the information presented in TM15 (DOE, 1994a).

6.2.5 Elimination of Essential Nutrients and Major Ions

Calcium, iron, magnesium, potassium, and sodium were eliminated from further consideration as COCs because these constituents are essential nutrients, occur naturally in the environment, and are toxic only at very high doses (EPA, 1994d). Anions in groundwater (other than nitrate) were not evaluated. The elimination of essential nutrients and major cations and anions is applied to all applicable media in OU 5.

6.2.6 Evaluation of Detection Frequency

PCOCs that were detected at a frequency of greater than 5 percent were considered potential OU-wide COCs. These chemicals were included in concentration/toxicity screens to identify chemicals that could contribute significantly to total risk. Analytes detected at or less than 5-percent frequency are not considered characteristic of OU-wide contamination and the potential for exposure is low. Maximum concentrations of infrequently detected organic constituents and metals were compared to risk-based concentrations (1000 X RBC) to identify isolated or highly localized occurrences of high concentrations (i.e., hot spots) that could pose a health risk if routine exposure were to occur as discussed in Section 6.2.8. Chemicals that exceeded the RBC comparison would have been retained as special-case COCs for evaluation in the risk assessment; however, none of the OU 5 PCOCs exceeded their respective threshold and therefore no special-case COCs were retained. Because DOE Order 5400.1 (DOE, 1990) stipulates the use of all data (except for rejected data) for radionuclides, negative values were used as reported and radionuclides were considered to be detected at 100-percent frequency.

6.2.7 Concentration/Toxicity Screen

COCs in each medium were selected using separate concentration/toxicity screens for noncarcinogens, nonradioactive carcinogens, and radionuclides. The screens included inorganics that were detected at concentrations or activities greater than background levels and at greater than 5-percent frequency, and organic chemicals that were detected at greater than 5-percent frequency. The purpose of applying the screen is to focus the risk assessment on the chief contributors to potential risk. To perform the screen, each PCOC in a medium is scored according to its maximum detected concentration and toxicity to obtain a risk factor. The risk factor for noncarcinogenic effects is the maximum detected concentration divided by the EPA reference dose (RfD) for that analyte. The risk factor for carcinogenic effects (including radionuclides) is the maximum detected concentration (or activity) multiplied by the EPA cancer slope factor (CSF) for that chemical (or radionuclide). The chemical-specific risk factors are summed to calculate total risk factors for the noncarcinogenic and carcinogenic (radioactive and nonradioactive) PCOCs in each medium. The ratio of the risk factor for each PCOC to the total risk factor is called a risk index; the risk index approximates the relative risk associated with each PCOC in the medium. Separate concentration/toxicity screens were performed for carcinogenic and noncarcinogenic effects of organic chemicals and metals and for carcinogenic effects of radionuclides. Several chemicals have both noncarcinogenic and carcinogenic effects and are included in both concentration/toxicity screens. The results of the concentration/toxicity screens are presented in Tables 6-1 through 6-20.

Each PCOC that comprised less than 1 percent of the total risk factor was not considered a COC for evaluation in the quantitative risk assessment. This approach reduces the number of chemicals to be carried through a risk assessment. However, the approach is conservative (i.e., health protective), because it retains some chemicals that contribute as little as 1 percent of the total potential risk in that medium. In most cases, only a few chemicals contribute the majority of potential risk in each medium.

TM11 (DOE, 1995a) identifies specific toxicity factors for each PCOC and how the factors were used to determine the OU 5 COCs. The toxicity factors that were used in TM11 (DOE, 1995a) were also used to estimate human health effects in the HHRA.

6.2.8 Evaluation of Risk-Based Concentrations for Infrequently Detected Analytes and Identification of Special-Case COCs

As discussed in Section 6.2.6, analytes detected infrequently (in less than 5 percent of all samples in the medium) are not considered characteristic of OU-wide contamination and the potential for exposure is low. These constituents were further screened to include any infrequently detected analyte that could contribute significantly to risk if routine exposure to a hot spot were to occur. In this analysis, maximum measured concentrations were compared to screening levels equivalent to 1000 times RBCs (DOE, 1995a). Any infrequently detected analyte measured at a concentration greater than 1000 times the respective RBC would have been identified as representing a potential health risk if exposure were to occur and included in the list of special-case COCs for evaluation in the HHRA. Tables 6-21 through 6-24 present the RBC comparisons. As shown by these tables, no special-case COCs were identified by the RBC comparisons. Table 6-25 presents a summary of OU 5 COCs by medium.

6.3 IDENTIFICATION OF SCENARIOS AND PATHWAYS

Potential exposure scenarios and pathways are identified using existing and potential future land uses. The RME is defined as the highest exposure that is reasonably expected to occur at a site according to the EPA concept of RME (EPA, 1989). The term "potential" is used as a reasonable chance of occurrence within the context of the RME scenario. Using this approach, potential exposure routes are evaluated using a CSM. In the CSM, exposure pathways are evaluated by their potential contribution to exposure and classified as significant, insignificant, and negligible or incomplete. Significant pathways are potentially complete pathways that involve relatively direct exposure or only moderately reduced concentrations due to contaminant fate and transport. Insignificant pathways are potentially complete pathways that are expected to result in exposure concentrations one or more orders of magnitude lower than significant exposure pathways. Negligible pathways are potentially complete pathways where either direct exposure is expected to be negligible or fate and transport is expected to reduce contaminant concentrations by several orders of magnitude or more in comparison to significant exposure pathways. Incomplete pathways are those where the exposure to the potential receptor is expected to be blocked or incomplete. Both significant and insignificant pathways will be evaluated quantitatively.

The following sections discuss current and future land uses, potential human receptors, and associated scenarios and pathways.

6.3.1 Current and Future Land Use

In general, current land use surrounding RFETS includes open space, agricultural, residential, office, gravel mining, and commercial/industrial. Table 6-26 summarizes the current patterns of land use at OU 5 and near RFETS, and identifies potential future land use. Future land-use scenarios are identified as improbable (scenarios that are unlikely to occur) or credible (scenarios that could reasonably occur or are expected to occur). Current and future land uses, both offsite and onsite (OU 5), are discussed in more detail in TM12 (DOE, 1995b).

Current activities within OU 5 consist of environmental investigations, monitoring, cleanup, and routine security surveillance. Operations and maintenance activities at RFETS are not conducted within OU 5. Future onsite residential and agricultural development is inconsistent with land use plans for the area (RFETS, 1995). Future land use would more likely involve industrial complexes at the developed portions of the RFETS and open-space uses in the buffer zone. The portions of OU 5 with suitable topography will also be evaluated further for construction and subsequent use of an office complex. Thus, onsite use of office facilities and designation of the buffer zone as an ecological preserve and/or open space were considered to be credible future land-use scenarios for OU 5 and are consistent with the recommendations of the Rocky Flats Future Site Use Working Group (RFETS, 1995).

6.3.2 Evaluation of Potential Human Receptors

Current and future human population groups on and near RFETS are potential candidates for evaluation (i.e., receptors), based on their likelihood of exposure to site-related COCs. EPA guidance does not require an exhaustive assessment of every potential receptor and exposure scenario (EPA, 1992e). Rather, the highest potential exposures that are reasonably expected to occur should be evaluated, along with an assessment of any associated uncertainty (EPA, 1989). All potential receptors have been identified and evaluated to ensure that important exposure pathways or receptors were not overlooked.

Potential human receptors on and near the OU 5 study area are current and future residents, current and future onsite workers, future onsite ecological researchers, and future open-space receptors (DOE, 1995b).

Current and future residents include OU 5 onsite and offsite residential receptors. The current and future offsite residential receptor potentially receives exposures of contaminants from RFETS and not just OU 5. As agreed to by the DOE, EPA, and CDPHE, the current and future offsite resident will not be evaluated in an OU-specific HHRA (except for the offsite OU) (DOE, 1995b), because OU 5 contributes only a portion of the potential exposures to this receptor. Rather, estimated risks to this receptor will be assessed in a sitewide risk assessment prior to the issuance of the final RFETS Record of Decision. Future onsite residential development is also inconsistent with future land-use plans (RFETS, 1995); therefore, a future onsite residential receptor will not be evaluated further in the OU 5 HHRA.

Current and future OU 5 onsite workers include current onsite security personnel, future office complex workers, and future construction workers. It is assumed that the current onsite security workers will continue to provide security services to the OU 5 study area and that most of the security work will continue to be performed from patrol vehicles. For the purposes of this HHRA, it is assumed that a security surveillance person spends one-half hour in OU 5 during each work day. Because some OU 5 locations may be suitable for an office complex, a future office worker and a future construction worker to build the complex will be evaluated in the OU 5 HHRA.

Because it is credible that the OU 5 study area may be preserved as an ecological reserve or as open space, a future onsite ecological researcher and a future onsite open-space receptor will be evaluated in the OU 5 HHRA.

A CSM (Figure 6-3) was used to evaluate potential exposure routes. The CSM documents each potential exposure by potential contribution to each human receptor. The exposure is classified as significant, insignificant, and negligible or incomplete.

6.3.3 Receptor Locations and Exposure Areas

For HHRAs conducted at RFETS, onsite exposures will be evaluated in separate AOCs identified in the OU. A discussion of the OU 5 AOCs is in Section 6.1.4, Determination of OU 5 Areas of Concern. Grids are typically placed over each AOC to define the areas in which a potential receptor can reasonably be expected to come in contact with COCs. Default grid sizes are 10 acres for a residential receptor, 30 acres for an industrial or office worker, and 50 acres for an ecological researcher or open-space recreational user. However, the largest AOC identified at OU 5 is AOC2 with 24.5 acres, and the chosen grid size should be appropriate for the potential receptors. Because a residential receptor is not appropriate, as discussed in Section 6.3.2, the next largest grid size is 30 acres which is larger than any of the three OU 5 AOCs. Therefore, all applicable receptors will be assessed on an AOC-wide basis. This results in calculating and using 95-percent, upper confidence limit (95% UCL) exposure concentrations on an AOC-wide basis, and using AOC-wide modeling results to calculate potential health effects for each applicable receptor in each AOC.

Using chemical sampling data and fate-and-transport modeling, as appropriate, the exposure-point concentrations and activities are used to quantitatively evaluate chemical intakes for potential receptors. Table 6-27 identifies current and future receptors and potentially complete pathways as associated with specific AOCs. Details regarding the selection of the five receptors and their associated pathways can be found in TM12 (DOE, 1995b).

6.4 EXPOSURE ASSESSMENT

Pathway-specific exposures or intakes are quantified through the use of intake equations, exposure parameters, and exposure concentrations. Intake equations are pathway-specific, whereas exposure parameters and exposure concentrations are both scenario-specific and pathway-specific. Depending on the pathway, exposure concentrations may be statistically derived directly from field investigation data, or may be modeled using fate-and-transport models or estimation techniques. This section first presents exposure concentrations and modeling, followed by exposure factors, intake equations, and then the resulting intakes.

6.4.1 Exposure Concentrations and Modeling

Where appropriate, measured chemical-specific concentrations in surface soil, subsurface soil, groundwater, seep water, and seep sediment were used to calculate 95% UCLs. The 95% UCL is an estimate of the average chemical concentration in an exposure area and is used instead of the mean to account for the uncertainty in calculating the true mean from a small data set. The method used to calculate 95% UCLs is consistent with the EPA guidance, Calculating the Concentration Term for Risk Assessment (EPA, 1994a). Concentrations of COCs suspended in air were estimated using an air dispersion model (Fugitive Dust Model) and are discussed in detail in Section 5.3.3. Groundwater and surface-water modeling are discussed in Section 5.3.1 and Section 5.3.2, respectively. Concentrations for each COC have been calculated separately for each of the three AOCs, and are used to calculate separate intakes. Tables 6-28 through 6-30 present chemical-specific concentrations in AOC1, AOC2, and AOC3 that were used to calculate OU 5 intakes.

Concentrations for each COC to be used in the risk assessment were calculated using the method consistent with the EPA Calculating the Concentration Term for Risk Assessment (EPA, 1994a). Where numerous groundwater and surface-water samples were taken at the same sampling location over a period of time, these concentrations were averaged and then the averages were used in the equations to calculate the respective 95% UCLs. Also, based on EPA guidance (EPA, 1992c), all UCLs were calculated assuming lognormal distributions of the data populations. The specific cases where this approach was not appropriate are discussed below.

The groundwater sample sizes in AOC1 were small, and wide variations in concentrations were noted. Therefore, the calculated 95% UCLs were not appropriate and maximum measured concentrations were conservatively used. Sample sizes for seep water and seep sediments in AOC1 were also small (two samples each) and not appropriate for calculating 95% UCLs; therefore, maximum concentrations were used.

Only one well in AOC2 was available for sampling groundwater, resulting in a small sample size. Therefore, calculating a 95% UCL was not appropriate and the maximum concentrations were used. Sample sizes for seep water and seep sediments in AOC2 were also small and were not appropriate for calculating 95% UCLs; therefore, maximum concentrations were used.

Two wells in AOC3 were available for sampling groundwater, resulting in a small sample size; therefore, calculating 95% UCLs was not appropriate, and maximum concentrations were used. Stream sediment samples of americium-241 and plutonium-239/240 were small, and therefore, the 95% UCL concentrations are not appropriate. For these two COCs in AOC3 stream sediment, the maximum concentrations were used.

6.4.2 Exposure Factors and Intake Equations

The Rocky Flats Site-Specific Exposure Factors for Quantitative Human Health Risk Assessment were used in the intake equations and are found in Appendix M. The appropriate exposure factors and chemical concentrations are incorporated into the intake equations (6-1) through (6-6) to calculate respective receptor COC intakes. Chemical intakes for exposure of future onsite office workers to VOC inhalation of basement air were not calculated because no VOCs were identified as COCs in either groundwater or subsurface-soil samples. The exposure factors presented in Appendix M for the current security worker are adjusted to reflect an assumed exposure time of one-half hour per day.

6.4.2.1 Incidental Ingestion of Soil, Sediment, and Dust

Receptor intakes may result from incidental ingestion of COCs in soil, sediment, and dust. The following equation is used to calculate the intake.

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times ME \times EF \times ED}{BW \times AT} \qquad (6\text{-}1)$$

where

CS	=	Chemical concentration in soil, sediment or dust (mg/kg or pCi/g)
IR	=	Ingestion rate (mg/day)
CF	=	Conversion factor (10^{-6} kg/mg)
ME	=	Matrix effect in GI tract (unitless)
FI	=	Fraction ingested from contaminated source (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days).

For calculation of radionuclide intakes, the concentration is expressed in pCi/g, and the expression is not divided by body weight and averaging time.

It should be noted that for all receptors, the EF for sediments is the same EF shown in Appendix M for surface water rather than for surface soil. It is assumed that sediment for ingestion is contacted as frequently as surface water for ingestion. The intake for radionuclides is expressed in pCi the EF.

<u>Age-Adjusted IRs</u> - Both child and adult soil and sediment ingestion rates were evaluated in the open-space-use exposure scenario. For noncarcinogens, child and adult soil ingestion were evaluated separately, using the equation shown above and parameter values listed in Appendix M. This approach yields separate hazard indices (HIs) for children and adults for the soil ingestion exposure route. The separate HI for children is a more protective estimate of potential noncarcinogenic hazard for this age group because it accounts for the greater amount of soil ingested by children relative to body weight.

For carcinogens, a combined child and adult weighted-ingestion rate was calculated, combining the soil IR, BW, EF, and ED for both age groups. It is not necessary to calculate separate cancer risk estimates for children and adults because, according to theories of carcinogenesis currently advocated by the EPA, a higher dose of a potential carcinogen over a short period of time is thought to have the same carcinogenic potential as a lower dose over a longer period of time. The calculation of age-adjusted soil ingestion rates for carcinogenic chemicals is shown in equation 6-1a.

$$IRadj = \frac{IRc \times EDc \times FCc}{BWc} + \frac{IRa \times EDa \times FCa}{BWa} \qquad (6\text{-}1a)$$

where

IRadj	=	Age and time-weighted soil or sediment ingestion rate (mg-years/day-kg)
IRc	=	Childhood soil ingestion rate (mg/day)
EDc	=	Childhood exposure duration (years)
FCc	=	Fraction ingested from contaminated source (child) (unitless)
BWc	=	Child body weight (kg)
IRa	=	Adult soil ingestion rate (mg/day)
EDa	=	Adult exposure duration (years)
FCa	=	Fraction ingested from contaminated source (adult) (unitless)
BWa	=	Adult body weight (kg)

Applying exposure factors from Appendix M for soil and sediment ingestion through open-space use yields weighted IRs of 9.2 mg-years/day-kg for CT and 57 mg-years/day-kg for RME. For radionuclides, BW is not included in the equation, yielding weighted IRs of 275 and 1800 mg-years/day for CT and RME, respectively.

Matrix Effect - This section presents the chemical-specific matrices for OU5 COCs for which toxicity factors were derived from studies and the agent was administered in solution. The soil matrix effect (ME) is used to account for decreased bioavailability of ingested compounds bound to a solid matrix relative to their bioavailability from drinking water or other solutions, such as corn oil.

As indicated in EPA guidance for risk assessment, adjustments of bioavailability may be necessary if "the medium of exposure in RFETS exposure assessment differs from the medium of exposure assumed by the toxicity value" (EPA, 1989). The EPA guidance further states that "a substance might be more completely absorbed following exposure to contaminated drinking water than following exposure to contaminated soil (e.g., if the substance does not desorb from soil in the gastrointestinal tract)." The ME is applied to COCs in soil and in sediment. The literature values for soil matrix effects shown in Table 6-31 are discussed in more detail below.

For OU 5 COCs in surface and subsurface soil or sediments whose toxicity factors were derived from studies in which the agent was administered in solution, a soil ME of 0.5 was used in calculating intake for risk assessment. Chemical-specific soil MEs for the following OU5 COCs are listed in

Table 6-32: antimony, Aroclor-1254, beryllium, fluoranthene, and pyrene. Several studies discussed in this section indicate that the decrease in bioavailability from the MEs of food and soil can be substantially greater than 50 percent (as much as 99 percent), indicating that an ME of 0.5 is conservative (Freeman et al., 1992; Cox et al., 1975; Sunagawa, 1981; Heard and Chamberlain, 1982; Sunderland et al., 1989; EPA, 1995).

There are several EPA precedents for assuming decreased bioavailability of inorganics from soil compared to that in water. For example, cadmium and manganese each have two oral RfDs, one for ingestion in food or other solid media, and one for ingestion in water. In deriving media-specific RfDs for cadmium, EPA assumed that 5 percent of cadmium ingested in water is bioavailable, compared to 2.5 percent for cadmium ingested in food (EPA, 1995). Cadmium has an oral RfD for ingestion (food) as seen in Table 6-31; therefore, no ME was needed for cadmium and the default ME of 1 was used. The RfD for manganese ingested in water is 28 times smaller than the RfD for manganese ingested in food (EPA, 1995). Although relative bioavailability of manganese in food and water is not discussed in IRIS, one explanation for a 28-fold decrease in toxicity of manganese ingested in food is an ME resulting in greatly decreased bioavailability. Another example of media-specific differences in toxicity is suggested by the EPA RfD for cyanide. In deriving the RfD for cyanide, based on a dietary study in rats, the EPA included a safety factor of 5 to protect for an expected increase in toxicity of cyanide ingested in water (EPA, 1995). The use of this safety factor implies that cyanide ingested in food is 0.2 times as toxic as cyanide ingested in water, corresponding to a matrix effect of 0.2. This ME is less than the conservative 0.5 ME used for those chemicals whose toxicity values were derived from studies in which the agent was administered in solution (Table 6-31).

The EPA does not discuss the ME of beryllium (an OU 5 COC) in IRIS (EPA, 1995). The IRIS file, however, presents an unpublished investigation by Cox et al., (1975) that indicates a much higher NOAEL of 25 mg/kg-day in the diet than that in the rat drinking-water study used to derive the RfD of 5.0E-03 mg/kg-day (NOAEL of 0.54 mg/kg bw-day) (Schroeder and Mitchner, 1975). The corresponding ME for beryllium is 0.02. This ME is much less than the conservative 0.5 ME used for those chemicals whose toxicity values were derived from studies in which the agent was administered in solution (Table 6-31).

Antimony, another OU 5 COC, has an RfD of 4.0E-04 mg/kg bw-day that was derived using a lowest observed adverse effect level (LOAEL) of 0.35 mg/kg bw-day from chromic drinking water study with rats (Schroeder et al., 1970). A LOAEL of 500 mg/kg was reported for rats fed metallic antimony for 24 weeks (Sunagawa, 1981). The resulting ME for antimony is 0.0007, which is much smaller than the conservative 0.5 ME used for those chemicals whose toxicity values were derived from studies in which the agent was administered in solution (Table 6-31).

Other evidence in the literature indicated that absolute absorption of inorganics ingested in food is less than that from water. Sixty percent of radiolabeled lead chloride administered to adult humans in water was bioavailable, compared to 3 percent for lead chloride ingested in food (Heard and Chamberlain, 1982). Similarly, nickel chloride administered to adult humans in food was much less bioavailable (0.7 percent) than nickel chloride administered in water (28 percent) (Sunderland et al., 1989). Increased blood levels of manganese were observed in humans ingesting high doses in water, but not when similar doses of manganese were ingested in food (Bales et al., 1987).

The absolute absorption of inorganics ingested in soil is also less than that from water. This is expected because inorganics only partially desorb from soil. The EPA Integrated Exposure Uptake Biokinetic (IEUBK) lead model assumes that the bioavailability for lead ingested in soil is 30 percent, compared to 50 percent bioavailability of lead ingested in water (EPA, 1994g). The corresponding soil matrix value is 0.6. In rats, the bioavailability of lead ingested in soil was 8 percent of that for lead acetate ingested in water (Freeman et al., 1992). Arsenic administered to rabbits in soil was much less bioavailable (28 percent) than arsenic administered to rabbits in water (59 percent), corresponding to a soil matrix effect of 0.47 (Freeman et al., 1993).

Several studies show that organic chemicals, including pesticides, also bind tightly to soil, reducing their bioavailability through both oral and dermal exposure. Clays and organic colloids have a large surface area and cation exchange capacity, which permits significant adsorption of virtually all classes of pesticides. Furthermore, the adsorbed fraction desorbs slowly and is effectively a bound fraction that increases over time as the soil-pesticide bond "ages" (Calderbank, 1989). The bound fraction is estimated to be about 20 to 70 percent of the total amount applied. McConnell et al., (1984) showed, using soil containing TCDD (a dioxin), that 3 μg/kg-bw TCDD in corn oil resulted in 6/6 deaths among treated guinea pigs and 13.3 parts per billion (ppb) TCDD in the liver, but 3.3 μg/kg-bw TCDD from soil caused only 2/6 deaths and 1.4 ppb in the liver, indicating about 10 percent relative bioavailability of TCDD from the soil. Shu et al., (1988) conducted further studies on TCDD and found an average 43 percent (range, 25 to 50 percent) bioavailability of TCDD to rats from soils from

Times Beach, Missouri. Goon et al., (1991) showed that benzo(a)pyrene (BaP) that had aged 6 months in soil was only 34 and 51 percent orally bioavailable for clayey and sandy soil respectively, relative to BaP administered alone to rats. PCBs, DDT, chlordane, and heptachlor may be expected to adsorb strongly to soil similarly to BaP (Ney, 1990), resulting in reduced bioavailability because of this matrix effect. These studies support a conservative estimate of 50 percent relative bioavailability of SVOCs in soil compared to those in solution.

In summary, a matrix factor of 0.5 was used in the health risk assessment to account for the decreased toxicity of COCs in soil and in sediment relative to that in water or other solutions. This value is based in part on EPA-derived relative bioavailability factors for cadmium in food (0.5) and lead in soil (0.6), a literature-derived relative bioavailability factor of 0.47 for arsenic in soil (Freeman et al., 1993; EPA, 1995), and the evidence supporting a 50 percent relative bioavailability of SVOCs in soil. Also, several studies indicate that the decrease in bioavailability from MEs can be substantially greater than 50 percent (as much as 95 percent), indicating that a matrix effect of 0.5 is conservative (Freeman et al., 1992; Heard and Chamberlain, 1982; Sunderland et al., 1989; EPA, 1995).

Where the critical toxicity study was dietary but no vehicle was indicated in IRIS, a default matrix effect of 1 was used, as was the case for BaP and copper. Other PAH COCs that had toxicity equivalency factors based on BaP (i.e., benzo[a]anthracene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene) (EPA, 1994b) were assigned a default ME of 1 by analogy to BaP. For COCs where the chemical was injected directly into the receptor (e.g., intraperitoneal or intravenous), it was not necessary to apply an ME. This was also the case for mercury and silver. Cadmium, molybdenum, and nickel were mixed directly into the diet and therefore a default ME of 1 was used.

For radionuclides, ingestion slope factors were calculated using gastrointestinal absorption factors (f_1) for soluble forms of each radionuclide; consequently, it would be appropriate to consider matrix effects as well as mineralized form to estimate carcinogenic effects from ingestion of radionuclides in a soil matrix (Nelson, 1995). However, the reduction in potential toxic effects cannot be quantified simply using an ME because the adjustment must account for differential effects on target organs. Therefore, an ME of 1 has been adopted for radionuclides in the present HHRA, even though this factor probably overestimates the effects of radionuclides ingested in soil and sediment.

6.4.2.2 Inhalation of Airborne Contaminants

Airborne contaminants associated with complete pathways at OU 5 are in the particulate form. Dermal absorption of contaminants that may be in the vapor-phase is considered to be negligible in proportion to inhalation intakes and, therefore, is disregarded in accordance with RAGS (EPA, 1989). The following equation is used to estimate inhalation intakes.

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times RF \times ET \times EF \times ED}{BW \times AT} \qquad (6\text{-}2)$$

where

CA = Contaminant concentration in air (mg/m^3 or pCi/m^3)
IR = Inhalation rate (m^3/hour)
RF = Respirable fraction (unitless)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days).

For calculation of intakes from inhalation of particulates, only the fraction of the particulate concentration in air that is considered to be respirable (<10 μ) is evaluated. Air-dispersion modeling performed for OU 5 considered particle size and, therefore, the air concentrations are the respirable particulates only. The respirable fraction parameter for inhalation of airborne contaminants at OU 5 is, therefore, always 1.0. The respiratory model developed by the International Commission on Radiological Protection indicates that particles with sizes above 10 μ are relatively unimportant contributors to internal dose (NCRP, 1985). For calculation of radionuclide intakes, the concentration is expressed in picocuries per cubic meter (pCi/m^3), and the expression is not divided by body weight and averaging time. The intake for radionuclides is expressed in pCi.

6.4.2.3 Dermal Contact with Soil and Sediments

The exposure from dermal contact with organic chemicals in soil and sediments is calculated in equation (6-3) which results in an estimate of the absorbed dose (i.e., intake), not the amount of chemical in contact with the skin. Exposure from dermal contact with metals and radionuclides was not estimated because of the low rate of absorption of these constituents.

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times FC \times AF \times ABS \times EF \times ED}{BW \times AT} \qquad (6\text{-}3)$$

where

CS	=	Chemical concentration in soil, or sediment (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface area available for contact (cm^2/event)
FC	=	Fraction contacted from contaminated source (unitless)
AF	=	Soil to skin adherence factor (mg/cm^2)
ABS	=	Skin absorption factor (unitless)
EF	=	Exposure frequency (events/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days).

Absorption Factors - The parameter ABS is a chemical-specific value describing the fraction of organic chemical in soil and sediment that is absorbed by the skin. Table 6-33 lists the values for ABS used in this risk assessment. Dermal absorption of metals from contact with soil is not considered a significant uptake route because metals bind strongly to soil, which greatly reduces their bioavailability. Most metals form strong bonds with other soil constituents and, due to polarity and solubility, metals are not absorbed well across the skin (EPA, 1991). Therefore, dermal uptake of metals was considered negligible and was not evaluated in this risk assessment. Likewise for radionuclides, EPA guidance states that "dermal uptake is generally not an important route of uptake for radionuclides, which have small dermal permeability constants" (EPA, 1989). Dermal permeability constants describe the rate at which dissolved (aqueous phase) chemicals permeate the skin. Absorption of radionuclides adhered to soil is also expected to be negligible.

6.4.2.4 Ingestion of Surface Water and Suspended Sediment

Equation (6-4) is used to calculate intake from ingestion of contaminated water.

$$\text{Intake (mg/kg-day)} = \frac{CW \times IR \times ER \times EF \times ED}{BW \times AT} \quad (6\text{-}4)$$

where

CW = Chemical concentration in water (mg/l or pCi/L)
IR = Ingestion rate (l/hour)
ER = Exposure rate (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days).

For calculation of radionuclide intakes, the concentration is expressed in pCi/L, and the expression is not divided by body weight and averaging time. The intake for radionuclides is expressed in pCi.

6.4.2.5 Dermal Contact with Surface Water

Equation (6-5) is used to calculate the actual absorbed dose (i.e., intake versus the amount of chemical that comes in contact with the skin) for dermal contact with chemicals in surface water.

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times CF \times SA \times PC \times ET \times EF \times ED}{BW \times AT} \quad (6\text{-}5)$$

where

CW = Chemical concentration in water (mg/l)
CF = Volumetric conversion factor for water (1 l/1,000 cm^3)
SA = Skin surface area available for contact (cm^2)
PC = Chemical-specific dermal permeability constant (cm/hour)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days).

Permeability constants (PCs) - PCs are chemical-specific factors that describe the rate at which dissolved (aqueous-phase) chemicals permeate the skin. Absorption of metals and radionuclides adhered to suspended sediment is assumed to be negligible and was not evaluated. PCs for organic chemicals in surface water are listed in Table 6-33.

6.4.2.6 External Radiation Exposure

Radionuclide intakes for external exposure are calculated using equation (6-6).

$$\text{Intake}\left(\frac{\text{pCi x Year}}{\text{g}}\right) = C \times EF_r \times ED \times (1\text{-}Se) \times Te \qquad (6\text{-}6)$$

where

C	=	Isotope activity (pCi/g)
EF_r	=	Exposure frequency ratio (unitless)
ED	=	Exposure duration (years)
Se	=	Gamma shielding factor (unitless)
Te	=	Gamma exposure factor (unitless).

6.4.3 Calculated Intakes

In accordance with EPA guidance, calculations are conducted for both CT and RME values for receptor intakes (EPA, 1994a). The Rocky Flats site-specific exposure factors in Appendix M contain both RME and CT values and were used to calculate intakes. Tables 6-34 through 6-43 document the RME and CT carcinogenic chemical intakes for receptors in AOC1, Tables 6-44 through 6-53 document the RME and CT carcinogenic chemical intakes for AOC2, and Tables 6-54 through 6-57 document the RME and CT carcinogenic chemical intakes for applicable receptors in AOC3. RME and CT noncarcinogenic chemical intakes for receptors in AOC1 are found in Tables 6-58 through 6-69. Tables 6-70 through 6-81 document the RME and CT noncarcinogenic chemical intakes for AOC2, and Tables 6-82 through 6-87 document the RME and CT noncarcinogenic chemical intakes for receptors at AOC3.

6.5 TOXICITY ASSESSMENT

Toxicity values are used to characterize potential risk and health effects, and this section documents the toxicity constants for the OU 5 COCs. The toxicity constants used in this risk assessment were obtained from several sources, but the primary source of information was the EPA Integrated Risk Information System (IRIS) database (EPA, 1994c; 1995). IRIS contains only those toxicity values that have been verified by the EPA's Carcinogenic Risk Assessment Verification Endeavor (CRAVE) Work Groups. The IRIS database is updated monthly and, per RAGS (EPA, 1989), supersedes all other sources of toxicity information. If the necessary data are not available in IRIS, the EPA's most recent issue of Health Effects Assessment Summary Tables (HEAST) is used (EPA, 1994b). The HEAST tables are published annually and updated approximately two times per year. HEAST contains a comprehensive listing of provisional risk assessment information that has undergone review and has the concurrence of individual EPA Program Offices, but has not had enough review to be recognized as high quality, agency-wide consensus information (EPA, 1994b). Additional sources of information used in this risk assessment include the EPA Environmental Criteria and Assessment Office (ECAO) and guidance from EPA toxicologists.

The COCs identified in TM11 (DOE, 1995a) have verified toxicity values available from IRIS or HEAST except for the chemicals that are documented in the EG&G toxicity memorandum (EG&G, 1994c). Table 6-33 provides a summary of the OU 5 COCs and their respective toxicity information that was used for the risk characterization. Additional detail and references for toxicity values can be found in TM11 (DOE, 1995a) and the OU 5 toxicity letter (EG&G, 1994c).

<u>Note on assessing effects of dermal exposure to chemicals</u> - The EPA recommends using oral toxicity factors, adjusted if possible by a gastrointestinal absorption fraction, to evaluate toxic effects from dermal contact with potentially contaminated media (EPA, 1989; 1992f). The oral toxicity factor relates the toxic response to an administered dose of chemical, only some of which may be absorbed by the body; whereas chemical intake from dermal contact is estimated as an absorbed dose, whose toxic effects could be underestimated by using unadjusted oral toxicity factors. Therefore, EPA (1989) suggests adjusting the oral toxicity factors by chemical-specific, gastrointestinal absorption rates, if available, to yield toxicity factors for dermally absorbed chemicals. When chemical-specific, gastrointestinal absorption rates are not available, gastrointestinal absorption is assumed to be 100 percent, and the unadjusted oral toxicity factor is used to assess response to dermal absorption.

Regarding using oral toxicity factors to evaluate response to dermal exposure, EPA (1992f) states:

> Until more appropriate dose-response factors are available, it is recommended that assessors use the oral factors.... Alternatively, if estimates of the gastrointestinal absorption fraction are available for the compound of interest in the appropriate vehicle, then the oral dose-response factor, unadjusted for absorption, can be converted to an absorbed dose basis.... Lacking this information, the oral factor

should be used as is accompanied by a strong statement of the uncertainty involved. (p. 10-9, 10-10)

Because chemical-specific, gastrointestinal absorption rates are not available for most chemicals, unadjusted oral toxicity factors were used to assess effects of dermal absorption. If dermal absorption of particular chemicals is demonstrated to be a potential significant contributor to overall risk in the risk assessment, a more detailed analysis of the toxicity by dermal absorption may be warranted.

EPA guidance (EPA, 1989) states that it is inappropriate to use oral CSFs to evaluate the risks associated with dermal exposure to PAHs, which can cause skin cancer through direct action at the point of application. In accordance with EPA guidance, generally only a qualitative assessment of risks from dermal exposure to PAHs is possible (see Section 6.6.3.3). In addition, PAHs do not have RfCs or CSFs for the inhalation pathway. Therefore, only oral exposures to PAHs were evaluated quantitatively in the risk assessment.

6.5.1 Toxicity Assessment for Noncarcinogenic Effects

Potential noncarcinogenic effects will be evaluated in the risk characterization by comparing daily intakes with chronic RfDs developed by the EPA. This section provides a definition of an RfD and discusses how it is applied in the risk assessment.

A chronic RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure that can be incurred during a lifetime, without an appreciable risk of a noncancer effect being incurred in human populations, including sensitive subgroups (EPA, 1989). The RfD is based on the assumption that thresholds exist for noncarcinogenic toxic effects (e.g., liver or kidney damage). RfDs are typically presented in units of mg/kg-day and are calculated by dividing a dose (representing a NOAEL or a LOAEL) at which there are no significant measurable effects produced by an uncertainty or safety factor that typically ranges from 10 to 10,000. Thus, there should be no adverse effects associated with chronic daily intakes at or below the RfD value. Conversely, if chronic daily intakes exceed this threshold level, there is a potential that some adverse noncarcinogenic health effects might be observed in exposed individuals.

RfDs have been derived by the EPA for both oral and inhalation exposures. However, in January 1991, the EPA decided to replace inhalation RfDs with RfCs. RfCs are expressed in terms of concentrations in air (mg/m^3), not in terms of "dose" or mg/kg-day. An RfC may be converted to a corresponding inhaled dose, (mg/kg-day), by dividing by 70 kg, (an estimated human body weight), multiplying by 20 m^3/day, (an assumed human inhalation rate), and adjusting by an appropriate absorption factor (EPA, 1994b).

6.5.2 Toxicity Assessment for Carcinogenic Effects

Potential carcinogenic risks are expressed as an estimated probability that an individual may develop cancer from lifetime exposure. This probability is based on projected intakes and chemical-specific dose-response data or CSFs. CSFs and the estimated daily intake of a compound, averaged over a lifetime of exposure, are used to estimate the incremental risk of an individual exposed to that compound developing cancer. There are two classes of potential carcinogens: nonradioactive and radioactive chemicals. For the purposes of this toxicity assessment, each of these two classes of elements or compounds are discussed separately.

6.5.2.1 Toxicity Assessment for Nonradioactive Chemical Carcinogens

Evidence of chemical carcinogenicity originates primarily from two sources: lifetime studies with laboratory animals and human (epidemiological) studies. For most such chemical carcinogens, animal data from laboratory experiments represent the primary basis for the extrapolation. Effects from exposure to high (i.e., administered) doses are based on laboratory animal bioassay results, whereas, effects associated with exposure to low doses of a chemical are generally estimated from mathematical models.

For these nonradioactive chemical carcinogens, the EPA assumes a small number of molecular events can evoke changes in a single cell that can lead to uncontrolled cellular proliferation and tumor induction. This mechanism for carcinogenesis is referred to as stochastic, which means that there is theoretically no level of exposure to a given chemical carcinogen that does not pose a small, but finite, probability of generating a carcinogenic response. Because risk at low-exposure levels cannot be measured directly either in laboratory animals or human epidemiology studies, various mathematical models have been proposed to extrapolate from high to low doses.

Consistent with guidance in RAGS (EPA, 1989), PAHs that have been identified as COCs in OU 5 will not be quantitatively evaluated for dermal exposure. RAGS states, "It is inappropriate to use the oral slope factor to evaluate the risks associated with dermal exposure to carcinogens such as benzo(a)pyrene, which cause skin cancer through a direct action at the point of application." RAGS also states, "Generally only a qualitative assessment of risks from dermal exposure to these chemicals is possible." The PAHs in OU 5 are: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene.

Uncertainties in the toxicity assessment for nonradioactive chemical carcinogens are dealt with by classifying each chemical into one of several groups, according to the weight-of-evidence from epidemiological studies and animal studies. Table 6-88 presents specific definitions for weight-of-evidence.

6.5.2.2 Toxicity Constants for Radioactive Chemicals

Extensive literature exists that describes the health effects of radionuclides on humans and animals. Intensive research by national and international commissions has established universally accepted limits to which workers and the public may be exposed without clinically detectable effects. This literature has resulted in the EPA classifying all radioactive chemicals as Group A carcinogens because they emit ionizing radiation, which at high doses, has been associated with increased cancer incidence in humans.

A fundamental difference between the assessment of potential toxicity associated with exposure to radionuclide and nonradionuclide carcinogens is that CSFs for radionuclides are typically best estimates (mean or median values) rather than upper 95th percentile values. Furthermore, in the past, risk factors for radionuclides have generally been based on fatalities (i.e., the number of laboratory animals or people who actually died from cancer), whereas CSFs for nonradiological carcinogens are based on incidence (i.e., the number of lab animals or people who developed cancer). Finally, the CSFs for radionuclides are expressed in different units, [i.e., risk per pCi (pCi^{-1}) rather than $mg/kg\text{-}day^{-1}$].

6.6 RISK CHARACTERIZATION

Risk characterization involves estimating the magnitude of the potential adverse effects of COCs under study, and summarizing risks to human health. Risk characterization considers the nature and weight-of-evidence supporting these risk estimates and the magnitude of uncertainty surrounding estimates. Risk characterization combines the results of the exposure and toxicity assessments to provide numerical estimates of health risk. These estimates are comparisons of exposure levels with RfDs or estimates of the lifetime cancer risk for a given intake. The process of characterizing risk includes the following:

- Calculating and characterizing cancer risk and potential noncarcinogenic effects
- Conducting qualitative uncertainty analysis
- Conducting quantitative uncertainty analysis

6.6.1 Calculating and Characterizing Cancer Risk and Noncarcinogenic Effects

To quantify the impact of contaminant exposure on human health, chemical intakes are first calculated for each COC, each applicable scenario, and each AOC. The CT and RME intakes are calculated based on measured or modeled concentrations, using the methodology documented in the RAGS (EPA, 1989) and discussed in Section 6.4, Exposure Assessment, and Section 6.4.3, Calculated Intakes. The toxicity factors (RfDs and CSFs) for each COC are then applied in conjunction with estimated chemical intakes to predict noncarcinogenic effects and carcinogenic health risks to hypothetically exposed individuals. Each of these calculations is discussed in the following sections.

6.6.1.1 Determining Carcinogenic Risks

The following calculation is used to determine carcinogenic risks by obtaining numerical estimates of lifetime cancer risks:

$$\text{Risk} = \text{Intake} \times \text{CSF} \qquad (6\text{-}7)$$

where

Risk = Potential lifetime excess cancer risk (unitless)
CSF = Cancer slope factor for chemicals $(\text{mg/kg-day})^{-1}$, or $(\text{pCi})^{-1}$
Intake = Chemical intake (mg/kg-day), or (pCi).

Section 6.4.3, Calculated Intakes, identifies where specific estimated intakes for each receptor by AOC are found, and Table 6-33 presents the CSFs for each applicable COC. Inhalation and ingestion CSFs were used with respective inhalation and ingestion intakes to estimate potential human health risks. The CSF is characterized as an upperbound estimate.

Cancer risks are summed separately across all potential nonradioactive and radioactive chemical carcinogens considered in the risk assessment using equation (6-8).

$$\text{Risk}_T = \sum \text{Risk}_i \qquad (6\text{-}8)$$

where

Risk_T = Total cancer risk, expressed as a unitless probability
Risk_i = Risk estimate for the ith contaminant.

This equation is an approximation of the precise equation for combining risks to account for the probability of a receptor developing cancer as a consequence of exposure to two or more carcinogens. As stated in RAGS (EPA, 1989), the difference between the precise equation and this approximation is negligible for total cancer risks less than 0.1. This risk summation assumes independence of action by the compounds involved. Some limitations are posed by this approach and are discussed in RAGS.

Most models for low-dose extrapolation produce quantitatively similar results in the range of observable data, but yield estimates that can vary by three or four orders of magnitude at lower doses. Animal bioassay data are not adequate to determine whether any of the competing models are better than the others. In addition, there is no evidence to indicate that the precision of low-dose risk estimates increases through the use of more sophisticated models. Thus, if a carcinogenic response occurs at the exposure level studied, it is assumed that a similar response will occur at all lower doses, unless evidence to the contrary exists.

Tables 6-89 through 6-98 document the risks calculated for AOC1 receptors using RME and CT exposure parameters, Tables 6-99 through 6-108 document risks calculated for AOC2 receptors using RME and CT exposure parameters, and Tables 6-109 through 6-112 document the risks calculated for AOC3 receptors, using RME and CT parameters. These tables identify the total calculated risk by receptor, total receptor risk for each COC across all applicable pathways, and total receptor risk for each pathway for all applicable COCs. Point estimates of potential human health risk are discussed further in Section 6.6.2.

6.6.1.2 Determining Noncarcinogenic Effects

Potential health effects associated with exposure to individual noncarcinogenic compounds are evaluated by calculating hazard quotients. A hazard quotient (HQ) is the ratio of the intake rate to the RfD, as described in equation (6-9).

$$HQ = \frac{Intake}{Rfd} \qquad (6\text{-}9)$$

where

HQ = Noncancer hazard quotient
Intake = Chemical intake (mg/kg-day)
RfD = Reference dose (mg/kg-day).

Chronic RfDs are extracted from IRIS and HEAST and specific values are documented on Table 6-33. Similar to CSFs, the RfDs for inhalation and ingestion are used with respective inhalation and oral intakes.

HIs are the summed HQs for each chemical across the applicable pathways. When the HI exceeds unity, there may be concern for potential human health effects from exposure to noncarcinogenic chemicals. Obviously, any single chemical with an exposure level greater than its toxicity value will cause the HI to exceed unity; however, multiple chemical exposures can also cause the HI to exceed this threshold even if no single chemical exposure exceeds its respective RfD.

Tables 6-113 through 6-124 document the calculated RME and CT HQs and HIs for the applicable receptors in AOC1. Tables 6-125 through 6-136 document the calculated RME and CT HQs and HIs for the applicable receptors in AOC2. Tables 6-137 through 6-142 document the calculated RME and CT HQs and HIs for the applicable receptors in AOC3. The tables identify individual HQs by COC and pathway, and provide total HIs by chemical and a total of all HIs by receptor. The point estimates of potential health effects that are documented on these tables are discussed in more detail in Section 6.6.2.

6.6.2 Point Estimates of Risk and Health Effects

Reasonable exposure pathways were evaluated in Section 6.3, Identification of Scenarios and Pathways, and the risks and HI values for the applicable COCs were summed across these pathways. Both RME and CT point estimates for lifetime cancer risk and potential noncarcinogenic health effects were calculated (EPA, 1992b). The total risks are presented for both nonradiological and radiological COCs and then added to arrive at a conservative total risk for each receptor. Total risks are expressed in the text using one significant figure, per EPA guidance (EPA, 1989). The risks presented in Tables 6-89 through 6-142 are expressed in two significant figures. Noncarcinogenic health effects are expressed as HI values. The HI values are not expressed in scientific notation to avoid confusion with risk values (EPA, 1989). First, the total HI values were calculated by summing HQ values by receptor, without regard for the target organ affected. Because no HI exceeded or approached unity, it was not necessary to sum the HQ values according to target organ. The following sections discuss the results of RME and CT point estimates of lifetime cancer risk and potential noncarcinogenic health effects by receptor. These estimates are summarized in Tables 6-143 and 6-144.

6.6.2.1 Future Construction Worker

The future construction worker is a potential receptor in AOC1 and AOC2. As discussed in Section 6.3, the construction worker receptor is not an applicable receptor in AOC3. Total calculated RME risk for this receptor in AOC1 is 3E-07, with ingestion of surface soil and exposure to external radiation being the driving pathways and uranium-238 being the most significant COC (Table 6-89).

The construction worker total CT risk in AOC1 is 1E-07, with a driving pathway of external radiation and uranium-238 as the most significant COC (Table 6-94). The total calculated RME risk for this receptor in AOC2 is 6E-08, with external radiation contributing the most risk and the most significant COC being uranium-238 (Table 6-99). The construction worker total CT risk in AOC 2 is 3E-08, with the external radiation pathway and uranium-238 contributing the greatest risk (Table 6-104).

Total RME HI calculated for the construction worker in AOC1 is 0.02 and the most significant pathway and COC, respectively, are ingestion of subsurface soil and Aroclor-1254 (Table 6-113). The total CT HI calculated for this receptor in AOC1 is 0.003, with the greatest contribution from ingestion of subsurface soil and from Aroclor-1254 (Table 6-119). Total RME HI calculated for this receptor in AOC2 is 0.01, with the greatest contributions coming from ingestion of subsurface soil and antimony (Table 6-125). Total CT HI calculated for the construction worker in AOC2 is 0.002, with ingestion of subsurface soil and antimony providing the greatest risk by pathway and COC, respectively (Table 6-131).

6.6.2.2 Current Worker (Security Worker)

The current security worker receptor is exposed to COCs in AOC1 and AOC2 and, but not in AOC3. Total RME risk for this receptor in AOC1 is 2E-06, with the greatest contribution from the external radiation pathway and uranium-238 (Table 6-90). The total CT risk for the current worker in AOC1 is 1E-07, with a driving pathway of external radiation and uranium-238 contributing the most risk (Table 6-95). The total RME risk for this receptor in AOC2 is 3E-06, with the external radiation pathway and uranium-238 contributing the most risk (Table 6-100). The total CT risk for the current security worker in AOC2 is 3E-07, with the greatest contributing pathway and COC of external radiation and uranium-238, respectively (Table 6-105).

The total RME HI for the current worker in AOC1 is 0.004, with the driving pathway being dermal absorption of surface soil and the most significant COC being Aroclor-1254 in surface soil (Table 6-114). The total CT HI for this receptor in AOC1 is 0.001, with dermal absorption the dominant pathway and Aroclor-1254 the dominant COC in soil (Table 6-120). The total RME HI for the current security worker in AOC2 is 0.0003, with the driving pathway being ingestion of surface soil and the most significant COC being copper (Table 6-126). The total CT HI for this receptor in

AOC2 is 0.000005, with the respective driving pathway and COCs being ingestion of surface soil and copper, and silver, respectively (Table 6-132).

6.6.2.3 Future Ecological Researcher

The future ecological researcher is an applicable receptor in all three AOCs. The RME total risk for this receptor in AOC1 is 1E-06. The driving pathway is exposure to external radiation and the most significant COC is uranium-238 (Table 6-91). The CT total risk for a future ecological researcher in AOC1 is 8E-07, with the dominant pathway and COC being external radiation and uranium-238, respectively (Table 6-96). The RME total risk for this receptor in AOC2 is 2E-07. The driving pathway is exposure to external radiation and the most significant COC is uranium-238 (Table 6-99). The CT total risk for this receptor in AOC2 is 1E-07, with the respective dominant pathway and COC being external radiation exposure and uranium-238 (Table 6-106). The RME total risk for an ecological researcher in AOC3 is 7E-09, with a driving pathway of ingestion of pond sediments and the most significant COC being plutonium-239/240 (Table 6-109). The CT total risk for this receptor in AOC3 is 1E-09, with the respective dominant pathway and COC being ingestion of pond sediments and plutonium-239/240 (Table 6-109).

The RME total HI for the ecological researcher in AOC1 is 0.03, with the dominant pathway being dermal absorption of surface soil and the most significant COC being Aroclor-1254 in surface soil (Table 6-113). The CT total HI for this receptor in AOC1 is 0.01, with the driving pathway being ingestion of seep sediments and the dominant COC being Aroclor-1254 (Table 6-119). Total RME HI for this receptor in AOC2 is 0.004, with the respective dominant pathway and COC being ingestion of seep sediments and antimony (Table 6-127). The CT total HI for an ecological researcher in AOC2, is 0.0008. The driving pathway is ingestion of seep sediments and the dominant COC is antimony (Table 6-133). The RME HI total for this receptor in AOC3 is 0.001, with the driving pathway being ingestion of stream sediments, and the driving COC being mercury (Table 6-137). The CT total HI for an ecological researcher in AOC3 is 0.0002. The respective dominant pathway and COC is ingestion of stream sediments and mercury (Table 6-140).

6.6.2.4 Future Office Worker

The future office worker is a potential receptor in AOC1 and AOC2 only. As discussed in Section 6.3, the office worker receptor is not an applicable receptor in AOC3. The total RME risk for this receptor in AOC1 is 3E-05, with the driving pathway being exposure to external radiation and the dominant COC being uranium-238 (Table 6-92). Total CT risk for a future office worker in AOC1 is 2E-06, with the respective dominant pathway and COC being external radiation and uranium-238 (Table 6-97). The total RME risk for this receptor in AOC2 is 4E-06. The driving pathway is exposure to external radiation, and the dominant COC is uranium-238 (Table 6-102). Total CT risk for this receptor in AOC2 is 3E-07, with the respective dominant pathway and COC being exposure to external radiation and uranium-238 (Table 6-107).

The RME total HI for the future office worker in AOC1 is 0.05. The driving pathway is dermal absorption of surface soil, and the dominant COC is Aroclor-1254 in surface soil (Table 6-116). CT total HI for this receptor in AOC1 is 0.007, with the dominant pathway and COC, respectively, being dermal absorption of surface soil and Aroclor-1254 in surface soil (Table 6-122). The total RME HI for a future office worker in AOC2 is 0.0005. The driving pathway is ingestion of surface soil and the most significant COC is copper (Table 6-128). Total CT HI for this receptor in AOC2 is 0.00004, with the driving pathway and COC, respectively, being ingestion of surface soil and copper (Table 6-134).

6.6.2.5 Future Open-Space User

Future open-space users consist of both adults and children with complete pathways in all three AOCs. Total lifetime cancer risks are estimated for an open-space user, incorporating a time-weighted average soil-ingestion factor. Noncancer HIs are calculated separately for adult and child receptors for the soil and sediment ingestion scenarios. The total RME risk for the open-space user in AOC1 is 6E-06, with the respective dominant pathway and COC being exposure to external radiation and uranium-238 (Table 6-93). The total CT risk for this receptor is 5E-07, with a driving pathway of external radiation exposure and uranium-238 being the most significant COC (Table 6-98). Total RME risk for this open-space receptor in AOC2 is 1E-06. The dominant pathway is exposure to external radiation, and the dominant COC is uranium-238 (Table 6-103). Total CT risk for an open-space user in AOC2 is 1E-07, with external radiation exposure being the dominant pathway and uranium-238 being the most significant COC (Table 6-108). Total RME risk for this receptor in AOC3 is 6E-08. The dominant pathway and COC are ingestion of pond sediments and plutonium-239/240, respectively (Table 6-110). The CT total risk for this adult receptor is 3E-09, with the driving pathway being ingestion of pond sediments and the driving COC being plutonium-239/240 (Table 6-112).

The total RME HI for the open-space user in AOC1 is 0.02, with a driving pathway of dermal absorption and the most significant COC being Aroclor-1254 in surface soil (Table 6-117). The total RME HI for a child open-space receptor in AOC1 is 0.03. The dominant pathway and COC are ingestion of seep sediments and antimony, respectively (Table 6-118). The total CT HI for the adult receptor in AOC1 is 0.001, with the driving pathway and COC being ingestion of seep sediments and antimony, respectively (Table 6-123). The total CT HI for a child open-space receptor in AOC1 is 0.004. The dominant pathway is ingestion of seep sediments, and the most significant COC is antimony (Table 6-124).

The total RME HI for an adult open-space receptor in AOC2 is 0.002, with the respective dominant pathway and COC being ingestion of seep sediments and antimony (Table 6-129). The total RME HI for this child receptor in AOC2 is 0.02. The driving pathway is ingestion of seep sediments, and the most significant COC is antimony (Table 6-130). Total CT HI for an adult receptor in AOC2 is 0.0003, with the dominant pathway being ingestion of seep sediments and antimony being the dominant COC (Table 6-135). The CT total HI for a child open space receptor in AOC2 is 0.003, with the driving pathway of ingestion of seep sediments and the driving COC being antimony (Table 6-136).

The total RME HI for an adult open space user in AOC3 is 0.0007, with respective dominant pathway and COC being ingestion of stream sediments and mercury (Table 6-138). Total RME HI for a child open-space receptor in AOC3 is 0.006. The dominant pathway is ingestion of stream sediments, and the dominant COC is mercury (Table 6-139). Total CT HI for the adult open-space receptor in AOC3 is 0.0001. The driving pathway is ingestion of stream sediments, and the most significant COC is mercury (Table 6-141). The CT total HI for the child open-space receptor in AOC3 is 0.0003, with the respective dominant pathway and COC being ingestion of stream sediments and mercury (Table 6-142).

6.6.3 Uncertainty Analysis

Analysis of uncertainty associated with risk estimates is an important part of the risk assessment process. EPA guidance (EPA, 1992b) states that point estimates of risk "...do not fully convey the range of information considered and used in developing the assessment." The EPA has suggested the use of both RME and CT exposure scenarios in order to provide upper (conservative) and lower (less conservative) bounds on what the actual risk may be. This is an alternative method of portraying the uncertainty inherent in the risk estimates to performing a more time-consuming and expensive probablistic uncertainty analysis. The RME estimates are to be used for risk-management decisions, but a comparison to the CT estimates provides a good estimation of the uncertainty associated with the decisions. Quantitative, probablistic uncertainty analysis was not performed in this risk assessment. The range between the RME and CT risk estimates is a good indicator of the uncertainty inherent in the RME characterization. Uncertainties identified during the risk assessment process are discussed below.

During the risk assessment process there are essentially four stages of the analysis that can introduce uncertainties. These stages are: data collection and evaluation, exposure assessment, toxicity assessment, and risk characterization. The uncertainties within the HHRA are driven by uncertainty in RFETS investigation data, the likelihood of hypothetical exposure scenarios, the transport models used to estimate concentrations at receptor locations, receptor intake parameters, and the toxicity values used to characterize risk. Uncertainties are also introduced in the risk assessment when exposure to several substances across multiple pathways are summed.

The following sections qualitatively discuss specific uncertainties introduced in the OU 5 HHRA. Table 6-145 summarizes the uncertainties and limitations in this HHRA.

6.6.3.1 Potential Impacts to HHRA

As discussed in Section 2.2, impacts, if any, that result from the collection of additional data during the TM15 field investigation on the conclusions of the OU 5 HHRA must be assessed. This section discusses an assessment of potential impacts to the HHRA.

Tables 2-3 through 2-10 provide a summary of the results of the analyses of samples collected during the 15 field investigations and those collected during the investigation outlined in the OU 5 Work Plan (DOE, 1992a). The information provided on these tables was discussed in Section 2.2 to assist in assessing whether the results of the TM15 field investigation impacted the conclusions of the HHRA. As discussed in Sections 4.0 and 6.0, the data collected under the OU 5 Work Plan investigation were aggregated by each sample medium on an OU-wide basis for comparison and background to identify PCOCs, and subsequent COCs. TM11, COCs for HHRA (DOE, 1995a), details the background comparison and PCOC and COC determinations. The purpose of this section is to compare the results of the sampling program for each environmental medium sampled under TM15 with the results of the OU 5 Work Plan investigation. It should be recognized that many of the samples collected during the TM15 field investigation were collected for purposes other than for the HHRA (e.g., for characterization of drummed cuttings and fluids). This assessment of the potential for impact to the conclusions of the HHRA was performed to ensure that the results of the HHRA represent the most conservative estimates of risk to human health.

Subsurface Soils - Data for subsurface-soil samples are provided in Tables 2-3, 2-4, and 2-5 for metals, radionuclides, and organic compounds, respectively. As indicated on Table 2-3, the mean concentration of the combined OU 5 subsurface-soil data set (includes samples collected prior to and during the implementation of TM15) for several metals increased significantly relative to the mean concentration calculated previously for the HHRA, using only those data collected prior to the implementation of TM15. A significant increase in concentrations could result in a metal that was not previously identified as a COC in being identified as a COC using the larger data set. The apparent increased concentrations of cesium, selenium, thallium, and tin can all be attributed to the increased reporting limits provided in RFEDS for the samples collected during the implementation of TM15 versus those reported for the pre-TM15 samples. Each of these metals was detected at relatively low frequencies, therefore, the increased reporting limits cause the mean to be skewed toward higher concentrations (for nondetect results, one-half of the reporting limit replaces the result for the calculation of statistics). This represents an apparent, rather than a real, increase in concentrations.

The mean concentration of lead also increased significantly from that reported previously. In addition, the maximum concentration of lead detected in subsurface soils increased from 935 mg/kg in the pre-TM15 data to 5,200 mg/kg in a sample collected from one of the TDEM anomalies in the IHSS 133 area (Table 2-3). The concentrations of lead detected in subsurface-soil samples from IHSS 115 collected during the TM15 field investigation are all within the range of background concentrations. As discussed in Section 6.6.3.2, the close association of high-lead concentrations with waste material identified during drilling in the ash pits (IHSS 133) indicates that the detected lead is not mobile in the soil or readily available for human intake, and lead is not considered a significant contributor to the human health risk associated with OU 5.

As indicated on Table 2-4, the mean activities of radionuclides in subsurface soils did not change appreciably from those calculated previously using only the pre-TM15 data. The most significant increases in both mean and maximum activities occurred only for the uranium isotopes. Each of these isotopes was identified as a COC in the OU 5 HHRA, therefore, an increase in concentrations would not result in a change in the list of COCs for subsurface soils. The mean and maximum concentrations for these isotopes are the same magnitude as those used for the HHRA, therefore, the risk calculations would not change significantly.

The following organic chemicals were detected in higher concentrations in subsurface-soil samples collected during the implementation of TM15 than in subsurface-soil samples collected prior to TM15 (Table 2-5): bis(2-ethylhexyl)phthalate, bromoform, butyl benzyl phthalate, chloroform, diethyl phthalate, di-n-octyl phthalate, and methylene chloride. Of these compounds only bis(2-ethylhexyl)phthalate and methylene chloride were evaluated in the concentration/toxicity screening for the OU 5 HHRA (DOE, 1995a). Butyl benzyl phthalate was evaluated by comparison to a RBC. None of these compounds were determined to be COCs for OU 5.

To evaluate whether the concentrations of these organic chemicals detected in samples collected under the TM15 field investigation would impact the conclusions of the HHRA, a comparison of the maximum concentration (both detects and nondetects) with the respective RBC was performed (Table 2-14). Although this comparison is usually performed only for those compounds that are detected at a frequency of less than 5 percent, it is used here for all of these compounds, regardless of detection frequency, as an initial indicator of whether the results of the HHRA may need to be reevaluated.

As indicated on Table 2-14, the maximum detected and nondetected concentrations for each of these organic chemicals in subsurface soils are significantly less than their respective RBC. In addition, for bis(2-ethylhexyl)phthalate and methylene chloride, the percentage of total risk that would be associated with these chemicals, at the maximum detected concentrations shown on Table 2-5, was recalculated for comparison to the concentration/toxicity screens presented in TM11 COCs for the HHRA (DOE, 1995a). Even with the increased concentrations, both chemicals still represent zero percent of the total risk factor, noncarcinogenic and carcinogenic, associated with subsurface soils.

In summary, the subsurface-soil data collected during the TM15 field investigation do not indicate that the conclusions of the OU 5 TM11, COCs for the HHRA need to be reevaluated to incorporate these data.

Groundwater - Tables 2-7 through 2-10 present summaries of data for groundwater samples collected during both the original OU 5 Work Plan investigation and during the TM15 field program. The following discussions only include data from unfiltered samples (i.e., "total" results) for metals and radionuclides, because only total concentrations are used in the HHRA.

As shown on Table 2-7, the mean concentrations of most metals in the combined OU 5 data set decreased from those calculated for the HHRA using only the data collected under the OU 5 Work Plan investigation. For those metals that were previously identified as being COCs, this decrease in concentrations could potentially result in one or more of these constituents no longer being identified as a COC. However, inspection of the data provided on Table 2-7 indicates that, although the mean concentrations for these metals decreased, the concentrations are still greater than the range of background concentrations. Additionally, for all of these metals, the highest concentration detected was in samples collected during the original OU 5 Work Plan investigation. Because the concentration/toxicity screens performed to determine COCs for the HHRA use the maximum concentration for each constituent, the inclusion of the additional data would not affect the identification of COCs.

The mean concentrations of arsenic and thallium in the combined data set are slightly higher than those calculated for samples collected during the OU 5 Work Plan investigation. As discussed above for subsurface soils, an increase in concentrations has the potential to result in a constituent that was not identified as a COC previously in being identified as a COC using the larger data set. Although the mean concentration for arsenic increased, arsenic concentrations in the samples collected during the TM15 investigation are within the range of concentrations reported from the previous sampling program. Additionally, the increased mean calculated for thallium is the result of the low frequency of detection and the increased reporting limit for this constituent.

As discussed above for total metals in groundwater, the mean total activities of most radionuclides in the combined data set also decreased from those calculated using only samples collected during the OU 5 Work Plan investigation (Table 2-9). In all cases, the mean activities of those radionuclides identified as COCs decreased slightly and the highest activities reported for OU 5 samples were from samples collected during the OU 5 Work Plan investigation. Therefore, it is unlikely that the slight decrease in mean activities would result in these radionuclides not being identified as PCOCs, and subsequently as COCs, using the larger data set.

The mean activities for two radionuclides, cesium-137 and tritium, calculated using the combined data set increased from those calculated using only the data collected under the OU 5 Work Plan investigation. Although the mean activities for these radionuclides increased, the activities detected in both the OU 5 Work Plan investigation data and the TM15 data are well within the range of background concentrations.

The data presented in Table 2-10 indicate that a large number of organic compounds were detected in samples collected during the TM15 field investigation, that were either not detected or were detected at lower concentrations in samples from the OU 5 Work Plan investigation. These compounds are identified in Table 2-15 with a comparison of the maximum detected and nondetected concentrations with the appropriate RBC. The maximum detected and nondetected concentrations of most of these compounds do not exceed the residential groundwater RBC. For those compounds where the maximum detected and/or nondetected concentrations exceed the RBC, none of the concentrations exceed 1,000 times the RBC. Therefore, according to the criterion used in the OU 5 TM11 COCs for the HHRA (DOE, 1995a), these compounds would not be considered special-case COCs.

Three of the organic compounds included in Table 2-15 were evaluated in the concentration/toxicity screens for OU 5 (DOE, 1995a). These compounds, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and naphthalene, were not identified as COCs based on the data collected under the OU 5 Work Plan investigation. The percentage of total risk that would be associated with these chemicals, using the maximum detected concentrations shown on Table 2-10, was recalculated for comparison to the concentration/toxicity screens presented in TM11, OU 5 COCs for the HHRA (DOE, 1995a). With the higher concentrations, the percentage of total noncarcinogenic risk attributable to these compounds did not change from that reported in (DOE, 1995a). The percentage of the total carcinogenic risk attributable to bis(2-ethylhexyl)phthalate increased from 0.03 percent to 0.07 percent. Therefore, even at the higher concentrations, none of these compounds would be identified as COCs.

In summary, the groundwater data collected during the TM15 field investigation do not indicate that the conclusions of the OU 5 HHRA, as presented in TM11 (DOE, 1995a), need to be reevaluated to incorporate these data.

Surface Soils - The activities of americium-241 and plutonium-239/240 detected in the surface-soil samples collected from IHSS 209 and the other surface disturbances during the TM15 field investigation were less than the maximum activities reported previously for surface-soil samples from OU 5. The concentration/toxicity screens performed to identify COCs for the OU 5 HHRA were calculated using the highest activity reported for the samples collected under the OU 5 Work Plan investigation. Because these concentration/toxicity screens did not identify americium-241 and plutonium-239/240 as COCs at that time (DOE, 1995a), the inclusion of additional data with lower activities would not change this determination. Therefore, the surface-soil data collected during the TM15 field investigation does not impact the conclusions of the HHRA presented in this section.

6.6.3.2 Source Areas and Areas of Concern

In the Surface Disturbance South of the Ash Pits, soil was the only medium in which PCOCs were detected. These PCOCs consisted of two organic compounds and 26 inorganic compounds, 5 of which were radionuclides. The carcinogenic and noncarcinogenic ratio sums for this source area were calculated to be 0.82 and 0.45, respectively (DOE, 1994d). Because the ratio sums do not exceed one, this source area was not considered an AOC and was not evaluated further.

Similarly, in the Surface Disturbance West of IHSS 209 PCOCs were detected only in soil. The detected PCOCs consisted of three organic compounds and 25 inorganic compounds, 5 of which were radionuclides. The carcinogenic and noncarcinogenic ratio sums for this source area were calculated to be 2.2 and 0.42, respectively. The carcinogenic ratio sum exceeds one because a single sample of plutonium-239/240 was greater than its RBC. No other detected PCOC approached its respective RBC. A review of the data indicated that the maximum activity of plutonium-239/240 was 5.01 pCi/g and the RBC is 3.43 pCi/g. Subsequent sampling has not produced samples at this level of plutonium-239/240 activity and, in fact, has yielded results lower than the RBC of 3.43 pCi. As a result, it was determined that this source area does not contribute significantly to the risk associated with OU 5 and was not quantitatively evaluated as an AOC.

6.6.3.3 Discussion of Analytes Without Toxicity Values

Toxicity values (RfDs and CSFs) derived by the EPA are conservative upperbound estimates of potential toxicity or carcinogenicity of chemicals, and their use in risk assessment tends to result in an overestimate of potential risk. However, several detected compounds do not have EPA-established toxicity factors (see Table 6-33). Therefore, they could not be evaluated in a quantitative risk assessment. Some of the compounds were detected at low frequency (less than 5 percent) and at low concentrations. The exclusion of infrequently detected compounds from risk assessment is not expected to contribute to an underestimation of potential risk because, generally, their concentrations and frequency of occurrence are trivial compared to concentrations of OU-wide COCs.

However, several analytes without EPA toxicity factors were detected at greater than 5 percent frequency. These are discussed individually below.

Nickel in soil - Nickel was detected in OU 5 soil, however, it was considered inappropriate to apply a CSF. The only forms of nickel known to be carcinogenic are nickel refinery dust and nickel subsulfide via the inhalation route (EPA, 1995a). Based on historical evidence, the only indication of nickel use at RFETS is in the form of nickel carbonyl. The limited toxicity information on nickel carbonyl indicates that it is a probable human carcinogen, however, there is inadequate data for human carcinogenicity. Therefore, no toxicity values (RfD/RfC or CSFs), are available for this form of nickel. Nickel carbonyl is also highly volatile at room temperature and readily decomposes in the presence of oxygen. Because of its physical properties and the fate-and-transport characteristics of nickel carbonyl, it is unlikely that any of this compound remains onsite after 20 years. Therefore, based on the research performed on this issue, nickel was not considered a significant contributor to OU 5 risk and was not evaluated as a carcinogenic chemical.

Lead in surface and subsurface soil - Lead was detected in greater than 5 percent of surface soil and subsurface-soil samples collected in OU 5. Currently, EPA-established toxicity factors for lead are not available, and therefore HIs or cancer risk cannot be estimated for lead. Concentrations of lead in surface soil were not different than background according to statistical background comparisons (DOE, 1995a, Appendix A). However, one surface-soil result exceeded the background $UTL_{99/99}$ of 70.52 mg/kg. The EPA Revised Interim Soil Lead Guidance recommends a screening level of 400 mg/kg for residential scenarios (EPA, 1994e). The maximum detected concentration of lead in surface soil in OU 5 (129 mg/kg) was far less than EPA's screening level for residential soil, indicating that lead in surface soil would not be expected to pose a health risk, even under long-term residential exposure conditions.

Concentrations of lead in subsurface soil were shown to be different than background according to the statistical background comparison, and 15 subsurface-soil results exceeded the background $UTL_{99/99}$ of 58.93 mg/kg (DOE, 1995a, Appendix A). The maximum detected concentration of lead in subsurface soil in OU 5 (935 mg/kg) exceeded EPA's screening level of 400 mg/kg for residential surface soil (EPA, 1994e), indicating that lead in subsurface soil could possibly pose a health threat if the land use was changed to residential, and if the soils were exposed at the surface. However, all of the highest concentrations were detected in samples collected from the boreholes drilled within the ash pits (IHSSs 133.1 to 133.4) from intervals where waste materials were encountered during drilling. This suggests that the detected lead is not modile in the soil or readily available for human intake. Based on this sampling data, lead is not considered a significant contributor to the OU 5 HHRA.

<u>Lead in groundwater</u> - Lead was detected in greater than 5 percent of groundwater samples collected in OU 5. Lead was found to be above background levels in unfiltered groundwater samples but was not detected in filtered groundwater samples (DOE, 1995a, Appendix A). The maximum concentration of lead in unfiltered groundwater (240 µg/L) exceeds the federal standard for tap water (15 µg/L). However, total suspended solids (TSS) in OU 5 groundwater samples were higher than in background samples. As a result, unfiltered groundwater samples collected in OU 5 had elevated levels of numerous metals, including lead, that are associated with TSS. Based on comparing concentrations of lead in unfiltered and filtered samples (240 µg/L versus nondetect), lead in groundwater in OU 5 is not considered to be a site contaminant, but rather the result of high TSS in the samples. In addition, exposure to lead in groundwater is an incomplete pathway for all receptors in OU 5 because groundwater from OU 5 is not currently used, nor is it expected to be used in the foreseeable future.

Dibenzofuran in surface and subsurface soil: HEAST (EPA, 1994b) states that data available for dibenzofuran are inadequate for quantitative risk assessment. Dibenzofuran was detected at a relatively low frequency and similar concentrations relative to other organic COCs in these media. Thus, dibenzofuran is not expected to contribute significantly to an estimate of site risk.

Benzo(g,h,i)perylene, 2-methylnaphthylene, and phenanthrene in surface soil, subsurface soil, and seep sediment - Benzo(g,h,i)perylene, 2-methylnaphthylene, and phenanthrene were detected at frequencies above 5 percent in surface soil, and subsurface soil. The maximum concentrations of phenanthrene (170 mg/kg in surface soil and 220 mg/kg in subsurface soil) in those media were somewhat higher than concentrations of other PAHs detected, whereas the maximum concentrations of benzo(g,h,i)perylene and 2-methylnaphthylene were lower. Inadequate data are available to assess toxicity of these compounds (EPA, 1994b), and they are likely to have lower toxicity than benzo(a)pyrene (which is among the most carcinogenic of the organic COCs in these media). Because benzo(a)pyrene concentrations did not result in unacceptable risk to any receptors in these media, the exclusion of these PAHs from quantitative risk assessment would have no effect on the estimate of site risk.

Phenanthrene was the only one of these PAHs that was detected in seep sediments. The maximum concentration (0.082 mg/kg) was similar to the maximum concentrations of other PAHs (with toxicity values) that were detected in seep sediment samples. Thus, the no-risk rationale provided above also applies here.

Phenanthrene in groundwater - Phenanthrene was detected at a frequency above 5 percent in groundwater. The maximum concentration of phenanthrene (6 µg/L) in groundwater was similar to concentrations of other PAHs detected. Thus, the same rationale provided for phenanthrene in soil and sediment applies here as well.

1,1,1-Trichloroethane in groundwater - 1,1,1-Trichloroethane was detected at a greater than 5 percent frequency in seep water. The maximum concentration of 1,1,1-trichloroethane (2 µg/L) in groundwater was similar or well below the concentrations of other VOCs detected. Estimated risks from exposure to suspected carcinogenic VOCs in seep water do not pose a significant risk to human health; therefore, 1,1,1-trichloroethane would not contribute more to the risk.

Dermal exposure to PAHs in surface soil, subsurface soil, and seep sediments - EPA guidance (EPA, 1989) states that it is inappropriate to use oral CSFs to evaluate the risks associated with dermal exposure to PAHs, which can cause skin cancer through direct action at the point of application. Because these types of skin carcinogens must be evaluated separately from the standard method of assessing dermal contact, risks from dermal exposure to PAHs are addressed in this section.

The draft *Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs)* (ATSDR, 1993) was consulted for a comprehensive review of research available on the toxicity of dermal exposure to PAHs. No studies were located that gave evidence of a direct association between human dermal exposure to individual PAHs and cancer induction. However, reports of skin tumors among individuals exposed to mixtures containing PAHs lend some qualitative support to their potential for carcinogenicity in humans (e.g., scrotal cancer among chimney sweeps, and individuals dermally exposed to oil shales). These reports provide only qualitative suggestions pertaining to the human carcinogenic potential of PAHs. The PAHs listed above are classified as B2, probable human carcinogens.

Various studies in laboratory animals, primarily mice and rats, have demonstrated the ability of the above four PAHs to induce skin tumors following intermediate (subchronic) dermal exposure (ATSDR, 1993). However, it is difficult to make a correlation between long-term, consistent, direct dermal exposed of mice to PAHs and the RFETS conditions under which potential receptors would be dermally exposed to PAHs. In addition, some studies also indicate that the dose response is influenced by the type of solvent used for delivery of the PAHs, suggesting that in an environmental medium not containing associated solvents, the availability of PAHs to induce skin cancer may be significantly reduced.

In conclusion, the carcinogenic risk estimates due to dermal exposure to subsurface soil, pond sediments, and stream/dry sediments may be slightly underestimated by excluding PAHs from the total risk. The types of exposure and low concentrations of PAHs in soil/sediment suggest that dermal exposure to PAHs would not contribute significantly to the total risk estimated for any pathway and receptor.

6.6.3.4 Evaluation of Risk Associated with Arsenic

Arsenic was selected for separate evaluation of potential hazard/risk associated with ingestion of stream sediment under an open-space, recreational-use scenario. Arsenic was not identified as a COC in OU 5 stream sediment primarily because, although it failed one of the four statistical tests in the background comparison, further evaluation of arsenic concentrations in stream sediment and the background samples indicated that arsenic was probably naturally occurring (DOE, 1995a). Furthermore, there are no significant sources or historical uses of arsenic at RFETS (DOE, 1995a). However, to address concerns that arsenic could pose a health risk under long-term exposure to detected concentrations, parties to the Interagency Agreement (IAG) agreed that arsenic would be evaluated separately in the uncertainties section (DOE, 1995i). Hazard/risk results for ingestion of arsenic in stream sediment in OU 5 and in background stream sediment by an open-space recreational user are summarized in Table 6-146.

Exposure concentrations used in the evaluation were 4.88 mg/kg (95% UCL in stream sediment, AOC3) and 4.90 mg/kg (background mean plus one standard deviation).

Noncarcinogenic Hazard - The total HIs for the open-space, recreational-use exposure (child) to arsenic in AOC3 via the sediment ingestion pathway are 0.004 or less for the average and RME exposure conditions (Table 6-146). The RME HI for ingestion of background levels of arsenic in stream sediment is also 0.004. The HIs for ingestion of stream sediment arsenic by adults is even smaller. Because the HIs are well below 1, no adverse noncarcinogenic health effects are expected for onsite receptors from ingestion of arsenic in stream sediments during recreational exposure. There is no substantial difference between HIs calculated for arsenic levels in OU 5 AOC3 and for background levels.

Carcinogenic Risk - The estimated lifetime excess cancer risks for an open-space, recreational-use exposure to arsenic in OU 5 AOC3 via ingestion of stream sediment is 3E-07 or less (Table 6-146). The RME cancer risk for ingestion of background levels of arsenic in stream sediment is 3E-07, which does not differ from the risk estimates for OU 5 AOC3. Because these levels are below the EPA "point of departure" for acceptable risk and the risks from other COCs at these locations were at the lower end of the EPA target risk range (1E-06 to 1E-04), incremental risk from arsenic would not significantly affect the total cancer risk estimate for exposure to stream sediment.

6.7 RADIATION DOSE CALCULATIONS

Total radiation doses for one year of exposure (expressed as total Effective Dose Equivalent [EDE], in millirem per year [mrem/year]) were estimated for receptors exposed to radionuclides in soil, air, and other media by ingestion, inhalation, and external irradiation pathways. The estimated doses are compared to DOE radiation standards for protection of public health, also expressed in mrem/yr.

6.7.1 Methodology

This section defines the terms used in estimating annual radiation doses, explains how the doses are calculated, and describes the national annual radiation protection standards that are used for comparison to the calculated doses.

6.7.1.1 Definitions

Dose Terms

Absorbed Dose - is the energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray.)

Committed Dose Equivalent - is the predicted total dose equivalent to a tissue or organ over a 50-year period after a known intake of radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem (or sievert).

Committed Effective Dose Equivalent (CEDE) - is the sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. The CEDE is expressed in units of rem (or sievert).

Dose Equivalent - is the product of absorbed dose in rad (or gray) in tissue and a quality factor. Dose equivalent is expressed in units or rem (or sievert).

Effective Dose Equivalent (EDE) - is the summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by the particular tissue. The EDE includes the CEDE from internal deposition of radionuclides and the EDE due to penetrating radiation from sources external to the body. EDE is expressed in units or rem (or sievert).

Weighting Factor - is tissue-specific and represents the fraction of the total health risk resulting from uniform, whole-body irradiation that could be contributed to that particular tissue. The weighting factors recommended by the International Commission on Radiological Protection (ICRP) (Publication 26) and used here are:

Organ or Tissue	Weighting Factor
Gonads	0.25
Breasts	0.15
Red Bone Marrow	0.12
Lungs	0.12
Thyroid	0.03
Bone Surfaces	0.03
Remainder[1]	0.30

1 "Remainder means the five other organs with the highest dose (e.g., liver, kidney, spleen, thymus, adrenal, pancreas, stomach, small intestine, or upper and lower large intestine, but excluding skin, lens of the eye, and extremities). The weighting factor for each of these organs is 0.06.

Quality Factor - is the principal modifying factor used to calculate the dose equivalent from the absorbed dose. For the purposes of the order, the following quality factors, which are taken from DOE 5480.11, are to be used.

Radiation Type	Quality Factor
X-rays, gamma rays, positrans, and electrons (including tritium)	1
Neutrons, <10 keV	3
Neutrons, >10 keV Protons and single charged particles of unknown energy with rest mass > one atomic mass unit	10
Alpha Particles Multiple charges particles (and particles of unknown energy)	20

* For neutrons of known energies, the more detailed quality factors given in DOE 5480.11 may be used.

Radioactivity - means the property or characteristic of radioactive material to spontaneously "disintegrate" with the emission of energy in the form of radiation. The unit of radioactivity is the curie (or becquerel).

6.7.2 Calculating Annual Radiation Doses

Annual radiation doses were determined by selecting dose conversion factors and calculating the radionuclide intake for each receptor and pathway. The annual EDE was then calculated.

6.7.2.1 Selection of Dose Conversion Factors

Radionuclide-specific dose conversion factors for the CEDE were used in the calculation of EDEs for the ingestion and inhalation routes of exposure. Radionuclide-specific dose conversion factors for the EDEs were used for the external irradiation route of exposure. These values were obtained from the EPA "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," (EPA, 1988d) for the inhalation and ingestion route of exposure, and from the "External Exposure to Radionuclides in Air, Water, and Soil" (EPA, 1993a).

For some radionuclides, dose conversion factors (DCF) vary based on the chemical species (e.g., oxidation state or mineralized form) of the radionuclide. Differences in DCFs for the ingestion route of exposure reflect differences in fractional uptake (f_1) of radionuclide species from the small intestine to blood. Less soluble radionuclide forms have smaller DCFs than more soluble forms, because the less soluble forms are absorbed to a lesser degree from the gastrointestinal tract into the bloodstream (EPA, 1988d). Because the form of radionuclides is not known, the most conservative (or greatest f_1) was used for the most conservative estimate of radionuclide intake via ingestion. Table 6-147 lists the fractional uptakes and ingestion DCFs (in sievert/becquerel [Sv/Bq]) for each radionuclide of concern.

DCFs for the inhalation route of exposure also vary based on the chemical species of the radionuclide. The different DCFs reflect the difference in the rates that radionuclide species are cleared from the lungs. Lung clearance rates are classified as days (D), weeks (W), or years (Y). In general, less soluble forms of the radionuclide are cleared from the lungs more slowly than more soluble forms. Once again, the species of each radionuclide of concern is not known, therefore the most conservative lung clearance class was used to determine radionuclide intake via inhalation. Table 6-147 lists the most conservative lung clearance class and corresponding inhalation DCF (in Sv/Bq) for each radionuclide of concern. A check was performed to ensure that the f_1 value and the lung clearance class were compatible and that the combination gave the highest combined ingestion and inhalation CEDE.

For the external irradiation route of exposure, the DCF is the annual EDE received (mrem/yr) from exposure to radiation from each radionuclide present external to the body. The radiation field is assumed to be equal to the radiation level at a distance of 1 m above the ground surface. The DCFs for external radiation exposure from surface soil were taken from an EPA report (EPA, 1993a) and are listed in terms of mrem/year per μCi/gram in Table 6-147.

6.7.2.2 Ingestion and Inhalation Routes of Exposure

For the inhalation and ingestion routes of exposure, annual intake of radionuclides, expressed in pCi/yr, is first calculated using equation (6-10).

$$\text{Intake (pCi/year)} = C \times IR \times EF \qquad (6\text{-}10)$$

where

C = Activity concentration at the exposure point (pCi/g, pCi/L, or pCi/m^3)
IR = Intake rate (mg/day, L/day, m^3/day)
EF = Exposure frequency (days/year).

Exposure factors used in calculating annual radionuclide intake for specific receptors and pathways are identical to the exposure factors used in the intake equations in Sections 6.4.2.1 through 6.4.2.6. The annual intake of each radionuclide in pCi/year is multiplied by the CEDE DCF (mrem/pCi or Sv/Bq) from Table 6-147 to estimate the CEDE for 1 year (mrem/year).

6.7.2.3 External Irradiation

For the external irradiation route of exposure, a concentration in soil (pCi-yr/gram) is calculated using equation (6-11):

$$C\left(\frac{\text{pCi - Yr}}{\text{gram}}\right) = C \times ED \times EF \times (1\text{-}Se) \times Te \qquad (6\text{-}11)$$

where

C = Mass activity concentration at the exposure point (pCi/g-soil)
ED = Exposure Duration (1 year)
EF_r = Exposure frequency ratio (unitless)
Se = Gamma shielding factor (unitless)
Te = Gamma exposure factor (unitless).

The concentration of each radionuclide in soil (in pCi-year/gram) is multiplied by the dose conversion factor for external radiation (mrem/year per pCi/gram) (Table 6-147) to estimate the annual EDE (mrem) for each radionuclide.

6.7.2.4 Estimating Annual Radiation Dose

The sum of CEDEs from all radionuclides taken into the body in a year, added to the EDEs for all radionuclides external to the body, is compared to radiation protection standards, which also reflect this sum.

Annual radiation doses were estimated for all receptors and exposure areas. The results are summarized (Tables 6-148 through 6-150) and compared to radiation protection standards in the following sections.

6.7.3 Radiation Protection Standards

DOE Order 5480.11, Radiation Protection for Occupational Workers, limits radiation exposure of radiological workers to 50 mSv/year (5,000 mrem/yr). DOE Order 5400.5, Radiation Protection of the Public and the Environment, limits the annual radiation dose limit for members of the public to 1 mSv/year (100 mrem/year) for all routes of exposure. The occupational limit for general employees (i.e., those not considered to be radiological workers) may be 100 mrem/year to 5,000 mrem/year depending on employment circumstances. However, general employees who have not completed Radiological Worker I or II Training are not to have permitted to have unescorted access to any area in which they are expected to receive doses in excess of 100 mrem in one year. General employees who have not received Radiological Worker I or II Training are not normally expected to exceed 100 mrem in a year. These values are for radiation doses received in addition to that from natural background radiation (U.S. average background radiation is approximately 300 mrem/year; NCRP, 1987) and that received from routine medical treatments (U.S. average is approximately 50 mrem/year; NCRP, 1987). Background levels in the Denver area are estimated to range from 350 to 700 mrem/year; these levels are higher than the national average because of high levels of radium, thorium, and radon in native rock and soils and because cosmic radiation exposure increases with increased altitude (NCRP, 1987).

6.7.4 Point Estimates of Annual Radiation Dose

Annual radiation doses in terms of mrem/year were calculated for onsite receptors in AOC1, AOC2, and AOC3. Results are summarized in Tables 6-148 through 6-150.

6.7.4.1 Future Construction Worker

Radionuclide exposure pathways evaluated for the current worker were:

- Ingestion of surface soil
- Ingestion of subsurface soil
- Inhalation of airborne particle
- External irradiation from subsurface soil

The future construction worker is a potential receptor in AOC1 and AOC2. As discussed in Section 6.6.2.1, the construction worker receptor is not a receptor in AOC3. The total annual radiation dose for the construction worker in AOC1 is 7.1E-02 mrem/year for the CT exposure condition and 3.6E-01 mrem/year for the RME conditions (Table 6-148). The total annual radiation dose for the construction worker in AOC2 is 3.1E-02 mrem/year for the average (CT) exposure condition and 1.3E-01 mrem/year for the RME condition (Table 6-149). These values are below the DOE limits for radiological workers (5,000 mrem/year) and members of the public (100 rem/year).

6.7.4.2 Current Worker (Security Worker)

Radionuclide exposure pathways evaluated for the current worker were:

- Ingestion of surface soil
- Inhalation of airborne particles
- External irradiation from surface soil

The future construction worker is a potential receptor in AOC1 and AOC2 and not in AOC3. The total annual dose for the current worker in AOC1 is 1.8E-01 mrem/year for the CT exposure conditions and 5.4E-01 mrem/year for the RME conditions (Table 6-148). The total annual radiation dose for the current worker in AOC2 is 3.2E-02 mrem/year for the average (CT) exposure condition and 9.9E-02 mrem/year for the RME condition (Table 6-149). These values are below the DOE limits for radiological workers (5,000 mrem/year) and members of the public (100 rem/year).

6.7.4.3 Future Ecological Researcher

The future ecological researcher is an applicable pathway for all AOCs. However, AOC3 pathway varied from AOC1 and AOC2 pathways, because of the unique nature of AOC3. Radionuclide exposure pathways evaluated for the ecological researcher in AOC1 and AOC2 were:

- Ingestion of surface soil
- Inhalation of airborne particles
- Ingestion of seep sediments
- External irradiation from surface soil

Radionuclide exposure pathways for the ecological researcher in AOC3 were:

- Ingestion of pond sediments
- Ingestion of stream sediments
- Ingestion of surface water

The total annual dose for the future ecological researcher in AOC1 is 1.9E-01 mrem/year for the CT exposure conditions and 2.6E-01 mrem/year for the RME conditions (Table 6-148). The total annual radiation dose for the ecological researcher in AOC2 is 6.2E-02 mrem/year for the average (CT) exposure condition and 5.9E-02 mrem/year for the RME condition (Table 6-149). The total annual dose for AOC3 was estimated as 4.1E-02 mrem/yr for the CT conditions and 1.3E-01 mrem/year for the RME conditions. These values are below the DOE limits for radiological workers (5,000 mrem/year) and members of the public (100 rem/year).

6.7.4.4 Future Office Worker

The future office worker is a potential receptor in only AOC1 and AOC2. The office worker is not an applicable receptor in AOC3. Radionuclide exposure pathways for the office worker were the same as for the current worker. The total annual dose for the office worker in AOC1 is 1.6E-01 mrem/year for the CT exposure conditions and 3.2E-01 mrem/year for the RME conditions (Table 6-148). The total annual dose for the future office worker in AOC2 is 2.5E-02 mrem/year for the average (CT) conditions, and 9.9E-02 for the RME conditions (Table 6-149). These values are below the DOE limits for radiological workers (5,000 mrem/year) and members of the public (100 rem/year).

6.7.4.5 Future Open-Space User

Radionuclide exposure pathways for the adult recreational user were the same as for the ecological worker. The total annual dose for the adult receptor in AOC1 is 1.7E-02 mrem/year for the CT exposure conditions and 6.0E-02 mrem/year for the RME conditions (Table 6-148). Annual doses for the adult user in AOC2 is 3.3E-03 mrem/year for CT exposure conditions, and 1.3E-02 mrem/yr for RME condition (Table 6-149). The radionuclide exposure pathways for AOC3 were the same as the AOC3 exposure pathways for the future ecological researcher. The total annual dose for the adult recreational user in AOC3 is 4.8E-03 mrem/year for CT conditions, and 2.5E-02 mrem/yr for RME exposure conditions (Table 6-150). These values are below the DOE limits for radiological workers (5,000 mrem/year) and members of the public (100 rem/year).

Radionuclide exposure pathways for the child open-space user in AOC1 and AOC2 were:

- Ingestion of surface soil
- Ingestion of seep sediments

The total annual dose for the child receptor in AOC1 is 6.2E-03 mrem/yr for CT conditions, and 6.2E-02 mrem/year for RME exposure conditions (Table 6-148). The total annual dose for the child open space user in AOC2 is 1.7E-03 mrem/year for CT exposure conditions and 5.8E-02 mrem/year for RME conditions. The radionuclide exposure pathways for the child receptor in AOC3 were the same as those for the adult open-space user. The total annual dose for the child open-space user in AOC3 is 9.6E-03 mrem/year for CT conditions, and 4.8E-02 mrem/year for RME exposure conditions (Table 6-150).

6.7.5 Summary of Results

Annual radiation dose calculations were performed for six onsite receptors in AOC1 and AOC2. Annual radiation dose calculations were performed for 3 on receptors (ecological researcher, adult and child open-space users) in AOC3. Dose conversion factors for radionuclide ingestion, inhalation, and external irradiation are listed in Table 6-147. Results are provided in Tables 6-148 through 6-150.

Exposure pathways evaluated were soil/sediment ingestion, inhalation of particles from soil, ingestion of surface water (AOC3 only), and external irradiation from surface soil. Additional pathways evaluated for the future ecological researcher and future open-space user (adult and child) in AOC3 were ingestion of pond sediments and ingestion of stream sediments.

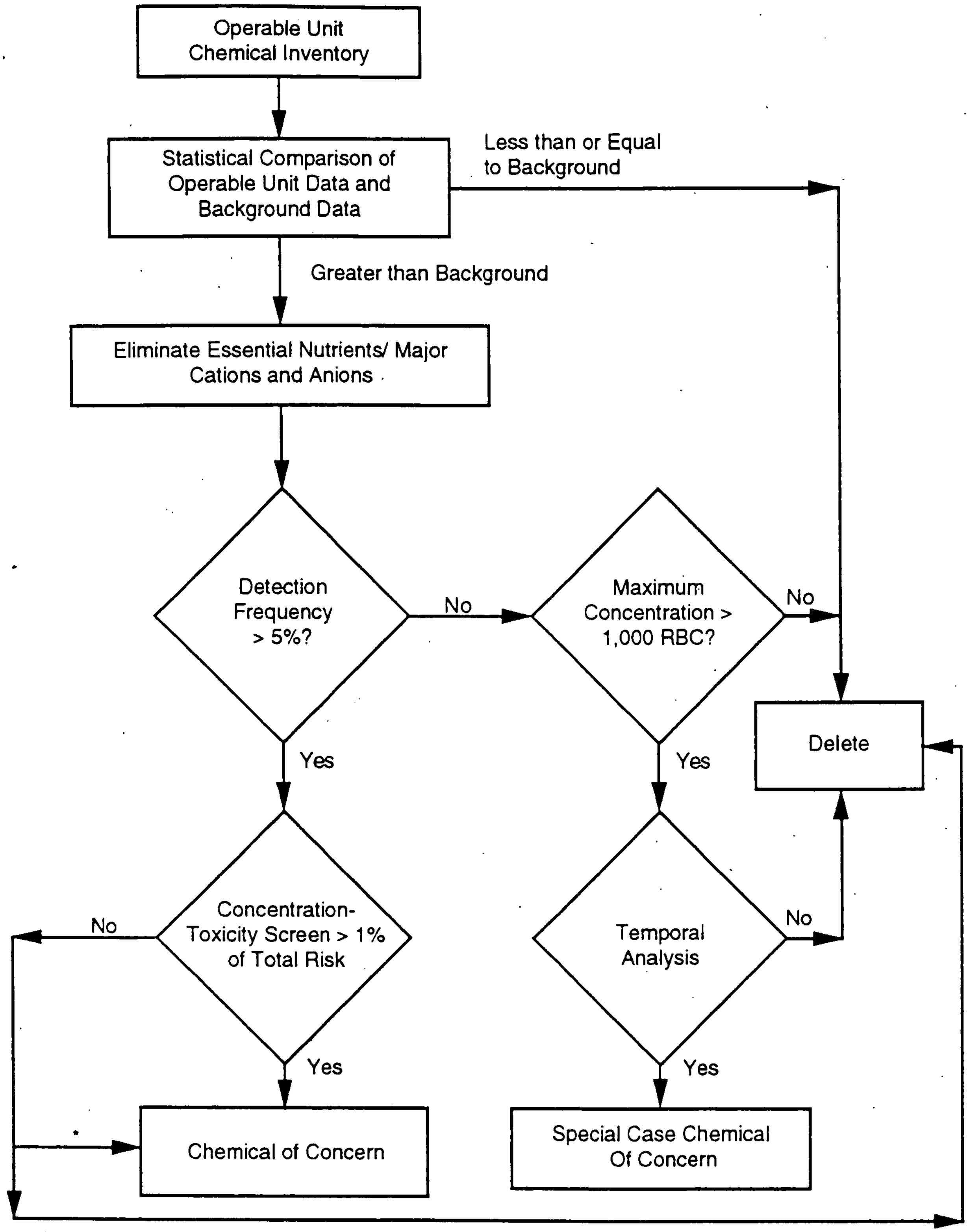
Total annual radiation doses for all receptors in all AOCs were less than 1, which falls below the DOE limit of 100 mrem/yr for members of the public and indicates that exposure to radionuclides in OU 5 is negligible.

6.8 RISK ASSESSMENT SUMMARY

The results of the risk and health effect calculations for all applicable receptors and pathways are summarized in Tables 6-143 and 6-144. The greatest total estimated risk was for the future office worker in AOC1, and is 3E-05. However, it is unlikely that an office building will be built on the landfill. The driving pathway is exposure to external radiation and the dominant COC is uranium-238. The greatest total estimated noncarcinogenic health effect was for the future office worker in AOC1 and is calculated to be 0.05. The driving pathway is dermal absorption of surface soil and the dominant COC is Aroclor-1254 in surface soil.

Although the highest calculated risk is still within the National Oil and Hazardous Substances Pollution Contingency Plan (NAP) target risk range of 1E-06 to 1E-04, some additional receptors and locations are mentioned here for comparison. The total RME estimated risk for a current security worker in AOC1 was calculated to be 2E-06, and the current security worker in AOC2 was estimated to be 3E-06. The estimated RME risk for a future open-space user in AOC1 and AOC2 is 6E-06 and 1E-06, respectively; a future office worker in AOC2 is 4E-06; and an ecological researcher in AOC1 is 1E-06. All other receptors and respective pathways had total RME risks estimated to be less than 1E-06. Respective total CT estimated risks for the future office worker at AOC1 were calculated to be 2E-06. No other CT risk estimates exceeded 1E-06.

Because RME total risk and RME HI estimates did not exceed 1E-04 and unity, respectively, a quantitative uncertainty analysis was not completed. Qualitative discussions of uncertainty are contained in Section 6.6.3, and a summary of the uncertainties and limitations is contained in Table 6-145. Uncertainties in this risk assessment are due to uncertainties in the risk assessment process in general, specific uncertainties in characterizing RFETS, and the uncertainties and limitations specific to this assessment. In general, health-protective assumptions were used such that the magnitude of human health risks are expected to be less than those calculated, even with errors due to uncertainty in the approach. This process bounds the plausible upper limits of risk and facilitates an informed risk management decision. Information regarding the uncertainty in quantifying intakes, toxicological and carcinogenic response, credibility of future exposure scenarios, and the magnitude of "background" risks, will be used by the risk manager for regulatory decision-making.



• Professional Judgement Applied

COC SELECTION PROCESS

DRAWN ____ DATE ____

CHECKED ____ DATE ____

APPROVED ____ DATE ____

F6-2.DRW

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 6-2

Tables 6-1 through 6-150

155 pages

Table 6-1
Rocky Flats OU 5 Concentration/Toxicity Screen of Noncarcinogens in Surface Soil

PCOC	Maximum Concentration (mg/kg)	RfD (mg/kg-day) [a]	Type of RfD [b]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Noncarcinogens							
Acenaphthene	4.40E+01	6.00E-02	o	7.33E+02	3.09E-03	0.31%	No
Anthracene	4.70E+01	3.00E-01	o	1.57E+02	6.60E-04	0.07%	No
Aroclor-1254	3.90E+00	2.00E-05	o	1.95E+05	8.21E-01	82.12%	Yes
Benzo(g,h,i)perylene	6.90E+00	n/a		-	-	-	No
Benzoic acid	7.70E-01	4.00E+00	o	1.93E-01	8.11E-07	0.00%	No
Bis(2-ethylhexyl)phthalate	2.00E-01	2.00E-02	o	1.00E+01	4.21E-05	0.00%	No
Cobalt	1.37E+01	6.00E-02	o	2.28E+02	9.62E-04	0.10%	No
Copper	1.84E+02	4.00E-02	o	4.60E+03	1.94E-02	1.94%	Yes
Di-n-butylphthalate	4.25E-01	1.00E-01	o	4.25E+00	1.79E-05	0.00%	No
Dibenzofuran	2.00E+01	n/a		-	-	-	No
Fluoranthene	1.40E+02	4.00E-02	o	3.50E+03	1.47E-02	1.47%	Yes
Fluorene	3.90E+01	4.00E-02	o	9.75E+02	4.11E-03	0.41%	No
Lead	1.29E+02	n/a		-	-	-	No
Mercury	6.60E-01	8.57E-05	i	7.70E+03	3.24E-02	3.24%	Yes
2-Methylnaphthalene	1.20E+01	n/a		-	-	-	No
Napthalene	4.10E+01	4.00E-02	o	1.03E+03	4.32E-03	0.43%	No
Phenanthrene	1.70E+02	n/a		-	-	-	No
Pyrene	1.20E+02	3.00E-02	o	4.00E+03	1.68E-02	1.68%	Yes
Silver	9.43E+01	5.00E-03	o	1.89E+04	7.94E-02	7.94%	Yes
Zinc	1.99E+02	3.00E-01	o	6.63E+02	2.79E-03	0.28%	No
		Total Risk Factor (Rj)	=	2.37E+05	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation reference dose is used.
(b) o = oral, i = inhalation
(n/a) Applicable toxicological criteria is not available.

Table 6-2
Rocky Flats OU 5 Concentration/Toxicity Screen of Carcinogens in Surface Soil

PCOC	Maximum Concentration (mg/kg)	Slope Factor (mg/kg-day)$^{-1}$ (a)	Type of Slope Factor (b)	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Carcinogens							
Aroclor-1254	3.90E+00	7.70E+00	o	3.00E+01	6.33E-02	6.33%	Yes
Benzo(a)anthracene	4.50E+01	7.30E-01	o	3.29E+01	6.92E-02	6.92%	Yes
Benzo(a)pyrene	4.10E+01	7.30E+00	o	2.99E+02	6.31E-01	63.07%	Yes
Benzo(b)fluoranthene	4.90E+01	7.30E-01	o	3.58E+01	7.54E-02	7.54%	Yes
Benzo(k)fluoranthene	2.50E+01	7.30E-02	o	1.83E+00	3.85E-03	0.38%	No
Bis(2-ethylhexyl)phthalate	2.00E-01	1.40E-02	o	2.80E-03	5.90E-06	0.00%	No
Chrysene	4.60E+01	7.30E-03	o	3.36E-01	7.08E-04	0.07%	No
Dibenzo(a,h)anthracene	7.00E+00	7.30E+00	o	5.11E+01	1.08E-01	10.77%	Yes
Indeno(1,2,3-cd)pyrene	3.20E+01	7.30E-01	o	2.34E+01	4.92E-02	4.92%	Yes
		Total Risk Factor (Rj)	=	4.75E+02	Total %	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral

Table 6-3
Rocky Flats OU5 Concentration/Toxicity Screen of Radionuclides in Surface Soil

PCOC	Maximum Concentration (pCi/g)	Slope Factor (risk/pCi) [(a)]	Type of Slope Factor [(b)]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Radionuclides							
Americium - 241	8.00E-01	3.20E-08	i	2.56E-08	2.55E-05	0.00%	No
Plutonium - 239/240	5.01E+00	3.80E-08	i	1.90E-07	1.90E-04	0.02%	No
Uranium - 233/234	2.80E+03 [(c)]	2.70E-08	i	7.56E-05	7.53E-02	7.53%	Yes
Uranium - 235	6.70E+02 [(c)]	2.50E-08	i	1.68E-05	1.67E-02	1.67%	Yes
Uranium - 238	3.80E+04 [(c)]	2.40E-08	i	9.12E-04	9.08E-01	90.79%	Yes
		Total Risk Factor (Rj)	=	1.00E-03	Total % =	100%	

Notes:

(a) The most conservative of the oral or inhalation slope factor is used.
(b) i = inhalation
(c) A hot spot removal program was conducted during August and September 1993 to remove the sources of high radioactivity (visible chunks of uranium-contaminated metals) in the landfill soils. The area where removal occurred was then surveyed with the Fidler for verification.

Table 6-4

Rocky Flats OU 5 Concentration/Toxicity Screen of Noncarcinogens in Subsurface Soil

PCOC	Maximum Concentration (mg/kg)	RfD (mg/kg-day) [(a)]	Type of RfD [(b)]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Noncarcinogens							
Acenaphthene	3.10E+01	6.00E-02	o	5.17E+02	4.67E-04	0.05%	No
Acetone	2.80E-01	1.00E-01	o	2.80E+00	2.53E-06	0.00%	No
Anthracene	4.60E+01	3.00E-01	o	1.53E+02	1.39E-04	0.01%	No
Antimony	1.49E+02	4.00E-04	o	3.73E+05	3.37E-01	33.69%	Yes
Aroclor-1254	9.60E-01	2.00E-05	o	4.80E+04	4.34E-02	4.34%	Yes
Barium	6.83E-01	1.40E-04	i	4.88E+03	4.41E-03	0.44%	No
Benzo(g,h,i)perylene	1.90E+01	n/a		-	-	-	No
2-Butanone	6.90E-02	2.90E-01	i	2.38E-01	2.15E-07	0.00%	No
Benzoic acid	9.74E-01	4.00E+00	o	2.44E-01	2.20E-07	0.00%	No
Beryllium	1.31E+02	5.00E-03	o	2.62E+04	2.37E-02	2.37%	Yes
Bis(2-ethylhexyl)phthalate	2.90E-01	2.00E-02	o	1.45E+01	1.31E-05	0.00%	No
Cadmium	5.69E+01	5.00E-04	o	1.14E+05	1.03E-01	10.29%	Yes
Chromium	8.31E+03	1.00E+00	o	8.31E+03	7.52E-03	0.75%	No
Cobalt	6.76E+01	6.00E-02	o	1.13E+03	1.02E-03	0.10%	No
Copper	6.92E+03	4.00E-02	o	1.73E+05	1.56E-01	15.65%	Yes
Dibenzofuran	2.00E+01	n/a		-	-	-	No
Fluoranthene	1.60E+02	4.00E-02	o	4.00E+03	3.62E-03	0.36%	No
Fluorene	3.50E+01	4.00E-02	o	8.75E+02	7.91E-04	0.08%	No
Lead	9.35E+02	n/a		-	-	-	No
Methylene chloride	6.60E-02	6.00E-02	o	1.10E+00	9.95E-07	0.00%	No
2-Methylnaphthalene	1.50E+01	n/a		-	-	-	No
Molybdenum	1.90E+02	5.00E-03	o	3.80E+04	3.44E-02	3.44%	Yes
Naphthalene	6.10E+01	4.00E-02	o	1.53E+03	1.38E-03	0.14%	No
Nickel	4.75E+03	2.00E-02	o	2.38E+05	2.15E-01	21.48%	Yes
Phenanthrene	2.20E+02	n/a		-	-	-	No
Pyrene	1.50E+02	3.00E-02	o	5.00E+03	4.52E-03	0.45%	No
Silver	3.11E+02	5.00E-03	o	6.22E+04	5.63E-02	5.63%	Yes
Tetrachloroethene	9.20E-01	1.00E-02	o	9.20E+01	8.32E-05	0.01%	No
Toluene	3.10E-01	1.14E-01	i	2.72E+00	2.46E-06	0.00%	No
Zinc	2.39E+03	3.00E-01	o	7.97E+03	7.21E-03	0.72%	No
		Total Risk Factor (Rj)	=	1.11E+06	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation reference dose is used.

(b) o = oral, i = inhalation

(n/a) Applicable toxicological criteria is not available.

Table 6-5
Rocky Flats OU 5 Concentration/Toxicity Screen of Carcinogens in Subsurface Soil

PCOC	Maximum Concentration (mg/kg)	Slope Factor (mg/kg-day)^-1 (a)	Type of Slope Factor (b)	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Carcinogens							
Aroclor-1254	9.60E-01	7.70E+00	o	7.39E+00	3.95E-03	0.39%	No
Benzo(a)anthracene	4.80E+01	7.30E-01	o	3.50E+01	1.87E-02	1.87%	Yes
Benzo(a)pyrene	4.30E+01	7.30E+00	o	3.14E+02	1.68E-01	16.76%	Yes
Benzo(b)fluoranthene	4.80E+01	7.30E-01	o	3.50E+01	1.87E-02	1.87%	Yes
Benzo(k)fluoranthene	1.90E+01	7.30E-02	o	1.39E+00	7.40E-04	0.07%	No
Beryllium	1.31E+02	8.40E+00	i	1.10E+03	5.87E-01	58.74%	Yes
Bis(2-ethylhexyl)phthalate	2.90E-01	1.40E-02	o	4.06E-03	2.17E-06	0.00%	No
Cadmium	5.69E+01	6.30E+00	i	3.58E+02	1.91E-01	19.14%	Yes
Chrysene	5.30E+01	7.30E-03	o	3.87E-01	2.07E-04	0.02%	No
Dibenzo(a,h)anthracene	7.00E-01	7.30E+00	o	5.11E+00	2.73E-03	0.27%	No
Indeno(1,2,3-cd)pyrene	2.20E+01	7.30E-01	o	1.61E+01	8.57E-03	0.86%	No
Methylene chloride	6.60E-02	7.50E-03	o	4.95E-04	2.64E-07	0.00%	No
Tetrachloroethene	9.20E-01	5.20E-02	o	4.78E-02	2.55E-05	0.00%	No
Trichloroethene	4.40E-01	1.10E-02	o	4.84E-03	2.58E-06	0.00%	No
		Total Risk Factor (Rj)	=	1.87E+03	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.
(b) o = oral, i = inhalation

Table 6-6
Rocky Flats OU 5 Concentration/Toxicity Screen of Radionuclides in Subsurface Soil

PCOC	Maximum Concentration (pCi/g)	Slope Factor (risk/pCi) (a)	Type of Slope Factor (b)	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Radionuclides							
Americium - 241	6.10E-01	3.20E-08	i	1.95E-08	6.04E-04	0.06%	No
Plutonium - 239/240	3.20E+00	3.80E-08	i	1.22E-07	3.76E-03	0.38%	No
Uranium - 233/234	1.26E+02 (c)	2.70E-08	i	3.40E-06	1.05E-01	10.52%	Yes
Uranium - 235	3.77E+01 (c)	2.50E-08	i	9.43E-07	2.92E-02	2.92%	Yes
Uranium -238	1.16E+03 (c)	2.40E-08	i	2.78E-05	8.61E-01	86.12%	Yes
		Total Risk Factor (Rj)	=	3.23E-05	Total % =	100%	

Notes:

(a) The most conservative of the oral or inhalation slope factor is used.
(b) i = inhalation
(c) A hot spot removal program was conducted during August and September 1993 to remove the sources of high radioactivity (visible chunks of uranium-contaminated metals) in the landfill soils. The area where removal occurred was then surveyed with the Fidler for verification. These maximum concentrations were retained in the data sets because they may represent other hotspots located in the landfill.

Table 6-7
Rocky Flats OU 5 Concentration/Toxicity Screen of Noncarcinogens in Groundwater

PCOC	Maximum Concentration (mg/L) [(a)]	RfD (mg/kg-day) [(b)]	Type of RfD [(c)]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Noncarcinogens							
Acenaphthene	5.00E-03	6.00E-02	o	8.33E-02	2.69E-05	0.00%	No
Aluminum	3.57E+02	2.90E+00	o	1.23E+02	3.97E-02	3.97%	Yes
Barium	3.04E+00	7.00E-02	o	4.34E+01	1.40E-02	1.40%	Yes
Beryllium	2.94E-02	5.00E-03	o	5.88E+00	1.89E-03	0.19%	No
Bis(2-ethylhexyl)phthalate	3.00E-03	2.00E-02	o	1.50E-01	4.83E-05	0.00%	No
Cadmium	8.20E-03	5.00E-04	o	1.64E+01	5.29E-03	0.53%	No
Chromium	4.42E-01	1.00E+00	o	4.42E-01	1.42E-04	0.01%	No
Cobalt	1.61E-01	6.00E-02	o	2.68E+00	8.65E-04	0.09%	No
Copper	4.20E-01	4.00E-02	o	1.05E+01	3.38E-03	0.34%	No
Di-n-butylphthalate	2.00E-03	1.00E-01	o	2.00E-02	6.45E-06	0.00%	No
Diethylphthalate	6.00E-03	8.00E-01	o	7.50E-03	2.42E-06	0.00%	No
Fluoranthene	4.00E-03	4.00E-02	o	1.00E-01	3.22E-05	0.00%	No
Fluorene	4.00E-03	4.00E-02	o	1.00E-01	3.22E-05	0.00%	No
Lead	2.40E-01	n/a		-	-	-	No
Lithium	3.06E-01	2.00E-02	o	1.53E+01	4.93E-03	0.49%	No
Manganese	1.37E+01	5.00E-03	o	2.74E+03	8.83E-01	88.30%	Yes
Mercury	3.00E-03	3.00E-04	o	1.00E+01	3.22E-03	0.32%	No
Molybdenum	1.80E-02	5.00E-03	o	3.60E+00	1.16E-03	0.12%	No
Naphthalene	1.30E-02	4.00E-02	o	3.25E-01	1.05E-04	0.01%	No
Nickel	3.13E-01	2.00E-02	o	1.57E+01	5.04E-03	0.50%	No
Phenanthrene	6.00E-03	n/a		-	-	-	No
Pyrene	6.50E-03	3.00E-02	o	2.17E-01	6.98E-05	0.01%	No
Silicon	3.54E+02	n/a		-	-	-	No
Silver	5.32E-02	5.00E-03	o	1.06E+01	3.43E-03	0.34%	No
Strontium	2.58E+00	6.00E-01	o	4.29E+00	1.38E-03	0.14%	No
Tin	3.00E-01	6.00E-01	o	5.00E-01	1.61E-04	0.02%	No
Vanadium	6.74E-01	7.00E-03	o	9.63E+01	3.10E-02	3.10%	Yes
Zinc	9.82E-01	3.00E-01	o	3.27E+00	1.05E-03	0.11%	No
		Total Risk Factor (Rj)	=	3.10E+03	Total % =	100%	

Notes:
(a) The more conservative total analyte maximum concentrations is used.
(b) Only oral reference doses are used for inorganic compounds.
(c) o = oral
(n/a) Applicable toxicological criteria is not available.

Table 6-8
Rocky Flats OU 5 Concentration/Toxicity Screen of Carcinogens in Groundwater

PCOC	Maximum Concentration (mg/L) [a]	Slope Factor $(mg/kg\text{-}day)^{-1}$ [b]	Type of Slope Factor [c]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Carcinogens							
Beryllium	2.94E-02	4.30E+00	o	1.26E-01	1.00E+00	99.97%	Yes
Bis(2-ethylhexyl)phthalate	3.00E-03	1.40E-02	o	4.20E-05	3.32E-04	0.03%	No
		Total Risk Factor (Rj)	=	1.26E-01	Total %	100%	

Notes:
(a) The more conservative total analyte maximum concentrations is used.
(b) Only oral slope factors are used.
(c) o = oral, i = inhalation

Table 6-9
Rocky Flats OU 5 Concentration/Toxicity Screen of Radionuclides in Groundwater

PCOC	Maximum Concentration (pCi/L) [a]	Slope Factor (risk/pCi) [b]	Type of Slope Factor [c]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Radionuclides							
Americium - 241	2.00E-01	2.40E-10	o	4.80E-11	1.89E-02	1.89%	Yes
Plutonium - 238	1.00E-02	2.20E-10	o	2.20E-12	8.64E-04	0.09%	No
Plutonium - 239/240	1.04E+00	2.30E-10	o	2.39E-10	9.40E-02	9.40%	Yes
Radium -226	4.40E+00	1.20E-10	o	5.28E-10	2.07E-01	20.74%	Yes
Uranium - 233/234	4.90E+01	1.60E-11	o	7.84E-10	3.08E-01	30.80%	Yes
Uranium - 235	4.00E+00	1.60E-11	o	6.40E-11	2.51E-02	2.51%	Yes
Uranium -238	4.40E+01	2.00E-11	o	8.80E-10	3.46E-01	34.57%	Yes
		Total Risk Factor (Rj)	=	2.55E-09	Total % =	100%	

Notes:
(a) The more conservative total analyte maximum concentrations is used.
(b) Only oral slope factors are used.
(c) o = oral

Table 6-10
Rocky Flats OU 5 Concentration/Toxicity Screen of Noncarcinogens in Surface Water

PCOC	Maximum Concentration (mg/L) [a]	RfD (mg/kg-day) [b]	Type of RfD [c]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Noncarcinogens							
Barium	1.87E-01	7.00E-02	o	2.67E+00	6.25E-01	62.54%	Yes
Lithium	1.38E-02	2.00E-02	o	6.90E-01	1.62E-01	16.15%	Yes
Strontium	5.46E-01	6.00E-01	o	9.10E-01	2.13E-01	21.30%	Yes
		Total Risk Factor (Rj)	=	4.27E+00	Total % =	100%	

Notes:
(a) The more conservative total analyte maximum concentrations is used.
(b) The most restrictive of the oral or inhalation reference dose is used.
(c) o = oral

Table 6-11
Rocky Flats OU 5 Concentration/Toxicity Screen of Radionuclides in Surface Water

PCOC	Maximum Concentration (pCi/L) [a]	Slope Factor (risk/pCi) [b]	Type of Slope Factor [c]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Radionuclides							
Americium - 241	3.80E-01	2.40E-10	o	9.12E-11	2.98E-01	29.81%	Yes
Uranium - 233/234	4.67E+00	1.60E-11	o	7.47E-11	2.44E-01	24.42%	Yes
Uranium -238	7.00E+00	2.00E-11	o	1.40E-10	4.58E-01	45.76%	Yes
		Total Risk Factor (Rj)	=	3.06E-10	Total % =	100%	

Notes:
(a) The more conservative total analyte maximum concentrations is used.
(b) The most restrictive of the oral or inhalation slope factor is used.
(c) o = oral

Table 6-12
Rocky Flats OU 5 Concentration/Toxicity Screen of Noncarcinogens in Seep Water

PCOC	Maximum Concentration (mg/L) [a]	RfD (mg/kg-day) [b]	Type of RfD [c]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Noncarcinogens							
Acetone*	6.50E-02	1.00E-01	o	6.50E-01	1.50E-01	14.98%	Yes
1,1-Dichloroethene	4.00E-03	9.00E-03	o	4.44E-01	1.02E-01	10.24%	Yes
1,2-Dichloroethene	4.00E-03	9.00E-03	o	4.44E-01	1.02E-01	10.24%	Yes
Tetrachloroethene	2.80E-02	1.00E-02	o	2.80E+00	6.45E-01	64.53%	Yes
1,1,1-Trichloroethane	2.00E-03	n/a	-	-	-	-	No
		Total Risk Factor (Rj)	=	4.34E+00	Total % =	100%	

Notes:
* Possibe laboratory contaminant.
(a) The most restrictive of the oral or inhalation reference dose is used.
(b) o = oral
(n/a) Applicable toxicological criteria is not available.

Table 6-13
Rocky Flats OU 5 Concentration/Toxicity Screen of Carcinogens in Seep Water

PCOC	Maximum Concentration (mg/L)	Slope Factor $(mg/kg\text{-}day)^{-1}$ (a)	Type of Slope Factor (b)	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Carcinogens							
1,1-Dichloroethene	4.00E-03	1.20E+00	i	4.80E-03	7.58E-01	75.79%	Yes
Tetrachloroethene	2.80E-02	5.20E-02	o	1.46E-03	2.30E-01	22.99%	Yes
Trichloroethene	7.00E-03	1.10E-02	o	7.70E-05	1.22E-02	1.22%	Yes
		Total Risk Factor (Rj)	=	6.33E-03	Total % =	100%	

Notes:
(a) The most restrictive of the oral or inhalation slope factor is used.
(b) o = oral, i = inhalation

Table 6-14
Rocky Flats OU 5 Concentration/Toxicity Screen of Noncarcinogens in Pond Sediment

PCOC	Maximum Concentration (mg/kg)	RfD (mg/kg-day) [a]	Type of RfD [b]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Noncarcinogens							
Benzoic acid	4.10E-01	4.00E+00	o	1.03E-01	5.30E-06	0.00%	No
Di-n-butylphthalate	1.10E-01	1.00E-01	o	1.10E+00	5.68E-05	0.01%	No
Fluoranthene	1.40E-01	4.00E-02	o	3.50E+00	1.81E-04	0.02%	No
Mercury	1.60E+00	8.57E-05	i	1.87E+04	9.65E-01	96.49%	Yes
Phenol	1.50E-01	6.00E-01	o	2.50E-01	1.29E-05	0.00%	No
Toluene	5.63E-01	1.10E-01	i	5.11E+00	2.64E-04	0.03%	No
Zinc	2.01E+02	3.00E-01	o	6.70E+02	3.46E-02	3.46%	Yes
		Total Risk Factor (Rj)	=	1.93E+04	Total % =	100%	

Notes:
(a) The most restrictive of the oral or inhalation reference dose is used.
(b) o = oral, i = inhalation
(n/a) Applicable toxicological criteria is not available.

Table 6-15
Rocky Flats OU 5 Concentration/Toxicity Screen of Radionuclides in Pond Sediment

PCOC	Maximum Concentration (pCi/g)	Slope Factor (risk/pCi) [a]	Type of Slope Factor [b]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Radionuclides							
Americium - 241	4.20E-01	3.20E-08	i	1.34E-08	4.89E-02	4.89%	Yes
Plutonium - 239/240	2.40E+00	3.80E-08	i	9.12E-08	3.32E-01	33.21%	Yes
Uranium 233/234	3.50E+00	2.70E-08	i	9.45E-08	3.44E-01	34.41%	Yes
Uranium-235	1.40E-01	2.50E-08	i	3.50E-09	1.27E-02	1.27%	Yes
Uranium-238	3.00E+00	2.40E-08	i	7.20E-08	2.62E-01	26.22%	Yes
		Total Risk Factor (Rj)	=	2.75E-07	Total % =	100%	

Notes:
(a) The most restrictive of the oral or inhalation slope factor is used.
(b) i = inhalation

Table 6-16
Rocky Flats OU 5 Concentration/Toxicity Screen of Noncarcinogens in Seep Sediment

PCOC	Maximum Concentration (mg/kg)	RfD (mg/kg-day) [a]	Type of RfD [b]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Noncarcinogens							
Acetone	1.70E-02	1.00E-01	o	1.70E-01	1.27E-06	0.00%	No
Antimony	5.13E+01	4.00E-04	o	1.28E+05	9.62E-01	96.18%	Yes
Beryllium	1.70E+00	5.00E-03	o	3.40E+02	2.55E-03	0.25%	No
Bis(2-ethylhexyl)phthalate	8.00E-02	2.00E-02	o	4.00E+00	3.00E-05	0.00%	No
Fluoranthene	9.70E-02	4.00E-02	o	2.43E+00	1.82E-05	0.00%	No
Methylene chloride	5.00E-03	6.00E-02	o	8.33E-02	6.25E-07	0.00%	No
Nickel	2.50E+01	2.00E-02	o	1.25E+03	9.37E-03	0.94%	No
Phenanthrene	8.20E-02	n/a		-	-	-	No
Pyrene	9.70E-02	3.00E-02	o	3.23E+00	2.42E-05	0.00%	No
Tetrachloroethene	1.00E-03	1.00E-02	o	1.00E-01	7.50E-07	0.00%	No
Zinc	1.05E+03	3.00E-01	o	3.50E+03	2.62E-02	2.62%	Yes
		Total Risk Factor (Rj)	=	1.33E+05	Total % =	100%	

Notes:
(a) The most restrictive of the oral or inhalation reference dose is used.
(b) o = oral
(n/a) Applicable toxicological criteria is not available.

Table 6-17
Rocky Flats OU 5 Concentration/Toxicity Screen of Carcinogens in Seep Sediment

PCOC	Maximum Concentration (mg/kg)	Slope Factor $(mg/kg\text{-}day)^{-1}$ (a)	Type of Slope Factor (b)	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Carcinogens							
Benzo(a)anthracene	3.80E-02	7.30E-01	o	2.77E-02	1.94E-03	0.19%	No
Beryllium	1.70E+00	8.40E+00	i	1.43E+01	9.98E-01	99.80%	Yes
Bis(2-ethylhexyl)phthalate	8.00E-02	1.40E-02	o	1.12E-03	7.83E-05	0.01%	No
Chrysene	4.10E-02	7.30E-03	o	2.99E-04	2.09E-05	0.00%	No
Methylene chloride	5.00E-03	7.50E-03	o	3.75E-05	2.62E-06	0.00%	No
Tetrachloroethene	1.00E-03	5.20E-02	o	5.20E-05	3.63E-06	0.00%	No
		Total Risk Factor (Rj)	=	1.43E+01	Total % =	100%	

Notes:
(a) The most restrictive of the oral or inhalation slope factor is used.
(b) o = oral, i = inhalation

Table 6-18
Rocky Flats OU 5 Concentration/Toxicity Screen of Radionuclides in Seep Sediment

PCOC	Maximum Concentration (pCi/g)	Slope Factor (risk/pCi) [a]	Type of Slope Factor [b]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Radionuclides							
Uranium - 233/234	2.00E+00	2.70E-08	i	5.40E-08	3.70E-01	36.97%	Yes
Uranium -235	1.30E-01	2.50E-08	i	3.25E-09	2.23E-02	2.23%	Yes
Uranium - 238	3.70E+00	2.40E-08	i	8.88E-08	6.08E-01	60.80%	Yes
		Total Risk Factor (Rj)	=	1.46E-07	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) i = inhalation

Table 6-19
Rocky Flats OU 5 Concentration/Toxicity Screen of Noncarcinogens in Stream Sediment

PCOC	Maximum Concentration (mg/kg)	RfD (mg/kg-day) [a]	Type of RfD [b]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Noncarcinogens							
Copper	1.36E+02	4.00E-02	o	3.39E+03	8.22E-02	8.22%	Yes
Mercury	3.05E+00	8.60E-05	i	3.55E+04	8.60E-01	86.05%	Yes
Zinc	7.09E+02	3.00E-01	o	2.36E+03	5.73E-02	5.73%	Yes
		Total Risk Factor (Rj)	=	4.12E+04	Total % =	100%	

Notes:
(a) The most restrictive of the oral or inhalation reference dose is used.
(b) o = oral, i = inhalation

Table 6-20

Rocky Flats OU 5 Concentration/Toxicity Screen of Radionuclides in Stream Sediment

PCOC	Maximum Concentration (pCi/g) [a]	Slope Factor (risk/pCi) [b]	Type of Slope Factor [c]	Chemical-Specific Risk Factor (Ri)	Ratio of Ri/Rj	Percentage of Total Risk Factor	Consider a COC?
Radionuclides							
Americium - 241	2.90E-01	3.20E-08	i	9.28E-09	1.32E-01	13.18%	Yes
Plutonium - 239/240	1.60E+00	3.80E-08	i	6.08E-08	8.64E-01	86.38%	Yes
Tritium	3.90E+03	7.80E-14	i	3.04E-10	4.32E-03	0.43%	No
		Total Risk Factor (Rj)	=	7.04E-08	Total % =	100%	

Notes:

(a) Tritium value is in pCi/L.

(b) The most restrictive of the oral or inhalation slope factor is used.

(c) i = inhalation

Table 6-21

Rocky Flats OU 5 Comparison of Concentrations to RBCs for Infrequently Detected Analytes in Surface Soil

Analyte	Range of Detected Concentrations (mg/kg)		Detection Frequency (%)	Range of Reporting Limits (mg/kg)	Range of Non-detect Values (mg/kg)		Residential Soil RBC (mg/kg)[a]	Max. Detected Concentration > RBC?	Max. Detected Concentration > 1000 x RBC?	Max. Non-detect>	Percent of Non-detect>
	Minimum	Maximum			Minimum	Maximum					
Organics											
Acenaphthylene	6.00E-01	6.00E-01	1.3	3.30E-1 - 1.5E+00	3.50E-01	2.30E+00	n/a	-	-	-	-
Aldrin	1.70E-02	1.70E-02	1.4	8.00E-03	8.00E-03	8.50E-02	3.77E-02	No	No	Yes	6.9
Butylbenzylphthalate	2.20E-01	2.20E-01	1.3	3.30E-01	3.50E-01	1.10E+00	5.49E+04	No	No	No	0.0
4,4-DDT	2.10E-02	2.10E-02	1.4	8.00E-03 - 1.60E-02	1.60E-02	1.70E-01	1.88E+00	No	No	No	0.0
Dieldrin	3.40E-02	3.40E-02	1.4	8.00E-03 - 1.60E-02	1.60E-02	1.70E-01	4.00E-02	No	No	Yes	20.8
Di-n-octyl phthalate	8.30E-02	8.30E-02	1.3	3.30E-01	3.50E-01	1.10E+00	4.57E+01	No	No	No	0.0
Endosulfan sulfate	2.40E-02	2.40E-02	1.4	8.00E-03 - 1.60E-02	1.60E-02	1.70E-01	1.65E+03	No	No	No	0.0
Endrin ketone	3.60E-02	3.60E-02	1.4	8.00E-03 - 1.60E-02	1.60E-02	1.70E-01	n/a	-	-	-	-
Heptachlor epoxide	1.00E-02	1.00E-02	1.4	8.00E-03	8.00E-03	8.50E-02	7.04E-02	No	No	Yes	1.4
Isophorone	9.60E-02	9.60E-02	1.3	3.30E-01	3.50E-01	1.10E+00	6.74E+02	No	No	No	0.0
Methoxychlor	4.50E-01	4.50E-01	1.4	8.00E-03 - 8.00E-02	8.00E-02	8.50E-01	1.37E+03	No	No	No	0.0
Inorganics											
Antimony	3.98E+01	4.98E+01	2.4	1.20E+01	1.20E+01	1.76E+01	1.10E+02	No	No	No	0.0

Notes:

(n/a) Applicable RBC is not available.
(a) - Rocky Flats PPRGs are used as RBCs.

Table 6-22
Rocky Flats OU 5 Comparison of Concentrations to RBCs for Infrequently Detected Analytes in Subsurface Soil

Analyte	Range of Detected Concentrations (mg/kg)		Detection Frequency (%)	Range of Reporting Limits (mg/kg)	Range of Non-detect Values (mg/kg)		Residential Soil RBC (mg/kg)[a]	Max. Detected Concentration > RBC?	Max. Detected Concentration > 1000 x RBC?	Max. Non-detect>	Percent of Non-detect>
	Minimum	Maximum			Minimum	Maximum					
Acenaphthylene	4.70E-02	8.40E-02	2.4	1.00E-02 - 3.30E-01	3.40E-01	7.70E+00	n/a	-	-	-	-
Aroclor-1260	4.50E-01	1.30E+00	3.9	1.60E-01	1.60E-01	4.30E-01	8.32E-02	Yes	No	Yes	100.0
alpha-BHC	1.50E-02	1.50E-02	1.3	8.00E-03	8.00E-03	2.20E-02	1.02E-01	No	No	No	0.0
Butylbenzylphthalate	6.90E-02	3.60E-01	2.4	1.00E-02 - 3.30E-01	3.40E-01	7.70E+00	5.49E+04	No	No	No	0.0
Di-n-butyl phthalate	9.50E-02	3.00E-01	2.4	1.00E-02 - 3.30E-01	3.40E-01	7.70E+00	2.74E+04	No	No	No	0.0
Ethylbenzene	6.60E-02	6.60E-02	0.5	5.00E-03 - 6.30E-03	5.00E-03	3.10E-02	2.74E+04	No	No	No	0.0
Heptachlor epoxide	1.10E-02	1.10E-02	1.3	8.00E-03	8.00E-03	2.20E-02	7.04E-02	No	No	No	0.0
Isophorone	8.20E-02	8.20E-02	1.2	1.00E-02 - 3.30E-01	3.40E-01	7.70E+00	6.74E+02	No	No	No	0.0
4-Methyl-2-pentanone	2.00E-03	2.00E-03	0.5	1.00E-02 - 1.30E-02	1.00E-02	6.20E-02	2.20E+04	No	No	No	0.0
Pentachlorophenol	1.60E-01	1.60E-01	1.2	5.00E-02 - 1.60E+00	1.70E+00	3.70E+01	5.34E+00	No	No	Yes	3.8
Phenol	5.30E-02	1.40E-01	4.9	1.00E-02 - 3.30E-01	3.40E-01	7.70E+00	1.65E+05	No	No	No	0.0
1,1,1-Trichloroethane	2.00E-03	2.00E-03	0.5	5.00E-03 - 6.30E-03	5.00E-03	3.10E-02	n/a	-	-	-	-
Total xylenes	1.50E-01	1.50E-01	0.5	5.00E-03 - 6.30E-03	5.00E-03	3.10E-02	5.49E+05	No	No	No	0.0

Notes:

(n/a) Applicable RBC is not available.
(a) - Rocky Flats PPRGs are used as RBCs.

Table 6-23
Rocky Flats OU 5 Comparison of Concentrations to RBCs for Infrequently Detected Analytes in Groundwater

Analyte	Range of Detected Concentrations (mg/L)		Detection Frequency (%)	Range of Reporting Limits (mg/L)	Range of Non-detect Values (mg/L)		Residential Groundwater RBC	Max. Detected Concentration > RBC?	Max. Detected Concentration > 1000 x RBC?	Max. Non-detect>	Percent of Non-detect>
	Minimum	Maximum			Minimum	Maximum					
Methylene chloride	6.00E-03	6.00E-03	4.8	1.00E-04 - 1.00E-02	1.00E-04	1.00E-02	6.22E-03	No	No	Yes	4.4

Notes:

(a) - Rocky Flats PPRGs are used as RBCs.

Table 6-24

Rocky Flats OU 5 Comparison of Concentrations to RBCs for Infrequently Detected Analytes in Surface Water

Analyte	Range of Detected Concentrations (mg/L)		Detection Frequency (%)	Range of Reporting Limits (mg/L)	Range of Non-detect Values (mg/L)		Residential Surface Water RBC	Max. Detected Concentration > RBC?	Max. Detected Concentration > 1000 x RBC?	Max. Non-detect>	Percent of Non-detect>
	Minimum	Maximum			Minimum	Maximum					
Benzoic acid	2.80E-02	2.80E-02	3.7	5.00E-02	5.00E-02	5.20E-02	1.12E+05	No	No	No	0.0
Methylene chloride	3.50E-03	3.50E-03	3.6	5.00E-03	5.00E-03	5.00E-03	8.73E+00	No	No	No	0.0
Pentachlorophenol	5.00E-03	5.00E-03	3.7	5.00E-02	5.00E-02	5.20E-02	5.46E-01	No	No	No	0.0

Notes:

(a) - Rocky Flats PPRGs are used as RBCs.

Table 6-25
Rocky Flats OU 5 Summary of Chemicals of Concern by Medium

Chemical of Concern	Surface Soil	Subsurface Soil	Ground-water	Surface Water	Seep Water [a]	Pond Sediment	Seep Sediment	Stream Sediment
Acetone					X			
Aluminum			X					
Antimony		X					X	
Aroclor-1254	X	X						
Barium			X	X				
Benzo(a)anthracene	X	X						
Benzo(a)pyrene	X	X						
Benzo(b)fluoranthene	X	X						
Beryllium		X	X				X	
Cadmium		X						
Copper	X	X						X
Dibenzo(a,h)anthracene	X							
1,1-Dichloroethene					X			
1,2-Dichloroethene					X			
Fluoranthene	X							
Indeno(1,2,3-cd)pyrene	X							
Lithium				X				
Manganese			X					
Mercury	X					X		X
Molybdenum		X						
Nickel		X						
Pyrene	X							
Silver	X	X						
Strontium				X				
Tetrachloroethene					X			
Trichloroethene					X			
Vanadium			X					
Zinc						X	X	X

Table 6-25 (continued)

Chemical of Concern	Surface Soil	Subsurface Soil	Ground-water	Surface Water	Seep Water [a]	Pond Sediment	Seep Sediment	Stream Sediment
Radionuclides								
Americium-241			X	X		X		X
Plutonium-239/240			X			X		X
Radium-226			X					
Uranium-233/234	X	X	X	X		X	X	
Uranium-235	X	X	X			X	X	
Uranium-238	X	X	X	X		X	X	

(a) The VOCs identified as COCs in "seep water" were detected in only one sample. This sample was actually a groundwater sample collected from a wellpoint installed just downgradient of the seep located NE of the landfill. The wellpoint was screened between 10 to 15 ft below groundsurface.

Table 6-26
Summary of Current and Future Land Uses[a,b]

Land Use Category	Current Offsite	Current Onsite (OU 5)	Future Offsite	Future Onsite (OU 5)
Residential	Yes	No	Credible	Improbable
Office Complex	Yes	No	Credible	Credible
Commercial/Industrial	Yes	No	Credible	Improbable[c]
Open Space	Yes	No	Credible	Credible[d]
Ecological Reserve	No	No	Improbable	Credible[d]
Agricultural	Yes	No	Credible	Improbable
Gravel Mining	Yes	No	Credible	Improbable[c]

[a] Credible is used to indicate scenarios that may reasonably occur.
[b] Improbable is used to indicate scenarios that are unlikely to occur.
[c] Expected in the currently developed area of the plant site but not in the OU 5 area.
[d] Expected in the Site buffer zone including the OU 5 area.

Table 6-27
Rocky Flats OU 5 Receptors and Pathways

Potentially Exposed Receptor	Potentially Complete Exposure Pathways by AOC		
	IHSS 115/196 Source Area (AOC 1)	IHSS 133 Source Area (AOC 2)	SID, C-2, Woman Creek, C-1 Source Area (AOC 3)
Current			
Onsite worker (security guard)	Dermal contact with surface soil Inhalation of airborne particulates (surface soil) Ingestion of surface soil External irradiation	Dermal contact with surface soil Inhalation of airborne particulates (surface soil) Ingestion of surface soil External irradiation	No exposure
Future			
Onsite construction worker	Dermal contact with subsurface soil Inhalation of airborne particulates (surface and subsurface soil) Ingestion of subsurface soil External irradiation	Dermal contact with subsurface soil Inhalation of airborne particulates (surface and subsurface soil) Ingestion of subsurface soil External irradiation	No exposure
Onsite office worker	Dermal contact with surface soil Inhalation of VOCs in indoor air • Inhalation of airborne particulates (surface soil) Ingestion of surface soil External irradiation	Dermal contact with surface soil Dermal contact with seep sediments Inhalation of VOCs in indoor air • Inhalation of airborne particulates Ingestion of surface soil External irradiation	No exposure

TABLE 6-27 (Continued)

Potentially Exposed Receptor	Potentially Complete Exposure Pathways by AOC		
	IHSS 115/196 Source Area (AOC 1)	IHSS 133 Source Area (AOC 2)	SID, C-2, Woman Creek, C-1 Source Area (AOC 3)
Onsite ecological researcher	Dermal contact with surface soil Dermal contact with seep sediments Dermal contact with seep water Inhalation of airborne particulates (surface soil) Ingestion of surface soil Ingestion of seep sediments Ingestion of seep water ** External irradiation	Dermal contact with surface soil Dermal contact with seep sediments Inhalation of airborne particulates (surface soil) Ingestion of surface soil Ingestion of seep sediments Ingestion of seep water External irradiation	Dermal contact with surface water Dermal contact with sediments Ingestion of surface water Ingestion of sediments Inhalation of airborne particulates (stream sediments) External irradiation from stream sediment
Onsite open-space receptor	Dermal contact with surface soil Dermal contact with seep sediments Dermal contact with seep water Inhalation of airborne particulates (surface soil) Ingestion of surface soil Ingestion of seep sediments Ingestion of seep water ** External irradiation	Dermal contact with surface soil Dermal contact with seep sediments Inhalation of airborne particulates (surface soil) Ingestion of surface soil Ingestion of seep sediments Ingestion of seep water External irradiation	Dermal contact with surface water Dermal contact with sediments Ingestion of surface water Ingestion of sediments Inhalation of airborne particulates (stream sediment) External irradiation from stream sediment

* This exposure pathway was not evaluated because no VOCs were identified as COCs in either the groundwater or subsurface soil media.

** The seep water sample collected in AOC1 was actually collected from a wellpoint associated with the seep and characterizes shallow groundwater below the seep.

Table 6-28
Chemical-Specific Concentrations for AOC1

Chemicals of Concern	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)	Seep Water (mg/L)	Pond Sediment (mg/kg)	Seep Sediment (mg/kg)	Stream Sediment (mg/kg)	Air (Particulates-Surface Soil) (mg/m^3)	Air[1] (Particulates Subsurface Soil) (mg/m^3)	Air[1] (Particulates-Seep Sediment) (mg/m^3)
Acetone					6.5E-02						
Aluminum			1.2E+02								
Antimony		7.2E+00					5.1E+01			1.6E-09	1.1E-08
Aroclor-1254	6.1E-01	2.1E-01							3.8E-09	4.5E-11	
Barium			1.5E+00								
Benzo(a)anthracene	1.1E+00	1.2E+00							1.7E-08	2.5E-10	
Benzo(a)pyrene	8.2E-01	1.1E+00							1.6E-08	2.3E-10	
Benzo(b)fluoranthene	1.1E+00	1.2E+00							1.9E-08	2.6E-10	
Beryllium		7.8E-01	9.6E-03				1.7E+00			1.7E-10	3.7E-10
Cadmium		5.9E-01								1.3E-10	
Copper	2.7E+01	4.4E+01							1.7E-10	9.5E-09	
Dibenzo(a,h)anthracene	5.0E-01								3.5E-09		
1,1-Dichloroethene					4.0E-03						
1,2-Dichloroethene					4.0E-03						
Fluoranthene	1.9E+00								4.8E-08		
Indeno(1,2,3-cd)pyrene	1.4E+00								1.2E-08		
Lithium											
Manganese			7.8E+00								
Mercury	1.2E-01								7.2E-12		
Molybdenum		2.5E+01								5.4E-09	
Nickel		2.1E+01								4.5E-09	
Pyrene	1.7E+00								4.3E-08		
Silver	1.6E+00	2.2E+00							5.8E-14	4.8E-10	
Strontium											
Tetrachloroethene					2.8E-02						
Trichloroethene					7.0E-03						
Vanadium			2.8E-01								
Zinc							7.0E+01				1.5E-08
Americium-241			9.0E-02								
Plutonium-239/240			4.5E-01								
Radium-226+D			4.4E+00								
Uranium-233/234	9.6E+00	1.7E+00	4.9E+01				1.4E+00		6.6E-05	3.6E-07	3.0E-07
Uranium-235+D	2.7E+00	1.3E-01	4.0E+00				1.1E-01		1.6E-05	2.8E-08	2.4E-08
Uranium-238+D	8.1E+01	1.6E+00	4.4E+01				1.2E+00		8.8E-04	3.3E-07	2.6E-07

(1) The air concentration for subsurface soil and sediments was calculated using the USEPA default particulate emissions factor (PEF) of 4.63E+9 m^3/kg.

NOTE: Radionuclide concentrations are in units of pCi/g for soil, pCi/L for water, and pCi/m^3 for air.

Table 6-29
Chemical-specific Concentrations for AOC2

Chemicals of Concern	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)	Seep Water (mg/L)	Pond Sediment (mg/kg)	Seep Sediment (mg/kg)	Stream Sediment (mg/kg)	Air (Particulates-Surface Soil) (mg/m³)	Air (Particulates-Subsurface Soil[1]) (mg/m³)	Air (Particulates-Seep Sediment[1]) (mg/m³)
Acetone											
Aluminum			3.6E+02								
Antimony		9.5E+00					4.4E+01			2.1E-09	9.4E-09
Aroclor-1254											
Barium			2.7E+00								
Benzo(a)anthracene											
Benzo(a)pyrene	3.7E-01								4.9E-10		
Benzo(b)fluoranthene	7.4E-03								4.0E-11		
Beryllium		1.3E+00	2.9E-02				1.5E+00			2.8E-10	3.2E-10
Cadmium		1.3E+00								2.7E-10	
Copper	1.8E+01	4.1E+01							9.6E-11	8.8E-09	
Dibenzo(a,h)anthracene	1.3E-02								6.5E-11		
1,1-Dichloroethene					2.5E-03						
1,2-Dichloroethene					2.5E-03						
Fluoranthene	8.9E-02								4.7E-10		
Indeno(1,2,3-cd)pyrene	1.8E-02								9.5E-11		
Lithium											
Manganese			3.5E+00								
Mercury	8.0E-02								4.2E-15		
Molybdenum		2.2E+01								4.8E-09	
Nickel		2.3E+01								4.9E-09	
Pyrene	1.1E-01								5.6E-10		
Silver	1.6E+00	4.3E+00							3.4E-10	9.2E-10	
Strontium											
Tetrachloroethene					2.5E-03						
Trichloroethene					2.5E-03						
Vanadium			6.7E-01								
Zinc							1.1E+03				2.3E-07
Americium-241			6.0E-02								
Plutonium-239/240			3.3E-01								
Radium-226			3.9E+00								
Uranium-233/234	5.2E+00	3.4E+00	7.6E+00				2.0E+00		6.1E-05	7.2E-07	4.3E-07
Uranium-235	3.5E-01	5.9E-01	4.7E-01				1.3E-01		8.3E-06	1.3E-07	2.8E-08
Uranium-238	1.4E+01	9.1E+00	1.1E+01				3.7E+00		3.6E-04	2.0E-06	8.0E-07

(1) The air concentrations for subsurface soil and seep sediments were calculated using the USEPA default particle emissions factor (PEF) of 4.63E+09 m³/kg.

NOTE: Radionuclide concentrations are in units of pCi/g for soil and pCi/m³ for air.

Table 6-30
Chemical-specific Concentrations for AOC3

Chemicals of Concern	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)	Seep Water (mg/L)	Pond Sediment (mg/kg)	Seep Sediment (mg/kg)	Stream Sediment (mg/kg)	Air (particulates)[1] (mg/m^3)
Acetone									
Aluminum			5.2E+00						
Antimony									
Aroclor-1254									
Barium			9.4E-02	1.0E-01					
Benzo(a)anthracene									
Benzo(a)pyrene									
Benzo(b)fluoranthene									
Beryllium			4.0E-03						
Cadmium									
Copper								2.2E+02	4.7E-08
Dibenzo(a,h)anthracene									
1,1-Dichloroethene									
1,2-Dichloroethene									
Fluoranthene									
Indeno(1,2,3-cd)pyrene									
Lithium				2.2E-02					
Manganese			1.6E+01						
Mercury						1.6E+00		2.2E+00	4.8E-10
Molybdenum									
Nickel									
Pyrene									
Silver									
Strontium				3.1E-01					
Tetrachloroethene									
Trichloroethene									
Vanadium			4.3E-02						
Zinc						2.4E+02		6.0E+02	1.3E-07
Americium-241			5.0E-01	8.0E-02		4.5E-01		2.9E-01	6.3E-08
Plutonium-239/240			1.0E-02			2.5E+00		1.6E+00	3.5E-07
Radium-226+D			4.6E+02						
Uranium-233/234			3.1E+03	1.9E+00		3.3E+00			
Uranium-235+D			1.4E+00			2.1E-01			
Uranium-238+D			8.3E-01	2.1E+00		2.9E+00			

NOTE: Radionuclide concentrations are in units of pCi/g for soil, pCi/L for water, and pCi/m^3 for air.

(1) Includes only stream sediment contribution.

TABLE 6-31
DERIVATION OF 0.5 SOIL MATRIX EFFECT

Compound (Species)	Fraction Absorbed from Food or Soil (Fm)	Fraction Absorbed from Water (Fw)	Matrix Effect	Source
Cadmium (in adults)	2.5	5	0.50[a]	EPA 1995; Kjellstrom and Nordberg, 1978
Manganese (adults)	NA	NA	0.04[b]	EPA 1995
Cyanide (rats)	NA	NA	0.20[c]	EPA 1995
Beryllium (rats)	NA	NA	0.2[d]	EPA 1995
Antimony (rats)	NA	NA	0.0007[e]	EPA 1995
Lead (children)	0.3	0.5	0.60[a]	EPA 1994
Lead (adults)	0.03	0.6	0.05[a]	Heard and Chamberlain (1982)
Lead (rats)	NA	NA	0.08 - 0.20[f]	Freeman et al. 1993
Nickel (adults)	0.007	0.28	0.03[a]	Sunderland et al. 1989
Arsenic (rabbits)	0.28	0.59	0.47[a]	Freeman et al. 1994
TCDD (guinea pigs)	NA	NA	0.10[g]	McConnell et al. 1984
Benzo(a) pyrene (rats)	NA	NA	0.34-0.51[h]	Goon et al. 1991
Matrix Effect Selected For Use In HHRA			0.5	

NA = Not available from the data.

[a]Based on Fm/Fw.

[b]Based on relative toxicity of manganese in water vs food (RfD water = 5E-03 mg/kg-d; RfD food = 1.4E-01 mg/kg-d; ratio = 0.04).

[c]Based on relative toxicity of cyanide in food and water; see text.

[d]Based on relative toxicity of beryllium in water vs. food (NOEL in water = 0.54 mg/kg bw/day; NOEL in food = 25 mg/kg-day.)

[e]Based on relative toxicity of antimony in water vs. food (LOAEL in water = 0.53 mg/kg bw/day; LOAEL in food = 500 mg/kg-day).

[f]Based on relative retention of lead in blood, bone, and liver.

[g]Based on relative retention of TCDD in liver.

[h]Based on relative bioavailability from soil compared to water.

TABLE 6-32
OU 5 SOIL MATRIX EFFECTS

Chemical of Concern	Type of Critical Study (1): Oral Reference Dose	Type of Critical Study (1): Oral Slope Factor	Soil Matrix Effect (2)
Antimony	Drinking water (rats)		0.5
Aroclor-1254	Glycerol & corn oil vehicle (monkeys)	Corn oil vehicle, stirred in food (rats) (3)	0.5
Benzo(a)anthracene		By analogy to benzo(a)pyrene	1
Benzo(a)pyrene (4)		Dietary: vehicle not specified (rats, mice, dogs)	1
Benzo(b)fluoranthene		By analogy to benzo(a)pyrene	1
Beryllium	Drinking water (rats)	Drinking water (rats)	0.5
Cadmium	Dietary (humans)		1
Copper	Oral dose; vehicles not specified (humans)		1
Dibenzo(a,h)anthracene		By analogy to benzo(a)pyrene	1
Fluoranthene	Gavage (mice)		0.5
Indeno(1,2,3-cd)pyrene		By analogy to benzo(a)pyrene	1
Mercury	Intraparenteral $HgCl_2$ (rats)		N/A
Molybdenum	Dietary (humans)		1
Nickel	Dietary (rats)		1
Pyrene	Gavage (mice)		0.5
Silver	Intravenous injection (humans)		N/A
Americium-241		Soluble form in food or water (5)	1
Plutonium-239/240		Soluble form in food or water (5)	1
Uranium-233/234		Soluble form in food or water (5)	1
Uranium-235		Soluble form in food or water (5)	1
Uranium-238		Soluble form in food or water (5)	1

N/A = Not applicable; chemical was administered directly into the receptor via injection.
(1) Source: IRIS, unless otherwise noted.
(2) A soil matrix effect of 0.5 is supported by literature review; see text and Table 6-32.
(3) Study actually done for Aroclor-1260; used by analogy.
(4) Adopted for all carcinogenic PAHs that are COCs in sediment.
(5) Personal communication (Nelson, 1995). Slope factors were derived using gastrointestinal absorption factors for soluble forms of each radionuclide. Retardation of radionuclide intake from soil matrix is appropriate to consider, but cannot be quantified using a simple soil matrix effect because the adjustment must account for differential effects on target organs. Therefore, a matrix effect of 1 is adopted, even though it probably overestimates bioavailability of mineralized forms of radionuclides in soils at Rocky Flats.

Table 6-33
OU5 COC Chemical-specific Parameters

Analyte	Oral RfD (mg/kg-day)	Oral CSF (mg/kg-day)$^{-1}$	Inhalation RfD (mg/kg-day)	Inhalation CSF (mg/kg-day)$^{-1}$	External CSF (risk/yr per pCi/g)	EPA Cancer Weight of Evidence	Dermal Absorption Factor	Dermal Permeability (cm/hr)	GI Matrix Effect
Acetone	1.00E-01	NA	NA	NA	NA	NA	NA	6.00E-4	1
Aluminum	2.9	NA	NA	NA	NA	NA	NA	NA	1
Antimony	4.00E-04	NA	NA	NA	NA	NA	NA	NA	0.5
Aroclor-1254	2.00E-05	7.70E+00	NA	NA	NA	B2	6.00E-02	7.10E-01	0.5
Barium	7.00E-02	NA	1.43E-04	NA	NA	NA	NA	NA	1
Benzo(a)anthracene	NA	7.30E-01	NA	NA	NA	B2	5.00E-02	8.10E-01	1
Benzo(a)pyrene	NA	7.30E+00	NA	NA	NA	B2	5.00E-02	1.20E+00	1
Benzo(b)fluoranthene	NA	7.30E-01	NA	NA	NA	B2	5.00E-02	1.20E+00	1
Beryllium	5.00E-03	4.30E+00	NA	8.40E+00	NA	B2	NA	NA	0.5
Cadmium	1.00E-03	NA	NA	6.30E+00	NA	NA	1.00E-02	NA	1
Copper	4.00E-02	NA	NA	NA	NA	D	NA	NA	1
Dibenzo(a,h)anthracene	NA	7.30E+00	NA	NA	NA	B2	5.00E-02	2.70E+00	1
1,1-Dichloroethene	9.00E-03	6.00E-01	NA	1.20E+00	NA	C	NA	1.60E-02	1
1,2-Dichloroethene	9.00E-03	NA	NA	NA	NA	NA	NA	1.00E-02	1
Fluoranthene	4.00E-02	NA	NA	NA	NA	NA	5.00E-02	3.60E-01	0.5
Indeno(1,2,3-cd)pyrene	NA	7.30E-01	NA	NA	NA	B2	5.00E-02	1.90E+00	1
Lithium	2.00E-02	NA	NA	NA	NA	NA	NA	NA	1
Manganese	5.00E-03	NA	1.43E-05	NA	NA	D	NA	NA	1

Table 6-33 (Continued)

Analyte	Oral RfD (mg/kg-day)	Oral CSF (mg/kg-day)$^{-1}$	Inhalation RfD (mg/kg-day)	Inhalation CSF (mg/kg-day)$^{-1}$	External CSF (risk/yr per pCi/g)	EPA Cancer Weight of Evidence	Dermal Absorption Factor	Dermal Permeability (cm/hr)	GI Matrix Effect
Mercury	3.00E-04	NA	8.60E-05	NA	NA	D	NA	NA	1
Molybdenum	5.00E-03	NA	NA	NA	NA	NA	NA	NA	1
Nickel	2.00E-02	NA	NA	NA	NA	NA	NA	NA	1
Pyrene	3.00E-02	NA	NA	NA	NA	D	5.00E-02	NA	0.5
Silver	5.00E-03	NA	NA	NA	NA	D	NA	NA	1
Strontium	6.00E-01	NA	NA	NA	NA	NA	NA	NA	1
Tetrachloroethene	1.00E-02	5.20E-02	NA	2.00E-03	NA	B2	NA	3.70E-01	1
Trichloroethene	NA	1.10E-02	NA	6.00E-03	NA	B2	NA	2.30E-01	1
Vanadium	7.00E-03	NA	NA	NA	NA	NA	NA	NA	1
Zinc	3.00E-01	NA	NA	NA	NA	D	NA	NA	1
Americium-241	NA	2.40E-10	NA	3.20E-08	4.90E-09	A	NA	NA	1
Plutonium-239/240	NA	2.30E-10	NA	3.80E-08	2.70E-11	A	NA	NA	1
Radium-226	NA	1.20E-10	NA	3.00E-09	6.00E-06	A	NA	NA	1
Uranium-233/234	NA	1.60E-11	NA	2.70E-08	4.20E-11	A	NA	NA	1
Uranium-235	NA	1.60E-11	NA	2.50E-08	2.40E-07	A	NA	NA	1
Uranium-238	NA	2.00E-11	NA	2.40E-08	5.10E-08	A	NA	NA	1

NA= Value is not available

Table 6-34
Construction Worker RME Carcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Subsurface Soil (mg/kg-day)	Inhalation of Airborne Particulates[(1)] (mg/kg-day)	Dermal Absorption of Subsurface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	2.9E-08	2.9E-13	NA	NA
Aroclor-1254	8.5E-10	7.2E-13	1.0E-09	NA
Benzo(a)anthracene	9.3E-09	3.3E-12	NA	NA
Benzo(a)pyrene	8.8E-09	3.1E-12	NA	NA
Benzo(b)fluoranthene	9.8E-09	3.6E-12	NA	NA
Beryllium	3.1E-09	3.2E-14	NA	NA
Cadmium	4.8E-09	2.4E-14	4.7E-10	NA
Copper	3.5E-07	1.8E-12	NA	NA
Dibenzo(a,h)anthracene	NA	6.6E-13	NA	NA
Fluoranthene	NA	9.1E-12	NA	NA
Indeno(1,2,3-cd)pyrene	NA	2.2E-12	NA	NA
Mercury	NA	1.3E-15	NA	NA
Molybdenum	2.0E-07	1.0E-12	NA	NA
Nickel	1.7E-07	8.4E-13	NA	NA
Pyrene	NA	8.0E-12	NA	NA
Silver	1.8E-08	9.1E-14	NA	NA
Uranium-233/234	2.4E+01	2.2E-02	NA	2.9E-01
Uranium-235+D	1.9E+00	5.2E-03	NA	8.2E-02
Uranium-238+D	2.2E+01	3.0E-01	NA	2.4E+00

(1) Includes particulate emissions from surface and subsurface soils.
Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-35
Current Security Worker RME Carcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Aroclor-1254	3.4E-09	5.5E-12	2.7E-08	NA
Benzo(a)anthracene	1.2E-08	2.5E-11	NA	NA
Benzo(a)pyrene	8.9E-09	2.3E-11	NA	NA
Benzo(b)fluoranthene	1.2E-08	2.7E-11	NA	NA
Copper	3.0E-07	2.5E-13	NA	NA
Dibenzo(a,h)anthracene	5.5E-09	5.1E-12	NA	NA
Fluoranthene	1.0E-08	7.0E-11	NA	NA
Indeno(1,2,3-cd)pyrene	1.5E-08	1.7E-11	NA	NA
Mercury	1.3E-09	1.0E-14	NA	NA
Pyrene	9.2E-09	6.2E-11	NA	NA
Silver	1.7E-08	8.3E-17	NA	NA
Uranium-233/234	1.9E+02	1.7E-01	NA	2.7E+00
Uranium-235+D	5.3E+01	4.0E-02	NA	7.6E-01
Uranium-238+D	1.6E+03	2.3E+00	NA	2.3E+01

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-36
Ecological Worker RME Carcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Acetone	NA	NA	5.5E-08	NA	NA	NA	6.1E-09	NA
Antimony	NA	4.6E-08	NA	1.1E-11	NA	NA	NA	NA
Aroclor-1254	3.0E-09	NA	NA	3.8E-12	1.6E-08	NA	NA	NA
Benzo(a)anthracene	1.0E-08	NA	NA	1.8E-11	NA	NA	NA	NA
Benzo(a)pyrene	7.9E-09	NA	NA	1.6E-11	NA	NA	NA	NA
Benzo(b)fluoranthene	1.1E-08	NA	NA	1.9E-11	NA	NA	NA	NA
Beryllium	NA	1.5E-09	NA	3.7E-13	NA	NA	NA	NA
Copper	2.6E-07	NA	NA	1.7E-13	NA	NA	NA	NA
Dibenzo(a,h)anthracene	4.8E-09	NA	NA	3.6E-12	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	3.4E-09	NA	NA	NA	1.0E-08	NA
1,2-Dichloroethene	NA	NA	3.4E-09	NA	NA	NA	6.2E-09	NA
Fluoranthene	9.1E-09	NA	NA	4.9E-11	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.3E-08	NA	NA	1.2E-11	NA	NA	NA	NA
Mercury	1.2E-09	NA	NA	7.3E-15	NA	NA	NA	NA
Pyrene	8.1E-09	NA	NA	4.3E-11	NA	NA	NA	NA
Silver	1.5E-08	NA	NA	5.9E-17	NA	NA	NA	NA
Tetrachloroethene	NA	NA	2.3E-08	NA	NA	NA	1.6E-06	NA
Trichloroethene	NA	NA	5.9E-09	NA	NA	NA	2.5E-07	NA
Zinc	NA	1.2E-07	NA	1.5E-11	NA	NA	NA	NA
Uranium-233/234	1.6E+02	4.5E+00	NA	1.2E-01	NA	NA	NA	1.4E+00
Uranium-235+D	4.7E+01	3.5E-01	NA	2.8E-02	NA	NA	NA	4.1E-01
Uranium-238+D	1.4E+03	3.8E+00	NA	1.6E+00	NA	NA	NA	1.2E+01

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-37
Office Worker RME Carcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Aroclor-1254	5.4E-08	8.8E-11	2.7E-07	NA
Benzo(a)anthracene	1.9E-07	4.0E-10	NA	NA
Benzo(a)pyrene	1.4E-07	3.7E-10	NA	NA
Benzo(b)fluoranthene	1.9E-07	4.4E-10	NA	NA
Copper	4.8E-06	3.9E-12	NA	NA
Dibenzo(a,h)anthracene	8.7E-08	8.1E-11	NA	NA
Fluoranthene	1.7E-07	1.1E-09	NA	NA
Indeno(1,2,3-cd)pyrene	2.4E-07	2.7E-10	NA	NA
Mercury	2.1E-08	1.7E-13	NA	NA
Pyrene	1.5E-07	9.9E-10	NA	NA
Silver	2.8E-07	1.3E-15	NA	NA
Uranium-233/234	3.0E+03	2.7E+00	NA	4.0E+01
Uranium-235+D	8.5E+02	6.4E-01	NA	1.1E+01
Uranium-238+D	2.5E+04	3.6E+01	NA	3.4E+02

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-38
Open Space User RME Carcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Acetone	NA	NA	8.2E-07	NA	NA	NA	9.1E-08	NA
Antimony	NA	8.6E-07	NA	3.3E-11	NA	NA	NA	NA
Aroclor-1254	1.7E-08	NA	NA	1.1E-11	8.2E-08	NA	NA	NA
Benzo(a)anthracene	6.0E-08	NA	NA	5.1E-11	NA	NA	NA	NA
Benzo(a)pyrene	4.6E-08	NA	NA	4.7E-11	NA	NA	NA	NA
Benzo(b)fluoranthene	6.1E-08	NA	NA	5.5E-11	NA	NA	NA	NA
Beryllium	NA	2.8E-08	NA	1.1E-12	NA	NA	NA	NA
Copper	1.5E-06	NA	NA	5.0E-13	NA	NA	NA	NA
Dibenzo(a,h)anthracene	2.8E-08	NA	NA	1.0E-11	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	5.0E-08	NA	NA	NA	1.5E-07	NA
1,2-Dichloroethene	NA	NA	5.0E-08	NA	NA	NA	9.3E-08	NA
Fluoranthene	5.3E-08	NA	NA	1.4E-10	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	7.6E-08	NA	NA	3.4E-11	NA	NA	NA	NA
Mercury	6.7E-09	NA	NA	2.1E-14	NA	NA	NA	NA
Pyrene	4.7E-08	NA	NA	1.3E-10	NA	NA	NA	NA
Silver	8.9E-08	NA	NA	1.7E-16	NA	NA	NA	NA
Tetrachloroethene	NA	NA	3.5E-07	NA	NA	NA	2.4E-05	NA
Trichloroethene	NA	NA	8.8E-08	NA	NA	NA	3.8E-06	NA
Zinc	NA	2.3E-06	NA	4.4E-11	NA	NA	NA	NA
Uranium-233/234	4.3E+02	3.8E+01	NA	3.5E-01	NA	NA	NA	5.7E+00
Uranium-235+D	1.2E+02	3.0E+00	NA	8.1E-02	NA	NA	NA	1.6E+00
Uranium-238+D	3.7E+03	3.2E+01	NA	4.6E+00	NA	NA	NA	4.9E+01

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-39
Construction Worker CT Carcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Subsurface Soil (mg/kg-day)	Inhalation of Airborne Particulates[1] (mg/kg-day)	Dermal Absorption of Subsurface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	5.17E-09	3.27E-14	NA	NA
Aroclor-1254	1.51E-10	5.72E-13	1.79E-10	NA
Benzo(a)anthracene	1.66E-09	2.63E-12	NA	NA
Benzo(a)pyrene	1.56E-09	2.42E-12	NA	NA
Benzo(b)fluoranthene	1.74E-09	2.86E-12	NA	NA
Beryllium	5.59E-10	3.53E-15	NA	NA
Cadmium	8.46E-10	2.67E-15	8.37E-11	NA
Copper	6.29E-08	2.24E-13	NA	NA
Dibenzo(a,h)anthracene	NA	5.30E-13	NA	NA
Fluoranthene	NA	7.28E-12	NA	NA
Indeno(1,2,3-cd)pyrene	NA	1.74E-12	NA	NA
Mercury	NA	1.08E-15	NA	NA
Molybdenum	3.59E-08	1.13E-13	NA	NA
Nickel	2.97E-08	9.37E-14	NA	NA
Pyrene	NA	6.45E-12	NA	NA
Silver	3.21E-09	1.02E-14	NA	NA
Uranium-233/234	4.31E+00	1.78E-02	NA	2.30E-01
Uranium-235+D	3.33E-01	4.19E-03	NA	6.53E-02
Uranium-238+D	3.98E+00	2.37E-01	NA	1.95E+00

(1) Includes particulate emissions from surface and subsurface soils.
Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-40
Current Security Worker CT Carcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Aroclor-1254	8.5E-11	7.7E-13	6.9E-10	NA
Benzo(a)anthracene	3.0E-10	3.5E-12	NA	NA
Benzo(a)pyrene	2.3E-10	3.3E-12	NA	NA
Benzo(b)fluoranthene	3.0E-10	3.8E-12	NA	NA
Copper	7.6E-09	3.5E-14	NA	NA
Dibenzo(a,h)anthracene	1.4E-10	7.1E-13	NA	NA
Fluoranthene	2.6E-10	9.8E-12	NA	NA
Indeno(1,2,3-cd)pyrene	3.8E-10	2.3E-12	NA	NA
Mercury	3.3E-11	1.5E-15	NA	NA
Pyrene	2.3E-10	8.7E-12	NA	NA
Silver	4.4E-10	1.2E-17	NA	NA
Uranium-233/234	4.7E+00	2.4E-02	NA	2.7E-01
Uranium-235+D	1.3E+00	5.6E-03	NA	7.6E-02
Uranium-238+D	4.0E+01	3.2E-01	NA	2.3E+00

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-41
Ecological Worker CT Carcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Acetone	NA	NA	6.4E-09	NA	NA	NA	3.5E-09	NA
Antimony	NA	7.5E-09	NA	6.0E-12	NA	NA	NA	NA
Aroclor-1254	8.3E-10	NA	NA	2.1E-12	2.8E-09	NA	NA	NA
Benzo(a)anthracene	2.9E-09	NA	NA	9.4E-12	NA	NA	NA	NA
Benzo(a)pyrene	2.2E-09	NA	NA	8.7E-12	NA	NA	NA	NA
Benzo(b)fluoranthene	3.0E-09	NA	NA	1.0E-11	NA	NA	NA	NA
Beryllium	NA	2.5E-10	NA	2.0E-13	NA	NA	NA	NA
Copper	7.4E-08	NA	NA	9.2E-14	NA	NA	NA	NA
Dibenzo(a,h)anthracene	1.4E-09	NA	NA	1.9E-12	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	3.9E-10	NA	NA	NA	5.8E-09	NA
1,2-Dichloroethene	NA	NA	3.9E-10	NA	NA	NA	3.6E-09	NA
Fluoranthene	2.6E-09	NA	NA	2.6E-11	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	3.7E-09	NA	NA	6.2E-12	NA	NA	NA	NA
Mercury	3.2E-10	NA	NA	3.9E-15	NA	NA	NA	NA
Pyrene	2.3E-09	NA	NA	2.3E-11	NA	NA	NA	NA
Silver	4.3E-09	NA	NA	3.1E-17	NA	NA	NA	NA
Tetrachloroethene	NA	NA	2.7E-09	NA	NA	NA	9.4E-07	NA
Trichloroethene	NA	NA	6.8E-10	NA	NA	NA	1.5E-07	NA
Zinc	NA	2.0E-08	NA	8.2E-12	NA	NA	NA	NA
Uranium-233/234	4.6E+01	7.3E-01	NA	6.4E-02	NA	NA	NA	1.1E+00
Uranium-235+D	1.3E+01	5.7E-02	NA	1.5E-02	NA	NA	NA	3.3E-01
Uranium-238+D	3.9E+02	6.2E-01	NA	8.5E-01	NA	NA	NA	9.8E+00

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-42
Office Worker CT Carcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Aroclor-1254	6.8E-10	8.4E-12	6.8E-09	NA
Benzo(a)anthracene	2.4E-09	3.9E-11	NA	NA
Benzo(a)pyrene	1.8E-09	3.6E-11	NA	NA
Benzo(b)fluoranthene	2.4E-09	4.2E-11	NA	NA
Copper	6.0E-08	3.8E-13	NA	NA
Dibenzo(a,h)anthracene	1.1E-09	7.8E-12	NA	NA
Fluoranthene	2.1E-09	1.1E-10	NA	NA
Indeno(1,2,3-cd)pyrene	3.0E-09	2.6E-11	NA	NA
Mercury	2.6E-10	1.6E-14	NA	NA
Pyrene	1.9E-09	9.5E-11	NA	NA
Silver	3.5E-09	1.3E-16	NA	NA
Uranium-233/234	3.8E+01	2.6E-01	NA	3.4E+00
Uranium-235+D	1.1E+01	6.2E-02	NA	9.8E-01
Uranium-238+D	3.2E+02	3.5E+00	NA	2.9E+01

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-43
Open Space User CT Carcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Acetone	NA	NA	2.0E-08	NA	NA	NA	2.2E-09	NA
Antimony	NA	2.5E-08	NA	6.9E-13	NA	NA	NA	NA
Aroclor-1254	2.0E-09	NA	NA	2.4E-13	3.7E-10	NA	NA	NA
Benzo(a)anthracene	7.2E-09	NA	NA	1.1E-12	NA	NA	NA	NA
Benzo(a)pyrene	5.4E-09	NA	NA	1.0E-12	NA	NA	NA	NA
Benzo(b)fluoranthene	7.3E-09	NA	NA	1.2E-12	NA	NA	NA	NA
Beryllium	NA	4.0E-11	NA	2.3E-14	NA	NA	NA	NA
Copper	1.8E-07	NA	NA	1.1E-14	NA	NA	NA	NA
Dibenzo(a,h)anthracene	3.3E-09	NA	NA	2.2E-13	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	1.3E-09	NA	NA	NA	3.7E-09	NA
1,2-Dichloroethene	NA	NA	1.3E-09	NA	NA	NA	2.3E-09	NA
Fluoranthene	6.3E-09	NA	NA	3.0E-12	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	9.1E-09	NA	NA	7.2E-13	NA	NA	NA	NA
Mercury	8.0E-10	NA	NA	4.5E-16	NA	NA	NA	NA
Pyrene	5.6E-09	NA	NA	2.7E-12	NA	NA	NA	NA
Silver	1.1E-08	NA	NA	3.6E-18	NA	NA	NA	NA
Tetrachloroethene	NA	NA	8.8E-09	NA	NA	NA	5.9E-07	NA
Trichloroethene	NA	NA	2.2E-09	NA	NA	NA	9.2E-08	NA
Zinc	NA	3.3E-09	NA	9.5E-13	NA	NA	NA	NA
Uranium-233/234	2.6E+01	1.9E+00	NA	7.4E-03	NA	NA	NA	6.9E-01
Uranium-235+D	7.5E+00	1.5E-01	NA	1.7E-03	NA	NA	NA	2.0E-01
Uranium-238+D	2.2E+02	1.7E+00	NA	9.8E-02	NA	NA	NA	5.9E+00

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-44
Construction Worker RME Carcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Subsurface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Subsurface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	3.84E-08	3.87E-13	NA	NA
Benzo(a)pyrene	NA	9.13E-14	NA	NA
Benzo(b)fluoranthene	NA	7.51E-15	NA	NA
Beryllium	5.23E-09	5.27E-14	NA	NA
Cadmium	1.01E-08	5.11E-14	9.93E-10	NA
Copper	3.30E-07	1.68E-12	NA	NA
Dibenzo(a,h)anthracene	NA	1.22E-14	NA	NA
Fluoranthene	NA	8.87E-14	NA	NA
Indeno(1,2,3-cd)pyrene	NA	1.78E-14	NA	NA
Mercury	NA	7.83E-19	NA	NA
Molybdenum	1.78E-07	8.98E-13	NA	NA
Nickel	1.82E-07	9.17E-13	NA	NA
Pyrene	NA	1.05E-13	NA	NA
Silver	3.44E-08	2.37E-13	NA	NA
Uranium-233/234	4.82E+01	2.06E-02	NA	1.56E-01
Uranium-235+D	8.50E+00	2.82E-03	NA	1.05E-02
Uranium-238+D	1.31E+02	1.21E-01	NA	4.10E-01

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-45
Current Security Worker RME Carcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates(1) (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Benzo(a)pyrene	4.1E-09	7.0E-13	NA	NA
Benzo(b)fluoranthene	8.0E-11	5.8E-14	NA	NA
Copper	2.0E-07	1.4E-13	NA	NA
Dibenzo(a,h)anthracene	1.4E-10	9.4E-14	NA	NA
Fluoranthene	4.9E-10	6.8E-13	NA	NA
Indeno(1,2,3-cd)pyrene	2.0E-10	1.4E-13	NA	NA
Mercury	8.7E-10	6.0E-18	NA	NA
Pyrene	5.9E-10	8.1E-13	NA	NA
Silver	1.7E-08	4.9E-13	NA	NA
Uranium-233/234	1.0E+02	1.6E-01	NA	2.2E+01
Uranium-235+D	6.8E+00	2.1E-02	NA	1.5E+00
Uranium-238+D	2.7E+02	9.3E-01	NA	5.7E+01

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-46
Ecological Worker RME Carcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	NA	3.9E-08	NA	9.6E-12	NA	NA	NA	NA
Benzo(a)pyrene	3.6E-09	NA	NA	4.9E-13	NA	NA	NA	NA
Benzo(b)fluoranthene	7.1E-11	NA	NA	4.1E-14	NA	NA	NA	NA
Beryllium	NA	1.3E-09	NA	3.3E-13	NA	NA	NA	NA
Copper	1.7E-07	NA	NA	9.7E-14	NA	NA	NA	NA
Dibenzo(a,h)anthracene	1.2E-10	NA	NA	6.6E-14	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	2.1E-09	NA	NA	NA	6.2E-09	NA
1,2-Dichloroethene	NA	NA	2.1E-09	NA	NA	NA	3.9E-09	NA
Fluoranthene	4.3E-10	NA	NA	4.8E-13	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.8E-10	NA	NA	9.6E-14	NA	NA	NA	NA
Mercury	7.7E-10	NA	NA	4.2E-18	NA	NA	NA	NA
Pyrene	5.2E-10	NA	NA	5.7E-13	NA	NA	NA	NA
Silver	1.5E-08	NA	NA	3.5E-13	NA	NA	NA	NA
Tetrachloroethene	NA	NA	2.1E-09	NA	NA	NA	1.4E-07	NA
Trichloroethene	NA	NA	2.1E-09	NA	NA	NA	8.9E-08	NA
Zinc	NA	1.9E-06	NA	2.3E-10	NA	NA	NA	NA
Uranium-233/234	8.9E+01	6.4E+00	NA	1.1E-01	NA	NA	NA	7.8E-01
Uranium-235+D	6.0E+00	4.1E-01	NA	1.5E-02	NA	NA	NA	5.3E-02
Uranium-238+D	2.4E+02	1.2E+01	NA	6.5E-01	NA	NA	NA	2.1E+00

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-47
Office Worker RME Carcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Benzo(a)pyrene	6.5E-08	1.1E-11	NA	NA
Benzo(b)fluoranthene	1.3E-09	9.3E-13	NA	NA
Copper	3.2E-06	2.2E-12	NA	NA
Dibenzo(a,h)anthracene	2.2E-09	1.5E-12	NA	NA
Fluoranthene	7.8E-09	1.1E-11	NA	NA
Indeno(1,2,3-cd)pyrene	3.2E-09	2.2E-12	NA	NA
Mercury	1.4E-08	9.7E-17	NA	NA
Pyrene	9.4E-09	1.3E-11	NA	NA
Silver	2.8E-07	7.9E-12	NA	NA
Uranium-233/234	1.6E+03	2.5E+00	NA	2.2E+01
Uranium-235+D	1.1E+02	3.4E-01	NA	1.5E+00
Uranium-238+D	4.3E+03	1.5E+01	NA	5.7E+01

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-48
Open Space User RME Carcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	NA	7.3E-07	NA	2.8E-11	NA	NA	NA	NA
Benzo(a)pyrene	2.1E-08	NA	NA	1.4E-12	NA	NA	NA	NA
Benzo(b)fluoranthene	4.1E-10	NA	NA	1.2E-13	NA	NA	NA	NA
Beryllium	NA	2.5E-08	NA	9.5E-13	NA	NA	NA	NA
Copper	1.0E-06	NA	NA	2.8E-13	NA	NA	NA	NA
Dibenzo(a,h)anthracene	7.1E-10	NA	NA	1.9E-13	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	3.1E-08	NA	NA	NA	9.3E-08	NA
1,2-Dichloroethene	NA	NA	3.1E-08	NA	NA	NA	5.8E-08	NA
Fluoranthene	2.5E-09	NA	NA	1.4E-12	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.0E-09	NA	NA	2.8E-13	NA	NA	NA	NA
Mercury	4.5E-09	NA	NA	1.2E-17	NA	NA	NA	NA
Pyrene	3.0E-09	NA	NA	1.6E-12	NA	NA	NA	NA
Silver	8.8E-08	NA	NA	1.0E-12	NA	NA	NA	NA
Tetrachloroethene	NA	NA	3.1E-08	NA	NA	NA	2.2E-06	NA
Trichloroethene	NA	NA	3.1E-08	NA	NA	NA	1.3E-06	NA
Zinc	NA	3.5E-05	NA	6.7E-10	NA	NA	NA	NA
Uranium-233/234	2.3E+02	5.4E+01	NA	3.2E-01	NA	NA	NA	3.1E+00
Uranium-235+D	1.6E+01	3.5E+00	NA	4.4E-02	NA	NA	NA	2.1E-01
Uranium-238+D	6.2E+02	1.0E+02	NA	1.9E+00	NA	NA	NA	8.2E+00

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-49
Construction Worker CT Carcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Subsurface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Subsurface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	6.83E-09	3.11E-13	NA	NA
Benzo(a)pyrene	NA	7.34E-14	NA	NA
Benzo(b)fluoranthene	NA	6.04E-15	NA	NA
Beryllium	9.32E-10	4.24E-14	NA	NA
Cadmium	1.81E-09	4.11E-14	1.79E-10	NA
Copper	5.87E-08	1.35E-12	NA	NA
Dibenzo(a,h)anthracene	NA	9.81E-15	NA	NA
Fluoranthene	NA	7.13E-14	NA	NA
Indeno(1,2,3-cd)pyrene	NA	1.43E-14	NA	NA
Mercury	NA	6.30E-19	NA	NA
Molybdenum	3.17E-08	7.21E-13	NA	NA
Nickel	3.24E-08	7.37E-13	NA	NA
Pyrene	NA	8.44E-14	NA	NA
Silver	6.12E-09	1.91E-13	NA	NA
Uranium-233/234	8.59E+00	1.65E-02	NA	1.25E-01
Uranium-235+D	1.51E+00	2.27E-03	NA	8.40E-03
Uranium-238+D	2.33E+01	9.72E-02	NA	3.28E-01

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-50
Current Security Worker CT Carcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Benzo(a)pyrene	1.0E-10	9.9E-14	NA	NA
Benzo(b)fluoranthene	2.0E-12	8.1E-15	NA	NA
Copper	5.0E-09	1.9E-14	NA	NA
Dibenzo(a,h)anthracene	3.5E-12	1.3E-14	NA	NA
Fluoranthene	1.2E-11	9.6E-14	NA	NA
Indeno(1,2,3-cd)pyrene	5.1E-12	1.9E-14	NA	NA
Mercury	2.2E-11	8.5E-19	NA	NA
Pyrene	1.5E-11	1.1E-13	NA	NA
Silver	4.4E-10	6.9E-14	NA	NA
Uranium-233/234	2.6E+00	2.2E-02	NA	1.9E+00
Uranium-235+D	1.7E-01	3.0E-03	NA	1.3E-01
Uranium-238+D	6.7E+00	1.3E-01	NA	4.9E+00

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-51
Ecological Worker CT Carcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	NA	6.3E-09	NA	5.1E-12	NA	NA	NA	NA
Benzo(a)pyrene	1.0E-09	NA	NA	2.6E-13	NA	NA	NA	NA
Benzo(b)fluoranthene	2.0E-11	NA	NA	2.2E-14	NA	NA	NA	NA
Beryllium	NA	2.2E-10	NA	1.8E-13	NA	NA	NA	NA
Copper	4.9E-08	NA	NA	5.2E-14	NA	NA	NA	NA
Dibenzo(a,h)anthracene	3.4E-11	NA	NA	3.5E-14	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	2.4E-10	NA	NA	NA	3.6E-09	NA
1,2-Dichloroethene	NA	NA	2.4E-10	NA	NA	NA	2.3E-09	NA
Fluoranthene	1.2E-10	NA	NA	2.6E-13	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	5.0E-11	NA	NA	5.1E-14	NA	NA	NA	NA
Mercury	2.2E-10	NA	NA	2.3E-18	NA	NA	NA	NA
Pyrene	1.4E-10	NA	NA	3.0E-13	NA	NA	NA	NA
Silver	4.3E-09	NA	NA	1.9E-13	NA	NA	NA	NA
Tetrachloroethene	NA	NA	2.4E-10	NA	NA	NA	8.4E-08	NA
Trichloroethene	NA	NA	2.4E-10	NA	NA	NA	5.2E-08	NA
Zinc	NA	3.1E-07	NA	1.2E-10	NA	NA	NA	NA
Uranium-233/234	2.5E+01	1.0E+00	NA	5.9E-02	NA	NA	NA	6.2E-01
Uranium-235+D	1.7E+00	6.8E-02	NA	8.1E-03	NA	NA	NA	4.2E-02
Uranium-238+D	6.6E+01	1.9E+00	NA	3.5E-01	NA	NA	NA	1.6E+00

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-52
Office Worker CT Carcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Benzo(a)pyrene	8.2E-10	1.1E-12	NA	NA
Benzo(b)fluoranthene	1.6E-11	8.9E-14	NA	NA
Copper	4.0E-08	2.1E-13	NA	NA
Dibenzo(a,h)anthracene	2.8E-11	1.4E-13	NA	NA
Fluoranthene	9.8E-11	1.0E-12	NA	NA
Indeno(1,2,3-cd)pyrene	4.1E-11	2.1E-13	NA	NA
Mercury	1.8E-10	9.3E-18	NA	NA
Pyrene	1.2E-10	1.2E-12	NA	NA
Silver	3.5E-09	7.6E-13	NA	NA
Uranium-233/234	2.0E+01	2.4E-01	NA	1.9E+00
Uranium-235+D	1.4E+00	3.3E-02	NA	1.3E-01
Uranium-238+D	5.4E+01	1.4E+00	NA	4.9E+00

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-53
Open Space User CT Carcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	NA	7.3E-08	NA	5.9E-13	NA	NA	NA	NA
Benzo(a)pyrene	2.5E-09	NA	NA	3.0E-14	NA	NA	NA	NA
Benzo(b)fluoranthene	4.9E-11	NA	NA	2.5E-15	NA	NA	NA	NA
Beryllium	NA	2.5E-09	NA	2.0E-14	NA	NA	NA	NA
Copper	1.2E-07	NA	NA	6.0E-15	NA	NA	NA	NA
Dibenzo(a,h)anthracene	8.5E-11	NA	NA	4.1E-15	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	7.9E-10	NA	NA	NA	2.3E-09	NA
1,2-Dichloroethene	NA	NA	7.9E-10	NA	NA	NA	1.4E-09	NA
Fluoranthene	3.0E-10	NA	NA	3.0E-14	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.2E-10	NA	NA	5.9E-15	NA	NA	NA	NA
Mercury	5.3E-10	NA	NA	2.6E-19	NA	NA	NA	NA
Pyrene	3.6E-10	NA	NA	3.5E-14	NA	NA	NA	NA
Silver	1.1E-08	NA	NA	2.1E-14	NA	NA	NA	NA
Tetrachloroethene	NA	NA	7.9E-10	NA	NA	NA	5.3E-08	NA
Trichloroethene	NA	NA	7.9E-10	NA	NA	NA	3.3E-08	NA
Zinc	NA	3.5E-06	NA	1.4E-11	NA	NA	NA	NA
Uranium-233/234	1.4E+01	2.8E+00	NA	6.8E-03	NA	NA	NA	3.7E-01
Uranium-235+D	9.6E-01	1.8E-01	NA	9.3E-04	NA	NA	NA	2.5E-02
Uranium-238+D	3.8E+01	5.1E+00	NA	4.0E-02	NA	NA	NA	9.8E-01

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-54
Ecological Worker RME Carcinogenic Chemical Intakes for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments (mg/kg-day)	Ingestion of Stream Sediments (mg/kg-day)	Ingestion of Surface Water (mg/kg-day)	Inhalation of Airborne Particulates[1] (mg/kg-day)	Dermal Absorption of Pond Sediments (mg/kg-day)	Dermal Absorption of Stream Sediments (mg/kg-day)	Dermal Absorption of Surface Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Barium	NA	NA	8.7E-08	NA	NA	NA	NA	NA
Copper	NA	3.9E-07	NA	4.8E-11	NA	NA	NA	NA
Lithium	NA	NA	1.9E-08	NA	NA	NA	NA	NA
Mercury	2.8E-09	3.9E-09	NA	4.8E-13	NA	NA	NA	NA
Strontium	NA	NA	2.6E-07	NA	NA	NA	NA	NA
Zinc	4.2E-07	1.1E-06	NA	1.3E-10	NA	NA	NA	NA
Americium-241	1.4E+00	9.2E-01	1.2E-01	1.1E-04	NA	NA	NA	4.4E-02
Plutonium-239/240	7.9E+00	5.1E+00	NA	6.3E-04	NA	NA	NA	2.4E-01
Uranium-233/234	1.0E+01	NA	2.8E+00	NA	NA	NA	NA	NA
Uranium-235+D	6.7E-01	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	9.2E+00	NA	3.2E+00	NA	NA	NA	NA	NA

(1) Includes only the contribution of stream sediments.
Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-55
Open Space User RME Carcinogenic Chemical Intakes for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments (mg/kg-day)	Ingestion of Stream Sediments (mg/kg-day)	Ingestion of Surface Water (mg/kg-day)	Inhalation of Airborne Particulates[(1)] (mg/kg-day)	Dermal Absorption of Pond Sediments (mg/kg-day)	Dermal Absorption of Stream Sediments (mg/kg-day)	Dermal Absorption of Surface Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Barium	NA	NA	1.3E-06	NA	NA	NA	NA	NA
Copper	NA	7.2E-06	NA	1.4E-10	NA	NA	NA	NA
Lithium	NA	NA	2.8E-07	NA	NA	NA	NA	NA
Mercury	5.3E-08	7.4E-08	NA	1.4E-12	NA	NA	NA	NA
Strontium	NA	NA	3.9E-06	NA	NA	NA	NA	NA
Zinc	7.9E-06	2.0E-05	NA	3.8E-10	NA	NA	NA	NA
Americium-241	1.2E+01	7.8E+00	1.8E+00	3.3E-04	NA	NA	NA	1.7E-01
Plutonium-239/240	6.7E+01	4.3E+01	NA	1.8E-03	NA	NA	NA	9.6E-01
Uranium-233/234	8.8E+01	NA	4.2E+01	NA	NA	NA	NA	NA
Uranium-235+D	5.7E+00	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	7.8E+01	NA	4.7E+01	NA	NA	NA	NA	NA

(1) Includes only contributions from stream sediments.
Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-56
Ecological Worker CT Carcinogenic Chemical Intakes for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments (mg/kg-day)	Ingestion of Stream Sediments (mg/kg-day)	Ingestion of Surface Water (mg/kg-day)	Inhalation of Airborne Particulates(1) (mg/kg-day)	Dermal Absorption of Pond Sediments (mg/kg-day)	Dermal Absorption of Stream Sediments (mg/kg-day)	Dermal Absorption of Surface Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Barium	NA	NA	1.0E-08	NA	NA	NA	NA	NA
Copper	NA	6.3E-08	NA	2.5E-11	NA	NA	NA	NA
Lithium	NA	NA	2.2E-09	NA	NA	NA	NA	NA
Mercury	4.6E-10	6.4E-10	NA	2.6E-13	NA	NA	NA	NA
Strontium	NA	NA	3.0E-08	NA	NA	NA	NA	NA
Zinc	6.9E-08	1.7E-07	NA	7.0E-08	NA	NA	NA	NA
Americium-241	2.3E-01	1.5E-01	1.4E-02	6.1E-05	NA	NA	NA	3.5E-02
Plutonium-239/240	1.3E+00	8.3E-01	NA	3.4E-04	NA	NA	NA	1.9E-01
Uranium-233/234	1.7E+00	NA	3.3E-01	NA	NA	NA	NA	NA
Uranium-235+D	1.1E-01	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	1.5E+00	NA	3.7E-01	NA	NA	NA	NA	NA

(1) Includes only contributions from stream sediments.
Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity value available or appropriate for exposure route.

Table 6-57
Open Space User CT Carcinogenic Chemical Intakes for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments (mg/kg-day)	Ingestion of Stream Sediments (mg/kg-day)	Ingestion of Surface Water (mg/kg-day)	Inhalation of Airborne Particulates(1) (mg/kg-day)	Dermal Absorption of Pond Sediments (mg/kg-day)	Dermal Absorption of Stream Sediments (mg/kg-day)	Dermal Absorption of Surface Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Barium	NA	NA	3.3E-08	NA	NA	NA	NA	NA
Copper	NA	7.2E-07	NA	2.9E-12	NA	NA	NA	NA
Lithium	NA	NA	7.0E-09	NA	NA	NA	NA	NA
Mercury	5.3E-09	7.3E-09	NA	3.0E-14	NA	NA	NA	NA
Strontium	NA	NA	9.7E-08	NA	NA	NA	NA	NA
Zinc	7.8E-07	2.0E-06	NA	8.1E-09	NA	NA	NA	NA
Americium-241	6.2E-01	4.0E-01	4.5E-02	7.0E-06	NA	NA	NA	2.1E-02
Plutonium-239/240	3.4E+00	2.2E+00	NA	3.9E-05	NA	NA	NA	1.2E-01
Uranium-233/234	4.5E+00	NA	1.1E+00	NA	NA	NA	NA	NA
Uranium-235+D	2.9E-01	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	4.0E+00	NA	1.2E+00	NA	NA	NA	NA	NA

(1) Includes only contributions of stream sediments.
Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity value available or appropriate for exposure route.

Table 6-58
Construction Worker RME Noncarcinogenic Chemical Intakes for OU5, AOC1

Chemicals of Concern	Ingestion of Subsurface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Subsurface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	2.0E-06	2.0E-11	NA	NA
Aroclor-1254	5.9E-08	5.0E-11	7.0E-08	NA
Benzo(a)anthracene	6.5E-07	2.3E-10	NA	NA
Benzo(a)pyrene	6.1E-07	2.1E-10	NA	NA
Benzo(b)fluoranthene	6.8E-07	2.5E-10	NA	NA
Beryllium	2.2E-07	2.2E-12	NA	NA
Cadmium	3.3E-07	1.7E-12	3.3E-08	NA
Copper	2.5E-05	1.3E-10	NA	NA
Dibenzo(a,h)anthracene	NA	4.6E-11	NA	NA
Fluoranthene	NA	6.3E-10	NA	NA
Indeno(1,2,3-cd)pyrene	NA	1.5E-10	NA	NA
Mercury	NA	9.4E-14	NA	NA
Molybdenum	1.4E-05	7.1E-11	NA	NA
Nickel	1.2E-05	5.9E-11	NA	NA
Pyrene	NA	5.6E-10	NA	NA
Silver	1.3E-06	6.4E-12	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-59
Current Security Worker RME Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Aroclor-1254	9.38E-09	1.53E-11	7.65E-08	NA
Benzo(a)anthracene	3.30E-08	7.07E-11	NA	NA
Benzo(a)pyrene	2.50E-08	6.50E-11	NA	NA
Benzo(b)fluoranthene	3.35E-08	7.67E-11	NA	NA
Copper	8.39E-07	6.90E-13	NA	NA
Dibenzo(a,h)anthracene	1.53E-08	1.43E-11	NA	NA
Fluoranthene	2.90E-08	1.96E-10	NA	NA
Indeno(1,2,3-cd)pyrene	4.18E-08	4.67E-11	NA	NA
Mercury	3.67E-09	2.91E-14	NA	NA
Pyrene	2.58E-08	1.73E-10	NA	NA
Silver	4.86E-08	2.33E-16	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" =Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-60
Ecological Worker RME Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Acetone	NA	NA	1.5E-06	NA	NA	NA	1.7E-07	NA
Antimony	NA	1.3E-06	NA	3.1E-10	NA	NA	NA	NA
Aroclor-1254	8.3E-08	NA	NA	1.1E-10	4.4E-07	NA	NA	NA
Benzo(a)anthracene	2.9E-07	NA	NA	4.9E-10	NA	NA	NA	NA
Benzo(a)pyrene	2.2E-07	NA	NA	4.5E-10	NA	NA	NA	NA
Benzo(b)fluoranthene	2.9E-07	NA	NA	5.4E-10	NA	NA	NA	NA
Beryllium	NA	4.2E-08	NA	1.0E-11	NA	NA	NA	NA
Copper	7.4E-06	NA	NA	4.8E-12	NA	NA	NA	NA
Dibenzo(a,h)anthracen	1.3E-07	NA	NA	1.0E-10	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	9.4E-08	NA	NA	NA	2.8E-07	NA
1,2-Dichloroethene	NA	NA	9.4E-08	NA	NA	NA	1.7E-07	NA
Fluoranthene	2.5E-07	NA	NA	1.4E-09	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	3.7E-07	NA	NA	3.3E-10	NA	NA	NA	NA
Mercury	3.2E-08	NA	NA	2.0E-13	NA	NA	NA	NA
Pyrene	2.3E-07	NA	NA	1.2E-09	NA	NA	NA	NA
Silver	4.3E-07	NA	NA	1.6E-15	NA	NA	NA	NA
Tetrachloroethene	NA	NA	6.6E-07	NA	NA	NA	4.5E-05	NA
Trichloroethene	NA	NA	1.6E-07	NA	NA	NA	7.0E-06	NA
Zinc	NA	3.5E-06	NA	4.3E-10	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-61
Office Worker RME Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Aroclor-1254	1.5E-07	2.5E-10	7.6E-07	NA
Benzo(a)anthracene	5.3E-07	1.1E-09	NA	NA
Benzo(a)pyrene	4.0E-07	1.0E-09	NA	NA
Benzo(b)fluoranthene	5.4E-07	1.2E-09	NA	NA
Copper	1.3E-05	1.1E-11	NA	NA
Dibenzo(a,h)anthracene	2.4E-07	2.3E-10	NA	NA
Fluoranthene	4.6E-07	3.1E-09	NA	NA
Indeno(1,2,3-cd)pyrene	6.7E-07	7.5E-10	NA	NA
Mercury	5.9E-08	4.7E-13	NA	NA
Pyrene	4.1E-07	2.8E-09	NA	NA
Silver	7.8E-07	3.7E-15	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-62
Adult Open Space User RME Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Acetone	NA	NA	1.9E-06	NA	NA	NA	2.1E-07	NA
Antimony	NA	7.5E-07	NA	7.6E-11	NA	NA	NA	NA
Aroclor-1254	1.5E-08	NA	NA	2.6E-11	1.9E-07	NA	NA	NA
Benzo(a)anthracene	5.3E-08	NA	NA	1.2E-10	NA	NA	NA	NA
Benzo(a)pyrene	4.0E-08	NA	NA	1.1E-10	NA	NA	NA	NA
Benzo(b)fluoranthene	5.4E-08	NA	NA	1.3E-10	NA	NA	NA	NA
Beryllium	NA	2.5E-08	NA	2.5E-12	NA	NA	NA	NA
Copper	1.3E-06	NA	NA	1.2E-12	NA	NA	NA	NA
Dibenzo(a,h)anthracene	2.4E-08	NA	NA	2.4E-11	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	1.2E-07	NA	NA	NA	3.5E-07	NA
1,2-Dichloroethene	NA	NA	1.2E-07	NA	NA	NA	2.2E-07	NA
Fluoranthene	4.6E-08	NA	NA	3.3E-10	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	6.7E-08	NA	NA	7.9E-11	NA	NA	NA	NA
Mercury	5.9E-09	NA	NA	4.9E-14	NA	NA	NA	NA
Pyrene	4.1E-08	NA	NA	2.9E-10	NA	NA	NA	NA
Silver	7.8E-08	NA	NA	3.9E-16	NA	NA	NA	NA
Tetrachloroethene	NA	NA	8.2E-07	NA	NA	NA	5.6E-05	NA
Trichloroethene	NA	NA	2.1E-07	NA	NA	NA	8.8E-06	NA
Zinc	NA	2.1E-06	NA	1.0E-10	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-63
Child Open Space User RME Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)
Antimony	NA	7.0E-06
Aroclor-1254	1.4E-07	NA
Benzo(a)anthracene	4.9E-07	NA
Benzo(a)pyrene	3.7E-07	NA
Benzo(b)fluoranthene	5.0E-07	NA
Beryllium	NA	2.3E-07
Copper	1.3E-05	NA
Dibenzo(a,h)anthracene	2.3E-07	NA
Fluoranthene	4.3E-07	NA
Indeno(1,2,3-cd)pyrene	6.2E-07	NA
Mercury	5.5E-08	NA
Pyrene	3.9E-07	NA
Silver	7.3E-07	NA
Zinc	NA	1.9E-05
Uranium-233/234	NA	NA
Uranium-235+D	NA	NA
Uranium-238+D	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-64

Construction Worker CT Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Subsurface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Subsurface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	3.6E-07	2.29E-12	NA	NA
Aroclor-1254	1.1E-08	4.00E-11	1.3E-08	NA
Benzo(a)anthracene	1.2E-07	1.84E-10	NA	NA
Benzo(a)pyrene	1.1E-07	1.69E-10	NA	NA
Benzo(b)fluoranthene	1.2E-07	2.00E-10	NA	NA
Beryllium	3.9E-08	2.47E-13	NA	NA
Cadmium	5.9E-08	1.87E-13	5.9E-09	NA
Copper	4.4E-06	1.57E-11	NA	NA
Dibenzo(a,h)anthracene	NA	3.71E-11	NA	NA
Fluoranthene	NA	5.09E-10	NA	NA
Indeno(1,2,3-cd)pyrene	NA	1.22E-10	NA	NA
Mercury	NA	7.58E-14	NA	NA
Molybdenum	2.5E-06	7.94E-12	NA	NA
Nickel	2.1E-06	6.56E-12	NA	NA
Pyrene	NA	4.51E-10	NA	NA
Silver	2.2E-07	7.11E-13	NA	NA
Uranium-233/234	NA	6.94E-07	NA	NA
Uranium-235+D	NA	1.64E-07	NA	NA
Uranium-238+D	NA	9.28E-06	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-65
Current Security Worker CT Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Aroclor-1254	1.48E-09	1.34E-11	1.21E-08	NA
Benzo(a)anthracene	5.20E-09	6.19E-11	NA	NA
Benzo(a)pyrene	3.95E-09	5.69E-11	NA	NA
Benzo(b)fluoranthene	5.27E-09	6.72E-11	NA	NA
Copper	1.32E-07	6.05E-13	NA	NA
Dibenzo(a,h)anthracene	2.41E-09	1.25E-11	NA	NA
Fluoranthene	4.57E-09	1.71E-10	NA	NA
Indeno(1,2,3-cd)pyrene	6.59E-09	4.09E-11	NA	NA
Mercury	5.79E-10	2.55E-14	NA	NA
Pyrene	4.07E-09	1.52E-10	NA	NA
Silver	7.67E-09	2.05E-16	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-66
Ecological Worker CT Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Acetone	NA	NA	1.8E-07	NA	NA	NA	9.9E-08	NA
Antimony	NA	2.1E-07	NA	4.2E-10	NA	NA	NA	NA
Aroclor-1254	2.3E-08	NA	NA	1.4E-10	7.9E-08	NA	NA	NA
Benzo(a)anthracene	8.1E-08	NA	NA	6.6E-10	NA	NA	NA	NA
Benzo(a)pyrene	6.2E-08	NA	NA	6.1E-10	NA	NA	NA	NA
Benzo(b)fluoranthene	8.2E-08	NA	NA	7.2E-10	NA	NA	NA	NA
Beryllium	NA	6.9E-09	NA	1.4E-11	NA	NA	NA	NA
Copper	2.1E-06	NA	NA	6.5E-12	NA	NA	NA	NA
Dibenzo(a,h)anthracene	3.8E-08	NA	NA	1.3E-10	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	1.1E-08	NA	NA	NA	1.6E-07	NA
1,2-Dichloroethene	NA	NA	1.1E-08	NA	NA	NA	1.0E-07	NA
Fluoranthene	7.1E-08	NA	NA	1.8E-09	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.0E-07	NA	NA	4.4E-10	NA	NA	NA	NA
Mercury	9.0E-09	NA	NA	2.7E-13	NA	NA	NA	NA
Pyrene	6.4E-08	NA	NA	1.6E-09	NA	NA	NA	NA
Silver	1.2E-07	NA	NA	2.2E-15	NA	NA	NA	NA
Tetrachloroethene	NA	NA	7.7E-08	NA	NA	NA	2.6E-05	NA
Trichloroethene	NA	NA	1.9E-08	NA	NA	NA	4.1E-06	NA
Zinc	NA	5.7E-07	NA	5.7E-10	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-67
Office Worker CT Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Aroclor-1254	1.2E-08	1.5E-10	1.2E-07	NA
Benzo(a)anthracene	4.2E-08	6.8E-10	NA	NA
Benzo(a)pyrene	3.2E-08	6.2E-10	NA	NA
Benzo(b)fluoranthene	4.2E-08	7.3E-10	NA	NA
Copper	1.1E-06	6.6E-12	NA	NA
Dibenzo(a,h)anthracene	1.9E-08	1.4E-10	NA	NA
Fluoranthene	3.7E-08	1.9E-09	NA	NA
Indeno(1,2,3-cd)pyrene	5.3E-08	4.5E-10	NA	NA
Mercury	4.6E-09	2.8E-13	NA	NA
Pyrene	3.3E-08	1.7E-09	NA	NA
Silver	6.1E-08	2.2E-15	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-68
Adult Open Space User CT Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Acetone	NA	NA	1.6E-07	NA	NA	NA	1.7E-08	NA
Antimony	NA	1.3E-07	NA	4.9E-11	NA	NA	NA	NA
Aroclor-1254	3.0E-09	NA	NA	1.7E-11	2.9E-09	NA	NA	NA
Benzo(a)anthracene	1.1E-08	NA	NA	7.6E-11	NA	NA	NA	NA
Benzo(a)pyrene	8.0E-09	NA	NA	7.0E-11	NA	NA	NA	NA
Benzo(b)fluoranthene	1.1E-08	NA	NA	8.3E-11	NA	NA	NA	NA
Beryllium	NA	4.2E-09	NA	1.6E-12	NA	NA	NA	NA
Copper	2.7E-07	NA	NA	7.5E-13	NA	NA	NA	NA
Dibenzo(a,h)anthracene	4.9E-09	NA	NA	1.5E-11	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	9.8E-09	NA	NA	NA	2.8E-08	NA
1,2-Dichloroethene	NA	NA	9.8E-09	NA	NA	NA	1.8E-08	NA
Fluoranthene	9.3E-09	NA	NA	2.1E-10	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.3E-08	NA	NA	5.0E-11	NA	NA	NA	NA
Mercury	1.2E-09	NA	NA	3.1E-14	NA	NA	NA	NA
Pyrene	8.3E-09	NA	NA	1.9E-10	NA	NA	NA	NA
Silver	1.6E-08	NA	NA	2.5E-16	NA	NA	NA	NA
Tetrachloroethene	NA	NA	6.8E-08	NA	NA	NA	4.6E-06	NA
Trichloroethene	NA	NA	1.7E-08	NA	NA	NA	7.2E-07	NA
Zinc	NA	3.4E-07	NA	6.6E-11	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-69
Child Open Space User CT Noncarcinogenic Chemical Intakes for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)
Acetone	NA	NA
Antimony	NA	1.2E-06
Aroclor-1254	2.8E-08	NA
Benzo(a)anthracene	9.8E-08	NA
Benzo(a)pyrene	7.5E-08	NA
Benzo(b)fluoranthene	1.0E-07	NA
Beryllium	NA	3.9E-08
Copper	2.5E-06	NA
Dibenzo(a,h)anthracene	4.6E-08	NA
1,1-Dichloroethene	NA	NA
1,2-Dichloroethene	NA	NA
Fluoranthene	8.7E-08	NA
Indeno(1,2,3-cd)pyrene	1.2E-07	NA
Mercury	1.1E-08	NA
Pyrene	7.7E-08	NA
Silver	1.5E-07	NA
Tetrachloroethene	NA	NA
Trichloroethene	NA	NA
Zinc	NA	3.2E-06
Uranium-233/234	NA	NA
Uranium-235+D	NA	NA
Uranium-238+D	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-70
Construction Worker RME Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Subsurface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Subsurface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	2.7E-06	2.71E-11	NA	NA
Benzo(a)pyrene	NA	6.39E-12	NA	NA
Benzo(b)fluoranthene	NA	5.26E-13	NA	NA
Beryllium	3.7E-07	3.69E-12	NA	NA
Cadmium	7.1E-07	3.58E-12	7.0E-08	NA
Copper	2.3E-05	1.18E-10	NA	NA
Dibenzo(a,h)anthracene	NA	8.55E-13	NA	NA
Fluoranthene	NA	6.21E-12	NA	NA
Indeno(1,2,3-cd)pyrene	NA	1.24E-12	NA	NA
Mercury	NA	5.48E-17	NA	NA
Molybdenum	1.2E-05	6.28E-11	NA	NA
Nickel	1.3E-05	6.42E-11	NA	NA
Pyrene	NA	7.35E-12	NA	NA
Silver	2.4E-06	1.66E-11	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-71
Current Security Worker RME Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Benzo(a)pyrene	1.1E-08	2.0E-12	NA	NA
Benzo(b)fluoranthene	2.2E-10	1.6E-13	NA	NA
Copper	5.5E-07	3.9E-13	NA	NA
Dibenzo(a,h)anthracene	3.9E-10	2.6E-13	NA	NA
Fluoranthene	1.4E-09	1.9E-12	NA	NA
Indeno(1,2,3-cd)pyrene	5.6E-10	3.8E-13	NA	NA
Mercury	2.4E-09	1.7E-17	NA	NA
Pyrene	1.6E-09	2.3E-12	NA	NA
Silver	4.8E-08	1.4E-12	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-72
Ecological Worker RME Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	NA	1.1E-06	NA	2.7E-10	NA	NA	NA	NA
Benzo(a)pyrene	1.0E-07	NA	NA	1.4E-11	NA	NA	NA	NA
Benzo(b)fluoranthene	2.0E-09	NA	NA	1.1E-12	NA	NA	NA	NA
Beryllium	NA	3.7E-08	NA	9.2E-12	NA	NA	NA	NA
Copper	4.9E-06	NA	NA	2.7E-12	NA	NA	NA	NA
Dibenzo(a,h)anthracene	3.4E-09	NA	NA	1.8E-12	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	5.9E-08	NA	NA	NA	1.7E-07	NA
1,2-Dichloroethene	NA	NA	5.9E-08	NA	NA	NA	1.1E-07	NA
Fluoranthene	1.2E-08	NA	NA	1.3E-11	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	5.0E-09	NA	NA	2.7E-12	NA	NA	NA	NA
Mercury	2.2E-08	NA	NA	1.2E-16	NA	NA	NA	NA
Pyrene	1.4E-08	NA	NA	1.6E-11	NA	NA	NA	NA
Silver	4.2E-07	NA	NA	9.7E-12	NA	NA	NA	NA
Tetrachloroethene	NA	NA	5.9E-08	NA	NA	NA	4.0E-06	NA
Trichloroethene	NA	NA	5.9E-08	NA	NA	NA	2.5E-06	NA
Zinc	NA	5.2E-05	NA	6.4E-09	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-73
Office Worker RME Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Benzo(a)pyrene	1.8E-07	3.2E-11	NA	NA
Benzo(b)fluoranthene	3.6E-09	2.6E-12	NA	NA
Copper	8.9E-06	6.2E-12	NA	NA
Dibenzo(a,h)anthracene	6.2E-09	4.2E-12	NA	NA
Fluoranthene	2.2E-08	3.1E-11	NA	NA
Indeno(1,2,3-cd)pyrene	9.0E-09	6.1E-12	NA	NA
Mercury	3.9E-08	2.7E-16	NA	NA
Pyrene	2.6E-08	3.6E-11	NA	NA
Silver	7.7E-07	2.2E-11	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-74
Adult Open Space User RME Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	NA	6.4E-07	NA	6.4E-11	NA	NA	NA	NA
Benzo(a)pyrene	1.8E-08	NA	NA	3.3E-12	NA	NA	NA	NA
Benzo(b)fluoranthene	3.6E-10	NA	NA	2.7E-13	NA	NA	NA	NA
Beryllium	NA	2.2E-08	NA	2.2E-12	NA	NA	NA	NA
Copper	8.9E-07	NA	NA	6.6E-13	NA	NA	NA	NA
Dibenzo(a,h)anthracene	6.2E-10	NA	NA	4.5E-13	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	7.3E-08	NA	NA	NA	2.2E-07	NA
1,2-Dichloroethene	NA	NA	7.3E-08	NA	NA	NA	1.4E-07	NA
Fluoranthene	2.2E-09	NA	NA	3.2E-12	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	9.0E-10	NA	NA	6.5E-13	NA	NA	NA	NA
Mercury	3.9E-09	NA	NA	2.9E-17	NA	NA	NA	NA
Pyrene	2.6E-09	NA	NA	3.8E-12	NA	NA	NA	NA
Silver	7.7E-08	NA	NA	2.3E-12	NA	NA	NA	NA
Tetrachloroethene	NA	NA	7.3E-08	NA	NA	NA	5.0E-06	NA
Trichloroethene	NA	NA	7.3E-08	NA	NA	NA	3.1E-06	NA
Zinc	NA	3.1E-05	NA	1.6E-09	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi..

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-75
Child Open Space User RME Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)
Antimony	NA	6.0E-06
Benzo(a)pyrene	1.7E-07	NA
Benzo(b)fluoranthene	3.4E-09	NA
Beryllium	NA	2.1E-07
Copper	8.3E-06	NA
Dibenzo(a,h)anthracene	5.8E-09	NA
Fluoranthene	2.0E-08	NA
Indeno(1,2,3-cd)pyrene	8.4E-09	NA
Mercury	3.7E-08	NA
Pyrene	2.4E-08	NA
Silver	7.2E-07	NA
Zinc	NA	2.9E-04
Uranium-233/234	NA	NA
Uranium-235+D	NA	NA
Uranium-238+D	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-76
Construction Worker CT Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Subsurface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Subsurface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	4.8E-07	2.18E-11	NA	NA
Benzo(a)pyrene	NA	5.14E-12	NA	NA
Benzo(b)fluoranthene	NA	4.23E-13	NA	NA
Beryllium	6.5E-08	2.97E-12	NA	NA
Cadmium	1.3E-07	2.88E-12	1.3E-08	NA
Copper	4.1E-06	9.45E-11	NA	NA
Dibenzo(a,h)anthracene	NA	6.87E-13	NA	NA
Fluoranthene	NA	4.99E-12	NA	NA
Indeno(1,2,3-cd)pyrene	NA	9.99E-13	NA	NA
Mercury	NA	4.41E-17	NA	NA
Molybdenum	2.2E-06	5.05E-11	NA	NA
Nickel	2.3E-06	5.16E-11	NA	NA
Pyrene	NA	5.91E-12	NA	NA
Silver	4.3E-07	1.34E-11	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-77
Current Security Worker CT Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Benzo(a)pyrene	1.80E-09	1.73E-12	NA	NA
Benzo(b)fluoranthene	3.54E-11	1.42E-13	NA	NA
Copper	8.75E-08	3.40E-13	NA	NA
Dibenzo(a,h)anthracene	6.12E-11	2.31E-13	NA	NA
Fluoranthene	2.15E-10	1.68E-12	NA	NA
Indeno(1,2,3-cd)pyrene	8.89E-11	3.36E-13	NA	NA
Mercury	3.86E-10	1.48E-17	NA	NA
Pyrene	2.58E-10	1.99E-12	NA	NA
Silver	7.62E-09	1.21E-12	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-78
Ecological Worker CT Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	NA	1.8E-07	NA	1.4E-10	NA	NA	NA	NA
Benzo(a)pyrene	2.8E-08	NA	NA	7.4E-12	NA	NA	NA	NA
Benzo(b)fluoranthene	5.5E-10	NA	NA	6.1E-13	NA	NA	NA	NA
Beryllium	NA	6.1E-09	NA	4.9E-12	NA	NA	NA	NA
Copper	1.4E-06	NA	NA	1.5E-12	NA	NA	NA	NA
Dibenzo(a,h)anthracene	9.6E-10	NA	NA	9.9E-13	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	6.8E-09	NA	NA	NA	1.0E-07	NA
1,2-Dichloroethene	NA	NA	6.8E-09	NA	NA	NA	6.3E-08	NA
Fluoranthene	3.4E-09	NA	NA	7.2E-12	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.4E-09	NA	NA	1.4E-12	NA	NA	NA	NA
Mercury	6.0E-09	NA	NA	6.3E-17	NA	NA	NA	NA
Pyrene	4.0E-09	NA	NA	8.5E-12	NA	NA	NA	NA
Silver	1.2E-07	NA	NA	5.2E-12	NA	NA	NA	NA
Tetrachloroethene	NA	NA	6.8E-09	NA	NA	NA	2.3E-06	NA
Trichloroethene	NA	NA	6.8E-09	NA	NA	NA	1.5E-06	NA
Zinc	NA	8.5E-06	NA	3.4E-09	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-79
Office Worker CT Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Benzo(a)pyrene	1.4E-08	1.9E-11	NA	NA
Benzo(b)fluoranthene	2.8E-10	1.6E-12	NA	NA
Copper	7.0E-07	3.7E-12	NA	NA
Dibenzo(a,h)anthracene	4.9E-10	2.5E-12	NA	NA
Fluoranthene	1.7E-09	1.8E-11	NA	NA
Indeno(1,2,3-cd)pyrene	7.1E-10	3.7E-12	NA	NA
Mercury	3.1E-09	1.6E-16	NA	NA
Pyrene	2.1E-09	2.2E-11	NA	NA
Silver	6.1E-08	1.3E-11	NA	NA
Uranium-233/234	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-80
Adult Open Space User CT Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	Ingestion of Seep Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Surface Soil (mg/kg-day)	Dermal Absorption of Seep Sediments (mg/kg-day)	Dermal Absorption of Seep Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	NA	1.1E-07	NA	4.6E-12	NA	NA	NA	NA
Benzo(a)pyrene	3.7E-09	NA	NA	2.4E-13	NA	NA	NA	NA
Benzo(b)fluoranthene	7.2E-11	NA	NA	1.9E-14	NA	NA	NA	NA
Beryllium	NA	3.7E-09	NA	1.6E-13	NA	NA	NA	NA
Copper	1.8E-07	NA	NA	4.7E-14	NA	NA	NA	NA
Dibenzo(a,h)anthracene	1.2E-10	NA	NA	3.2E-14	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	6.1E-09	NA	NA	NA	1.8E-08	NA
1,2-Dichloroethene	NA	NA	6.1E-09	NA	NA	NA	1.1E-08	NA
Fluoranthene	4.4E-10	NA	NA	2.3E-13	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.8E-10	NA	NA	4.6E-14	NA	NA	NA	NA
Mercury	7.8E-10	NA	NA	2.0E-18	NA	NA	NA	NA
Pyrene	5.2E-10	NA	NA	2.7E-13	NA	NA	NA	NA
Silver	1.5E-08	NA	NA	1.7E-13	NA	NA	NA	NA
Tetrachloroethene	NA	NA	6.1E-09	NA	NA	NA	4.1E-07	NA
Trichloroethene	NA	NA	6.1E-09	NA	NA	NA	2.6E-07	NA
Zinc	NA	5.1E-06	NA	1.1E-10	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-81
Child Open Space User CT Noncarcinogenic Chemical Intakes for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil (mg/kg-day)	Ingestion of Seep Sediments (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Antimony	NA	1.0E-06	NA
Benzo(a)pyrene	3.4E-08	NA	NA
Benzo(b)fluoranthene	6.7E-10	NA	NA
Beryllium	NA	3.4E-08	NA
Copper	1.7E-06	NA	NA
Dibenzo(a,h)anthracene	1.2E-09	NA	NA
Fluoranthene	4.1E-09	NA	NA
Indeno(1,2,3-cd)pyrene	1.7E-09	NA	NA
Mercury	7.3E-09	NA	NA
Pyrene	4.9E-09	NA	NA
Silver	1.4E-07	NA	NA
Zinc	NA	4.8E-05	NA
Uranium-233/234	NA	NA	NA
Uranium-235+D	NA	NA	NA
Uranium-238+D	NA	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-82
Ecological Worker RME Noncarcinogenic Chemical Intakes for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments (mg/kg-day)	Ingestion of Stream Sediments (mg/kg-day)	Ingestion of Surface Water (mg/kg-day)	Inhalation of Airborne Particulates[1] (mg/kg-day)	Dermal Absorption of Pond Sediments (mg/kg-day)	Dermal Absorption of Stream Sediments (mg/kg-day)	Dermal Absorption of Surface Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Barium	NA	NA	2.4E-06	NA	NA	NA	NA	NA
Copper	NA	1.1E-05	NA	1.3E-09	NA	NA	NA	NA
Lithium	NA	NA	5.2E-07	NA	NA	NA	NA	NA
Mercury	7.9E-08	1.1E-07	NA	1.4E-11	NA	NA	NA	NA
Strontium	NA	NA	7.2E-06	NA	NA	NA	NA	NA
Zinc	1.2E-05	3.0E-05	NA	3.7E-09	NA	NA	NA	NA
Americium-241	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA

(1) Includes only contributions of stream sediments.
Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-83
Adult Open Space User RME Noncarcinogenic Chemical Intakes for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments (mg/kg-day)	Ingestion of Stream Sediments (mg/kg-day)	Ingestion of Surface Water (mg/kg-day)	Inhalation of Airborne Particulates[1] (mg/kg-day)	Dermal Absorption of Pond Sediments (mg/kg-day)	Dermal Absorption of Stream Sediments (mg/kg-day)	Dermal Absorption of Surface Water (mg/kg-day)	External Radiation Exposure (year per pCi/g)
Barium	NA	NA	3.0E-06	NA	NA	NA	NA	NA
Copper	NA	6.4E-06	NA	3.2E-10	NA	NA	NA	NA
Lithium	NA	NA	6.5E-07	NA	NA	NA	NA	NA
Mercury	4.7E-08	6.5E-08	NA	3.3E-12	NA	NA	NA	NA
Strontium	NA	NA	9.0E-06	NA	NA	NA	NA	NA
Zinc	6.9E-06	1.8E-05	NA	8.9E-10	NA	NA	NA	NA
Americium-241	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA

(1) Includes only contributions of stream sediments.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-84
Child Open Space User RME Noncarcinogenic Chemical Intakes for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments (mg/kg-day)	Ingestion of Stream Sediments (mg/kg-day)
Copper	NA	5.9E-05
Mercury	4.4E-07	6.0E-07
Zinc	6.5E-05	1.6E-04
Americium-241	NA	NA
Plutonium-239/240	NA	NA
Uranium-233/234	NA	NA
Uranium-235+D	NA	NA
Uranium-238+D	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-85
Ecological Worker CT Noncarcinogenic Chemical Intakes for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments (mg/kg-day)	Ingestion of Stream Sediments (mg/kg-day)	Ingestion of Surface Water (mg/kg-day)	Inhalation of Airborne Particulates(1) (mg/kg-day)	Dermal Absorption of Pond Sediments (mg/kg-day)	Dermal Absorption of Stream Sediments (mg/kg-day)	Dermal Absorption of Surface Water (mg/kg-day)
Barium	NA	NA	2.8E-07	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA
Copper	NA	1.8E-06	NA	7.1E-10	NA	NA	NA
Lithium	NA	NA	6.1E-08	NA	NA	NA	NA
Mercury	1.3E-08	1.8E-08	NA	7.2E-12	NA	NA	NA
Strontium	NA	NA	8.4E-07	NA	NA	NA	NA
Zinc	1.9E-06	4.9E-06	NA	2.0E-06	NA	NA	NA
Americium-241	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA

(1) Includes only contribution of stream sediments.
Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity value available or appropriate for exposure route.

Table 6-86
Adult Open Space User CT Noncarcinogenic Chemical Intakes for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments (mg/kg-day)	Ingestion of Stream Sediments (mg/kg-day)	Ingestion of Surface Water (mg/kg-day)	Inhalation of Airborne Particulates (mg/kg-day)	Dermal Absorption of Pond Sediments (mg/kg-day)	Dermal Absorption of Stream Sediments (mg/kg-day)	Dermal Absorption of Surface Water (mg/kg-day)
Barium	NA	NA	2.5E-07	NA	NA	NA	NA
Copper	NA	1.1E-06	NA	2.3E-11	NA	NA	NA
Lithium	NA	NA	5.4E-08	NA	NA	NA	NA
Mercury	7.8E-09	1.1E-08	NA	2.3E-13	NA	NA	NA
Strontium	NA	NA	7.5E-07	NA	NA	NA	NA
Zinc	1.2E-06	2.9E-06	NA	6.3E-08	NA	NA	NA
Americium-241	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA

(1) Includes only contributions of stream sediments.
Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity value available or appropriate for exposure route.

Table 6-87
Child Open Space User CT Noncarcinogenic Chemical Intakes for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments (mg/kg-day)	Ingestion of Stream Sediments (mg/kg-day)
Copper	NA	2.8E-06
Mercury	2.1E-08	2.9E-08
Zinc	3.1E-06	7.8E-06
Americium-241	NA	NA
Plutonium-239/240	NA	NA
Uranium-233/234	NA	NA
Uranium-235+D	NA	NA
Uranium-238+D	NA	NA

Note: Radionuclide intakes are in units of pCi.
"NA" = Not a COC for this pathway or no toxicity value available or appropriate for exposure route.

Table 6-88
Carcinogen Groups

Weight-of-Evidence	Description
A	Human Carcinogen (sufficient evidence of carcinogenicity in humans)
B	Probable Human Carcinogen (B1- limited evidence of carcinogenicity in humans; B2- sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
C	Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data)
D	Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
E	Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies)

Table 6-89
Construction Worker RME Carcinogenic Risks for OU 5, AOC1

Chemicals of Concern	Ingestion of Subsurface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Subsurface Soil	External Radiation Exposure	Total Risk by Chemical
Antimony	NA	NA	NA	NA	NA
Aroclor-1254	6.5E-09	NA	7.7E-09	NA	1.4E-08
Benzo(a)anthracene	6.8E-09	NA	NA	NA	6.8E-09
Benzo(a)pyrene	6.4E-08	NA	NA	NA	6.4E-08
Benzo(b)fluoranthene	7.1E-09	NA	NA	NA	7.1E-09
Beryllium	1.4E-08	2.7E-13	NA	NA	1.4E-08
Cadmium	NA	1.5E-13	NA	NA	1.5E-13
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risk by Pathway				
	9.8E-08	4.2E-13	7.7E-09	NA	
Uranium-233/234	1.1E-09	3.1E-10	NA	6.1E-12	1.4E-09
Uranium-235+D	8.8E-11	6.8E-11	NA	2.2E-08	2.2E-08
Uranium-238+D	1.4E-09	3.7E-09	NA	1.3E-07	1.3E-07
	Radiological Risks by Pathway				
	2.5E-09	4.0E-09	NA	1.5E-07	
			Total Nonradiological Risk:		1.1E-07
			Total Radiological Risk:		1.6E-07
			Total Risk:		3E-07

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-90
Current Security Worker RME Carcinogenic Risks for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total Risk by Chemical
Aroclor-1254	2.6E-08	NA	2.1E-07	NA	2.4E-07
Benzo(a)anthracene	8.6E-09	NA	NA	NA	8.6E-09
Benzo(a)pyrene	6.5E-08	NA	NA	NA	6.5E-08
Benzo(b)fluoranthene	8.7E-09	NA	NA	NA	8.7E-09
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	4.0E-08	NA	NA	NA	4.0E-08
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.1E-08	NA	NA	NA	1.1E-08
Mercury	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway				
	1.6E-07	NA	2.1E-07	NA	
Uranium-233/234	8.3E-09	2.4E-09	NA	5.7E-11	1.1E-08
Uranium-235+D	2.5E-09	5.2E-10	NA	2.0E-07	2.0E-07
Uranium-238+D	9.9E-08	2.8E-08	NA	1.2E-06	1.3E-06
	Radiological Risks by Pathway				
	1.1E-07	3.1E-08	NA	1.4E-06	
			Total Nonradiological Risk:		3.7E-07
			Total Radiological Risk:		1.5E-06
			Total Risk:		2E-06

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-91
Ecological Worker RME Carcinogenic Risks for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total Risk by Chemical
Acetone	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	2.3E-08	NA	NA	NA	1.2E-07	NA	NA	NA	1.4E-07
Benzo(a)anthracene	7.6E-09	NA	NA	NA	NA	NA	NA	NA	7.6E-09
Benzo(a)pyrene	5.8E-08	NA	NA	NA	NA	NA	NA	NA	5.8E-08
Benzo(b)fluoranthene	7.7E-09	NA	NA	NA	NA	NA	NA	NA	7.7E-09
Beryllium	NA	6.5E-09	NA	3.1E-12	NA	NA	NA	NA	6.5E-09
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	3.5E-08	NA	NA	NA	NA	NA	NA	NA	3.5E-08
1,1-Dichloroethene	NA	NA	2.0E-09	NA	NA	NA	6.0E-09	NA	8.0E-09
1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	9.6E-09	NA	NA	NA	NA	NA	NA	NA	9.6E-09
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	1.2E-09	NA	NA	NA	8.4E-08	NA	8.5E-08
Trichloroethene	NA	NA	6.5E-11	NA	NA	NA	2.8E-09	NA	2.8E-09
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway								
	1.4E-07	6.5E-09	3.3E-09	3.1E-12	1.2E-07	NA	9.3E-08	NA	
Uranium-233/234	7.3E-09	2.0E-10	NA	1.7E-09	NA	NA	NA	3.1E-11	9.2E-09
Uranium-235+D	2.2E-09	1.6E-11	NA	3.7E-10	NA	NA	NA	1.1E-07	1.1E-07
Uranium-238+D	8.7E-08	2.4E-10	NA	2.0E-08	NA	NA	NA	6.4E-07	7.5E-07
	Radiological Risks by Pathway								
	9.6E-08	4.5E-10	NA	2.2E-08	NA	NA	NA	7.5E-07	
						Total Nonradiological Risk:			3.6E-07
						Total Radiological Risk:			8.7E-07
						Total Risk:			1E-06

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-92
Office Worker RME Carcinogenic Risks for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total Risk by Chemical
Aroclor-1254	4.1E-07	NA	2.1E-06	NA	2.5E-06
Benzo(a)anthracene	1.4E-07	NA	NA	NA	1.4E-07
Benzo(a)pyrene	1.0E-06	NA	NA	NA	1.0E-06
Benzo(b)fluoranthene	1.4E-07	NA	NA	NA	1.4E-07
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	6.4E-07	NA	NA	NA	6.4E-07
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.7E-07	NA	NA	NA	1.7E-07
Mercury	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway				
	2.5E-06	NA	2.1E-06	NA	
Uranium-233/234	1.3E-07	3.8E-08	NA	8.6E-10	1.7E-07
Uranium-235+D	4.0E-08	8.4E-09	NA	3.0E-06	3.1E-06
Uranium-238+D	1.6E-06	4.5E-07	NA	1.8E-05	2.0E-05
	Radiological Risks by Pathway				
	1.8E-06	5.0E-07	NA	2.1E-05	
			Total Nonradiological Risk:		4.6E-06
			Total Radiological Risk:		2.3E-05
			Total Risk:		3E-05

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-93
Open Space User RME Carcinogenic Risks for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total Risk by Chemical
Acetone	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	1.3E-07	NA	NA	NA	6.3E-07	NA	NA	NA	7.6E-07
Benzo(a)anthracene	4.4E-08	NA	NA	NA	NA	NA	NA	NA	4.4E-08
Benzo(a)pyrene	3.3E-07	NA	NA	NA	NA	NA	NA	NA	3.3E-07
Benzo(b)fluoranthene	4.5E-08	NA	NA	NA	NA	NA	NA	NA	4.5E-08
Beryllium	NA	1.2E-07	NA	9.1E-12	NA	NA	NA	NA	1.2E-07
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	2.0E-07	NA	NA	NA	NA	NA	NA	NA	2.0E-07
1,1-Dichloroethene	NA	NA	3.0E-08	NA	NA	NA	9.0E-08	NA	1.2E-07
1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	5.6E-08	NA	NA	NA	NA	NA	NA	NA	5.6E-08
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	1.8E-08	NA	NA	NA	1.3E-06	NA	1.3E-06
Trichloroethene	NA	NA	9.7E-10	NA	NA	NA	4.1E-08	NA	4.2E-08
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway								
	8.1E-07	1.2E-07	4.9E-08	9.1E-12	6.3E-07	NA	1.4E-06	NA	
Uranium-233/234	1.9E-08	1.7E-09	NA	4.8E-09	NA	NA	NA	1.2E-10	2.6E-08
Uranium-235+D	5.8E-09	1.4E-10	NA	1.1E-09	NA	NA	NA	4.3E-07	4.4E-07
Uranium-238+D	2.3E-07	2.0E-09	NA	5.7E-08	NA	NA	NA	2.6E-06	2.9E-06
	Radiological Risks by Pathway								
	2.5E-07	3.8E-09	NA	6.3E-08	NA	NA	NA	3.0E-06	
							Total Nonradiologicl Risk:		3.0E-06
							Total Radiologicl Risk:		3.3E-06
							Total Risk:		6E-06

"NA" = Not a COC for this pathway or no toxicity factor is available or aprorriate for exposure route.

Table 6-94
Construction Worker CT Carcinogenic Risks for OU 5, AOC1

Chemicals of Concern	Ingestion of Subsurface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Subsurface Soil	External Radiation Exposure	Total Risk by Chemical
Antimony	NA	NA	NA	NA	NA
Aroclor-1254	1.2E-09	NA	1.4E-09	NA	2.5E-09
Benzo(a)anthracene	1.2E-09	NA	NA	NA	1.2E-09
Benzo(a)pyrene	1.1E-08	NA	NA	NA	1.1E-08
Benzo(b)fluoranthene	1.3E-09	NA	NA	NA	1.3E-09
Beryllium	2.4E-09	3.0E-14	NA	NA	2.4E-09
Cadmium	NA	1.7E-14	NA	NA	1.7E-14
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway				
	1.7E-08	4.7E-14	1.4E-09	NA	
Uranium-233/234	1.9E-10	2.5E-10	NA	4.9E-12	4.5E-10
Uranium-235+D	1.6E-11	5.5E-11	NA	1.7E-08	1.7E-08
Uranium-238+D	2.5E-10	2.9E-09	NA	1.0E-07	1.1E-07
	Radiological Risks by Pathway				
	4.5E-10	3.2E-09	NA	1.2E-07	
			Total Nonradiological Risk:		1.9E-08
			Total Radiological Risk:		1.2E-07
			Total Risk:		1E-07

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-95
Current Security Worker CT Carcinogenic Risks for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total Risk by Chemical
Aroclor-1254	6.5E-10	NA	5.3E-09	NA	6.0E-09
Benzo(a)anthracene	2.2E-10	NA	NA	NA	2.2E-10
Benzo(a)pyrene	1.6E-09	NA	NA	NA	1.6E-09
Benzo(b)fluoranthene	2.2E-10	NA	NA	NA	2.2E-10
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	1.0E-09	NA	NA	NA	1.0E-09
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.7E-10	NA	NA	NA	2.7E-10
Mercury	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway				
	4.0E-09	NA	5.3E-09	NA	
Uranium-233/234	2.1E-10	3.3E-10	NA	5.7E-12	5.5E-10
Uranium-235+D	6.3E-11	7.3E-11	NA	2.0E-08	2.0E-08
Uranium-238+D	2.5E-09	4.0E-09	NA	1.2E-07	1.3E-07
	Radiological Risks by Pathway				
	2.8E-09	4.4E-09	NA	1.4E-07	
			Total Nonradiological Risk:		9.3E-09
			Total Radiological Risk:		1.5E-07
			Total Risk:		2E-07

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-96
Ecological Worker CT Carcinogenic Risks for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total Risk by Chemical
Acetone	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	6.4E-09	NA	NA	NA	2.2E-08	NA	NA	NA	2.8E-08
Benzo(a)anthracene	2.1E-09	NA	NA	NA	NA	NA	NA	NA	2.1E-09
Benzo(a)pyrene	1.6E-08	NA	NA	NA	NA	NA	NA	NA	1.6E-08
Benzo(b)fluoranthene	2.2E-09	NA	NA	NA	NA	NA	NA	NA	2.2E-09
Beryllium	NA	1.1E-09	NA	1.7E-12	NA	NA	NA	NA	1.1E-09
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	9.9E-09	NA	NA	NA	NA	NA	NA	NA	9.9E-09
1,1-Dichloroethene	NA	NA	2.3E-10	NA	NA	NA	3.5E-09	NA	3.7E-09
1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.7E-09	NA	NA	NA	NA	NA	NA	NA	2.7E-09
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	1.4E-10	NA	NA	NA	4.9E-08	NA	4.9E-08
Trichloroethene	NA	NA	7.5E-12	NA	NA	NA	1.6E-09	NA	1.6E-09
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway								
	3.9E-08	1.1E-09	3.8E-10	1.7E-12	2.2E-08	NA	5.4E-08	NA	
Uranium-233/234	2.1E-09	3.2E-11	NA	9.0E-10	NA	NA	NA	2.5E-11	3.0E-09
Uranium-235+D	6.2E-10	2.7E-12	NA	2.0E-10	NA	NA	NA	8.6E-08	8.7E-08
Uranium-238+D	2.4E-08	3.9E-11	NA	1.1E-08	NA	NA	NA	5.1E-07	5.5E-07
	Radiological Risks by Pathway								
	2.7E-08	7.4E-11	NA	1.2E-08	NA	NA	NA	6.0E-07	
							Total Nonradiologicl Risk:		1.2E-07
							Total Radiologicl Risk:		6.4E-07
							Total Risk:		8E-07

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-97
Office Worker CT Carcinogenic Risks for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total Risk by Chemical
Aroclor-1254	5.2E-09	NA	5.2E-08	NA	5.8E-08
Benzo(a)anthracene	1.7E-09	NA	NA	NA	1.7E-09
Benzo(a)pyrene	1.3E-08	NA	NA	NA	1.3E-08
Benzo(b)fluoranthene	1.8E-09	NA	NA	NA	1.8E-09
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	8.1E-09	NA	NA	NA	8.1E-09
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.2E-09	NA	NA	NA	2.2E-09
Mercury	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway				
	3.2E-08	NA	5.2E-08	NA	
Uranium-233/234	1.7E-09	3.6E-09	NA	7.4E-11	5.4E-09
Uranium-235+D	5.0E-10	8.0E-10	NA	2.6E-07	2.6E-07
Uranium-238+D	2.0E-08	4.3E-08	NA	1.5E-06	1.6E-06
	Radiological Risks by Pathway				
	2.2E-08	4.8E-08	NA	1.8E-06	
			Total Nonradiological Risk:		8.5E-08
			Total Radiological Risk:		1.9E-06
			Total Risk:		2E-06

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure routes.

Table 6-98
Open Space User CT Carcinogenic Risks for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total Risk by Chemical
Acetone	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	1.6E-08	NA	NA	NA	2.9E-09	NA	NA	NA	1.9E-08
Benzo(a)anthracene	5.2E-09	NA	NA	NA	NA	NA	NA	NA	5.2E-09
Benzo(a)pyrene	4.0E-08	NA	NA	NA	NA	NA	NA	NA	4.0E-08
Benzo(b)fluoranthene	5.3E-09	NA	NA	NA	NA	NA	NA	NA	5.3E-09
Beryllium	NA	1.7E-10	NA	1.9E-13	NA	NA	NA	NA	1.7E-10
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	2.4E-08	NA	NA	NA	NA	NA	NA	NA	2.4E-08
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	6.6E-09	NA	NA	NA	NA	NA	NA	NA	6.6E-09
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	4.6E-10	NA	NA	NA	3.1E-08	NA	3.1E-08
Trichloroethene	NA	NA	2.4E-11	NA	NA	NA	1.0E-09	NA	1.0E-09
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway								
	9.7E-08	1.7E-10	1.2E-09	1.9E-13	2.9E-09	NA	3.4E-08	NA	
Uranium-233/234	1.2E-09	8.5E-11	NA	1.0E-10	NA	NA	NA	1.5E-11	1.4E-09
Uranium-235+D	3.5E-10	7.1E-12	NA	2.3E-11	NA	NA	NA	5.2E-08	5.2E-08
Uranium-238+D	1.4E-08	1.0E-10	NA	1.2E-09	NA	NA	NA	3.1E-07	3.2E-07
	Radiological Risks by Pathway								
	1.5E-08	1.9E-10	NA	1.3E-09	NA	NA	NA	3.6E-07	
							Total Nonradiological Risk:		1.4E-07
							Total Radiological Risk:		3.8E-07
							Total Risk:		5E-07

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-99
Construction Worker RME Carcinogenic Risks for UO 5, AOC2

Chemicals of Concern	Ingestion of Subsurface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Subsurface Soil	External Radiation Exposure	Total Risk by Chemical
Antimony	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Beryllium	2.3E-08	4.4E-13	NA	NA	2.3E-08
Cadmium	NA	3.2E-13	NA	NA	3.2E-13
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA
	Nonradiological Risk by Pathway				
	2.3E-08	7.7E-13	NA	NA	
Uranium-233/234	2.1E-09	2.9E-10	NA	3.3E-12	2.4E-09
Uranium-235+D	4.0E-10	3.7E-11	NA	2.8E-09	3.2E-09
Uranium-238+D	8.1E-09	1.5E-09	NA	2.2E-08	3.1E-08
	Radiological Risks by Pathway				
	1.1E-08	1.8E-09	NA	2.4E-08	
			Total Nonradiological Risk:		2.3E-08
			Total Radiological Risk:		3.7E-08
			Total Risk:		6E-08

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-100
Current Security Worker RME Carcinogenic Risks for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total Risk by Chemical
Benzo(a)pyrene	3.0E-08	NA	NA	NA	3.0E-08
Benzo(b)fluoranthene	5.9E-11	NA	NA	NA	5.9E-11
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	1.0E-09	NA	NA	NA	1.0E-09
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.5E-10	NA	NA	NA	1.5E-10
Mercury	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risk by Pathway				
	3.1E-08	NA	NA	NA	
Uranium-233/234	4.5E-09	2.2E-09	NA	4.7E-10	7.2E-09
Uranium-235+D	3.2E-10	2.8E-10	NA	3.9E-07	3.9E-07
Uranium-238+D	1.7E-08	1.2E-08	NA	3.0E-06	3.0E-06
	Radiological Risk by Pathway				
	2.1E-08	1.4E-08	NA	3.4E-06	
			Total Nonradiological Risk:		3.1E-08
			Total Radiological Risk:		3.4E-06
			Total Risk:		3E-06

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-101
Ecological Worker RME Carcinogenic Risks for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total Risk by Chemical
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	2.6E-08	NA	NA	NA	NA	NA	NA	NA	2.6E-08
Benzo(b)fluoranthene	5.2E-11	NA	NA	NA	NA	NA	NA	NA	5.2E-11
Beryllium	NA	5.7E-09	NA	2.8E-12	NA	NA	NA	NA	5.7E-09
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	8.9E-10	NA	NA	NA	NA	NA	NA	NA	8.9E-10
1,1-Dichloroethene	NA	NA	1.3E-09	NA	NA	NA	3.7E-09	NA	5.0E-09
1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.3E-10	NA	NA	NA	NA	NA	NA	NA	1.3E-10
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	1.1E-10	NA	NA	NA	7.5E-09	NA	7.6E-09
Trichloroethene	NA	NA	2.3E-11	NA	NA	NA	9.8E-10	NA	1.0E-09
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risk by Pathway								
	2.7E-08	5.7E-09	1.4E-09	2.8E-12	NA	NA	1.2E-08	NA	
Uranium-233/234	4.0E-09	2.8E-10	NA	1.6E-09	NA	NA	NA	1.7E-11	5.8E-09
Uranium-235+D	2.8E-10	1.9E-11	NA	2.0E-10	NA	NA	NA	1.4E-08	1.4E-08
Uranium-238+D	1.5E-08	7.3E-10	NA	8.1E-09	NA	NA	NA	1.1E-07	1.3E-07
	Radiological Risk by Pathway								
	1.9E-08	1.0E-09	NA	9.8E-09	NA	NA	NA	1.2E-07	
						Total Nonradiological Risk:			4.7E-08
						Total Radiological Risk:			1.5E-07
						Total Risk:			2E-07

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-102
Office Worker RME Carcinogenic Risks for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total Risk by Chemical
Benzo(a)pyrene	4.8E-07	NA	NA	NA	4.8E-07
Benzo(b)fluoranthene	9.4E-10	NA	NA	NA	9.4E-10
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	1.6E-08	NA	NA	NA	1.6E-08
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.4E-09	NA	NA	NA	2.4E-09
Mercury	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risk by Pathway				
	5.0E-07	NA	NA	NA	
Uranium-233/234	7.2E-08	3.5E-08	NA	4.7E-10	1.1E-07
Uranium-235+D	5.1E-09	4.5E-09	NA	3.9E-07	4.0E-07
Uranium-238+D	2.7E-07	1.8E-07	NA	3.0E-06	3.5E-06
	Radiological Risk by Pathway				
	3.4E-07	2.2E-07	NA	3.4E-06	
			Total Nonradiological Risk:		5.0E-07
			Total Radiological Risk:		4.0E-06
			Total Risk:		4E-06

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-103
Open Space User RME Carcinogenic Risks for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total Risk by Chemical
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	1.5E-07	NA	NA	NA	NA	NA	NA	NA	1.5E-07
Benzo(b)fluoranthene	3.0E-10	NA	NA	NA	NA	NA	NA	NA	3.0E-10
Beryllium	NA	1.1E-07	NA	8.0E-12	NA	NA	NA	NA	1.1E-07
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	5.2E-09	NA	NA	NA	NA	NA	NA	NA	5.2E-09
1,1-Dichloroethene	NA	NA	1.9E-08	NA	NA	NA	5.6E-08	NA	7.5E-08
1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	7.5E-10	NA	NA	NA	NA	NA	NA	NA	7.5E-10
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	1.6E-09	NA	NA	NA	1.1E-07	NA	1.1E-07
Trichloroethene	NA	NA	3.5E-10	NA	NA	NA	1.5E-08	NA	1.5E-08
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risk by Pathway								
	1.6E-07	1.1E-07	2.1E-08	8.0E-12	NA	NA	1.8E-07	NA	
Uranium-233/234	1.0E-08	2.4E-09	NA	4.5E-09	NA	NA	NA	6.7E-11	1.7E-08
Uranium-235+D	7.4E-10	1.6E-10	NA	5.7E-10	NA	NA	NA	5.6E-08	5.7E-08
Uranium-238+D	3.8E-08	6.2E-09	NA	2.3E-08	NA	NA	NA	4.3E-07	5.0E-07
	Radiological Risk by Pathway								
	4.9E-08	8.8E-09	NA	2.8E-08	NA	NA	NA	4.9E-07	
						Total Nonradiological Risk:			4.7E-07
						Total Radiological Risk:			5.7E-07
						Total Risk:			1E-06

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-104
Construction Worker CT Carcinogenic Risks for OU 5, AOC2

Chemicals of Concern	Ingestion of Subsurface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Subsurface Soil	External Radiation Exposure	Total Risk by Chemical
Antimony	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Beryllium	4.0E-09	3.6E-13	NA	NA	4.0E-09
Cadmium	NA	2.6E-13	NA	NA	2.6E-13
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway				
	4.0E-09	6.1E-13	NA	NA	
Uranium-233/234	3.8E-10	2.3E-10	NA	2.7E-12	6.2E-10
Uranium-235+D	7.1E-11	3.0E-11	NA	2.2E-09	2.3E-09
Uranium-238+D	1.4E-09	1.2E-09	NA	1.7E-08	2.0E-08
	Radiological Risks by Pathway				
	1.9E-09	1.5E-09	NA	1.9E-08	
			Total Nonradiological Risk:		4.0E-09
			Total Radiological Risk:		2.3E-08
			Total Risk:		3E-08

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-105
Current Security Worker CT Carcinogenic Risks for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total Risk by Chemical
Benzo(a)pyrene	7.5E-10	NA	NA	NA	7.5E-10
Benzo(b)fluoranthene	1.5E-12	NA	NA	NA	1.5E-12
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	2.6E-11	NA	NA	NA	2.6E-11
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	3.7E-12	NA	NA	NA	3.7E-12
Mercury	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway				
	7.8E-10	NA	NA	NA	
Uranium-233/234	1.1E-10	3.1E-10	NA	4.0E-11	4.6E-10
Uranium-235+D	8.1E-12	3.9E-11	NA	3.3E-08	3.3E-08
Uranium-238+D	4.2E-10	1.6E-09	NA	2.6E-07	2.6E-07
	Radiological Risks by Pathway				
	5.4E-10	2.0E-09	NA	2.9E-07	
			Total Nonradiological Risk:		7.8E-10
			Total Radiological Risk:		2.9E-07
			Total Risk:		3.0E-07

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-106
Ecological Worker CT Carcinogenic Risks for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total Risk by Chemical
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	7.4E-09	NA	NA	NA	NA	NA	NA	NA	7.4E-09
Benzo(b)fluoranthene	1.4E-11	NA	NA	NA	NA	NA	NA	NA	1.4E-11
Beryllium	NA	9.4E-10	NA	1.5E-12	NA	NA	NA	NA	9.4E-10
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	2.5E-10	NA	NA	NA	NA	NA	NA	NA	2.5E-10
1,1-Dichloroethene	NA	NA	1.5E-10	NA	NA	NA	2.2E-09	NA	2.3E-09
1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	3.6E-11	NA	NA	NA	NA	NA	NA	NA	3.6E-11
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	1.3E-11	NA	NA	NA	4.4E-09	NA	4.4E-09
Trichloroethene	NA	NA	2.7E-12	NA	NA	NA	5.7E-10	NA	5.8E-10
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway								
	7.7E-09	9.4E-10	1.6E-10	1.5E-12	NA	NA	7.1E-09	NA	
Uranium-233/234	1.1E-09	4.6E-11	NA	8.3E-10	NA	NA	NA	1.3E-11	2.0E-09
Uranium-235+D	7.9E-11	3.2E-12	NA	1.0E-10	NA	NA	NA	1.1E-08	1.1E-08
Uranium-238+D	4.1E-09	1.2E-10	NA	4.3E-09	NA	NA	NA	8.6E-08	9.5E-08
	Radiological Risks by Pathway								
	5.3E-09	1.7E-10	NA	5.3E-09	NA	NA	NA	9.7E-08	
						Total Nonradiological Risk:			1.6E-08
						Total Radiological Risk:			1.1E-07
						Total Risk:			1E-07

"NA" = no toxicity factor is available or appropriate for exposure route.

Table 6-107
Office Worker CT Carcinogenic Risks for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total Risk by Chemical
Benzo(a)pyrene	6.0E-09	NA	NA	NA	6.0E-09
Benzo(b)fluoranthene	1.2E-11	NA	NA	NA	1.2E-11
Copper	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	2.0E-10	NA	NA	NA	2.0E-10
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	3.0E-11	NA	NA	NA	3.0E-11
Mercury	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway				
	6.3E-09	NA	NA	NA	
Uranium-233/234	9.1E-10	3.4E-09	NA	4.0E-11	4.3E-09
Uranium-235+D	6.5E-11	4.3E-10	NA	3.3E-08	3.4E-08
Uranium-238+D	3.3E-09	1.8E-08	NA	2.6E-07	2.8E-07
	Radiological Risks by Pathway				
	4.3E-09	2.1E-08	NA	2.9E-07	
			Total Nonradiological Risk:		6.3E-09
			Total Radiological Risk:		3.2E-07
			Total Risk:		3E-07

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-108
Open Space User CT Carcinogenic Risks for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total Risk by Chemical
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	1.8E-08	NA	NA	NA	NA	NA	NA	NA	1.8E-08
Benzo(b)fluoranthene	3.6E-11	NA	NA	NA	NA	NA	NA	NA	3.6E-11
Beryllium	NA	1.1E-08	NA	1.7E-13	NA	NA	NA	NA	1.1E-08
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	6.2E-10	NA	NA	NA	NA	NA	NA	NA	6.2E-10
1,1-Dichloroethene	NA	NA	4.7E-10	NA	NA	NA	1.4E-09	NA	1.8E-09
1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	9.0E-11	NA	NA	NA	NA	NA	NA	NA	9.0E-11
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	4.1E-11	NA	NA	NA	2.8E-09	NA	2.8E-09
Trichloroethene	NA	NA	8.6E-12	NA	NA	NA	3.6E-10	NA	3.7E-10
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway								
	1.9E-08	1.1E-08	5.2E-10	1.7E-13	NA	NA	4.5E-09	NA	
Uranium-233/234	6.3E-10	1.2E-10	NA	9.6E-11	NA	NA	NA	8.0E-12	8.6E-10
Uranium-235+D	4.5E-11	8.4E-12	NA	1.2E-11	NA	NA	NA	6.7E-09	6.7E-09
Uranium-238+D	2.3E-09	3.2E-10	NA	5.0E-10	NA	NA	NA	5.2E-08	5.5E-08
	Radiological Risks by Pathway								
	3.0E-09	4.5E-10	NA	6.1E-10	NA	NA	NA	5.8E-08	
						Total Nonradiological Risk:			3.5E-08
						Total Radiological Risk:			6.2E-08
						Total Risk:			1E-07

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-109
Ecological Worker RME Carcinogenic Risks for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments	Ingestion of Stream Sediments	Ingestion of Surface Water	Inhalation of Airborne Particulates[1]	Dermal Absorption of Pond Sediments	Dermal Absorption of Stream Sediments	Dermal Absorption of Surface Water	External Radiation Exposure	Total Risk by Chemical
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lithium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
Americium-241	4.7E-10	3.0E-10	3.9E-11	4.4E-12	NA	NA	NA	2.0E-10	1.0E-09
Plutonium-239/240	2.5E-09	1.6E-09	NA	1.7E-11	NA	NA	NA	3.0E-12	4.1E-09
Uranium-233/234	4.6E-10	NA	1.2E-10	NA	NA	NA	NA	NA	5.8E-10
Uranium-235+D	3.1E-11	NA	NA	NA	NA	NA	NA	NA	3.1E-11
Uranium-238+D	5.7E-10	NA	2.0E-10	NA	NA	NA	NA	NA	7.7E-10
	Radiological Risks by Pathway								
	4.0E-09	1.9E-09	3.6E-10	2.2E-11	NA	NA	NA	2.0E-10	
							Total Nonradiological Risk:		NA
							Total Radiological Risk:		6.5E-09
							Total Risk:		7E-09

(1) Includes only contributions from stream sediments.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-110
Open Space User RME Carcinogenic Risks for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments	Ingestion of Stream Sediments	Ingestion of Surface Water	Inhalation of Airborne Particulates(1)	Dermal Absorption of Pond Sediments	Dermal Absorption of Stream Sediments	Dermal Absorption of Surface Water	External Radiation Exposure	Total Risk by Chemical
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lithium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
Americium-241	4.0E-09	2.6E-09	5.9E-10	1.3E-11	NA	NA	NA	8.0E-10	8.0E-09
Plutonium-239/240	2.1E-08	1.4E-08	NA	5.0E-11	NA	NA	NA	1.2E-11	3.5E-08
Uranium-233/234	3.9E-09	NA	1.9E-09	NA	NA	NA	NA	NA	5.8E-09
Uranium-235+D	2.7E-10	NA	NA	NA	NA	NA	NA	NA	2.7E-10
Uranium-238+D	4.9E-09	NA	2.9E-09	NA	NA	NA	NA	NA	7.8E-09
	Radiological Risks by Pathway								
	3.4E-08	1.6E-08	5.4E-09	6.3E-11	NA	NA	NA	8.1E-10	
							Total Nonradiological Risk:		NA
							Total Radiological Risk:		5.7E-08
							Total Risk:		6E-08

(1) Includes only contributions from stream sediments.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-111
Ecological Worker CT Carcinogenic Risks for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments	Ingestion of Stream Sediments	Ingestion of Surface Water	Inhalation of Airborne Particulates(1) (mg/kg-day)	Dermal Absorption of Pond Sediments	Dermal Absorption of Stream Sediments	Dermal Absorption of Surface Water	External Radiation Exposure	Total Risk by Chemical
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lithium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
Americium-241	7.7E-11	4.9E-11	4.6E-12	2.3E-12	NA	NA	NA	1.6E-10	2.9E-10
Plutonium-239/240	4.1E-10	2.6E-10	NA	9.3E-12	NA	NA	NA	2.4E-12	6.8E-10
Uranium-233/234	7.5E-11	NA	1.5E-11	NA	NA	NA	NA	NA	9.0E-11
Uranium-235+D	5.1E-12	NA	NA	NA	NA	NA	NA	NA	5.1E-12
Uranium-238+D	9.3E-11	NA	2.3E-11	NA	NA	NA	NA	NA	1.2E-10
	Radiological Risks by Pathway								
	6.6E-10	3.1E-10	4.2E-11	1.2E-11	NA	NA	NA	1.6E-10	
							Total Nonradiological Risk:		NA
							Total Radiological Risk:		1.2E-09
							Total Risk:		1E-09

(1) Includes only contribution from stream sediments.
"NA" = Not a COC for this pathway or no toxicity value available or appropriate for exposure route.

Table 6-112
Open Space User CT Carcinogenic Risks for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments	Ingestion of Stream Sediments	Ingestion of Surface Water	Inhalation of Airborne Particulates[1]	Dermal Absorption of Pond Sediments	Dermal Absorption of Stream Sediments	Dermal Absorption of Surface Water	External Radiation Exposure	Total Risk by Chemical
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lithium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nonradiological Risks by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
Americium-241	2.0E-10	1.3E-10	1.5E-11	2.7E-13	NA	NA	NA	9.6E-11	4.4E-10
Plutonium-239/240	1.1E-09	7.0E-10	NA	1.1E-12	NA	NA	NA	1.5E-12	1.8E-09
Uranium-233/234	2.0E-10	NA	4.7E-11	NA	NA	NA	NA	NA	2.5E-10
Uranium-235+D	1.4E-11	NA	NA	NA	NA	NA	NA	NA	1.4E-11
Uranium-238+D	2.5E-10	NA	7.4E-11	NA	NA	NA	NA	NA	3.2E-10
	Radiological Risks by Pathway								
	1.7E-09	8.3E-10	1.4E-10	1.3E-12	NA	NA	NA	9.7E-11	
							Total Nonradiological Risk:		NA
							Total Radiological Risk:		2.8E-09
							Total Risk:		3E-09

(1) Includes only contributions from stream sediments.
"NA" = Not a COC for this pathway or no toxicity value available or appropriate for exposure route.

Table 6-113
Construction Worker RME Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Subsurface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Subsurface Soil	External Radiation Exposure	Total HI by Chemical
Antimony	0.005	NA	NA	NA	0.005
Aroclor-1254	0.003	NA	0.0035	NA	0.01
Benzo(a)anthracene	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Beryllium	0.00004	NA	NA	NA	0.00004
Cadmium	0.0003	NA	0.00003	NA	0.0004
Copper	0.0006	NA	NA	NA	0.0006
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	NA	0.000000001	NA	NA	0.000000001
Molybdenum	0.003	NA	NA	NA	0.003
Nickel	0.0006	NA	NA	NA	0.001
Pyrene	NA	NA	NA	NA	NA
Silver	0.0003	NA	NA	NA	0.0003
	Nonradiological Hazard Indices by Pathway				
	0.01	0.000000001	0.004	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
			Nonradiological Hazard Index:		0.02
			Radiological Hazard Index:		NA
			Total Hazard Index:		0.02

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-114
Current Security Worker RME Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total HI by Chemical
Aroclor-1254	0.0005	NA	0.004	NA	0.004
Benzo(a)anthracene	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Copper	0.00002	NA	NA	NA	0.00002
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	NA	NA	NA
1,2-Dichloroethene	NA	NA	NA	NA	NA
Fluoranthene	0.0000007	NA	NA	NA	0.0000007
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	0.00001	0.0000000003	NA	NA	0.00001
Pyrene	0.0000009	NA	NA	NA	0.0000009
Silver	0.00001	NA	NA	NA	0.00001
	Nonradiological Hazard Indices by Pathway				
	0.0005	0.0000000003	0.004	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
			Nonradiological Hazard Index:		0.004
			Radiological Hazard Index:		NA
			Total Hazard Index:		0.004

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-115
Ecological Worker RME Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total HI by Chemical
Acetone	NA	NA	0.00002	NA	NA	NA	0.000002	NA	0.00002
Antimony	NA	0.00	NA	NA	NA	NA	NA	NA	0.00
Aroclor-1254	0.004	NA	NA	NA	0.02	NA	NA	NA	0.03
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	0.00001	NA	NA	NA	NA	NA	NA	0.00001
Copper	0.0002	NA	NA	NA	NA	NA	NA	NA	0.0002
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	0.00001	NA	NA	NA	0.00003	NA	0.00004
1,2-Dichloroethene	NA	NA	0.00001	NA	NA	NA	0.00002	NA	0.00003
Fluoranthene	0.000006	NA	NA	NA	NA	NA	NA	NA	0.000006
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.0001	NA	NA	0.000000002	NA	NA	NA	NA	0.0001
Pyrene	0.000008	NA	NA	NA	NA	NA	NA	NA	0.000008
Silver	0.00009	NA	NA	NA	NA	NA	NA	NA	0.00009
Tetrachloroethene	NA	NA	0.00007	NA	NA	NA	0.005	NA	0.005
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	0.00001	NA	NA	NA	NA	NA	NA	0.00001
	Nonradiological Hazard Indices by Pathway								
	0.005	0.003	0.0001	0.000000002	0.02	NA	0.005	NA	
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
							Nonradiological Hazard Index:		0.03
							Radiological Hazard Index:		NA
							Total Hazard Index:		0.03

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-116
Office Worker RME Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Ariborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total HI by Chemical
Aroclor-1254	0.008	NA	0.04	NA	0.05
Benzo(a)anthracene	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Copper	0.0003	NA	NA	NA	0.0003
Dibenzo(a,h)anthracen	NA	NA	NA	NA	NA
Fluoranthene	0.00001	NA	NA	NA	0.00001
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	0.0002	0.000000005	NA	NA	0.0002
Pyrene	0.00001	NA	NA	NA	0.00001
Silver	0.0002	NA	NA	NA	0.0002
	Nonradiological Hazard Indices by Pathway				
	0.008	0.000000005	0.04	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
			Nonradiological Hazard Index:		0.05
			Radiological Hazard Index:		NA
			Total Hazard Index:		0.05

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for this exposure route.

Table 6-117
Adult Open Space User RME Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total HI by Chemical
Acetone	NA	NA	0.00002	NA	NA	NA	0.000002	NA	0.00002
Antimony	NA	0.002	NA	NA	NA	NA	NA	NA	0.002
Aroclor-1254	0.0008	NA	NA	NA	0.010	NA	NA	NA	0.01
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	0.000005	NA	NA	NA	NA	NA	NA	0.000005
Copper	0.00003	NA	NA	NA	NA	NA	NA	NA	0.00003
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	0.00001	NA	NA	NA	0.00004	NA	0.00005
1,2-Dichloroethene	NA	NA	0.00001	NA	NA	NA	0.00002	NA	0.00004
Fluoranthene	0.000001	NA	NA	NA	NA	NA	NA	NA	0.000001
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.00002	NA	NA	0.000000001	NA	NA	NA	NA	0.00002
Pyrene	0.000001	NA	NA	NA	NA	NA	NA	NA	0.000001
Silver	0.00002	NA	NA	NA	NA	NA	NA	NA	0.00002
Tetrachloroethene	NA	NA	0.00008	NA	NA	NA	0.006	NA	0.00572
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	0.00001	NA	NA	NA	NA	NA	NA	0.00001
	Nonradiological Hazard Indices by Pathway								
	0.0008	0.002	0.0001	0.000000001	0.01	NA	0.006	NA	
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
						Nonradiological Hazard Index:			0.02
						Radiological Hazard Index:			NA
						Total Hazard Index:			0.02

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-118
Child Open Space User RME Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Total HI by Chemical
Antimony	NA	0.02	0.02
Aroclor-1254	0.007	NA	0.007
Benzo(a)anthracene	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA
Beryllium	NA	0.00005	0.00005
Copper	0.0003	NA	0.0003
Dibenzo(a,h)anthracene	NA	NA	NA
Fluoranthene	0.00001	NA	0.00001
Indeno(1,2,3-cd)pyrene	NA	NA	NA
Mercury	0.0002	NA	0.0002
Pyrene	0.00001	NA	0.00001
Silver	0.0001	NA	0.0001
Zinc	NA	0.0001	0.0001
	Nonradiological Hazard Indices by Pathway		
	0.008	0.02	
Uranium-233/234	NA	NA	NA
Uranium-235+D	NA	NA	NA
Uranium-238+D	NA	NA	NA
	Radiological Hazard Indices by Pathway		
	NA	NA	
	Nonradiological Hazard Index:		0.03
	Radiological Hazard Index:		NA
	Total Hazard Index:		0.03

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-119
Construction Worker CT Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Subsurface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Subsurface Soil	External Radiation Exposure	Total HI by Chemical
Antimony	0.0009	NA	NA	NA	0.0009
Aroclor-1254	0.0005	NA	0.0006	NA	0.001
Benzo(a)anthracene	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Beryllium	0.00001	NA	NA	NA	0.00001
Cadmium	0.00006	NA	0.000006	NA	0.00007
Copper	0.0001	NA	NA	NA	0.0001
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	NA	0.0000000009	NA	NA	0.0000000009
Molybdenum	0.0005	NA	NA	NA	0.0005
Nickel	0.0001	NA	NA	NA	0.0001
Pyrene	NA	NA	NA	NA	NA
Silver	0.00004	NA	NA	NA	0.00004
	Nonradiological Hazard Indices by Pathway				
	0.002	0.0000000009	0.0006	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
		Total Nonradiological Hazard Index:			0.003
		Total Radiological Hazard Index:			NA
		Total Hazard Index:			0.003

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-120
Current Security Worker CT Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total HI by Chemical
Aroclor-1254	0.00007	NA	0.0006	NA	0.0007
Benzo(a)anthracene	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Copper	0.000003	NA	NA	NA	0.000003
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	0.0000001	NA	NA	NA	0.0000001
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	0.000002	0.0000000003	NA	NA	0.000002
Pyrene	0.0000001	NA	NA	NA	0.0000001
Silver	0.000002	NA	NA	NA	0.000002
	Nonradiological Hazard Indices by Pathway				
	0.00008	0.0000000003	0.0006	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
		Total Nonradiological Hazard Index:			0.001
		Total Radiological Hazard Index:			NA
		Total Hazard Index:			0.001

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-121
Ecological Worker CT Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total HI by Chemical
Acetone	NA	NA	0.000002	NA	NA	NA	9.9E-07	NA	0.000003
Antimony	NA	0.0005	NA	NA	NA	NA	NA	NA	0.000520
Aroclor-1254	0.001	NA	NA	NA	0.004	NA	NA	NA	0.01
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	0.000001	NA	NA	NA	NA	NA	NA	NA
Copper	0.00005	NA	NA	NA	NA	NA	NA	NA	0.00005
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	0.000001	NA	NA	NA	0.00002	NA	0.000019
1,2-Dichloroethene	NA	NA	0.000001	NA	NA	NA	0.00001	NA	0.000012
Fluoranthene	0.000002	NA	NA	NA	NA	NA	NA	NA	0.000002
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.00003	NA	NA	0.000000003	NA	NA	NA	NA	0.00003
Pyrene	0.000002	NA	NA	NA	NA	NA	NA	NA	0.000002
Silver	0.00002	NA	NA	NA	NA	NA	NA	NA	0.00002
Tetrachloroethene	NA	NA	0.000008	NA	NA	NA	0.003	NA	0.002633
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	0.000002	NA	NA	NA	NA	NA	NA	0.000002
	Nonradiological Hazard Indices by Pathway								
	0.001	0.0005	0.00001	0.000000003	0.004	NA	0.003	NA	
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
						Total Nonradiological Hazard Index:			0.01
						Total Radiological Hazard Index:			NA
						Total Hazard Index:			0.01

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure routes.

Table 6-122
Office Worker CT Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total HI by Chemical
Aroclor-1254	0.0006	NA	0.006	NA	0.007
Benzo(a)anthracene	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Copper	0.00003	NA	NA	NA	0.00003
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	0.0000009	NA	NA	NA	0.0000009
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	0.00002	0.000000003	NA	NA	0.00002
Pyrene	0.000001	NA	NA	NA	0.000001
Silver	0.00001	NA	NA	NA	0.00001
	Nonradiological Hazard Indices by Pathway				
	0.0006	0.000000003	0.006	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
		Total Nonradiological Hazard Index:			0.007
		Total Radiological Hazard Index:			NA
		Total Hazard Index:			0.007

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-123
Adult Open Space User CT Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total HI by Chemical
Acetone	NA	NA	0.000002	NA	NA	NA	0.0000002	NA	0.000002
Antimony	NA	0.0003	NA	NA	NA	NA	NA	NA	0.0003
Aroclor-1254	0.0002	NA	NA	NA	0.0001	NA	NA	NA	0.0003
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	0.000001	NA	NA	NA	NA	NA	NA	0.0000008
Copper	0.000007	NA	NA	NA	NA	NA	NA	NA	0.000007
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	0.000001	NA	NA	NA	0.000003	NA	0.000004
1,2-Dichloroethene	NA	NA	0.000001	NA	NA	NA	0.000002	NA	0.000003
Fluoranthene	0.0000002	NA	NA	NA	NA	NA	NA	NA	0.0000002
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.000004	NA	NA	0.0000000004	NA	NA	NA	NA	0.000004
Pyrene	0.0000003	NA	NA	NA	NA	NA	NA	NA	0.0000003
Silver	0.000003	NA	NA	NA	NA	NA	NA	NA	0.000003
Tetrachloroethene	NA	NA	0.000007	NA	NA	NA	0.0005	NA	0.0005
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	0.000001	NA	NA	NA	NA	NA	NA	0.000001
	Nonradiological Hazard Indices by Pathway								
	0.0002	0.0003	0.00001	0.0000000004	0.0001	NA	0.0005	NA	
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
					Total Nonradiological Hazard Index:				0.001
					Total Radiological Hazard Index:				NA
					Total Hazard Index:				0.001

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-124
Child Open Space User CT Noncarcinogenic Hazard Indices for OU 5, AOC1

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Total HI by Chemical
Acetone	NA	NA	NA
Antimony	NA	0.003	0.003
Aroclor-1254	0.001	NA	0.001
Benzo(a)anthracene	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA
Beryllium	NA	0.00001	0.000008
Copper	0.00006	NA	0.00006
Dibenzo(a,h)anthracene	NA	NA	NA
1,1-Dichloroethene	NA	NA	NA
1,2-Dichloroethene	NA	NA	NA
Fluoranthene	0.000002	NA	0.000002
Indeno(1,2,3-cd)pyrene	NA	NA	NA
Mercury	0.00004	NA	0.00004
Pyrene	0.000003	NA	0.000003
Silver	0.00003	NA	0.00003
Tetrachloroethene	NA	NA	NA
Trichloroethene	NA	NA	NA
Zinc	NA	0.00001	0.00001
	Nonradiological Hazard Indices by Pathway		
	0.002	0.003	
Uranium-233/234	NA	NA	NA
Uranium-235+D	NA	NA	NA
Uranium-238+D	NA	NA	NA
	Radiological Hazard Indices by Pathway		
	NA	NA	
	Total Nonradiological Hazard Index:		0.004
	Total Radiological Hazard Index:		NA
	Total Hazard Index:		0.004

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-125
Construction Worker RME Noncarcinogenic Hazard Indices for OU 5, AOC2

Chemicals of Concern	Ingestion of Subsurface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Subsurface Soil	External Radiation Exposure	Total HI by Chemical
Antimony	0.007	NA	NA	NA	0.007
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Beryllium	0.00007	NA	NA	NA	0.00007
Cadmium	0.0007	NA	0.00007	NA	0.0008
Copper	0.0006	NA	NA	NA	0.0006
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	NA	0.0000000000006	NA	NA	0.0000000000006
Molybdenum	0.002	NA	NA	NA	0.002
Nickel	0.0006	NA	NA	NA	0.0006
Pyrene	NA	NA	NA	NA	NA
Silver	0.0005	NA	NA	NA	0.0005
	Nonradiological Hazard Iindices by Pathway				
	0.01	0.0000000000006	0.00007	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
			Nonradiological Hazard Index:		0.01
			Radiological Hazard Index:		NA
			Total Hazard Index:		0.01

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-126
Current Security Worker RME Noncarcinogenic Hazard Indices for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total HI by Chemical
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Copper	0.00001	NA	NA	NA	0.00001
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	0.00000003	NA	NA	NA	0.00000003
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	0.000008	0.0000000000002	NA	NA	0.000008
Pyrene	0.00000005	NA	NA	NA	0.00000005
Silver	0.00001	NA	NA	NA	0.00001
	Nonradiological Hazard Indices by Pathway				
	0.00003	0.0000000000002	NA	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
			Nonradiological Hazard Index:		0.00003
			Radiological Hazard Index:		NA
			Total Hazard Index:		0.00003

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-127
Ecological Worker RME Noncarcinogenic Hazard Indices for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total HI by Chemical
Antimony	NA	0.003	NA	NA	NA	NA	NA	NA	0.003
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	0.00001	NA	NA	NA	NA	NA	NA	0.000007
Copper	0.0001	NA	NA	NA	NA	NA	NA	NA	0.0001
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	0.000007	NA	NA	NA	0.00002	NA	0.00003
1,2-Dichloroethene	NA	NA	0.000007	NA	NA	NA	0.00001	NA	0.00002
Fluoranthene	0.0000003	NA	NA	NA	NA	NA	NA	NA	0.0000003
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.00007	NA	NA	0.000000000001	NA	NA	NA	NA	0.00007
Pyrene	0.0000005	NA	NA	NA	NA	NA	NA	NA	0.0000005
Silver	0.00008	NA	NA	NA	NA	NA	NA	NA	0.00008
Tetrachloroethene	NA	NA	0.000006	NA	NA	NA	0.0004	NA	0.0004
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	0.0002	NA	NA	NA	NA	NA	NA	0.0002
	Nonradiological Hazard Indices by Pathway								
	0.0003	0.003	0.00002	0.000000000001	NA	NA	0.0004	NA	
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
						Nonradiological Hazard Index:			0.004
						Radiological Hazard Index:			NA
						Total Hazard Index:			0.004

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-128
Office Worker RME Noncarcinogenic Hazard Indices for OU 5, AOC2

	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total HI by Chemical
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Copper	0.0002	NA	NA	NA	0.0002
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	0.0000005	NA	NA	NA	0.0000005
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	0.0001	0.000000000003	NA	NA	0.0001
Pyrene	0.0000009	NA	NA	NA	0.0000009
Silver	0.0002	NA	NA	NA	0.0002
	Nonradiological Hazard Indices by Pathway				
	0.0005	0.000000000003	NA	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
			Nonradiological Hazard Index:		0.0005
			Radiological Hazard Index:		NA
			Total Hazard Index:		0.0005

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-129
Adult Open Space User RME Noncarcinogenic Hazard Indices for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total HI by Chemical
Antimony	NA	0.002	NA	NA	NA	NA	NA	NA	0.002
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	0.000004	NA	NA	NA	NA	NA	NA	0.000004
Copper	0.00002	NA	NA	NA	NA	NA	NA	NA	0.00002
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	0.000008	NA	NA	NA	0.00002	NA	0.00003
1,2-Dichloroethene	NA	NA	0.000008	NA	NA	NA	0.00002	NA	0.00002
Fluoranthene	0.00000005	NA	NA	NA	NA	NA	NA	NA	0.0000001
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.00001	NA	NA	0.0000000000003	NA	NA	NA	NA	0.00001
Pyrene	0.00000009	NA	NA	NA	NA	NA	NA	NA	0.0000001
Silver	0.00002	NA	NA	NA	NA	NA	NA	NA	0.00002
Tetrachloroethene	NA	NA	0.000007	NA	NA	NA	0.0005	NA	0.0005
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	0.0001	NA	NA	NA	NA	NA	NA	0.0001
	Nonradiological Hazard Indices by Pathway								
	0.00005	0.002	0.00002	0.0000000000003	NA	NA	0.0005	NA	
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
						Nonradiological Hazard Index:			0.002
						Radiological Hazard Index:			NA
						Total Hazard Index:			0.002

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-130
Child Open Space User RME Noncarcinogenic Hazard Indcies for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Total HI by Chemical
Antimony	NA	0.01	0.01
Aroclor-1254	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA
Beryllium	NA	0.00004	0.00004
Copper	0.0002	NA	0.0002
Dibenzo(a,h)anthracene	NA	NA	NA
Fluoranthene	0.0000005	NA	0.0000005
Indeno(1,2,3-cd)pyrene	NA	NA	NA
Mercury	0.0001	NA	0.0001
Pyrene	0.0000008	NA	0.0000008
Silver	0.0001	NA	0.0001
Zinc	NA	0.001	0.001
	Nonradiological Hazard Indices by Pathway		
	0.0005	0.02	
Uranium-233/234	NA	NA	NA
Uranium-235+D	NA	NA	NA
Uranium-238+D	NA	NA	NA
	Radiological Hazard Indices by Pathway		
	NA	NA	
	Nonradiological Hazard Index:		0.02
	Radiological Hazard Index:		NA
	Total Hazard Index:		0.02

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriatefor exposure route.

Table 6-131
Construction Worker CT Noncarcinogenic Hazard Indices for OU 5, AOC2

Chemicals of Concern	Ingestion of Subsurface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Subsurface Soil	External Radiation Exposure	Total HI by Chemical
Antimony	0.001	NA	NA	NA	0.001
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Beryllium	0.00001	NA	NA	NA	0.00001
Cadmium	0.0001	NA	0.00001	NA	0.0001
Copper	0.0001	NA	NA	NA	0.0001
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	NA	0.0000000000005	NA	NA	0.0000000000005
Molybdenum	0.0004	NA	NA	NA	0.0004
Nickel	0.0001	NA	NA	NA	0.0001
Pyrene	NA	NA	NA	NA	NA
Silver	0.00009	NA	NA	NA	0.00009
	Nonradiological Hazard Indices by Pathway				
	0.002	0.0000000000005	0.00001	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
		Total Nonradiological Hazard Index:			0.002
		Total Radiological Hazard Index:			NA
		Total Hazard Index:			0.002

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for esposure route.

Table 6-132
Current Worker CT Noncarcinogenic Hazard Indices for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total HI by Chemical
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Copper	0.000002	NA	NA	NA	0.000002
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	0.000000005	NA	NA	NA	0.000000005
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	0.000001	0.0000000000002	NA	NA	0.000001
Pyrene	0.000000009	NA	NA	NA	0.000000009
Silver	0.000002	NA	NA	NA	0.000002
	Nonradiological Hazard Indices by Pathway				
	0.000005	0.0000000000002	NA	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
		Total Nonradiological Hazard Index:			0.000005
		Total Radiological Hazard Index:			NA
		Total Hazard Index:			0.000005

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for this exposure route.

Table 6-133
Ecological Worker CT Noncarcinogenic Hazard Indices for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total HI by Chemical
Antimony	NA	0.0004	NA	NA	NA	NA	NA	NA	0.0004
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	0.000001	NA	NA	NA	NA	NA	NA	0.000001
Copper	0.00003	NA	NA	NA	NA	NA	NA	NA	0.00003
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	0.0000008	NA	NA	NA	0.00001	NA	0.00001
1,2-Dichloroethene	NA	NA	0.0000008	NA	NA	NA	0.000007	NA	0.000008
Fluoranthene	0.00000008	NA	NA	NA	NA	NA	NA	NA	0.00000008
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.00002	NA	NA	0.000000000001	NA	NA	NA	NA	0.00002
Pyrene	0.0000001	NA	NA	NA	NA	NA	NA	NA	0.0000001
Silver	0.00002	NA	NA	NA	NA	NA	NA	NA	0.00002
Tetrachloroethene	NA	NA	0.0000007	NA	NA	NA	0.0002	NA	0.0002
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	0.00003	NA	NA	NA	NA	NA	NA	0.00003
	Nonradiological Hazard Indices by Pathway								
	0.00008	0.0005	0.000002	0.000000000001	NA	NA	0.0003	NA	
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
					Total Nonradiological Hazard Index:				0.0008
					Total Radiological Hazard Index:				NA
					Total Hazard Index:				0.0008

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-134

Office Worker CT Noncarcinogenic Hazard Indices for OU 5, AOC2

	Ingestion of Surface Soil	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	External Radiation Exposure	Total HI by Chemical
Benzo(a)pyrene	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA
Copper	0.00002	NA	NA	NA	0.00002
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
Fluoranthene	0.00000004	NA	NA	NA	0.00000004
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
Mercury	0.00001	0.000000000002	NA	NA	0.00001
Pyrene	0.00000007	NA	NA	NA	0.00000007
Silver	0.00001	NA	NA	NA	0.00001
	Nonradiological Hazard Indices by Pathway				
	0.00004	0.000000000002	NA	NA	
Uranium-233/234	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway				
	NA	NA	NA	NA	
		Total Nonradiological Hazard Index:			0.00004
		Total Radiological Hazard Index:			NA
		Total Hazard Index:			0.00004

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-135
Adult Open Space User CT Noncarcinogenic Hazard Indices for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Ingestion of Seep Water	Inhalation of Airborne Particulates	Dermal Absorption of Surface Soil	Dermal Absorption of Seep Sediments	Dermal Absorption of Seep Water	External Radiation Exposure	Total HI by Chemical
Antimony	NA	0.0003	NA	NA	NA	NA	NA	NA	0.0003
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	0.000001	NA	NA	NA	NA	NA	NA	0.000001
Copper	0.000004	NA	NA	NA	NA	NA	NA	NA	0.000004
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	0.0000007	NA	NA	NA	0.000002	NA	0.000003
1,2-Dichloroethene	NA	NA	0.0000007	NA	NA	NA	0.000001	NA	0.000002
Fluoranthene	0.00000001	NA	NA	NA	NA	NA	NA	NA	0.00000001
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.000003	NA	NA	0.00000000000002	NA	NA	NA	NA	0.000003
Pyrene	0.00000002	NA	NA	NA	NA	NA	NA	NA	0.00000002
Silver	0.000003	NA	NA	NA	NA	NA	NA	NA	0.000003
Tetrachloroethene	NA	NA	0.0000006	NA	NA	NA	0.00004	NA	0.00004
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	0.00002	NA	NA	NA	NA	NA	NA	0.00002
	Nonradiological Hazard Indices by Pathway								
	0.00001	0.0003	0.000002	0.00000000000002	NA	NA	0.00004	NA	
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
					Total Nonradiological Hazard Index:				0.0003
					Total Radiological Hazard Index:				NA
					Total Hazard Index:				0.0003

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-136

Child Open Space User CT Noncarcinogenic Hazard Indices for OU 5, AOC2

Chemicals of Concern	Ingestion of Surface Soil	Ingestion of Seep Sediments	Total HI by Chemical
Antimony	NA	0.002	0.002
Benzo(a)pyrene	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA
Beryllium	NA	0.000007	0.000007
Copper	0.00004	NA	0.00004
Dibenzo(a,h)anthracene	NA	NA	NA
Fluoranthene	0.0000001	NA	0.0000001
Indeno(1,2,3-cd)pyrene	NA	NA	NA
Mercury	0.00002	NA	0.00002
Pyrene	0.0000002	NA	0.0000002
Silver	0.00003	NA	0.00003
Zinc	NA	0.0002	0.0002
	Nonradiological Hazard Indices by Pathway		
	0.00009	0.003	
Uranium-233/234	NA	NA	NA
Uranium-235+D	NA	NA	NA
Uranium-238+D	NA	NA	NA
	Radiological Hazard Indices by Pathway		
	NA	NA	
	Total Nonradiological Hazard Index:		0.003
	Total Radiological Hazard Index:		NA
	Total Hazard Index:		0.003

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-137
Ecological Worker RME Noncarcinogenic Hazard Indices for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments	Ingestion of Stream Sediments	Ingestion of Surface Water	Inhalation of Airborne Particulates(1)	Dermal Absorption of Pond Sediments	Dermal Absorption of Stream Sediments	Dermal Absorption of Surface Water	External Radiation Exposure	Total HI by Chemical
Barium	NA	NA	0.00003	NA	NA	NA	NA	NA	0.00003
Copper	NA	0.0003	NA	NA	NA	NA	NA	NA	0.0003
Lithium	NA	NA	0.00003	NA	NA	NA	NA	NA	0.00003
Mercury	0.0003	0.0004	NA	0.0000002	NA	NA	NA	NA	0.0006
Strontium	NA	NA	0.00001	NA	NA	NA	NA	NA	0.00001
Zinc	0.00004	0.0001	NA	NA	NA	NA	NA	NA	0.0001
	Nonradiological Hazard Indices by Pathway								
	0.0003	0.001	0.00007	0.0000002	NA	NA	NA	NA	
Americium-241	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
						Total Nonradiological Hazard Index:			0.001
						Total Radiological Hazard Index:			NA
						Total Hazard Index:			0.001

(1) Includes only contribution of stream sediments.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-138
Adult Open Space User RME Noncarcinogenic Hazard Indices for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments	Ingestion of Stream Sediments	Ingestion of Surface Water	Inhalation of Airborne Particulates(1)	Dermal Absorption of Pond Sediments	Dermal Absorption of Stream Sediments	Dermal Absorption of Surface Water	External Radiation Exposure	Total Risk by Chemical
Barium	NA	NA	0.00004	NA	NA	NA	NA	NA	0.00004
Copper	NA	0.0002	NA	NA	NA	NA	NA	NA	0.0002
Lithium	NA	NA	0.00003	NA	NA	NA	NA	NA	0.00003
Mercury	0.0002	0.0002	NA	0.00000004	NA	NA	NA	NA	0.0004
Strontium	NA	NA	0.00002	NA	NA	NA	NA	NA	0.00002
Zinc	0.00002	0.00006	NA	NA	NA	NA	NA	NA	0.00008
	Nonradiological Hazard Indices by Pathway								
	0.0002	0.0004	0.00009	0.00000004	NA	NA	NA	NA	
Americium-241	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
						Total Nonradiological Hazard Index:			0.0007
						Total Radiological Hazard Index:			NA
						Total Hazard Index:			0.0007

(1) Includes only contributions of stream sediments.
"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-139
Child Open Space User RME Noncarcinogenic Hazard Indices for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments	Ingestion of Stream Sediments	Total Risk by Chemical
Copper	NA	0.001	0.001
Mercury	0.001	0.002	0.003
Zinc	0.0002	0.0005	0.0008
	Nonradiological Hazard Indices by Pathway		
	0.002	0.004	
Americium-241	NA	NA	NA
Plutonium-239/240	NA	NA	NA
Uranium-233/234	NA	NA	NA
Uranium-235+D	NA	NA	NA
Uranium-238+D	NA	NA	NA
	Radiological Hazard Indices by Pathway		
	NA	NA	
	Total Nonradiological Hazard Index:		0.006
	Total Radiological Hazard Index:		NA
	Total Hazard Index:		0.006

"NA" = Not a COC for this pathway or no toxicity factor is available or appropriate for exposure route.

Table 6-140

Ecological Worker CT Noncarcinogenic Hazard Indices for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments	Ingestion of Stream Sediments	Ingestion of Surface Water	Inhalation of Airborne Particulates[(1)]	Dermal Absorption of Pond Sediments	Dermal Absorption of Stream Sediments	Dermal Absorption of Surface Water	External Radiation Exposure	Total HI by Chemical
Barium	NA	NA	0.000004	NA	NA	NA	NA	NA	0.000004
Copper	NA	0.00004	NA	NA	NA	NA	NA	NA	0.00004
Lithium	NA	NA	0.000003	NA	NA	NA	NA	NA	0.000003
Mercury	0.00004	0.00006	NA	0.00000008	NA	NA	NA	NA	0.0001
Strontium	NA	NA	0.000001	NA	NA	NA	NA	NA	0.000001
Zinc	0.000006	0.00002	NA	NA	NA	NA	NA	NA	0.00002
		Nonradiological Hazard Indices by Pathway							
	0.00005	0.0001	0.000008	0.00000008	NA	NA	NA		
Americium-241	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Radiological Hazard Indices by Pathway							
	NA	NA	NA	NA	NA	NA	NA	NA	
						Total Nonradiological Hazard Index:			0.0002
						Total Radiological Hazard Index:			NA
						Total Hazard Index:			0.0002

(1) Includes only contributions of stream sediments.
"NA" = Not a COC for this pathway or no toxicity value available or appropriate for exposure route.

Table 6-141
Adult Open Space User CT Noncarcinogenic Hazard Indices for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments	Ingestion of Stream Sediments	Ingestion of Surface Water	Inhalation of Airborne Particulates[1]	Dermal Absorption of Pond Sediments	Dermal Absorption of Stream Sediments	Dermal Absorption of Surface Water	External Radiation Exposure	Total HI by Chemical
Barium	NA	NA	0.000004	NA	NA	NA	NA	NA	0.000004
Copper	NA	0.00003	NA	NA	NA	NA	NA	NA	0.00003
Lithium	NA	NA	0.000003	NA	NA	NA	NA	NA	0.000003
Mercury	0.00003	0.00004	NA	0.000000003	NA	NA	NA	NA	0.00006
Strontium	NA	NA	0.000001	NA	NA	NA	NA	NA	0.000001
Zinc	0.000004	0.00001	NA	NA	NA	NA	NA	NA	0.00001
	Nonradiological Hazard Indices by Pathway								
	0.00003	0.0001	0.000008	0.000000003	NA	NA	NA	NA	
Americium-241	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238+D	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Radiological Hazard Indices by Pathway								
	NA	NA	NA	NA	NA	NA	NA	NA	
						Total Nonradiological Hazard Index:			0.0001
						Total Radiological Hazard Index:			NA
						Total Hazard Index:			0.0001

(1) Includes only contribution of stream sediments.
"NA" = Not a COC for this pathway or no toxicity value available or appropriate for exposure route.

Table 6-142

Child Open Space User CT Noncarcinogenic Hazard Indicess for OU 5, AOC3

Chemicals of Concern	Ingestion of Pond Sediments	Ingestion of Stream Sediments	Total HI by Chemical
Copper	NA	0.00007	0.00007
Mercury	0.00007	0.00010	0.0002
Zinc	0.00001	0.00003	0.00004
	Nonradiological Hazard Indices by Pathway		
	0.0001	0.0002	
Americium-241	NA	NA	NA
Plutonium-239/240	NA	NA	NA
Uranium-233/234	NA	NA	NA
Uranium-235+D	NA	NA	NA
Uranium-238+D	NA	NA	NA
	Radiological Hazard Indices by Pathway		
	NA	NA	
	Total Nonradiological Hazard Index:		0.0003
	Total Radiological Hazard Index:		NA
	Total Hazard Index:		0.0003

"NA" = Not a COC for this pathway or no toxicity value available or appropriate for exposure route.

Table 6-143
Summary of RME Point Estimates of Carcinogenic Risk

Receptor/Location	Total Risk	Dominant COC	Dominant Pathway
Future Construction Worker, AOC1	3E-07	uranium-238	Ingestion of surface soil and external radiation
Future Construction Worker, AOC2	6E-08	uranium-238	Ingestion of surface soil
Current Security Worker, AOC1	2E-06	uranium-238	External radiation
Current Security Worker, AOC2	3E-06	uranium-238	External radiation
Future Ecological Researcher, AOC1	1E-06	uranium-238	External radiation
Future Ecological Researcher, AOC2	2E-07	uranium-238	External radiation
Future Ecological Researcher, AOC3	7E-09	plutonium-239/240	Ingestion of pond sediments
Future Office Worker, AOC1	3E-05	uranium-238	External radiation
Future Office Worker, AOC2	4E-06	uranium-238	External radiation
Future Open Space User, AOC1	6E-06	uranium-238	External radiation
Future Open Space User, AOC2	1E-06	uranium-238	External radiation
Future Open Space User, AOC3	6E-08	plutonium-239/240	Ingestion of pond sediment

Table 6-144
Summary of RME Point Estimates of Noncarcinogenic Hazard Indices

Receptor/Location	Total HI	Dominant COC	Dominant Pathway
Future Construction Worker, AOC1	0.02	Aroclor-1254	Ingestion of subsurface soil
Future Construction Worker, AOC2	0.01	antimony	Ingestion of subsurface soil
Current Security Worker, AOC1	0.004	Aroclor-1254	Dermal absorption of surface soil
Current Security Worker, AOC2	0.00003	copper/silver	Ingestion of subsurface soil
Future Ecological Researcher, AOC1	0.03	Aroclor-1254	Dermal absorption of surface soil
Future Ecological Researcher, AOC2	0.004	antimony	Ingestion of seep sediments
Future Ecological Researcher, AOC3	0.001	mercury	Ingestion of stream sediments
Future Office Worker, AOC1	0.05	Aroclor-1254	Dermal absorption of surface soil
Future Office Worker, AOC2	0.0005	copper/silver	Ingestion of surface soil
Future Adult Open Space User, AOC1	0.02	Aroclor-1254	Dermal absorption of surface soil
Future Adult Open Space User, AOC2	0.002	antimony	Ingestion of seep sediments
Future Adult Open Space User, AOC3	0.0007	mercury	Ingestion of stream sediments
Future Child Open Space User, AOC1	0.03	antimony	Ingestion of seep sediments
Future Child Open Space User, AOC2	0.02	antimony	Ingestion of seep sediments
Future Child Open Space User, AOC3	0.006	mercury	Ingestion of stream sediments

Table 6-145
HHRA Uncertainty Factors at OU 5

Uncertainty Factor	Effect of Uncertainty	Comments
Data Collection and Evaluation		
Use of unvalidated data	May slightly over or underestimate risk.	When available and appropriate, unvalidated data were replaced with validated data. Unvalidated data used are consistent with previous measurements and should only slightly affect risk estimates. Subsequent evaluation of the validation results for unvalidated data used in the HHRA indicates that no impacts to the conclusions of the HHRA result (see Section 4.1)
Identification and selection of OU 5 PCOCs and COCs	May slightly over or underestimate risk.	Professional judgement was used to analyze and aggregate OU data. However, the approved selection process was used and agency meetings were held to minimize uncertainty. Additional discussions regarding lead are contained in the text.
Selection of source areas and AOCs	May slightly underestimate risk.	Professional judgement was used to analyze and aggregate OU data. However, the agreed-upon process for selection of source areas and AOCs was used and agency meetings were held to minimize uncertainty. Six source areas were identified, resulting in three AOCs.
Arsenic was not considered a PCOC in groundwater, pond sediments, and stream sediments.	May slightly underestimate risk.	Background comparison and professional judgement were applied to eliminate arsenic from these media. An agency meeting was held specifically for this issue and all three agencies agreed to this approach.
Pond sediment data collection.	May slightly underestimate risk.	Calculations of inhalation intake of pond sediment used data from the inlet and midpoint sampling locations but not from the deep sampling location. This approach was agreed to by the agencies and is not expected to significantly affect inhalation risk.

Table 6-145 (Continued)

Uncertainty Factor	Effect of Uncertainty	Comments
	Exposure Assessment	
Exposure scenario assumptions	May over or underestimate risk.	Exposure scenarios are qualitatively evaluated and documented in the OU 5 Exposure Assessment TM.
Exposure parameter assumptions	May slightly over or underestimate risk.	Site-specific RFETS exposure factors were used. The values have been reviewed and agreed to by all three agencies and uncertainty is assumed to be low.
Chemical-specific matrix effects	May overestimate risk.	Chemical-specific matrix effects were derived for applicable OU 5 COCs. The values are conservative.
Nickel evaluated as a noncarcinogen only.	May underestimate risk.	Based on process knowledge at RFETS, nickel subsulfide (carcinogenic form) is not expected to be a contaminant in soils.
Dermal exposure	May over or underestimate risk.	Soil adherence factors, skin absorption factors, and dermal permeability can introduce potential uncertainty. Dermal absorption of metals is expected to be insignificant compared to the ingestion pathway.
	Toxicity Assessment	
Critical toxicity values derived primarily from animal studies.	May over or underestimate risk.	Extrapolation from animal to humans may induce error due to differences in absorption, pharmacokinetics, target organs, enzymes, and population variability.
Critical toxicity values derived primarily from high doses, and OU 5 exposures are at low doses.	May over or underestimate risk.	Assumes a linear extrapolation to low doses. OU 5 exposure assumptions are also conservative.
Critical toxicity values and classification of carcinogens.	May over or underestimate risk.	Not all toxicity values represent the same degree of certainty. All are subject to change as new evidence becomes available.

Table 6-145 (Continued)

Uncertainty Factor	Effect of Uncertainty	Comments
Lack of dermal absorption or direct action toxicity values.	May slightly underestimate risk.	The unavailability of consensus absorption values does not facilitate comparison of absorbed dose to toxicity constants based on administered dose. Dermal absorption of metals is expected to be insignificant when compared to ingestion. Consistent with RAGS, dermal absorption of PAHs is not quantitatively evaluated.
	Risk Characterization	
Use of cancer slope factors	May overestimate risk.	Potencies are upper 95th percentile confidence limits. Considered unlikely to underestimate true risk.
Lack of toxicological data for some PCOCs	May underestimate risk.	No EPA-established toxicity criteria are provided for benzo(g,h,i)perylene, dibenzofuran, lead, 2-methylnaphthylene, phenanthrene, silicon, and 1,1,1-trichloroethane.
Addition of risks across weight-of-evidence classifications.	May overestimate risk.	Addition of risks across weight-of-evidence classifications is extremely health conservative and potentially even inappropriate.

Table 6-146
Comparison of Human Health Risks for Arsenic in OU 5 Stream Sediment with Background Risk from Arsenic

Ingestion of Arsenic in Stream Sediment/Open-Space User	Central Tendency		Reasonable Maximum Exposure	
	Hazard Index	Carcinogenic Risk	Hazard Index	Carcinogenic Risk
OU 5:				
Arsenic (Child)	0.001		0.004	
Arsenic (Adult)	0.0001		0.0005	
Arsenic (Carcinogenic)		1.53E-08		2.86E-07
Background:				
Arsenic (Child)	0.001		0.004	
Arsenic (Adult)	0.0001		0.0005	
Arsenic (Carcinogenic)		1.54E-08		2.88E-07

Table 6-147
Effective Dose Conversion Factors for Radionuclides

Radionuclide	f_1[1]	Ingestion DCF (Sv/Bq)[2]	Lung Clearance Class[3]	Inhalation DCF (Sv/Bq)[2]	External DCF (mrem/yr per pCi/g)
Americium - 241	1.00E-03	9.84E-07	W	1.20E-04	2.99E-02
Plutonium -239[4]	1.00E-03	9.56E-07	W	1.16E-04	3.78E-04
Uranium - 234[5]	5.00E-02	7.66E-08	W	2.13E-06	8.07E-04
Uranium - 235	5.00E-02	7.19E-08	W	1.97E-06	1.90E-01
Uranium - 238	5.00E-02	6.88E-08	W	1.90E-06	2.59E-02

(1) Fractional uptake from the small intestine to the blood.
(2) To convert to conventional units of mrem/pCi, multiply the table entry by 3.7E+03.
(3) Lung clearance class: W = weeks.
(4) Used to evaluate Pu-239/240.
(5) Used to evaluate U-233/234.

Table 6 - 148
Summary of Annual Radiation Dose for AOC1

Pathway	Annual Radiation Dose Central Tendency (mrem/yr)	Reasonable Maximum (mrem/yr)
Construction Worker		
Ingestion of surface soil	6.5E-02	3.5E-01
Ingestion of subsurface soil	2.5E-03	1.3E-02
Inhalation of airborne particulates	2.1E-03	2.3E-03
External irradiation from surface soil	5.9E-01	7.3E-01
Total	6.6E-01	1.1E+00
Current Worker		
Ingestion of surface soil	5.3E-02	3.0E-01
Inhalation of airborne particulates	1.0E-02	1.1E-02
External irradiation from surface soil	2.2E+00	4.1E+00
Total	2.3E+00	4.4E+00
Ecological Worker		
Ingestion of surface soil	1.2E-01	1.7E-01
Ingestion of seep sediments	1.6E-03	5.0E-03
Inhalation of airborne particulates	5.0E-03	5.0E-03
External irradiation from surface soil	1.2E+00	1.5E+00
Total	1.3E+00	1.6E+00
Office Worker		
Ingestion of surface soil	2.6E-02	3.0E-01
Inhalation of airborne particulates	7.6E-03	1.1E-02
External irradiation from surface soil	2.2E+00	4.1E+00
Total	2.2E+00	4.4E+00
Open Space Recreational User (adult)		
Ingestion of surface soil	6.0E-03	3.0E-02
Ingestion of seep sediments	1.8E-04	9.1E-04
Inhalation of airborne particulates	4.6E-04	1.9E-03
External irradiation from surface soil	2.0E-01	4.9E-01
Total	2.0E-01	5.2E-01
Open Space Recreational User (child)		
Ingestion of surface soil	6.0E-03	6.0E-02
Ingestion of seep sediments	1.8E-04	1.8E-03
Total	6.2E-03	6.2E-02

Table 6 - 149
Summary of Annual Radiation Dose
for AOC2

Pathway	Annual Radiation Dose Central Tendency (mrem/yr)	Annual Radiation Dose Reasonable Maximum (mrem/yr)
Construction Worker		
Ingestion of surface soil	1.4E-02	7.4E-02
Ingestion of subsurface soil	9.3E-03	4.9E-02
Inhalation of airborne particulates	1.0E-03	1.1E-03
External irradiation from surface soil	1.8E-01	1.2E-01
Total	2.1E-01	2.5E-01
Current Worker		
Ingestion of surface soil	1.1E-02	6.4E-02
Inhalation of airborne particulates	4.9E-03	5.6E-03
External irradiation from surface soil	6.9E-01	6.8E-01
Total	7.1E-01	7.5E-01
Ecological Worker		
Ingestion of surface soil	4.8E-02	3.5E-02
Ingestion of seep sediments	3.3E-03	1.1E-02
Inhalation of airborne particulates	2.4E-03	2.4E-03
External irradiation from surface soil	3.7E-01	2.4E-01
Total	4.2E-01	2.9E-01
Office Worker		
Ingestion of surface soil	5.6E-03	6.4E-02
Inhalation of airborne particulates	3.7E-03	5.6E-03
External irradiation from surface soil	6.9E-01	6.8E-01
Total	7.0E-01	7.5E-01
Open Space Recreational User (adult)		
Ingestion of surface soil	1.3E-03	6.4E-03
Ingestion of seep sediments	3.9E-04	1.9E-03
Inhalation of airborne particulates	2.2E-04	9.4E-04
External irradiation from surface soil	6.2E-02	8.1E-02
Total	6.3E-02	9.0E-02
Open Space Recreational User (child)		
Ingestion of surface soil	1.3E-03	5.5E-02
Ingestion of seep sediments	3.9E-04	2.3E-03
Total	1.7E-03	5.8E-02

Table 6 - 150
Summary of Annual Radiation Dose for AOC3

Pathway	Annual Radiation Dose Central Tendency (mrem/yr)	Reasonable Maximum (mrem/yr)
Ecological Worker		
Ingestion of pond sediments	2.6E-02	8.4E-02
Ingestion of stream sediments	1.4E-02	4.6E-02
Ingestion of surface water	9.6E-05	8.2E-04
Total	4.1E-02	1.3E-01
Open Space Recreational User (adult)		
Ingestion of pond sediments	3.1E-03	1.5E-02
Ingestion of stream sediments	1.7E-03	8.4E-03
Ingestion of surface water	1.0E-04	1.0E-03
Total	4.8E-03	2.5E-02
Open Space Recreational User (child)		
Ingestion of pond sediments	6.1E-03	3.1E-02
Ingestion of stream sediments	3.4E-03	1.7E-02
Ingestion of surface water	1.7E-04	3.4E-04
Total	9.6E-03	4.8E-02

This page intentionally left blank.

7.0 ECOLOGICAL RISK ASSESSMENT SUMMARY FOR THE WOMAN CREEK PRIORITY DRAINAGE

The ecological risk assessment (ERA) for the Woman Creek Priority Drainage is summarized in this section. ERAs for the Walnut Creek and Woman Creek watersheds were combined and results presented in a single report (Appendix N). The ERAs represent the ecological portions of the baseline risk assessments associated with the RFI/RIs for OUs 1, 2, 4 (in part), 5, 6, 7, 10 (in part), and 11. ERAs were formerly planned for each OU, and preliminary ecological field investigations were conducted on that basis. The resulting analyses fulfills the requirements of Attachment 2, Section VIII, Interagency Agreement.

The combined ERA was conducted based on recent agreements among the EPA, CDPHE, and DOE. The agencies agreed that it is ecologically more appropriate to conduct the ERAs for each watershed. This scale is more relevant to ecological receptors because they are not constrained by the administrative boundaries associated with the OUs. ERAs are now required for four areas: (1) the industrial area/protected area (IA/PA); (2) the Walnut Creek watershed; (3) the Woman Creek watershed; and (4) offsite areas, including Great Western Reservoir, Standley Lake, and Mower Reservoir. The ERA accompanying this report addresses ecological risks from contaminant sources in the Walnut Creek and Woman Creek watersheds with the Site boundaries but outside of the IA/PA.

An ERA is required to support the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Record of Decision or the Resource Conservation and Recovery Act (RCRA) Corrective Action Decision for any of the OUs within the areas mentioned above. Sections within CERCLA include statements that both human health and the environment must be considered when assessing risks associated with releases from hazardous waste sites. Also, the National Contingency Plan (NCP) specifically states that an environmental evaluation must be performed to assess threats to the environment (40 CFR Part 300.430 [e][2][i][G]) during the overall process of assessing the need to remediate a hazardous waste site. The Interagency Agreement (IAG) negotiated among DOE, EPA, and CDPHE states that one objective of the RFI/RI is to provide data to establish the baseline risk assessment for human health and the environment for the OU. The methodology used here evaluates the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to one or more chemical stressors (EPA, 1992d).

7.1 SUMMARY OF ECOLOGICAL RISK ASSESSMENT METHODOLOGY

An ERA methodology for the RFETS was developed to support risk management decisions for individual OUs. The approach used is consistent with a screening-level risk assessment appropriate for sites where ecological effects have not been observed but contaminant levels have been measured and can be compared with concentrations considered protective of ecological receptors. The RFETS ERA methodology draws from DOE and EPA guidance, and ERA tools developed at Oak Ridge National Laboratory (ORNL) and the Savannah River Site (DOE 1993k, 1993b; EPA 1992d, 1994f; Norton et al. 1992; Opresko et al. 1994).

The ERA methodology is documented in two technical memoranda (TMs):

- The Sitewide Conceptual Model TM (SCMTM)
- The Ecological Chemicals of Concern (ECOCs) Screening Methodology TM (ECOCTM)

The SCMTM (DOE, 1995f) describes ecological components of the site that are potentially affected by contamination and presents baseline assumptions and parameter values used in exposure estimates and risk characterization. The following information was included in the SCMTM:

- Descriptions of the key ecological features of the RFETS including vegetation, wildlife, aquatic organisms, and protected species
- Summaries of existing sitewide monitoring programs
- Exposure pathway models, which describe the contaminant transport and exposure mechanisms important in evaluating exposure of ecological receptors to the chemical stressors at the RFETS
- Selection criteria for the identification of key ecological receptors
- General exposure parameters for key receptor species

The ECOCTM (DOE 1995g) describes a phased approach to identify ECOCs-the environmental contaminants that are the focus of risk characterization. Tier 1 screening consisted of identifying contaminants within each source area that were detected at levels above-background concentrations. This was done using a statistical methodology developed specifically for the RFETS. The result of Tier 1 was a list of PCOCs that was further screened in Tier 2 and Tier 3 using ecotoxicity criteria. Tier 2 and Tier 3 screens each required estimates of exposure for the key ecological receptors at the RFETS. Methods used in Tiers 1, 2, and 3 screening are explained in detail in Appendix N (Section N3.0). The watershed ERA focused on identification and characterization of ECOCs because chemical stressors are usually of greatest concern for ERAs conducted as part of CERCLA investigations (EPA, 1994f).

7.2 PRELIMINARY EXPOSURE AND RISK SCREEN

An initial step in conducting the watershed ERAs was to evaluate contaminant distribution and identify ECOCs. This evaluation required screening-level exposure and risk estimations using data collected during RFI/RI activities and sitewide environmental monitoring programs. The screen corresponds to the preliminary exposure and risk calculation step of the EPA procedure for conducting ERAs at Superfund sites (EPA, 1994f).

The purpose of the sitewide ERA is to provide information that is useful for both evaluating ecological risk on a watershed basis and making decisions regarding remedial actions associated with the individual OUs and IHSSs within them. Therefore, ecological risks were estimated for distinct subareas of each watershed, called ERA source areas, that were identified by grouping IHSSs based on OU, location, and contaminant sources (Figure 7.2-1). Source area boundaries were determined based on abiotic and biotic sampling locations. Risks were quantified for each source area separately and their contribution to overall risk in the watershed was determined.

The primary objective of the ecotoxicity screen is to evaluate exposures to determine if the chemical concentrations represent an ecotoxicological threat. The risk was evaluated by comparing site exposures to toxicity reference values (TRVs) or benchmark exposures that, if exceeded, could result in adverse effects. The comparison was conducted using the hazard quotient (HQ) approach described in the ECOCTM. The HQ is the ratio of the site exposure versus the TRV (exposure ÷ TRV). The hazard index (HI) is the sum of individual HQs for individual chemicals and was used to approximate cumulative risk in an area (DOE 1995g).

Assistance in developing TRVs was solicited from other sites in the DOE complex and associated academic institutions. Specific uses of TRVs for the watershed ERAs is presented in Appendix N (Section N3.2.6). Site-specific ecotoxicological benchmarks were derived using methods developed at ORNL (Opresko et al., 1994). Toxicologists from Clemson University and radioecologists from Oregon State University and Argonne National Laboratory conducted extensive literature searches for the remaining PCOCs and developed preliminary benchmarks. Life history information on representative species found at the RFETS was obtained from EPA (1993b) or scientific literature and documented by in the SCMTM (DOE, 1995f).

Many factors affect the accuracy of the HQ in predicting toxicity and risk. TRVs were derived to represent the No Observed Adverse Effects Level (NOAEL) for sublethal effects that, if incurred, may result in reduced reproductive capacity of individuals. For most species, the ultimate goal is to assess risks that may affect the size or resiliency of local populations. TRVs and exposures were based on calculating effects on individual organisms, because the most reliable methods for estimating exposure and effects are individual-based. Extrapolation to populations or communities was qualitative and based on area of affected habitat, quality of resources, and species-specific behaviors.

The actual endpoints and studies on which TRVs were based varies greatly among receptor types (i.e., birds, mammals, and insects) and chemicals. Because of this, uncertainty factors were built into final identification of TRVs to minimize the chance of underestimating risk (Opresko et al., 1994). Thus, HQs progressively larger than 1 indicate increasing chances of occurrence for the effect on which the TRV is based, and not necessarily exceedance of absolute risk criteria. As a result, an HQ was used as an indicator that potential risk from exposure to a chemical should be evaluated further in the risk characterization phase of the ERA.

The bioavailability of a chemical in environmental media is another factor that affects the accuracy of TRVs in representing risk levels. Bioavailability was assumed to be 100 percent for exposure estimates used in the preliminary risk screen. However, bioavailability of contaminants is usually less than 100 percent, especially for metals. Toxicological dose-response studies usually use highly bioavailable forms so that the true relationship between concentration (dose) and toxic effect can be determined. Therefore, assuming that PCOCs in environmental media at RFETS are 100 percent bioavailable probably overestimates exposures. However, this factor is useful in a screening-level assessment to avoid underestimating risk.

The preliminary exposure and risk screens were conducted for species representing various taxonomic and functional groups at RFETS. Representative species were identified in the SCMTM and approved by EPA prior to implementation of the screen. Species used in the analysis included three wide-ranging wildlife species (coyote, mule deer, and red-tailed hawk); four wildlife species with more restricted home ranges or habitat requirements (mallard, great blue heron, American kestrel, and Preble's Meadow Jumping Mouse); and vegetation. Aquatic life (fish, aquatic invertebrates, aquatic plants) were included as one receptor group, because state water quality standards used in screening apply to all aquatic species. The wildlife species used in the assessment have varying habits and may spend different amounts of time at RFETS. However, for screening purposes, all species were assumed to spend 100 percent of their time at RFETS.

Risk for wide-ranging species was negligible; no HQs or HIs were greater than 1. ECOCs were identified for limiting species and aquatic receptors that may spend all or most of their time in small areas and, therefore, are in more frequent contact with contaminants. ECOCs were identified by source area and receptor type and included metals, radionuclides, and organic compounds (Table 7.2-1).

7.3 PROBLEM FORMULATION AND RISK CHARACTERIZATION

The preliminary risk screen identified ECOCs based on chemical concentrations in abiotic and biotic media and conservative assumptions concerning exposure and toxicity. The remainder of the ERA focuses on further characterization of ecological risk from exposure to the ECOCs. Specific objectives and the approach for risk characterization are described in problem formulation (EPA, 1994f).

7.3.1 Problem Formulation

The risk characterization has two main goals: (1) refine risk estimates through use of less conservative and more realistic assumptions, and characterize remaining uncertainty; and (2) identify areas, chemicals, and media contributing to risk. Where feasible, guidance for developing cleanup criteria protective of assessment endpoints was also provided. Where appropriate, exposures and risk were summarized by watershed, OU, and IHSS to aid in risk management and remediation decisions.

Conservative assumptions were used in the Tier 3 screen to improve efficiency of the screen or to account for uncertainty in exposure or toxicity estimates. Conservative assumptions were selected to minimize the probability of underestimating risk so that uncertainty would be biased in only one direction (EPA, 1994f). Refinement of risk estimates involved use less conservative assumptions and/or site data on direct measurement of toxic effects to reduce uncertainty. In most cases, a combination of data types was used in a weight-of-evidence approach to risk characterization.

The risk characterization for each of the ECOCs included the following activities: (1) refine exposure estimates to more accurately reflect site conditions, including bioavailability, contaminant distribution, and frequency and duration of exposures; (2) refine toxicity estimates based on a more specific evaluation of contaminant forms and potential toxicity; (3) review site data to determine if predicted effects were manifested; (4) if appropriate, extrapolate effects on individuals to estimate effects to the RFETS populations or communities; and (5) identify, characterize, and rank sources of uncertainty and identify data needed to further refine estimates.

The risk characterization focused on the potential toxic effects of ECOCs on five ecological receptor groups:

1. Aquatic life
2. Aquatic-feeding birds
3. Terrestrial-feeding raptors
4. Small mammals
5. Vegetation communities

These receptor groups were selected based on results of the ECOC screen presented in Appendix N, Section N3.0, either because of potential toxicity from one or more ECOCs or because available data were inadequate to conclude that risk was negligible. These receptor groups correspond to those represented by the species with restricted home ranges or habitat requirements. Risk characterization was not conducted for wide-ranging wildlife species, because potential ecotoxicity appeared to be negligible.

Assessment endpoints and specific objectives of the risk characterization were identified for each resource category and presented in Appendix N, Table N4-1. Assessment endpoints are explicit expressions of the environmental values to be protected (Suter, 1989 and EPA, 1992d). The purpose of assessment endpoints in this phase of the watershed ERAs was to focus the risk characterization on potential exposures to ECOCs and the specific effects that may result. The potential for exposure and toxicity was established in the Tier 3 screen. In most cases, the specific effect is defined by the toxicological endpoints on which the TRVs were based. Most of these endpoints were based on chronic sublethal or reproductive effects that were not measured at the RFETS. Results of toxicity testing or other measurements of effects were available for some groups and were used where appropriate.

For each receptor group, assessment endpoints, exposure pathways, and specific goals and objectives are identified and described in Appendix N, Section N4.0. Where appropriate, a working null hypothesis (H_0) was defined to help guide analysis and evaluation of uncertainty.

7.3.2 Risk Characterization

The risk characterization was completed using qualitative and quantitative approaches described in the problem formulation step. In some cases, the evaluation focused on assessing the adequacy of data used in exposure calculations. In other cases, less conservative or more quantitative methods were used to more accurately estimate frequency or duration of exposures.

Specific measurements of metals, radionuclides, and PCBs in biota were available for evaluating exposures and food-web transfers. These data were reliable indicators of exposure (Suter, 1993) and were also used to evaluate potential impacts to upper-level consumers from ECOCs accumulated in forage or prey. However, for other ECOCs, the risk characterization was largely conducted without the benefit of sampling and analysis specifically designed to evaluate effects of ECOCs. Results of risk characterization are detailed in Appendix N and summarized in the following subsections. Analyses of potential effects on aquatic life for the watersheds were combined. Evaluation of effects on terrestrial biota are discussed for the Woman Creek watershed. Risks are summarized by receptor group, ECOC, and ERA source areas in Table 7-2.

7.3.2.1 Summary of Risks to Aquatic Life

The preliminary risk screen for aquatic life was based on comparisons of chemical concentrations in sediments and surface water to Colorado state water-quality standards or sediment-quality criteria derived from the literature or calculated using methods recommended by EPA (EPA 1992d). The screen identified several ECOCs in sediments but none for surface water. Sediment ECOCs included volatile and semivolatile organics, PCBs, and metals.

The magnitude of sediment HQ and HI values for some sites in Walnut Creek suggested a high level of toxicity to benthic organisms, especially in the A- and B-series ponds furthest upstream and closest to the IA of the RFETS. HQs exceeded 100 for some chemicals at these sites as shown in Appendix N, Figure N5-5. Polynuclear Aromatic Hydrocarbons (PAHs) were the main contributors to risk estimates at most sites in Walnut Creek, accounting for 90 percent or more of the HI in Ponds A-1 and B-1. However, PAH water-quality standards for aquatic life are based on human health standards and may overestimate ecotoxicity. Risk estimates were much lower in the Woman Creek watershed where HIs were below 3; and no individual HQ exceeded 2.6.

Two types of data were evaluated to assess whether the high level of toxicity predicted in the preliminary screen were manifested in aquatic communities at RFETS. Results of standard laboratory toxicity tests conducted with site sediment samples and the organisms *Hyalella azteca* and *Chironomus tentans* were evaluated for ponds with varying ECOC concentrations to determine whether risk quotients (HQs and HIs) correspond to laboratory test results. Measures of benthic community structure (e.g., richness, abundance, and organism density) are important indicators of community health and are often used to assess water and sediment quality. If toxicity is an important factor in controlling benthic community structure, correlation between risk quotients and community metrics would be expected.

Correlations were evaluated using cluster analysis and regression methods. Cluster analyses (Ludwig and Reynolds 1988) were conducted to determine whether groups of sites with similar community composition (e.g., total organism density and species richness) also had similar HIs or HQs.

Regression methods (Sokal and Rholf 1968) were used to estimate if the proportion of variation in community structure could be explained by differences in HIs.

Results indicate that predicted toxicity accounts for some of the variation in community composition, but other factors are clearly important. Groups that were identified by cluster analysis based on density, richness, and pollution tolerance were not similar to those identified when the same analysis was conducted using HIs. However, differences in HIs accounted for about 50 percent of the variation in rank order of ponds with respect to richness. Results of sediment toxicity testing indicated significant toxicity in only Pond B-2, but this pond did not have the highest HIs.

These results suggest that although toxicity tests do not show robust toxicity, effects of sediment contamination may be manifested in the benthic community structure of the detention ponds. However, other factors such as size, fluctuating water levels, and the presence or absence of upper trophic levels are also important. Potential toxicity of sediment contaminants, particularly PAHs, may be important factors in limiting aquatic communities if physical stress was reduced through a change in management of the ponds.

It should be noted that the ponds were constructed to minimize offsite transport of contaminants, especially radionuclides, in sediments and surface water. The presence of PAHs and metals in sediments are, in part, a result of runoff from industrial areas and input from the wastewater treatment plant. The fact that sediment contaminant concentrations decrease dramatically with distance downstream indicates that the ponds are effective in attenuating offsite transport of sediment-bound contaminants.

7.3.2.2 Summary of Risks to Aquatic-Feeding Birds

<u>Risks from PCBs</u> - Sediment contamination in ponds, streams, and wetlands may also affect wildlife that feed in contaminated areas. ECOCs identified for aquatic-feeding wildlife in OU 5 included PCBs (Aroclor-1254), mercury, and antimony. Great blue herons and mallards were identified as representative receptors because birds are more sensitive to many contaminants than mammals. Analyses used in the risk characterization are described in Appendix N, Section N4.2. The following subsections provide more detail on methods and present results. Because the analysis approach differed by chemical, results are presented separately for each ECOC.

Aroclor-1254 was identified as an ECOC in the 903 Pad ERA source area, primarily because of concentrations detected in sediments in the SID. The initial risk calculations were based on estimates of PCB uptake by aquatic biota, because no tissue data were available for the site. Initial uptake estimates were based on potential bioconcentration of PCBs from interstitial water. When compared to actual data from the B-ponds, this method greatly overestimated tissue concentrations.

Therefore, potential risk from PCB exposure was further evaluated using data from B-ponds to establish site-specific uptake rates for accumulation of PCBs from sediments. This information was then used to identify sediment PCB concentrations that would result in exposures equal to or less than the TRVs, and be protective of aquatic birds. These criteria were based on partitioning of PCBs between lipid in biota and organic carbon in sediments. The criteria vary with the intensity of site use and complexity of food chains, (see Appendix N, Table N5-10). The most restrictive criteria are associated with the highest level of site use and longest food chains. Available data on PCB concentrations in sediments were then compared to the criteria.

Data on total organic carbon in sediment from the SID were not available. However, the maximum Aroclor-1254 concentration detected in bulk sediments (0.26 mg/kg) was below the average concentrations in sediments of Pond A-3, which represented negligible risk even if aquatic-feeding birds obtained all of their food from there. Therefore, sediments of the SID do not appear to represent a risk to aquatic-feeding birds.

Risks from Mercury - Mercury was identified as an ECOC in the C-ponds and the Original Landfill source areas. Mercury was identified as a PCOC in soil, groundwater, stream sediments, and pond sediments in OU 5 (see Appendix N, Table N5-11A). In each source area, mercury was included as an ECOC because of measured or calculated concentrations in fish tissues.

Mercury was detected in 2 of 13 (15 percent) fish collected from Pond C-1 (see Appendix N, Table N5-11A.). The maximum detected concentration (0.47 mg/kg) was greater than the average dietary concentration (0.027 mg/kg) considered safe for great blue herons (Opresko et al., 1994) and corresponds to an HQ of 17. Mercury was identified as an ECOC for the Old Landfill source area based on the estimated bioconcentration in fish tissue calculated from the maximum detected concentration in surface water.

Mercury was detected in less than 50 percent of samples from all abiotic media in OU 5 except pond sediments (see Appendix N, Table N5-11A). Pond sediments are probably the primary source for uptake of mercury by fish, however, only 15 percent of fish collected from Pond C-1 contain detectable quantities of mercury. It is possible that the two samples with detectable quantities may have had sediment in the gastrointestinal tract when analyzed.

Actual risks to great blue herons from mercury ingestion are probably less than indicated by the HQ of 17, because this value was calculated using the maximum detected mercury concentration in fish, and assumed that the herons obtain all of their food from Pond C-1. Although great blue herons return frequently to feeding areas, they could not use a pond the size of C-1 exclusively. Therefore, the exposure calculation probably overestimates both the exposure-point concentration and the frequency of exposure.

Risks from Antimony - Antimony was identified as an ECOC based on incidental ingestion of sediments from Woman Creek. The HQ of 1.6 was based on 100-percent site use by herons in the section of Woman Creek in the Old Landfill source area. This segment of Woman Creek is seasonally intermittent and supports a minimal fish population. Herons have not been observed in this area, although they have been sighted at Pond C-1. It is unlikely that a heron would use this segment of Woman Creek to the extent necessary to exceed an HQ of 1.

7.3.2.3 Summary of Risks to Terrestrial-Feeding Raptors

Chromium, lead, mercury, and vanadium were detected in terrestrial arthropods from OU 2 (included in the Woman Creek drainage) at concentrations that could be toxic to raptors feeding extensively in the areas. American kestrels were selected to represent ecological receptors because they have relatively small home ranges and are known to breed at the RFETS.

The preliminary risk estimate for chromium in terrestrial arthropods from OU 2 was based on the maximum detected concentration from the East Trenches source area. Chromium concentrations in terrestrial arthropods from the 903 Pad area were estimated based on data from the East Trenches, but data were inadequate to accurately estimate exposures. A review of the OU 2 data suggests that the maximum concentration was anomolously high and that its use overestimates risk. The mean chromium concentration in OU 2 soils was not elevated compared to background, and chromium was included in the PCOCs because of two samples that exceeded the background $UTL_{99/99}$. The OU 2 source areas represent a small portion of the mesic and xeric-mixed grassland habitat type at the RFETS. Therefore, exposure to chromium in OU 2 does not appear to represent a significant ecological risk to kestrels given the low magnitude of the exposures, probable overestimate of exposure, and relatively small area involved.

7.3.2.4 Summary of Risks to Small Mammals

Preliminary risk estimates indicated little risk to small mammals from inhalation of organic contaminants volatilizing from subsurface soils into burrow air. Potential toxicity was characterized from exposure estimates for individuals. Individual-based exposure and risk assessment was applicable to Preble's Meadow Jumping Mouse, a species of special concern at RFETS. Risks were extrapolated to the population level for more common species such as meadow voles and deer mice.

Toluene exceeded the environmental effects criteria (EEC) for exposure of small mammals to burrow air in areas of OU 2 that are known to contain buried waste or contaminated soil (see Appendix N, Table N5-16, Figure N5-18). Inhalation TRVs were available for only six other organic PCOCs (see Appendix N, Attachment 6, Table 9); soil concentrations for these compounds did not exceed TRVs. At the time of this report preparation, adequate information on respiratory toxicity was not available for most of the organic PCOCs found in soils, and inhalation TRVs could not be set. Review of existing information in IRIS (EPA, 1994b) indicates that EPA is currently developing reference concentrations (RfCs) for some of the compounds. Respiratory exposures were estimated for all organic PCOCs, which are presented in Appendix N, Attachment 6, Table 9.

Toluene irritates mucosal membranes of the eyes and respiratory tract at very low concentrations (EPA, 1994b). Therefore, animals may avoid areas of contaminated soil when constructing burrows, fortuitously reducing their exposure. For the purposes of this study, no avoidance behavior is assumed, and all areas exceeding the EEC are included in Appendix N, Figure N5-18.

Areas in which toluene exceeded the EEC were identified using Thiessen polygons. These areas covered approximately 0.31 hectares in the 903 Pad areas and 0.27 hectares in the East Trenches area. All of the affected polygons lie within or adjacent to IHSSs. This suggests that risks to burrowing animals from toluene exposure in OU 2 may be restricted to the primary contaminant source areas. However, risk from organic PCOCs without TRVs remains unclear.

Areas impacted by toluene are found in the mesic and xeric-mixed grassland habitat types on the ridge between South Walnut Creek and Woman Creek. None of the areas overlap with probable Preble's Meadow Jumping Mouse habitat. The Thiessen polygons represent about 0.011 percent of the mesic and 0.088 percent of the xeric grassland habitats at the RFETS. These percentages may be used as a rough estimate of the proportion of burrowing habitat affected for more common species such as deer mice and prairie voles that use the drier, more upland areas of the site.

7.3.2.5 Summary of Risks to Vegetation Communities

Results of the Tier 3 screen indicated that several PCOCs exceed subsurface soil or sediment TRVs in several source areas (see Appendix N, Table N3-23). This group of chemicals included mostly metals. Concentrations of organic PCOCs did not exceed TRVs (see Appendix N, Attachment 6, Table 1). However, TRVs were not available for several organic compounds that were PCOCs for subsurface soil and sediments (see Appendix N, Attachment 6, Tables 2 and 7). Subsurface soil data were not available for the OU 5 Surface Disturbance; no HQs exceeded 1 for PCOCs in the OU 1 881 Hillside or OU 2 East Trenches.

Chromium (7.9), nickel (3.7), and zinc (3.0) all had HQs of 3 or greater in the Ash Pits source area. All other HQs for metals in subsurface soil were 2 or below. Many of the TRVs for metals were equal to the RFETS background soil concentrations, because literature-based toxicity values were below the 95% UCL for background. Therefore, HQs greater than 1 indicate concentrations that exceed background. Soil toxicity tests were not conducted using site soils. The risk associated with HQ values near 1 is unclear because background concentrations can vary by orders of magnitude. As noted previously, areas of obvious vegetation stress were not observed during preliminary field surveys. Therefore, the importance of these risk estimates is not clear.
TRVs were not available for most organic soil or sediment PCOCs. HQs were well below 1 for organic PCOCs using available TRVs. As with metals, the potential phytotoxicity of most organic PCOCs was not quantified with plant toxicity tests.

7.3.2.6 Summary of Risks from Radionuclides

Transuranic radionuclides were identified as PCOCs for most OUs. The ECOC screen indicated relatively few areas with radionuclide concentrations (activities) in soils that exceeded TRVs.

Plutonium-239/240 and americium-241 concentrations in soils exceeded TRVs in two locations in the 903 Pad source areas, and uranium-233/234 and uranium-238 concentrations in soils exceeded TRVs at two locations in the Old Landfill source area. Radionuclides were also elevated in vegetation and small mammals collected from ERA source areas.

The potential risks from radionuclide uptake by biota were evaluated by calculating the internal radiological dose and comparing it to the TRV. The TRV was based on a benchmark value of 0.1 rad/day, which was identified by IAEA (1992) as protective of biological receptors. Results indicated that maximum radionuclide concentrations measured in small mammals resulted in dose rates at least 1,000 times less than the TRV. The potential uptake by predators was also evaluated and indicated that risks to predators were also not significant. Although abiotic media and biota contain elevated concentrations of transuranic radionuclides, the risks of adverse effects appear to be negligible.

Tables 7-1 and 7-2

2 pages

Table 7-1
Summary of Risk Estimates for ECOCs by Source Area

Source Areas	Receptors at Risk	Exposure Points Contributing the Most Risk	ECOC	HQ
Woman Creek Watershed				
Woman Creek	Wetland Vegetation Communities	Sediments	Zinc	1.6
OU5 Ash Pits	Aquatic Species	Surface Water	Barium	17
	Vegetation Communities	Subsurface Soil	Chromium	7.9
			Nickel	3.7
			Zinc	3.0
			Silver	2.0
			Antimony	1.3
			Copper	1.1
			Lead	1.1
			Cadmium	1.0
OU5 C-Ponds	Aquatic Species	Surface Water	Barium	24
	Great Blue Heron	Fish	Mercury	6.4
	Vegetation Communities	Subsurface Soil	Chromium	2.7
			Zinc	1.1
Pond C-1	Aquatic Species	Sediments	Benzoic acid	2.6
	Wetland Vegetation Communities	Sediments	Mercury	6.0
			Zinc	1.5
Pond C-2	Aquatic Species	Sediments	Benzoic acid	1.7
			Zinc	1.3
	Wetland Vegetation Communities	Sediments	Zinc	2.8
		Subsurface Soil	Mercury	2.3
OU5 Original Landfill	Aquatic Species	Surface Water	Barium	37
	Great Blue Heron	Fish	Mercury	29
		Sediments	Antimony	1.6
	Small Mammals[1]	Surface Soils	Uranium-233/234	1.6
			Uranium-238	23.8
	Vegetation Communities	Subsurface Soil	Copper	2.6
			Zinc	2.0
OU2 903 Pad	American Kestrel	Terrestrial Arthropods	Chromium	5.6
	Aquatic Species	Surface Water	Barium	39
	Great Blue Heron	Fish	Aroclor-1254	5.8
	Small Mammals	Burrow Air (Calc. from Soils[2])	Toluene	1,900
	Small Mammals[1]	Surface Soils	Plutonium-239/240	1.92
	Vegetation Communities	Subsurface Soil	Zinc	1.2
OU2 East Trenches	American Kestrel	Terrestrial Arthropods	Chromium	4.4
	Small Mammals	Burrow Air (Calc. from Soils[2])	Toluene	20

[1] Radionuclide benchmarks use small mammals as the limiting exposure scenario. Preble's meadow jumping mouse was used to represent this group.

[2] HQ is for maximum concentration of toluene in soils

Table 7-2
Summary of Ecological Risks for Woman Creek Watershed

Receptor Group	ECOCs	ERA Source Area	Media/Exposure Point	Conclusions
Wide-Ranging Wildlife	None	Not Applicable	Not Applicable	No ECOCs were identified as result of Tier 3 screen.
Aquatic Life	Metals and organics in sediments	OU2 903 Pad OU5 C-Ponds OU5 Original Landfill	Sediments	Risks are primarily due to PAHs in sediments. However, no toxicity was detected in sediment toxicity tests with *Hyalella azteca.* The importance of sediment contamination is unclear but does not appear to be the primary factor controlling benthic community structure.
Aquatic-Feeding Birds	Aroclor-1254	OU5 C-Ponds	Sediments of SID	Aroclor-1254 concentrations in sediment did not exceed risk based criteria developed for sediment at the Site.
	Mercury	OU5 Original Landfill OU5 C-Ponds	Fish Tissue	Mercury was detected in 2 of 24 fish from the C-ponds. Mercury was not detected in other fish. Risks are significant only if birds obtain all food from Pond C-1.
	Antimony	OU5 Original Landfill	Sediments	The screening estimate assumes 100% site use. Actual use is much less because the stream supports a small fish population. Risks were not significant when adjusted for realistic site-use factor.
Terrestrial-Feeding Raptors	Chromium	OU2 903 Pad OU2 East Trenches	Terrestrial Arthropods	The mean chromium concentration in soils was not greater than the background mean. No clear contaminant source exists. Chromium was not a risk to the kestrel population at the Site.
Small Mammals	Plutonium-239/240 Americium-241	OU2 903 Pad OU2 East Trenches	Soils	Radionuclides do not present significant risk to terrestrial receptors. Maximum tissue concentrations do not result in dose rates that exceed TRVs (0.1 rad/day).
	Uranium-233/234 Uranium-238	OU5 Original Landfill	Soils	See text for plutonium and americium conclusions.
	Toluene	OU2 903 Pad OU2 East Trenches	Burrow Air	Organic PCOCs in subsurface soil could volatilize into burrow air. Soil toluene concentrations in some areas of OU2 could lead to air concentrations > TRV. Little toxicity data are available for assessing other organics.
Vegetation	Metals	Most Source Areas	Soils, Sediments	Soils of the Ash Pits contained several metals with HQs >1. The highest HQ (7.9) was for chromium. Ecological risk to vegetation communities is minimal because each of the Ash Pits involves relatively small areas.
				Sediments of C-ponds contain mercury at concentrations that exceed TRVs for wetland vegetation. However, growth of vegetation in littoral zone appears normal.

8.0 PRELIMINARY EVALUATION OF REMEDIAL ALTERNATIVES

Section 5.7 of the OU 5 RFI/RI Work Plan (DOE, 1992a) describes the process to be used for the development and screening of remedial alternatives for OU 5. The process to be employed for the development and evaluation of alternatives for OU 5 is similar to that described in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA, 1988c) and, as mandated by the IAG, complies with both RCRA and CERCLA guidance. This process uses the site-characterization data generated by the RFI/RI along with data generated under other investigations, such as treatability studies, to develop, refine, and select remedial alternatives appropriate for each IHSS where contamination is present and remediation is warranted.

The development and screening of remedial alternatives for OU 5 will be conducted under the OU 5 Corrective Measure Study/Feasibility Study (CMS/FS) program if a further action is warranted. Two technical memoranda will be prepared under the CMS/FS program and will be issued at a later date. CMS/FS TM1, Development of Corrective/Remedial Action Objectives, will provide a description of corrective/remedial action objectives based on: chemical- and radionuclide-specific standards (when available); site-specific, risk-related factors; and other criteria, as appropriate. CMS/FS TM2, Detailed Screening of Alternatives, will describe the evaluation remedial alternatives applicable to OU 5 against the short- and long-term aspects of the following specific evaluation criteria:

- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements (ARARs)
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost

- State acceptance

- Community acceptance

These criteria are described in EPA (1988c). The initial two criteria are considered threshold criteria because these criteria must be satisfied before further consideration of the remaining criteria. The next five criteria are considered the primary criteria on which the analysis is based. The final two criteria, state and community acceptance, are addressed during the final decision-making process after completion of the CMS/FS.

9.0 PRELIMINARY IDENTIFICATION OF DATA GAPS

Throughout the RFI/RI process, available data are evaluated to determine if they are sufficient to define the risk associated with a site, and to develop remedial alternatives. The observational approach employed for the OU 5 RFI/RI allowed the data collected during each stage of the investigation to be evaluated and subsequent stages to be designed to obtain the data needed for assessing risk (i.e., determining the need for remedial action) and for developing remedial alternatives. Additionally, the field program defined by TM15 (DOE, 1994a) was, in large part, designed to obtain data needed for the evaluation of remedial alternatives in the OU 5 CMS/FS. For example, the geotechnical drilling program at IHSS 115/196 was designed to obtain data that are required for an assessment of the stability of the slopes in this area in anticipation that a likely remedial alternative for this area will be to stabilize the slopes and cover the area with a soil cap. Also, during the drilling program at IHSS 133 to investigate the additional pits identified by the TDEM survey, samples of ash were collected from IHSS 133.2 for use in treatability studies.

At this time, the data collected under the Phase I RFI/RI at OU 5 are believed to be adequate for defining the risk associated with each of the IHSSs (Sections 6.0 and 7.0). In addition, these data are adequate for the development and screening of remedial alternatives. As the OU 5 CMS/FS progresses, additional data gaps may be identified, and data-gathering programs will be developed to fill these gaps.

10.0 SUMMARY AND RECOMMENDATIONS

This section summarizes the results of the OU 5 Phase I RFI/RI, and provides recommendations for additional investigations that may be required.

10.1 SUMMARY

The Phase I RFI/RI of OU 5 was conducted as directed by the Interagency Agreement of 1991. The purpose was to assess the site physical characteristics; characterize contaminant sources and the nature and extent of potential contamination in surface soil, subsurface soil, groundwater, surface water, sediment, and air; assess fate and transport of environmental contaminants; and estimate potential risks to human health and the environment from the identified contaminants.

Field investigations indicate that the site physical characteristics are complex. Site meteorologic, geologic, hydrologic, and hydrogeologic conditions are interconnected and provide mechanisms and pathways for surface and subsurface constituents to migrate through the environment. For example, because most of the UHSU groundwater pathways discharge to surface water within OU 5, there is limited potential for migration of VOCs to offsite locations via groundwater.

The nature and extent of environmental contamination within OU 5 have been characterized through the collection, analysis, and assessment of hundreds of samples of various environmental media. Environmental samples were analyzed for a comprehensive suite of chemicals to help characterize potential contamination associated with waste handling and disposal practices conducted during the operating history of Rocky Flats in the area of OU 5. The OU 5 data assessment process, including rigorous data validation, was designed to be conservative to ensure a healthy protective and comprehensive understanding of potential contamination conditions in OU 5.

The results of the OU 5 data assessment indicated the presence of PCOCs in surface soil; subsurface soil; groundwater; pond, seep, and stream water; and pond, seep, and stream sediments. PCOCs identified in one or more of these environmental media include VOCs, SVOCs, PCBs/pesticides, metals and other inorganic constituents, including radionuclides. The Phase I RFI/RI indicated that both the lateral and vertical extent of the PCOCs are limited. The limited extent of PCOC migration is due to the low hydraulic conductivities, the hydrogeologic setting, and the small amounts of highly mobile wastes disposed in OU 5. The list of PCOCs for each medium was then screened using risk-based and other screening methods to identify COCs for both the HHRA and the ERA. COCs were identified as the chemicals in each medium that were likely to contribute at least 1 percent of overall risk. For the HHRA, COCs were selected on an OU-wide basis; for the ERA, the COCs were identified for the Woman Creek watershed. In groundwater and surface water, metals and radionuclides are the primary COCs; however, in seep water, the COCs are all VOCs. The COCs in surface soil and subsurface soil include uranium isotopes, several metals, PAHs, and PCBs. In all sediments, radionuclides and metals are the only COCs.

The presence of COCs in all media is a result of historical releases to the environment. Under the hydrogeochemical conditions of OU 5, metals and radionuclides are not expected to be very mobile via the groundwater pathway. However, several mechanisms of contaminant transport are present; such as storm-water runoff which may transport contaminated soils to surface waters, with subsequent transport to downstream receptors. The presence of COCs in stream, seep, and pond sediments as a result of surface-water transport of contaminated surface soils to, and along Woman Creek, supports this exposure mechanism. Fugitive dust emissions from OU 5 surface soils and dry sediments may also contribute contaminated particulates to future onsite receptors. Exposure to subsurface soils by future onsite construction workers may result from contaminant inhalation and ingestion during an excavation.

The results of the OU 5 HHRA indicate estimated health risks and annual radiation doses for current and future onsite receptors that could potentially be exposed directly or indirectly to COCs at, or released from, sources in OU 5. Exposure scenarios that were evaluated involved a current industrial worker (security guard); a future industrial/office worker; a future ecological researcher; a future open-space recreational user; and a future construction worker. Future onsite residential receptors were not considered in the HHRA because future land-use plans do not include residential use. It was determined during HHRA negotiations with the regulatory agencies that health risks to offsite receptors would not be addressed on an OU-specific basis, but would best be examined on a sitewide basis prior to issuance of the final Sitewide Record of Decision.

For the HHRA, exposure media that were evaluated included surface soil; subsurface soil; outdoor and indoor air; stream, seep, and pond water; and stream, seep, and pond sediments. Groundwater was not evaluated as an exposure pathway because there are no current or future receptors.

Risks were evaluated for three AOCs. The Original Landfill (IHSS 115/196 Source Area) is AOC1 and AOC2 includes the Ash Pits (IHSS 133 Source Area). AOC3 includes the SID and the Pond C-2 Source Area, Woman Creek, and the Pond C-1 Source Area.

The risk characterization process combines average and reasonable maximum estimates of exposure with upperbound estimates of toxicity to yield conservative (protective) estimates of human health risk. Estimates of human health risk for average (CT) and RME conditions are provided so that risk management decisions can be based on a range of potential risks for different exposure scenarios.

The following are the major conclusions of the HHRA:

- AOC1: Cumulative HIs were below 1 and RME cancer risk estimates were 3E-05 or below for all receptors. The maximum cancer risk estimate is 3E-05 for the future office worker; this risk is still within EPA's target risk range of 1E-06 to 1E-04. External irradiation due to exposure of uranium-238 in surface soil is the primary contributor to this estimate of cancer risk.

- AOC2: Cumulative HIs were below 1 and RME cancer risk estimates were 4E-06 or below for all receptors. The maximum cancer risk estimate is 4E-06 for the future office worker; this risk is at the low end of EPA's target risk range of 1E-06 to 1E-04. External irradiation due to exposure of uranium-238 in surface soil is the primary contributor to this estimate of cancer risk.

- AOC3: Cumulative HIs were below 1 and the RME cancer risk estimates were below EPA's "point of departure" of 1E-06 for both receptors. These results indicate that no adverse noncarcinogenic health hazards and negligible cancer risk are expected for all receptors evaluated.

The ERA for Woman Creek was conducted for aquatic and terrestrial biota exposed to contaminants in OUs 1, 2, and 5. Assessment of ecological risks was based on evaluating exposure of biological receptors to PCOCs in designated ERA-source areas. Source areas include individual or groups of IHSSs within an OU and were based on abiotic and biotic sampling locations in and around IHSSs. A preliminary exposure and risk calculation was conducted for PCOCs in source areas. The analysis was conducted to estimate the contribution of each PCOC and each source area to overall risk in the watershed. ECOCs were identified from preliminary risk calculations and evaluated further in risk characterization.

Ecotoxicological risk to terrestrial receptors in OU 5 was minimal. Concentrations (activities) of uranium-233/234 and uranium-238 in soils exceeded the risk-based screening criteria developed for the RFETS. However, the criteria were exceeded in only two locations, both of which are in the Old Landfill source area and which represent a negligible portion of habitat in the watershed. In addition, maximum concentrations of radionuclides in small mammals were not associated with levels that exceed the benchmarks for "safe" radiological doses; therefore, risk from exposure to radionuclides appears to be minimal.

The screening-level assessment also indicated that concentrations of mercury, antimony, and Aroclor-1254 could represent risks to aquatic-feeding birds if they acquired all of their food from the SID, Pond C-1, and segments of Woman Creek. However, it is unlikely that birds would spend all of the time in the AOCs, because the size and quality of habitat in these areas is inadequate to support their needs.

10.2 RECOMMENDATIONS

The results of the HHRA support the conclusions that environmental contamination within OU 5 does not pose a significant threat to human health under the evaluated exposure scenarios. Therefore, remediation of environmental media to address risk to human health and the environment may not be warranted, pending further evaluation using the No Further Remedial Action decision criteria.

11.0 REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR), 1993, *Draft Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs)*, Prepared by Clement International Corporation for U.S. Department of Health and Human Services, Atlanta, Georgia, October.

Ambrose, R.B. and T.O. Barnwell, Jr. 1989, "Environmental Software at the U.S. Environmental Protection Agency's Center for Exposure Assessment Modeling," In: Environmental Software, Vol. 4, No. 2.

Anderson, M.P. and W.W. Woessner, 1991, *Applied Groundwater Modeling, Simulation of Flow and Advective Transport*, Academic Press, Inc., San Diego, California.

Anderson, P.F., 1993, *A Manual of Instructional Problems for the U.S.G.S. MODFLOW Model*, EPA/600/R-93/010, U. S. EPA Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma.

Army Corps of Engineers, 1984, *Dam Safety Reports*, EG&G Rocky Flats, Inc., Golden Colorado, May.

ASI (Advanced Sciences, Inc.), 1990, *Water-Yield and Water-Quality Study of Walnut Creek and Woman Creek Watersheds, Rocky Flats Plant Site*, Task 4 of the Zero-Offsite Water-Discharge Study, Prepared for EG&G Rocky Flats, Inc, Golden, Colorado, Rev. 4.

ASI, 1991, *Surface-Water and Ground-Water Rights Study in the Vicinity of Rocky Flats Plant*, Task 14 of the Zero-Offsite Water-Discharge Study, Prepared for EG&G Rocky Flats, Inc., May 21.

ASI, 1993, *Stormwater NPDES Permit-Application Monitoring Program, Rocky Flats Plant Site - Final Report*: Prepared for EG&G Rocky Flats, Inc., BOA Contract BA 72429B, Purchase Order No. BA 99041CL, ASI Project No. 9208.10, March 31, 57 p., 10 figures, 12 tables, and Appendices A through C.

Bales, C.W., J.H. Freeland-Graves, P-H. Lin, J.M. Stone, and V. Dougherty, 1987, *Plasma Uptake of Manganese: Influence of Dietary Factors*, In: Nutritional Bioavailability of Manganese, C. Kies, Ed., ACS Symposium Series 354, p. 112-122.

Battelle, 1984, *Chemical Attenuation Rates, Coefficients, and Constants in Leachate Migration*, Volume I: A Critical Review, Battelle Pacific Northwest Laboratories for Electric Power Research Institute (EPRI), EA-3356 Volume I Final Report, February.

Beljin, M.S. and P.K.M. van der Heijde, 1993, *SOLUTE, A Program Package for Solute Transport in Groundwater*, International Groundwater Modeling Center, IGWMC-BAS 15, Version 3.0, June 1993, Colorado School of Mines, Golden, Colorado.

Bicknell, B.R., J.C. Imhoff, J.L. Kittle, A.S. Donigian, and R.C. Johanson, 1993, Hydrological Simulation Program - Fortran (HSPF): Users Manual for Release 10: Environmental Research Laboratory, U. S. Environmental Protection Agency, Athens, Georgia, 660 p.

Brookins, D.G., 1988, *Eh-pH Diagrams for Geochemistry*, 176 pgs.

Brooks, P.P. and S.M. Coplan, 1988, "The Role of Verification and Validation in Licensing Repositories for Disposal of High-Level Waste," In: *Geoval-87, A Symposium on Verification and Validation of Geosphere Performance Assessment Models*, held in Stockholm, Sweden, April 7-9, 1987, Proceedings Vol. 1, pp. 41-50.

Calderbank, A., 1989, *The Occurrence and Significance of Bound Pesticide Residues in Soil,* New York: Reviews of Environmental Contamination and Toxicology, col. 108, Springer-Verlag, Inc., pp. 71-103.

Cole, C.R., T.J. Nickolson, P. Cavis, and T.J. McCartin, 1988, "Lessons Learned from the Hydrocoin Experience," In: *Geoval-87, A Symposium on Verification and Validation of Geosphere Performance Assessment Models*, Held in Stockholm Sweden, April 7-9, 1987, Proceedings Vol.1, pp. 269-285.

Cooley, R.L., 1977, *A Method of Estimating Parameters and Assessing Reliability for Models of Steady State Groundwater Flow, 1. Theory and Numerical Properties*, Water Resources Research, Vol. 13, No. 2, p. 322.

Cowherd, Jr., C., G.E. Muleski, P.J. Englehart, and D.A. Gillette, 1985, *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites*, Washington, D. C.: U. S. Environmental Protection Agency, Office of Health and Environmental Assessment.

Cox, G.E., D.E. Bailey, and K. Morgareidge, 1975, "Chronic feeding studies with beryllium sulfate in rats," unpublished report submitted by the Food and Drug Research Laboratories, Inc., to the Aluminum Company of America, Pittsburg, PA., (as cited in EPA 1995).

Crawford, N.H. and R.K. Lindsey, 1966, *Digital Simulation in Hydrology: Stanford Watershed Model IV*: Stanford University, Department of Civil Engineering Technical Report No. 39, 210 p.

Dean, J.A., 1992, *Lange's Handbook of Chemistry*, 14th ed., New York: McGraw-Hill, Inc.

Dixon, W.J, and F.J. Massey, 1957, *Introduction to Statistical Analysis,* McGraw-Hill, 128 p.

DOA (Department of Agriculture), 1970, *Irrigation Water Requirements*, U. S. Department of Agriculture, Soil Conservation Service, Engineering Division, Technical Release No. 21, April 1967, revised September.

DOA, 1980, *Soil Survey of Golden Area, Colorado*, Soil Conservation Service.

DOE (Department of Energy), 1980, *Final Environmental Impact Statement: Rocky Flats Plant Site, Golden, Jefferson County, Colorado*, Vol. 1, 2, and 3, U. S. Department of Energy Report, Washington, D. C. DOE/EIS-0064.

DOE, 1986, *Resource Conservation and Recovery Act 3004 (u) Waste Management Units,* Appendix I Volume I, (for U.S. DOE - Rocky Flats Plant), November, 1986.

DOE, 1987, *Resource Conservation and Recovery Act Part B - Operating Permit Application*, Vol. VI, Revision No. 1.0, December.

DOE, 1988, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0070, Assistant Secretary for Environment, Safety and Health, Washington, D. C.

DOE, 1990, *General Environmental Protection Program*, DOE Order 5400.1, U. S. Department of Energy, Washington, D. C., June 29.

DOE, 1991, *Geologic Characterization Report for U. S. DOE-Rocky Flats Plant*, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, July.

DOE, 1992a, *Final Phase I RFI/RI Work Plan for Rocky Flats Plant Woman Creek Priority Drainage (Operable Unit No. 5)*, Revision 1, U. S. Department of Energy, Rocky Flats Plant, Golden, Colorado, February.

DOE, 1992b, *Surface Geophysical Surveys*, Technical Memorandum 2, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, October.

DOE, 1992c, *Baseline Biological Characterization of Terrestrial and Aquatic Habitats at the Rocky Flats Plant*, Final Report, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, September.

DOE, 1993a, *Background Geochemical Characterization Report, Rocky Flats Plant*, Prepared for the U. S. Department of Energy, Rocky Flats Plant, Golden, Colorado, September.

DOE, 1993b, *Revised Network Design - Field Sampling Plan*, Technical Memorandum 1, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, May.

DOE, 1993c, *Surface Soil Sampling Plan - Original Landfill*, Technical Memorandum 3, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, January.

DOE, 1993d, *Surface Soil Sampling Plan - Ash Pits, Incinerator and Concrete Wash Pad*, Technical Memorandum 4, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, April.

DOE, 1993e, *Revised Soil Gas Sampling Plan - Original Landfill*, Technical Memorandum 5, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, February.

DOE, 1993f, *Cone Penetrometer Testing and Groundwater Sampling Plan - IHSS 115*, Technical Memorandum 6, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, March.

DOE, 1993g, *Soil Boring Sampling Plan - Ash Pits 1-4, Incinerator and Concrete Wash Pad*, Technical Memorandum 7, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, February.

DOE, 1993h, *Monitoring Well Installation Plan - IHSS 133*, Technical Memorandum 9, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, June.

DOE, 1993i, *Soil Sampling Plan - Surface Disturbance Areas*, Technical Memorandum 10, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, March.

DOE, 1993j, *Phase II RFI/RI Report for Operable Unit 2 (preliminary draft)*, U. S. Department of Energy, Rocky Flats Plant, Golden, Colorado, December.

DOE, 1993k, *Draft Ecological Risk Assessment Guidance for Preparation of Remedial Investigation/Feasibility Study Work Plans*, DOE/EH-0338T, Washington, D. C.

DOE, 1993l, *Policy Framework and Implementation Plan for Using Ecological Risk Assessment at DOE Facilities*, DOE/RL/01830-H16, Washington, D. C.

DOE, 1994a, *Amended Field Sampling Plan, Phase I RFI/RI Work Plan for Operable Unit 5, Woman Creek Priority Drainage*, Technical Memorandum No. 15, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, August.

DOE, 1994b, *Model Descriptions for Operable Unit No. 5, Human Health Risk Assessment*, Technical Memorandum No. 13, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, November.

DOE, 1994c, *OU3 Wind Tunnel Study Vol. I: Test Report*, prepared by Midwest Research Institute under DOE Prime Contract No. DE-AC04-90DP62349, Subcontract No. ASC218973GG, MRI Project No. 3155-M, Golden, Colorado: EG&G Rocky Flats, Inc., January 24.

DOE, 1994d, *Colorado Department of Public Health and Environment Source Area Delineation and Risk-Based Conservative Screen and Environmental Protection Agency Areas of Concern Delineation*, Letter Report for Human Health Risk Assessment, Woman Creek Priority Drainage, Operable Unit No. 5, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, November.

DOE, 1995a, *Chemicals of Concern, Human Health Risk Assessment, Woman Creek Priority Drainage, Operable Unit No. 5*, Technical Memorandum No. 11, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, March.

DOE, 1995b, *Exposure Assessment, Human Health Risk Assessment, Woman Creek Priority Drainage, Operable Unit No. 5*, Technical Memorandum No. 12, Addendum to Final Phase I RFI/RI Work Plan, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, April.

DOE, 1995c, *1994 Population, Economic, and Land Use Data Base for Rocky Flats Environmental Technology Site*, U. S. Department of Energy Rocky Flats Environmental Technology Site Golden, Colorado, Final, Revision 0, March.

DOE, 1995d, *Programmatic Risk Based Preliminary Remediation Goals, Rocky Flats Plant, Golden, Colorado*, Final, Rev. 2, U. S. Department of Energy, Rocky Flats Area Office, Golden, Colorado, February.

DOE, 1995e, Changes to the Site-Wide Exposure factors and Exposure Scenarios, U. S. Department of Energy, Rocky Flats Area Office, Memorandum from Jessie M. Roberson, ER:NC:08232, April 13, 1995.

DOE, 1995f, *Ecological Risk Assessment Methodology Technical Memorandum No. 2: Sitewide Conceptual Model, Draft Final*, Rocky Flats Environmental Technology Site, Golden, Colorado, February.

DOE, 1995g, *Ecological Risk Assessment Methodology Technology Memorandum No. 3: Ecological Chemicals of Concern (ECOC) Screening Methodology, Draft Final*, Rocky Flats Environmental Technology Site, Golden, Colorado, April.

DOE, 1995h, *Phase I IM/IRA Decision Document for Operable Unit 7, Present Landfill, Draft Report*, Rocky Flats Environmental Technology Site, Golden, Colorado.

DOE, 1995i, *Meeting minutes, update on OU6 RI/FS issues*, April 20.

Donigian, Jr., A.S., J.C. Imhoff, B.R. Bicknell and J.L. Kittle, Jr. 1984, Application Guide for Hydrological Simulation Program - Fortran (HSPF): Prepared by Anderson-Nichols and Co., Environmental Research Laboratory, Office of Research and Development, U. S. Environmental Protection Agency, Athens, Georgia, EPA-600/3-84-065, 177 p.

Doty and Associates, 1992, *Evaluation of the OU-3 Pumping Test, Woman Creek Alluvium, Rocky Flats Plant*, Prepared for EG&G Rocky Flats, Inc., January.

Droppo, J.G. Jr., D.L. Strenge, J.W. Buck, B.L. Hoopes, R.D. Brockhaus, M.B. Walter, G. Whelen, 1991, *Multimedia Environmental Pollutant Assessment System Application Guidance, Vol. 2 -- Guidelines for Evaluating MEPAS Input Parameters*, p. 2.36, p. 2.37, Battelle Memorial Institute, December.

Denver Water Board (DWB), 1994, Faxed communication from Beth Roman, Operations and Maintenance, October 14.

EG&G, 1991a, *General Radiochemistry and Routine Analytical Services Protocol (GRRASP)*, Parts A and B, Environmental Restoration Program, Rocky Flats Plant, U. S. Department of Energy, Golden, Colorado, EG&G Rocky Flats, Inc., Golden, Colorado, July.

EG&G, 1991b, *Rocky Flats Plant Site Environmental Report for 1991*, RFP-ENV-91, EG&G Rocky Flats, Inc., Golden, Colorado, Prepared for the U. S. Department of Energy under control contract No. DE-AC04-90DP62349.

EG&G, 1992a, Environmental Management Department (EMD) Operating Procedures, Manual No. 5-21000-OPS-FO, Vol. I: Field Operations. EG&G Rocky Flats, Inc., Golden, Colorado, March 1.

EG&G, 1992b, Environmental Management Department (EMD) Operating Procedures, Manual No. 5-21000-OPS-GW, Vol. II: Groundwater. EG&G Rocky Flats, Inc., Golden, Colorado, March 1.

EG&G, 1992c, Environmental Management Department (EMD) Operating Procedures, Manual No. 5-21000-OPS-GT, Vol. III: Geotechnical. EG&G Rocky Flats, Inc., Golden, Colorado, March 1.

EG&G, 1992d, Environmental Management Department (EMD) Operating Procedures, Manual No. 5-21000-OPS-SW, Vol. IV: Surface Water, EG&G Rocky Flats, Inc., Golden, Colorado, March 1.

EG&G, 1992e, *Rocky Flats Plant Environmental Report For 1992*, Prepared for the U. S. Department of Energy, EG&G Rocky Flats Plant.

EG&G, 1992f, *Phase II Geologic Characterization Data Acquisition Surface Geologic Mapping of the Rocky Flats Plant and Vicinity, Jefferson and Boulder Counties, Colorado*, EG&G Rocky Flats, Inc., Golden, Colorado, March.

EG&G, 1992g, *Survey of Preble's Meadow Jumping Mouse, Rocky Flats Buffer Zone, Jefferson County, Colorado,* Report of Findings, EG&G Rocky Flats, Inc., Golden, Colorado, September.

EG&G, 1992h, *Ute Ladies'-Tresses Surveys, Rocky Flats Buffer Zone, Jefferson County, Colorado*, Report of Findings, EG&G Rocky Flats, Inc., Golden, Colorado, September.

EG&G, 1992i, *Historical Release Report for the Rocky Flats Plant, Vol. I - Text,* Manual No. 21100-TR-12501.01, EG&G Rocky Flats, Inc., Golden, Colorado, June.

EG&G, 1993a, *Monthly Environmental Monitoring Report,* ER-4180110-219, EG&G Rocky Flats, Inc., Golden, Colorado.

EG&G, 1993b, *Status Report: Sitewide Groundwater Flow Modeling at the Rocky Flats Plant*, Golden, Colorado, EG&G Rocky Flats Environmental Management, Golden, Colorado.

EG&G, 1993c, *Rocky Flats Plant Site Environmental Report for 1993,* EG&G Rocky Flats, Rocky Flats Plant, Golden, Colorado, Prepared for the U. S. Department of Energy under control contract No. DE-AC34-9ORF62349.

EG&G, 1993d, Personal communication from A. Berzins, ER/SWD, August 20.

EG&G, 1994a, Guidance Document, Statistical Comparisons of Site-Background Data in Support of RFI/RI Investigations, EG&G Rocky Flats, Inc., Golden, Colorado, January.

EG&G, 1994b, *Monthly Environmental Monitoring Reports*, January-December ER-4180110-222, EG&G Rocky Flats, Inc., Golden, Colorado.

EG&G, 1994c, Written Communication from Ed C. Mast to Frazer Lockhart, RFFO-DOE, Operable Unit 5, Woman Creek Priority Drainage: Toxicity Technical Memorandum #14-ECM-065-94, November 14.

EG&G, 1994d, Event-Related Surface-Water Monitoring Report, RFETS: WY 1993, Appendix I, Discharge Data Tables, prepared by EG&G-EP, Surface-Water Division, Rocky Flats, Golden, Colorado, September.

EG&G, 1994e, Event-Related Surface-Water Monitoring Report, RFETS: WY 1993, Appendix VI, Surface-Water Monitoring Network, prepared by EG&G-EP, Surface-Water Division, Rocky Flats, Golden, Colorado, September.

EG&G, 1994f, *Operable Unit 1 HHRA Modeling*, EG&G Rocky Flats Environmental Management, Golden, Colorado.

EG&G, 1995a, *Geologic Characterization Report for the Rocky Flats Environmental Technology Site*, Vol. I of the Sitewide Geoscience Characterization Study, EG&G Rocky Flats, Inc., Golden, Colorado, March.

EG&G, 1995b, *Hydrogeologic Characterization Report for the Rocky Flats Environmental Technology Site*, Vol. II of the Sitewide Geoscience Characterization Study, EG&G Rocky Flats, Inc., Golden, Colorado, April.

EG&G, 1995c, *Groundwater Geochemistry Report for the Rocky Flats Environmental Technology Site*, Vol. III of the Sitewide Geoscience Characterization Study, EG&G Rocky Flats, Inc., Golden, Colorado, January.

EG&G, 1995d, *Evaluation of the Capability of Inferred Faults in the Vicinity of Building 371, Rocky Flats Environmental Technology Site, Colorado*, Prepared by Geomatrix Consultants, Inc., for EG&G Rocky Flats, Inc., Draft Report, January.

EG&G, 1995e, *Preliminary Rocky Flats Environmental Technology Site (RFETS) OU-5 Geotechnical Investigation*, Draft, EG&G Rocky Flats, Inc., Golden, Colorado, June.

EG&G, 1995f, *Rocky Flats Environmental Technology Site Ecological Monitoring Program 1995 Annual Report*, Rocky Flats Environmental Technology Site, EG&G Rocky Flats, Inc., Golden, Colorado.

EG&G, 1995g, Verbal communication from Dr. M.A. Siders, geochemist for EG&G-ERPD, March 20.

EG&G, 1995h, Minutes of meeting held February 16, 1995 to discuss the treatment of arsenic in OU5 RFI/RI, EG&G Rocky Flats, Inc., Golden, Colorado.

EG&G, 1995i, *Draft Aquifer Testing Program*, Rocky Flats Environmental Technology Site, EG&G Rocky Flats, Inc., Golden, Colorado.

EPA (U. S. Environmental Protection Agency), 1985, *Compilation of Air Pollutant Emission Factors Vol. I: Stationary Point and Area Sources*, 4th ed. (AP-42), U. S. Environmental Protection Agency, Research Triangle Park, North Carolina: Office of Air Quality Planning and Standards.

EPA, 1986, *Guidelines on Air Quality Models (Revised)* (EPA-450/2-78-027R), U. S. Environmental Protection Agency, Research Triangle Park, NC: Office of Air Quality Planning and Standards.

EPA, 1988a, *Research and Development Aerial Photographic Analysis Comparison Report, Rocky Flats, Golden, Colorado*, TS-PIC-99760, Appendix A, U. S. Environmental Protection Agency, EPA Region 8, July.

EPA, 1988b, *Superfund Exposure Assessment Manual* (EPA-450/1-88/001), Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC.

EPA, 1988c, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (OSWER Directive 9355.3-01) Interim Final, Environmental Protection Agency, Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response, Washington DC, October.

EPA, 1988d, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Publication EPA-520/1-88-020, Office of Radiation Programs, Washington, D. C.

EPA, 1989, *Risk Assessment Guidance for Superfund, Vol, 1, Human Health Evaluation Manual (Part A), Interim Final*, EPA/540/1-89/002, U. S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D. C.

EPA, 1991, *Preliminary Risk Assessment for the California Gulch NPL Site, Leadville, Colorado,* Doc. Control No. 4800-01-0722, December.

EPA, 1992a, *Assessing Potential Indoor Air Impacts for Superfund Sites* (EPA-451/R-92-002), U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

EPA, 1992b, *Guidance on Risk Characterization for Risk Managers and Risk Assessors*, U. S. Environmental Protection Agency, Office of the Administrator, Memorandum, F.H. Habicht, II.

EPA, 1992c, *Supplemental Guidance to RAGS; Calculating the Concentration Term*, U. S. Envirionmental Protection Agency, Office of Solid Waste and Emergency Response, Publication 9285.7-091, Washington, D. C., March.

EPA, 1992d, Framework for Ecological Risk Assessment: Risk Assessment Forum, Washington D. C. EPA/630/R-92/001, February.

EPA, 1992e, *Guidelines for Exposure Assessment,* Office of Health and Environmental Assessment, Federal Register, Vol. 57, No. 104: 22888-22938.

EPA, 1992f, *Dermal Exposure Assessment: Principles and Applications,* EPA/600/8-91/011B, January.

EPA, 1993a, *External Exposure to Radionuclides in Air, Water, and Soil*, Publication EPA-402-R-93-081, Office of Radiation Programs, Washington, D. C.

EPA, 1993b, *Wildlife Exposure Factors Handbook*, Vol. I and II EPA/600/R-93/187a, Office of Research and Development, Washington, D. C., December.

EPA, 1994a, *Calculating the Concentration Term for Risk Assessment: Use of One "C" Term to Estimate a Lower Average and an Upper RME Risk Range*, U. S. Environmental Protection Agency, Region 8 Superfund Technical Guidance, No. RA-02, September.

EPA, 1994b, *Health Effects Assessment Summary Tables*, Publication 9200.6-e0e(94-1), Annual Update, FY 1994 and Supplement No 2, EPA540/R-94/0202, U. S. Environmental Protection Agency, Office of Research and Development, Washington, DC, March.

EPA, 1994c, *Integrated Risk Information System (IRIS)*, On-line database, U. S. Environmental Protection Agency.

EPA, 1994d, *Evaluating and Identifying Contaminants of Concern for Human Health*, U. S. Environmental Protection Agency, Region 8 Superfund Technical Guidance, No. RA-03, September.

EPA, 1994e, *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*, OSWER Directive # 9355.4-12, U. S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC, July.

EPA, 1994f, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Review Draft*, Environmental Response Team, Edison, New Jersey, September.

EPA, 1994g, *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children,* EPA/540/R-93/81, February.

EPA, 1994h, *Development of Toxicity Values for PAHs to Use in Human Risk Assessments,* EPA Region 8 Superfund Technical Guidance No. RA-04, September.

EPA, 1995, *Integrated Risk Information System (IRIS),* on-line database.

Ermak, D.L., 1977, An Analytical Model for Air Pollutant Transport and Deposition from a Point Source, *Atmospheric Environment* 11: 231-237.

Fedors, R. and J.W. Warner, 1993a, *Characterization of Physical and Hydrologic Properties of Surficial Materials and Groundwater/Surface Water Interaction Study at Rocky Flats Plant, Golden, Colorado*, Groundwater Technical Report #21, Colorado State University, Fort Collins, Colorado, July.

Fedors, R., J.W. Warner, B. Roberts, and A.D. Berzins, 1993b, *Numerical Modeling of Variably Saturated Flow and Transport - 881 Hillside, Rocky Flats Plant, Jefferson County, Colorado*, Groundwater Technical Report #20, Colorado State University, Fort Collins, Colorado, June.

Fetter, C.W., 1980, *Applied Hydrogeology*, pp. 61, pp.67, Merrill Publishing Company.

Fetter, C.W., 1993, *Contaminant Hydrogeology.*

Freeman, G.B., J.D. Johnson, J.M. Killinger, S.C. Liao, P.I. Feder, A.O. Davis, M.V. Ruby, R.L. Chaney, S.C. Lovre, and P.D. Bergstrom, 1992, *Relative Bioavailability of Lead from Mining Waste Soil in Rats,* Fundam. Appl. Toxicol., 19: 388-398.

Freeman, G.B., J.D. Johnson, J.M. Killinger, S.C. Liao, A.O. Davis, M.V. Ruby, R.L. Chaney, S.C. Lovre, and P.D. Bergstrom, 1993, *Bioavailability of Arsenic in Soil Impacted by Smelter Activities Following Oral Administration in Rabbits,* Fundam. Appl. Toxicol., 21: 83-88.

Freeze, R.A. and J.A. Cherry, 1979, *Groundwater*, p. 29, pp.33-34, Prentice-Hall, Inc.

Gilbert, R.O., 1993, Letter report recommending process for comparing RFETS site analytical results to background concentrations, Richard Gilbert, Battelle Pacific Northwest Laboratories, to Beverly Ramsey, Systematic Management Services, Inc., July 30.

Gilbert, T.L., C. Yu, Y.C. Yuan, A.J. Zielen, M.J. Jusko, and A. Wallo III, 1989, *A Manual for Implementing Residual Radioactive Material Guidelines,* Argonne National Laboratory, June.

Gile, L.H., F.F. Peterson, and R.B. Grossman, 1966, "Morphological and Genetic Sequences of Carbonate Accumulations in Desert Soils," In: Soil Science, v. 101, p. 347-360.

Goon, D., N.S. Hatoum, M.J. Klan, J.D. Jernigan, and R.G. Farmer, 1991, *Oral Bioavailability of "Aged" Soil-Adsorbed Benzo(a)pyrene (BaP) in Rats,* Society of Toxicology Annual Meeting Abstracts #1356.

Heard, M.J. and A.C. Chamberlain, 1982, *Effect of Minerals and Food on the Uptake of Lead from the Gastrointestinal Tract in Humans,* Human Toxicol. 1: 411-415.

Hem, John D., 1985, *Study and Interpretation of the Chemical Characteristics of Natural Water,* 3rd Ed., U. S. Geological Survey, Alexandria, Virginia.

Holzworth, G.C., 1972, *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States* (AP-101), EPA, Office of Air Programs, Research Triangle Park, North Carolina.

Hurr, R.T., 1976, *Hydrology of a Nuclear Processing Plant Site*, Rocky Flats, Jefferson County, Colorado, U. S. Geological Survey Open-File Report 76-268.

IAEA (International Atomic Energy Agency), 1992, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*, Technical Reports Series 332, IAEA, Vienna.

IAG (Interagency Agreement), 1991, *Federal Facility Agreement and Consent Order (IAG), for Rocky Flats Plant*, Colorado Department of Health (CDH), Department of Energy (DOE), Environmental Protection Agency (EPA), January..

ICF Kaiser, 1993, *Water Balance and Chemical Balance of Operable Unit 2,* Draft Report, prepared for EG&G Rocky Flats, Inc., Golden, Colorado, April.

Jacobs Engineering Group (Jacobs), 1994, *Draft Technical Memorandum Number 1, Data Compilation, Operable Unit 8*, Prepared for EG&G Rocky Flats, Inc., April (Draft).

Javandel, I., C. Doughty, and C. Tsang, 1984, *Groundwater Transport: Handbook of Mathematical Models*, Water Resources Monograph 10, American Geophysical Union.

Johnson, P.C., C.C. Stanley, M.W. Kemblowski, D.L. Byers, and J.D. Colthart, 1990, *A Practical Approach to the Design, Operation, and Monitoring of In Situ Soil-Venting Systems*, Groundwater Monitoring Report, Spring.

Johnson, P.C. and R.A. Ettinger, 1991, "Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings," In: Environmental Science and Technology, 25 (8): 1,445-1,452.

Kiusalaas, N. and Kunkel, J.R., 1993, Fortran Code PETO, Version 2.0, for Calculating Potential Evapotranspiration Using the Penman FAO-24 Equation: Prepared by Advanced Sciences, Inc., November.

Koffer, J.P., 1989, *Investigation of the Surface and Groundwater Flow Mechanics of the Evaporation Spray Field at the Rocky Flats Nuclear Weapons Plant, Jefferson, County, Colorado,* Master of Engineering Thesis, Colorado School of Mines, ER-3728.

Ludwig, J.A., and J.F. Reynolds, 1988, *Statistical Ecology, A Primer on Methods and Computing,* New York: John Wiley and Sons, 337 pp.

Lumb, A.M., J.L. Kittle Jr., and K.M. Flynn, 1989, Users Manual for ANNIE, A Computer Program for Interactive Hydrologic Analyses and Data Management: U. S. Geological Survey Water-Resources Investigation Report 89-4080, 236 p. (including Appendices A and B).

Luthin, J.N., 1966, *Drainage Engineering*, John Wiley & Sons.

Marr, J.W., 1964, "The Vegetation of the Boulder Area," University of Colorado Museum, Leaflet 13, pp. 34-42, Boulder, Colorado.

McClane, A.J., 1978, *Freshwater Fishes of North America*, Holt, Rinehart, and Winston: New York.

McConnell, E.E., G.W. Lucier, R.C. Rumbaugh, P.W. Albro, D.J. Harvan, Jr., R. Hass, and M.W. Harris, 1984, *Dioxin in Soil: Bioavailability after Ingestion by Rats and Guinea Pigs,* Science, 223: 1077-1079.

McDonald, M.G. and A.W. Harbaugh, 1988, *A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model,* U. S. Geological Survey Techniques of Water-Resources Investigations, Chapter A1, Book 6.

Merrick Engineering, 1992, *Final Summary Report Detention Pond Capacity Study, Rocky Flats Plant,* September 30, 1992.

Midwest Research Institute, 1988, *Background Document for AP-42 Section 11.2.7 on Industrial Wind Erosion* (Final Report EPA Contract No. 68-02-4395, Assignment No. 5, MRI Project No. 8985-K[05]), Midwest Research Institute, Kansas City, Missouri.

Montgomery, J.H. and L.M. Welkom, 1989, *Groundwater Chemicals, Desk Reference,* Lewis Publishers, Inc.

Mood, A.M. and F.A Graybill, 1963, *Introduction to the Theory of Statistics*, p. 156. McGraw-Hill.

National Research Council, 1983, *A Study of the Isolation System for Geologic Disposal of Radioactive Waste.*

NCRP (National Council on Radiation Protection and Measurements), 1985, *General Concepts for the Dosimetry of Internally Deposited Radionuclides*, Report No. 84.

NCRP, 1987, *Recommendations On Limits for Exposure to Ionizing Radiation*, Report No. 91, Bethesda, Maryland.

Nelson, C., 1995, *Personal Communication via Bill Richards, Woodward-Clyde Consultants,* EPA.

Ney, R.E., 1990, *Where Did That Chemical Go? A Practical Guide to Chemical Fate and Transport in the Environment*, New York: Van Norstrand Reinhold.

Nicks, A.D., 1985, "Generation of Climate Data," *Proceedings of the Natural Resources Modeling Symposium*, USDA-ASA ARS-30, pp. 297-300.

Nihiser, J., 1993, Personal communication between J. Nihiser, Jefferson County (Colorado) Building Department, and G. Mathews, Advanced Sciences, Inc., subject: Typical commercial and residential buildings in Jefferson County, September 20.

Norton, S.B., et al., 1992, *A Framework for Ecological Risk Assessment at the EPA,* Environmental Toxicology and Chemistry, 11:1663-1672.

Opresko, D.M. et al., 1994, *Toxicological Benchmarks for Wildlife: 1994 Revision*, Oak Ridge National Laboratory, ES/ER/TM-86/R1, September.

ORNL (Oak Ridge National Laboratory), 1994, *Toxicological Benchmarks for Screening Contaminants of Potential Concern*, 1994 Revision.

Owen, J.B. and L.M. Steward, 1973, *Environmental Inventory: A Historical Summation of Environmental Incidents Affecting Soils at or near the USAEC Rocky Flats Plant*, Dow Chemical Company, Rocky Flats Division, draft report.

Papadopulos & Assoc., 1992, *MT3D, A Modular Three-Dimensional Transport Model, Version 1.5, Documentation and User's Guide, Second Revision,* S.S. Papadopulos and Associates, Inc., March 15.

Papadopulos & Assoc., 1993, *MODFLOW/mt, USGS Modular Flow Model with MT3D Interface Users Manual*, S.S. Papadopulos and Associates, Inc., January.

Patton, I., 1995, Verbal Communication, Surface Water Hydrologyist with Rocky Mountain Remediation Services, September 27.

Pollock, D.W., 1989, *Documentation of Computer Programs to Compute and Display Pathlines Using Results from the U. S. Geological Survey Modular Three-Dimensional Finite-Difference Ground-Water Flow Model,* U. S. Geological Survey Open File Report 89-381.

Price, A.B. and A.E. Amen, 1980, *Soil Survey of Golden, Colorado: Parts of Denver, Douglas, Jefferson, and Park Counties*, U. S. Department of Agriculture, Soil Conservation Service.

Quackenbush, T.H. and J.T. Phelan, 1965, "Irrigation Water Requirements of Lawns," *Journal of the Irrigation and Drainage Division*, ASCE, IR 2, June, pp. 11-19.

Rasmussen, J.B. *et al.*, 1990, "Food Chain Structure in Ontario Lakes Determines PCB Levels in Lake Trout (*Salvelinus namaycush*) and Other Pelagic Fish," In: Canadian Journal of Fisheries and Aquatic Sciences, 47:2030-2038.

RFETS, 1995, Rocky Flats Future Site Use Working Group Recommendations for Rocky Flats Environmental Technology Site, July.

Robson, SG., J.C. Romero and S. Zawistowski, 1981a, "Geologic Structure, Hydrology, and Water Quality of the Arapahoe Aquifer in the Denver Basin, Colorado," In: U. S. Geological Survey Atlas HA-647.

Robson, S.G., A. Wacinski, S. Zawistowski, and J.C. Romero, 1981b, "Geologic Structure Hydrology, and Water Quality of the Laramie-Fox Hills Aquifer in the Denver Basin, Colorado," In: U. S. Geological Survey Hydrologic Atlas HA-650.

Rockwell International, 1987, *Draft Remedial Investigation Report for 903 Pad, Mound, and East Trenches Areas*, U. S. Department of Energy, Rocky Flats Plant, Golden, Colorado.

Rockwell International, 1988, *Draft Remedial Investigation and Feasibility Study Plans for Low Priority Sites*, Rocky Flats Plant, Jefferson County, Colorado, Vol. 1, June.

Schroeder, H.A. and M. Mitchner, 1975, *Life-term studies in rats: Effects of aluminum, barium, beryllium, and tungsten,* J. Nutr. 105: 421-427, (as cited in EPA, 1995).

Schroeder, H.A., M. Mitchner, and A.P. Nasor, 1970, *Zirconium, niobium, antimony, vanadium, and lead in rats: Life term studies,* J. Nutr. 100: 59-66, (as cited in EPA, 1995).

Schulz, E.F., 1976, *Problems in Applied Hydrology,* Water Resources Publications, Fort Collins, Colorado.

Scott, G.R., 1960, "Subdivision of the Quaternary Alluvium East of the Front Range near Denver Colorado," In: Geological Society of America Bulletin, V. 71, No. 10, pp. 1541-1543.

Scott, G.R., 1963, *Quaternary Geology and Geomorphic History of the Kassler Quadrangle, Colorado*, USGS Professional Paper 421, pp. 1-70.

Seinfeld, J.H., 1986, *Atmospheric Chemistry and Physics of Air Pollution*, John Wiley and Sons, Inc., New York.

Shroba, R.R., and P.E. Carrara, 1994, *Preliminary Surficial Geologic Map of the Rocky Flats Plant and Vicinity, Jefferson and Boulder Counties, Colorado*, U. S. Geological Survey Open-File Report 94-162.

Shu, H.D., Paustenbach, F.J. Murray, L. Marpie, B. Brunck, D. Dei Rossi, and P. Teitelbaum, 1988, *Bioavailability of Soil-Bound TCDD: Oral Bioavailability in the Rat,* Fundam. Appl. Toxicol., 10: 648-654.

Smith, D.M., 1989, *An Investigation of Uncertainties Associated with Groundwater Modeling, for Exposure Assessment and Carcinogenic Risk Assessment at a Hazardous Waste Site*, University of Pittsburgh, Graduate School of Public Health, December.

Sokal, R.R. and F.J. Rohlf, 1968, *Biometry: The Principals and Practice of Statistics in Biological Research*," W.H. Freeman and Company, 776 p. San Francisco, California.

Strenge, D.L. and S.R. Peterson, 1989, *Chemical Data Bases for the Multimedia Environmental Pollutant Assessment System (MEPAS): Version 1,* PNL-7145, Prepared for U. S. Department of Energy, Battelle Pacific Northwest Laboratory, December.

Sunagawa, S., 1981, *Experimental studies on antimony poisoning*, Iguku kenkyu, 51: 129-142, (as cited in ATSDR, 1991).

Sunderland, W.F., Jr., S.M. Hopfer, K.R. Sweeney, A.H. Marcus, B.M. Most, and J. Creason, 1989, *Nickel Absorption and Kinetics in Human Volunteers,* Soc. Exp. Biol. Med. 191: 5-11.

Suter, G.W. II, 1989, "Ecological Endpoints," In: Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference Document, W. Warren-Hicks, B.R. Parkhurst, and S.S. Baker, Jr. (eds.), EPA 600/3-89/013, Corvallis Environmental Research Laboratory, Oregon.

Suter, G.W. II, ed., 1993, *Ecological Risk Assessment*, Lewis Publishers, Boca Raton, Florida.

Trescott, P.C., G.F. Pinder, and S.P. Larson, 1976, *Finite Difference Model for Aquifer Simulation in Two Dimensions with Results of Numerical Experiments*, p.30, U. S. Geological Survey, Techniques of Water-Resources Investigations, Book 7, Chapter C1.

Turner, D.B., 1970, *Workbook of Atmospheric Dispersion Estimates*, Department of Health, Education, and Welfare, Cincinnati, Ohio.

Turner, J.E., 1986, *Atoms, Radiation, and Radiation Protection,* Page 64, Pergamon Press, New York.

USGS, 1971, Eldorado Springs, Colorado and Ralston Buttes, Colorado: 7.5-minute series, topographic maps at 1:25,000 scale, 40 feet contour interval, U. S. Geological Survey.

USGS, 1979, Louisville, Colorado: 7.5- minute series, topographic map at 1:25,000 scale, 10 feet contour interval, U. S. Geological Survey.

USGS, 1980, Golden, Colorado: 7.5-minute series, topographic maps at 1:25,000 scale, 10 feet contour interval, U. S. Geological Survey.

Van Horn, R., 1957, *Bedrock Geology of the Golden Quadrangle, Colorado*, U. S. Geological Survey Geologic Quadrangle Map GQ-103.

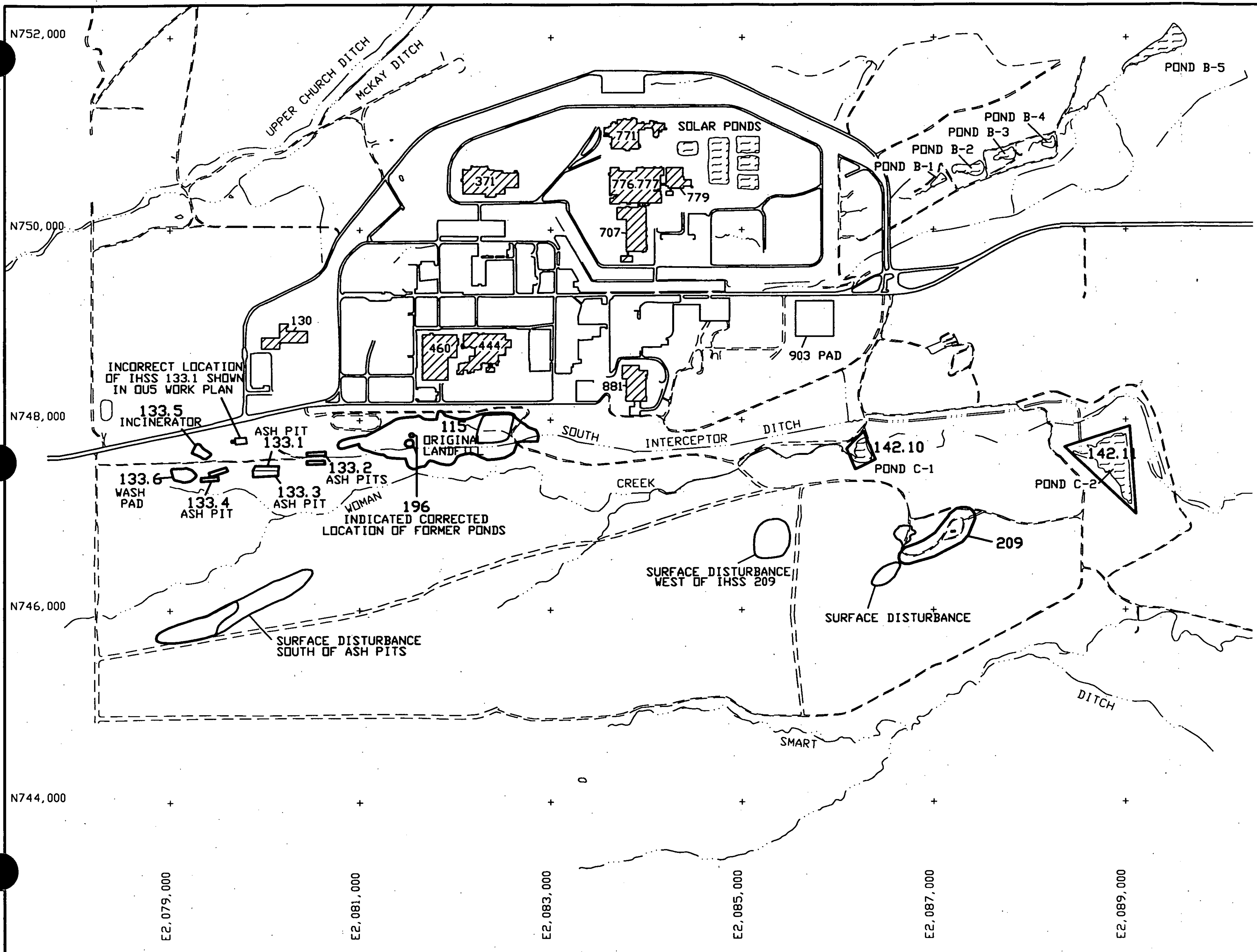
Walton, W.C., 1985, *Practical Aspects of Groundwater Modeling*, 2nd Edition, National Water Well Association, p. 37.

Winges, K.D., 1991, *User's Guide for the Fugitive Dust Model (FDM) (Revised)* (EPA-910/9-88-202R), EPA Region X, Seattle, WA.

Winges, K.D., 1994, Personal communications between K. Winges, McCulley, Frick, and Gilman, Inc., and G. Mathews, Advanced Sciences, Inc., 5 each, subject: Fugitive Dust Model, July 7 through August 4.

Woodruff, N.P. and F.H. Siddoway, 1965, "A wind erosion equation," In: Soil Science of America Proceeding, Vol 29 No. 5: pp. 602-608.

This page intentionally left blank.



Drawn N.M. 8/3/95 Date

Approved 8/3/95 Date

Approved Date

FILE OU5-1-2.DWG

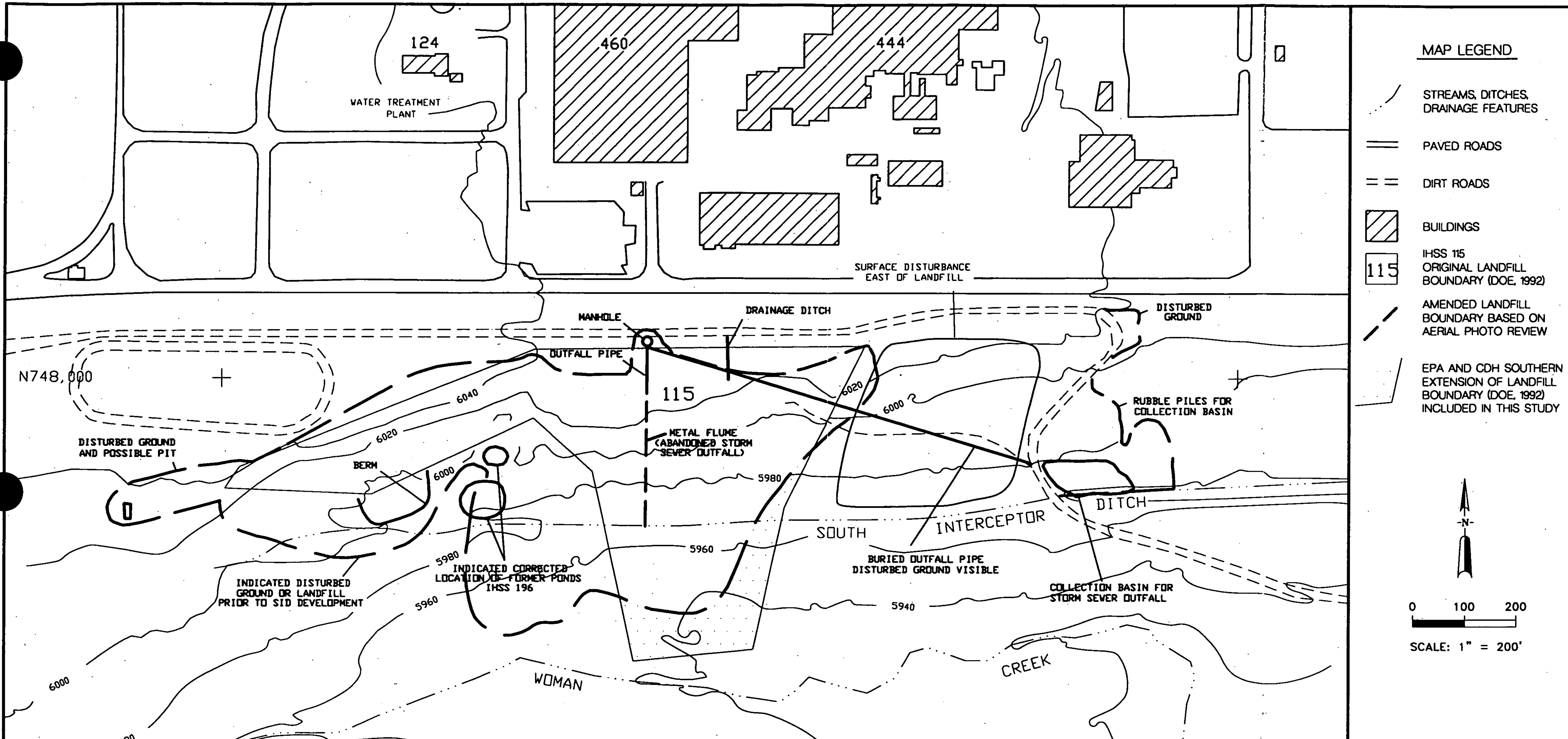
WOMAN CREEK PRIORITY DRAINAGE AREA (OPERABLE UNIT No. 5)

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 1-2



Drawn NM 8/1/95 Date
Approved [signature] 8/1/95 Date
Approved ______ Date

FILE OU5-1-3.DWG

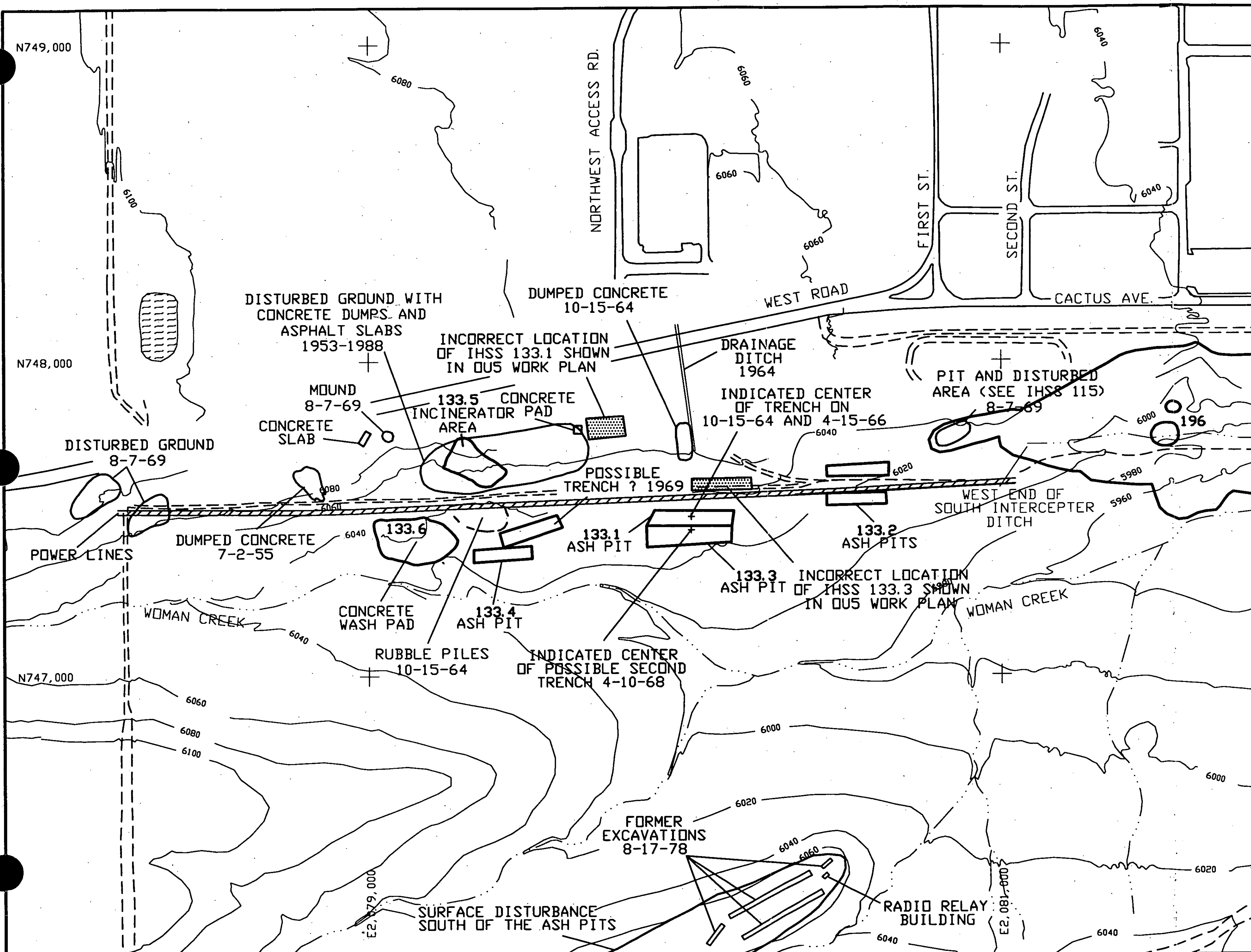
IHSS 115 ORIGINAL LANDFILL AND EXTENDED AREAS AND IHSS 196 FILTER BACKWASH POND

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 1-3



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- SURFACE WATER IMPOUNDMENTS
- 133.1 INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- EXTENDED OR CORRECTED LOCATION FROM AERIAL PHOTOGRAPHS WITH PHOTOGRAPH DATE
- POWER LINES
- 133.1 INCORECT LOCATION OF IHSS SHOWN ON FIGURE 2-6 OF OU5 WORK PLAN

-N-

0 150 300

SCALE: 1" = 300'

Drawn NM 8/3/95 Date
Approved TEF 8/3/95 Date
Approved Date

FILE OU5-1-4.DWG

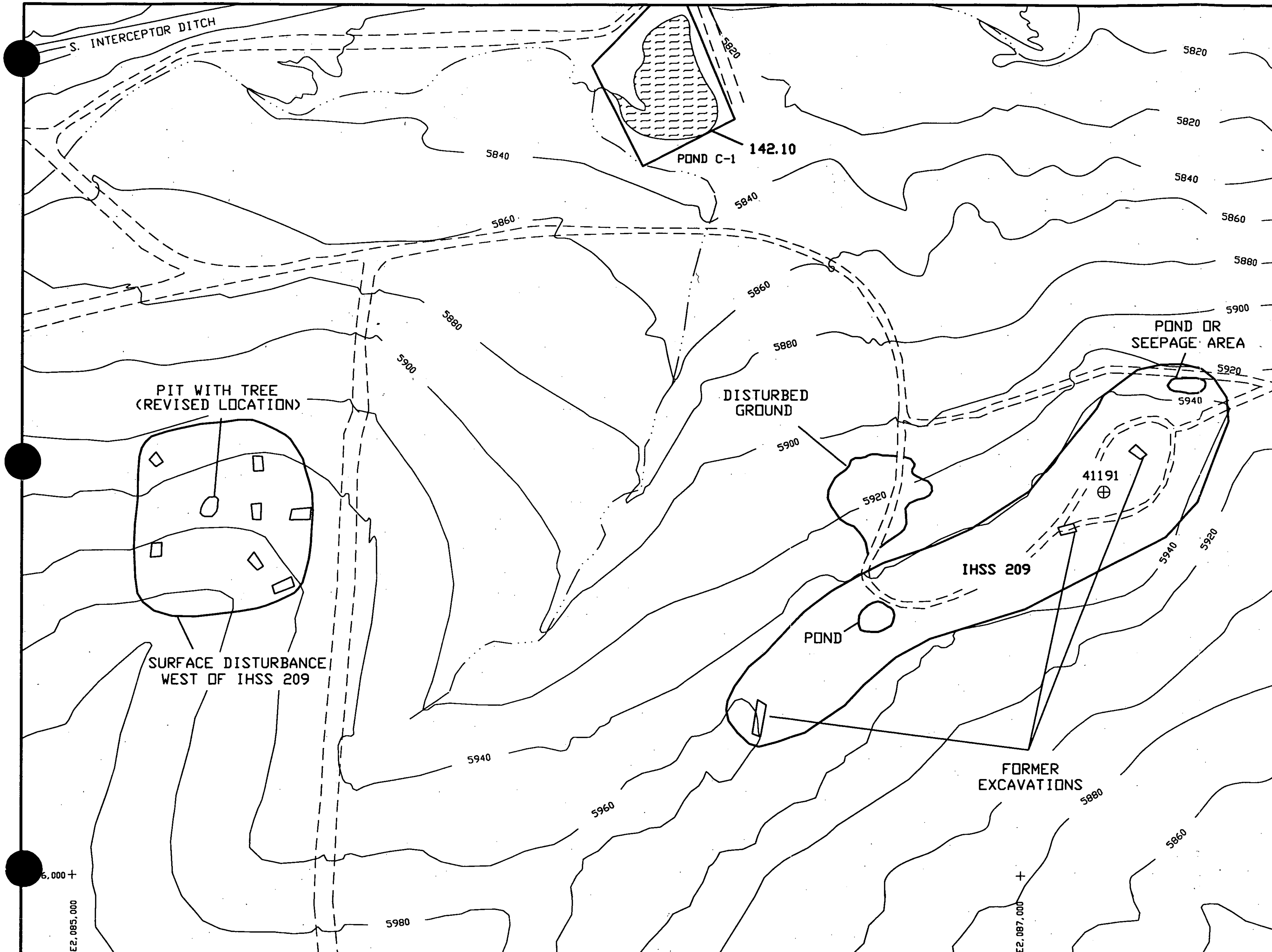
REVISED LOCATIONS OF IHSS 133 SITES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 1-4



Drawn NM 8/1/95 Date
Approved TEP 8/1/95 Date
Approved Date

FILE OU5-1-5.DWG

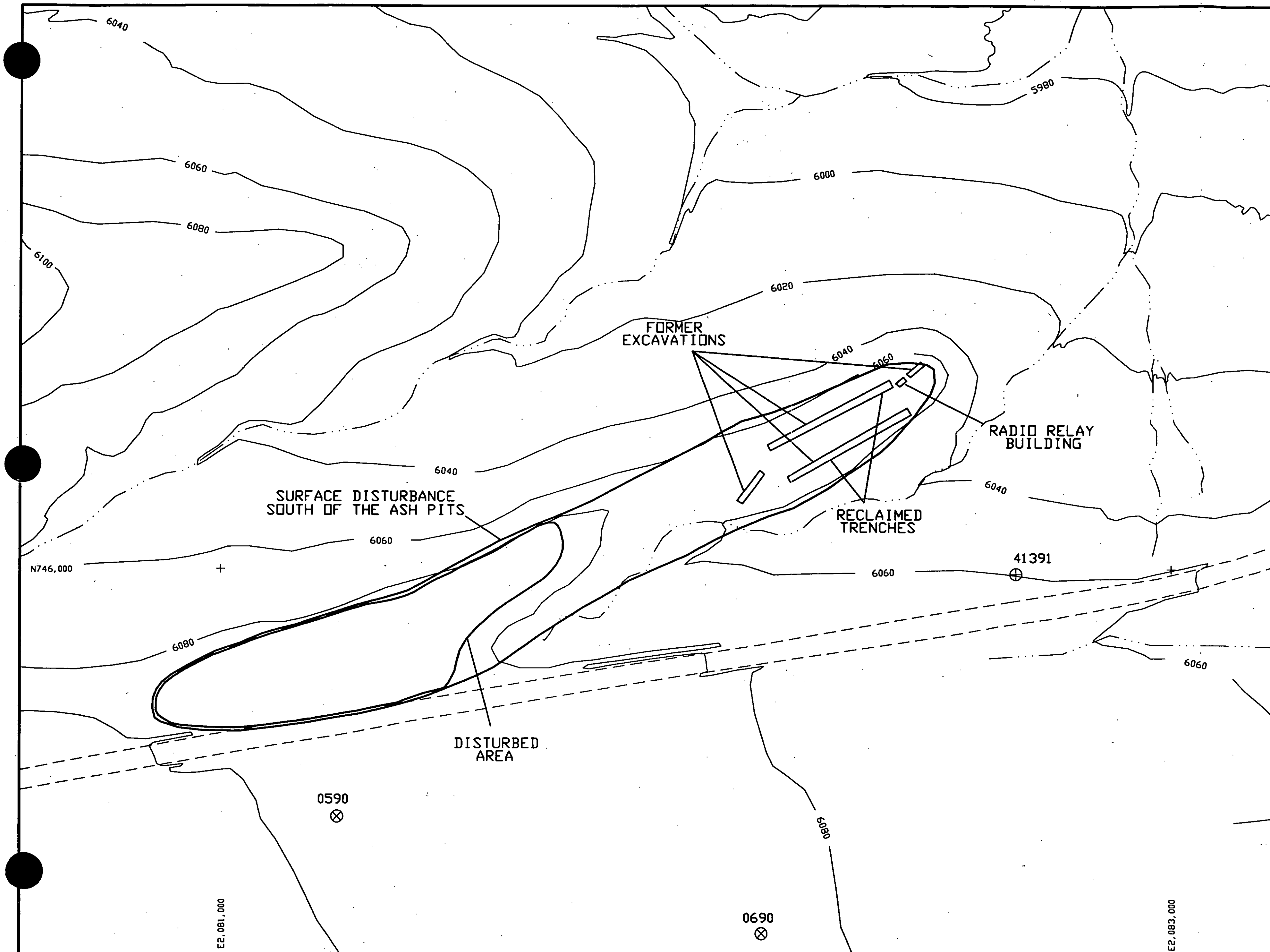
IHSS 209 &
SURFACE DISTURBANCE
WEST OF IHSS 209
LOCATION MAP

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 1-5



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

DIRT ROADS

SURFACE WATER IMPOUNDMENTS

209 INDIVIDUAL HAZARDOUS SUBSTANCE SITES (IHSS)

41391 EXISTING BOREHOLE

0690 EXISTING MONITORING WELLS

-N-

0 100 200

SCALE: 1" = 200'

Drawn NM 8/1/95 Date

Approved TEQ 8/1/95 Date

Approved Date

FILE OU5-1-6.DWG

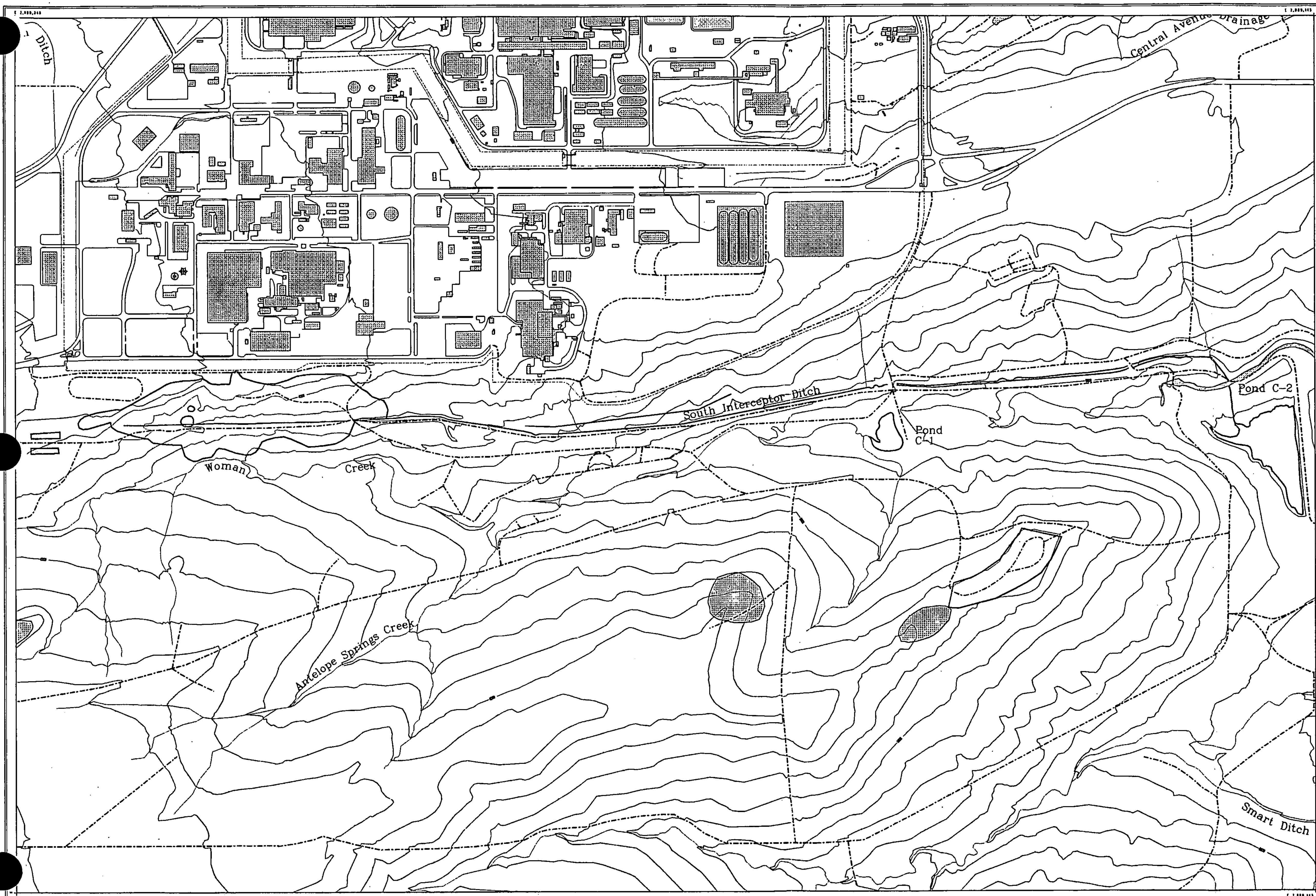
SURFACE DISTURBANCE SOUTH OF THE ASH PITS LOCATION MAP

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 1-6



Map showing location of the South Interceptor Ditch (SID)

Figure 1-7

EXPLANATION

- Operable Unit 5 IHSS's
- Surface Disturbance
- Individual Hazardous Substance Sites (IHSS)
- South Interceptor Ditch
- French Drainage System

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20' Intervals)
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)
Individual Hazardous Substance Sites (IHSS's) are determined by the following:
OU1 - RF/RI Phase III Report
OU2, 4, 7, 11, & 15 - HRR
The remaining OU's are defined by their respective Operation Unit Workplan.

Scale = 1 : 7960
1 inch represents approximately 663.33 feet

250 0 500 1000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

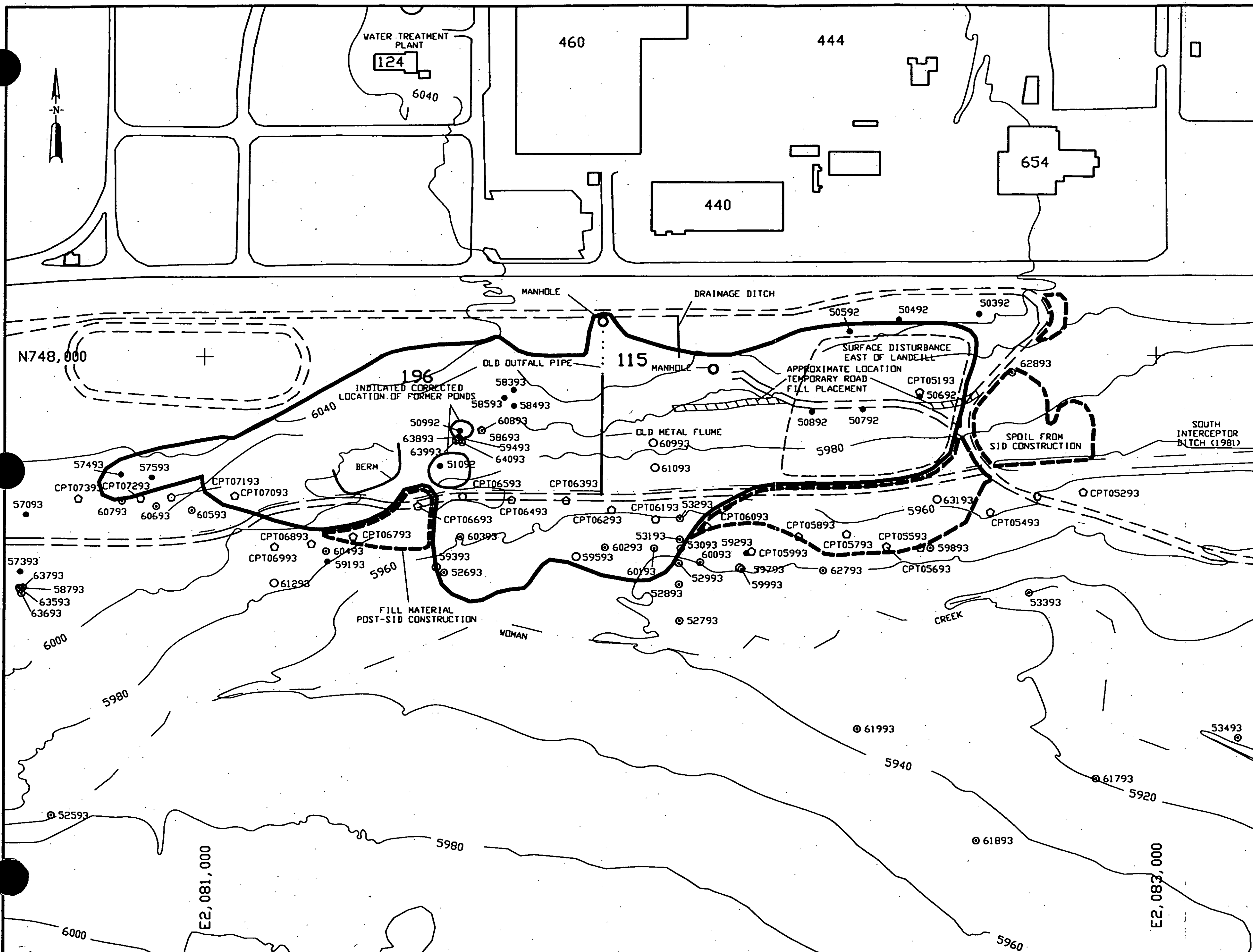
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

MAP ID: SID

September 19, 1995



MAP LEGEND

- STREAMS DITCHES DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- ORIGINAL LANDFILL AND SURFACE DISTURBANCE, PRE - SID
- LANDFILL AND DISTURBANCE POST - SID
- 60993 MONITORING WELL LOCATION
- 50392 BOREHOLE LOCATION
- 62893 WELL POINT LOCATIONS
- CPT05293 CONE PENETROMETER TESTING (CPT) LOCATIONS

0 100 200

SCALE: 1" = 200'

Drawn NAM 9/28/95 Date
Checked [signature] 9/28/95 Date
Approved MRW 9/29/95 Date

FILE OU5-2-1.DWG

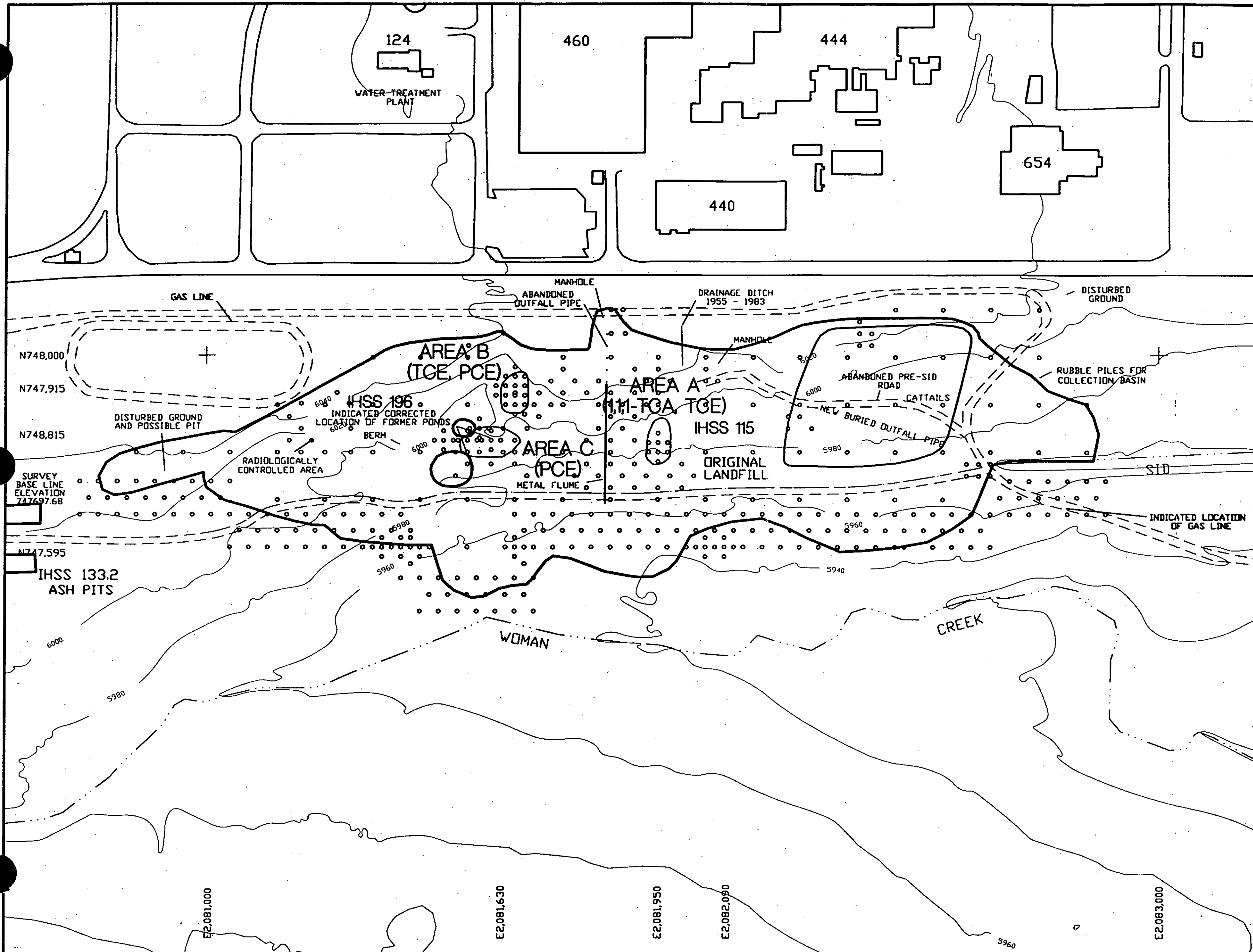
PRE-TM15 SAMPLE LOCATIONS (EXCLUDING SURFACE SOILS) AT IHSS 115

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-1



Drawn NAM 9/28/95 Date

Checked [signature] 9/28/95 Date

Approved [signature] 9/29/95 Date

FILE OU5-2-2.DWG

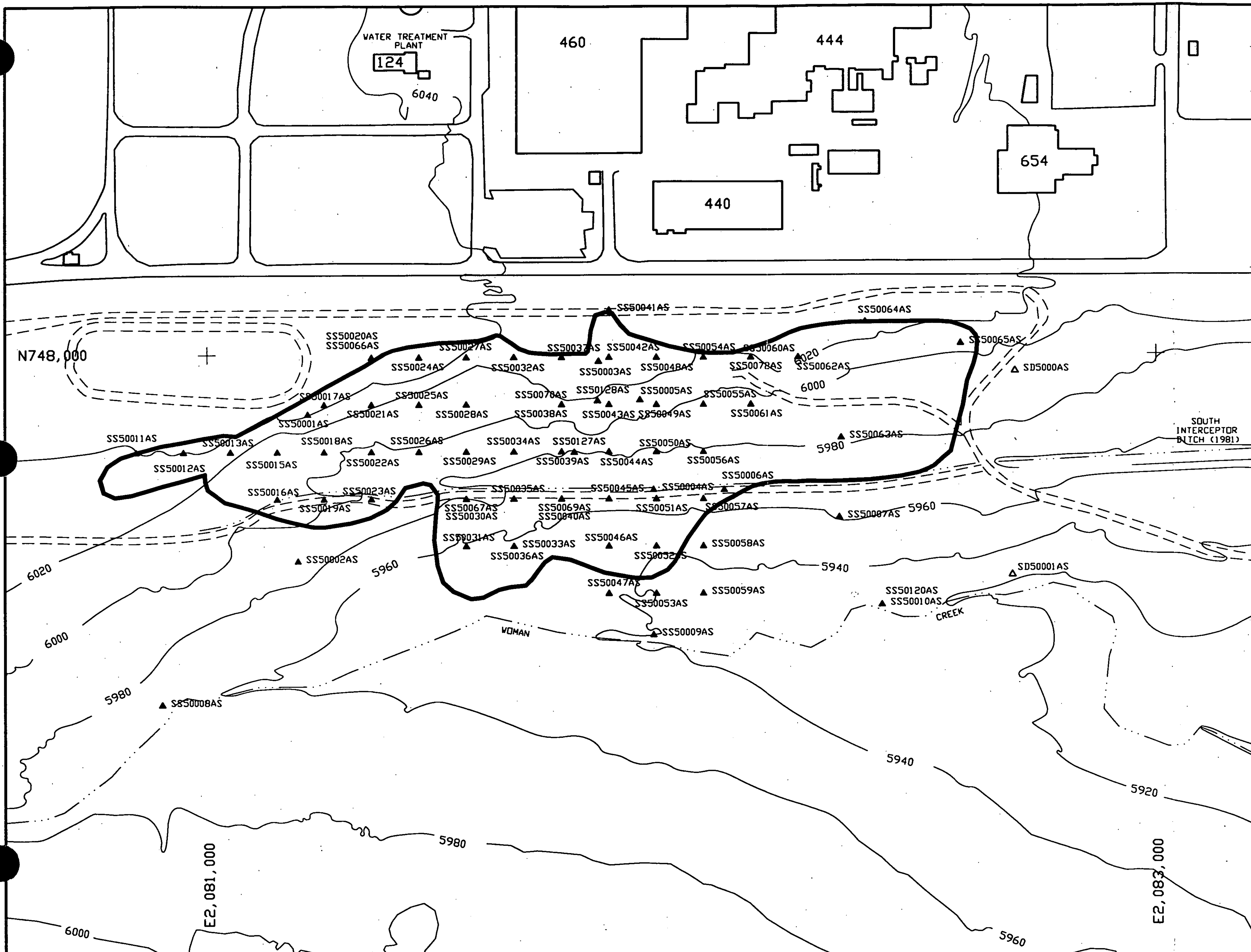
SOIL GAS RESULTS FOR IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-2



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- LANDFILL BOUNDARY SURFACE DISTURBANCE, PRE - SID
- SS50053AS — SURFACE SOIL SAMPLE LOCATION
- SD5000AS — SEEP SEDIMENT SAMPLE LOCATION

-N-

0 100 200

SCALE: 1" = 200'

Drawn SAB 7/28/95 Date

Checked TEG 7/28/95 Date

Approved ________ Date

FILE OU5-2-3.DWG

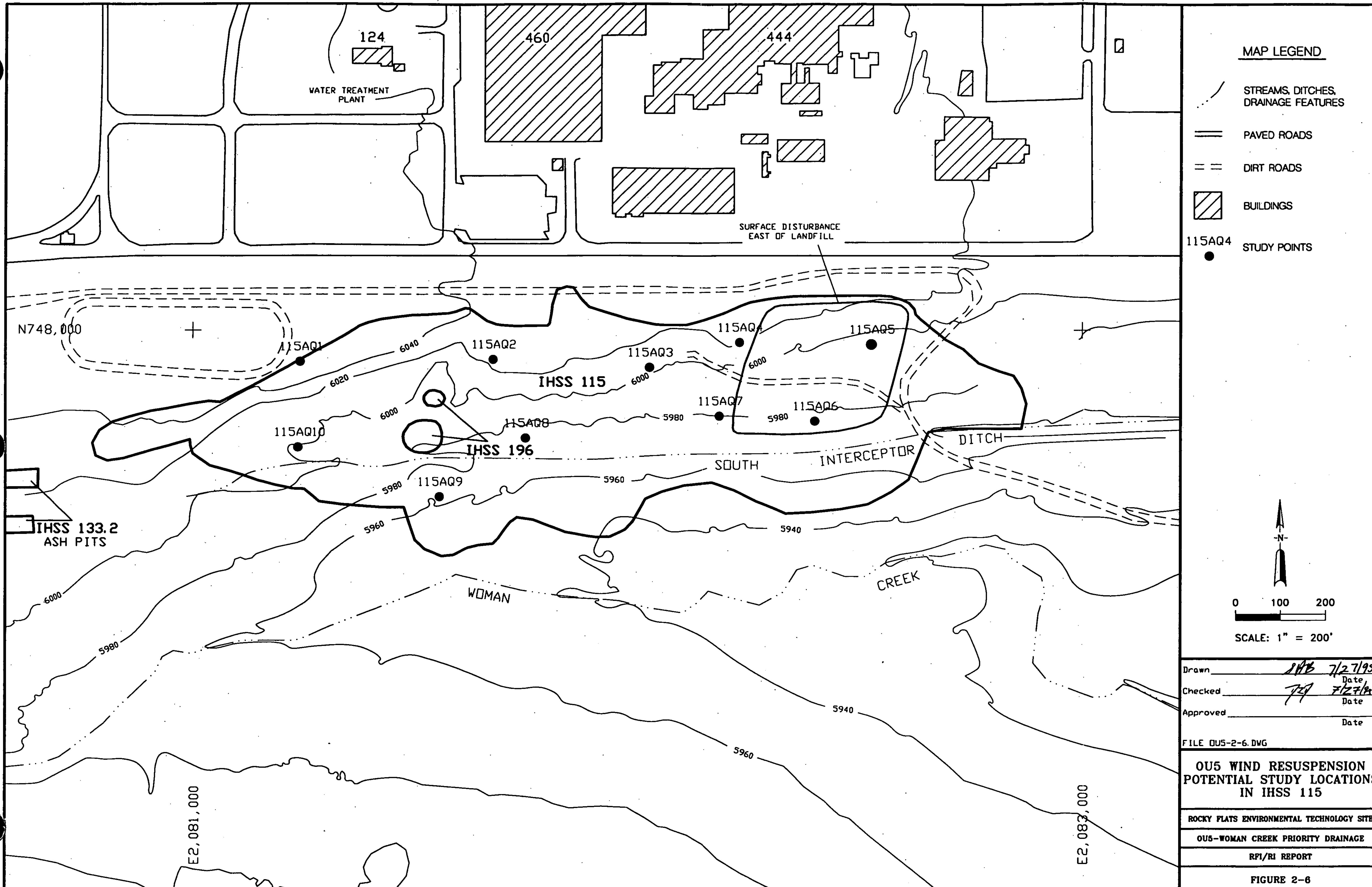
SURFACE SOIL AND SEEP SEDIMENT SAMPLE LOCATIONS IHSS 115

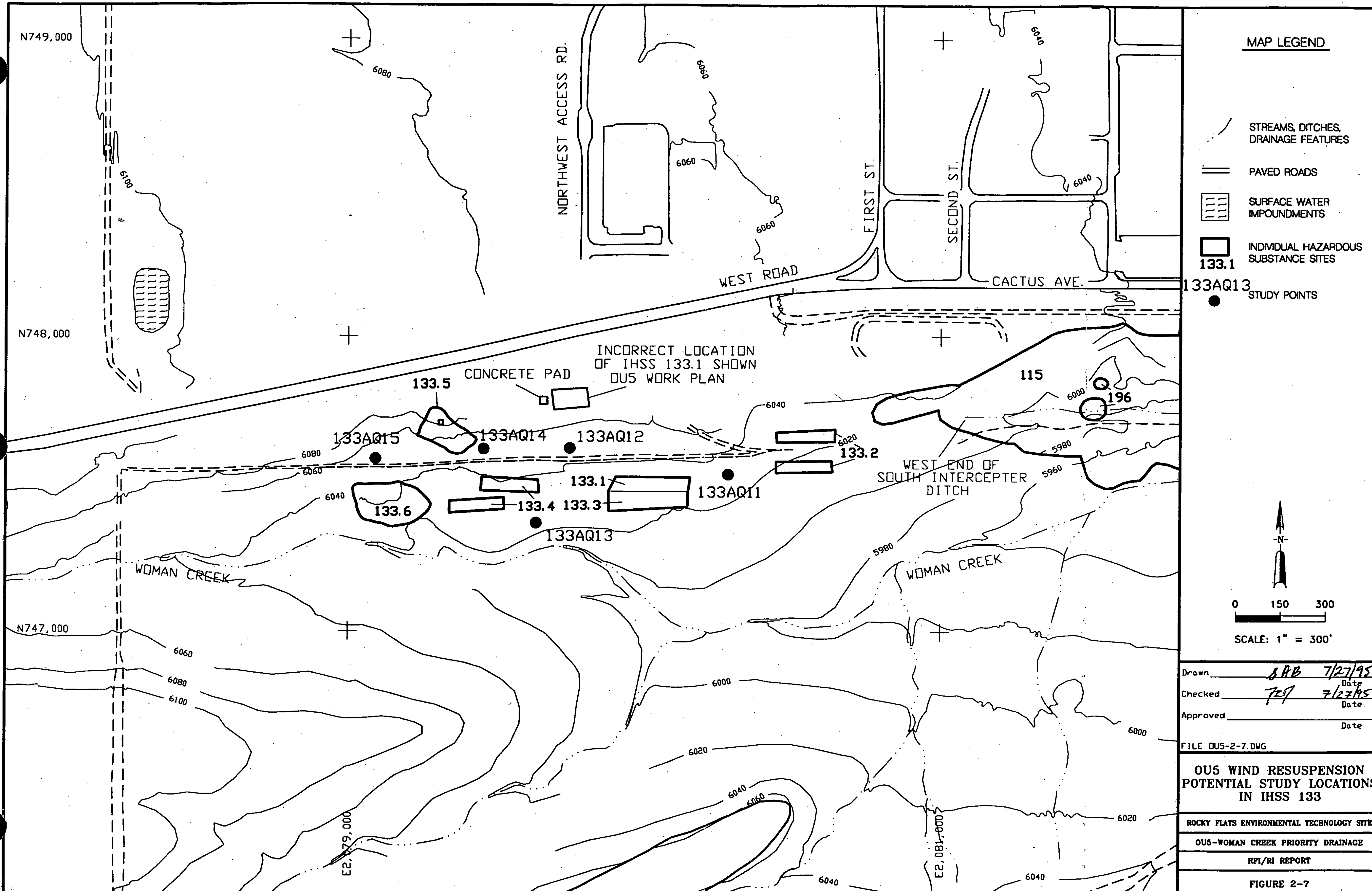
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-3


124
WATER TREATMENT PLANT
460
444
SURFACE DISTURBANCE EAST OF LANDFILL
N748,000
115AQ1
115AQ2
115AQ3
115AQ4
115AQ5
115AQ6
115AQ7
115AQ8
115AQ9
115AQ10
IHSS 115
IHSS 196
IHSS 133.2
ASH PITS
SOUTH INTERCEPTOR DITCH
WOMAN CREEK
6040
6020
6000
5980
5960
5940
E2,081,000
E2,083,000
MAP LEGEND
STREAMS, DITCHES, DRAINAGE FEATURES
PAVED ROADS
DIRT ROADS
BUILDINGS
115AQ4
STUDY POINTS
N
0
100
200
SCALE: 1" = 200'
Drawn
7/27/95
Date
Checked
Date
Approved
Date
FILE OU5-2-6.DWG
OU5 WIND RESUSPENSION POTENTIAL STUDY LOCATIONS IN IHSS 115
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
OU5-WOMAN CREEK PRIORITY DRAINAGE
RFI/RI REPORT
FIGURE 2-6



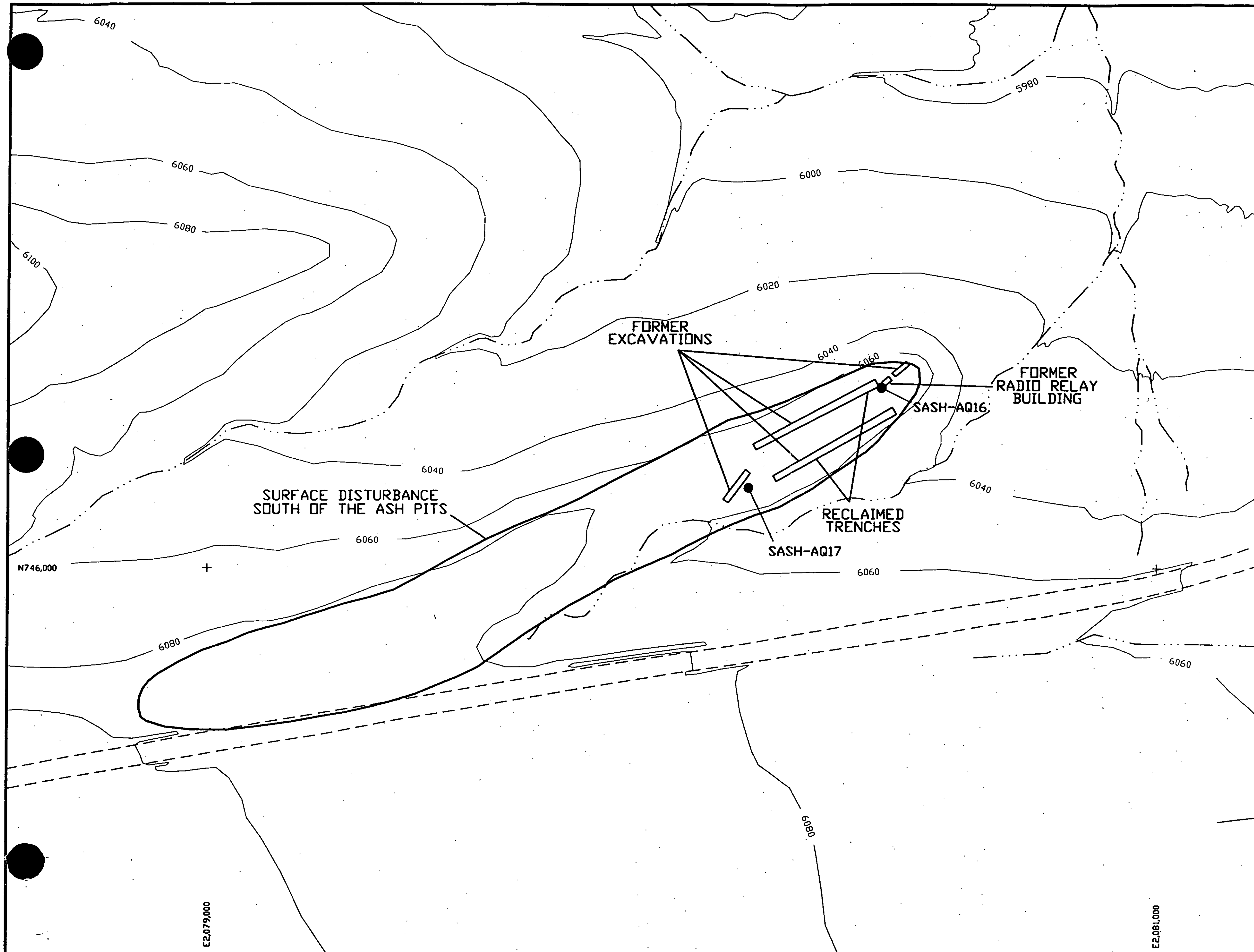
OU5 WIND RESUSPENSION POTENTIAL STUDY LOCATIONS IN IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-7



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

DIRT ROADS

209 INDIVIDUAL HAZARDOUS SUBSTANCE SITES (IHSS)

SASH-AQ17 STUDY POINTS

N

0 100 200

SCALE: 1" = 200'

Drawn NAM 9/28/95 Date
Checked [signature] 9/28/95 Date
Approved MRW 9/29/95 Date

FILE OU5-2-8.DWG

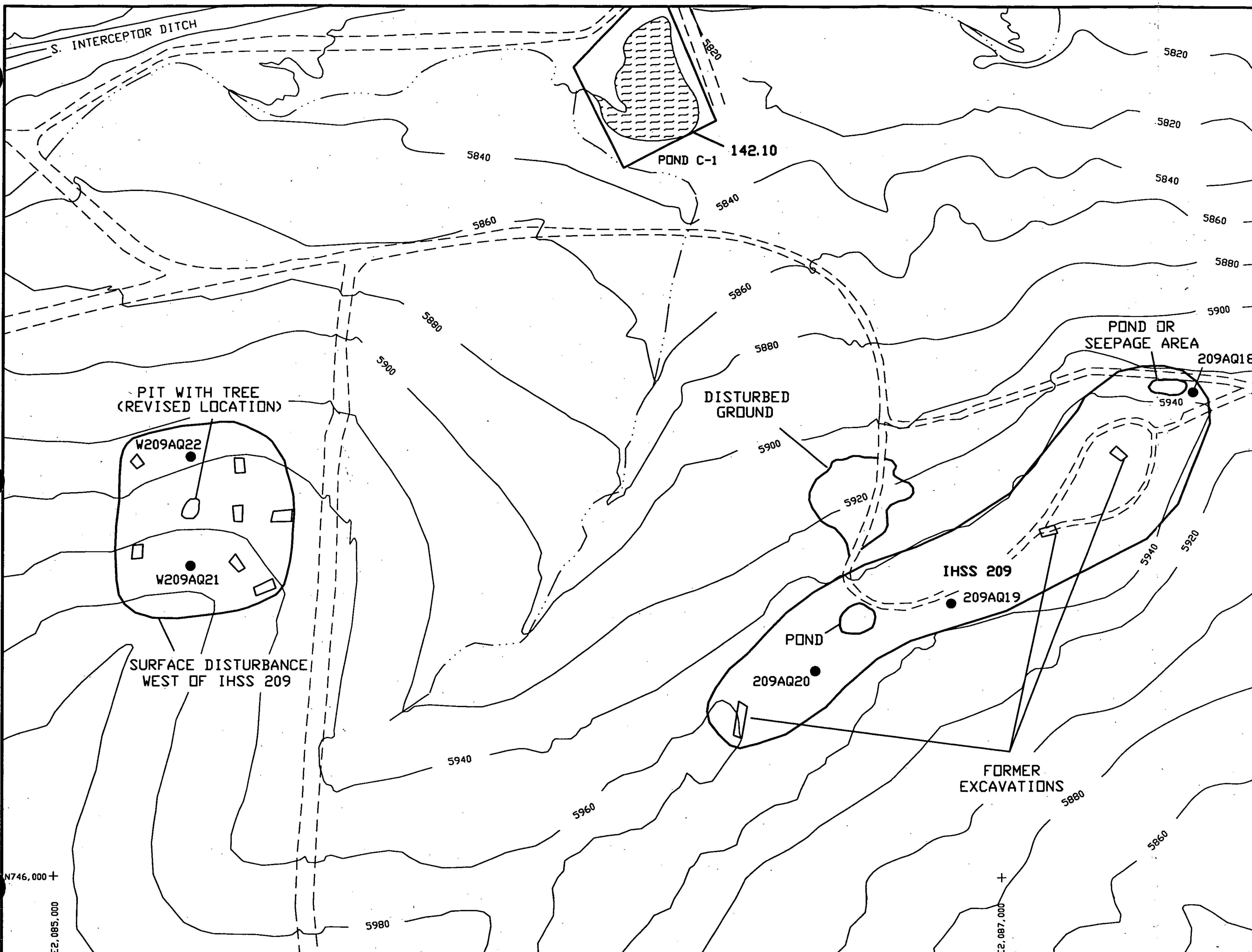
OU5 WIND RESUSPENSION STUDY LOCATIONS IN SURFACE DISTURBANCE SOUTH OF THE ASH PITS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-8



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- DIRT ROADS
- SURFACE WATER IMPOUNDMENTS
- REVISED PIT LOCATIONS
- 209 INDIVIDUAL HAZARDOUS SUBSTANCE SITES (IHSS)
- 209AQ18 STUDY POINTS

Drawn ______ Date
Checked ______ Date
Approved ______ Date
File OU5-2-9.DWG

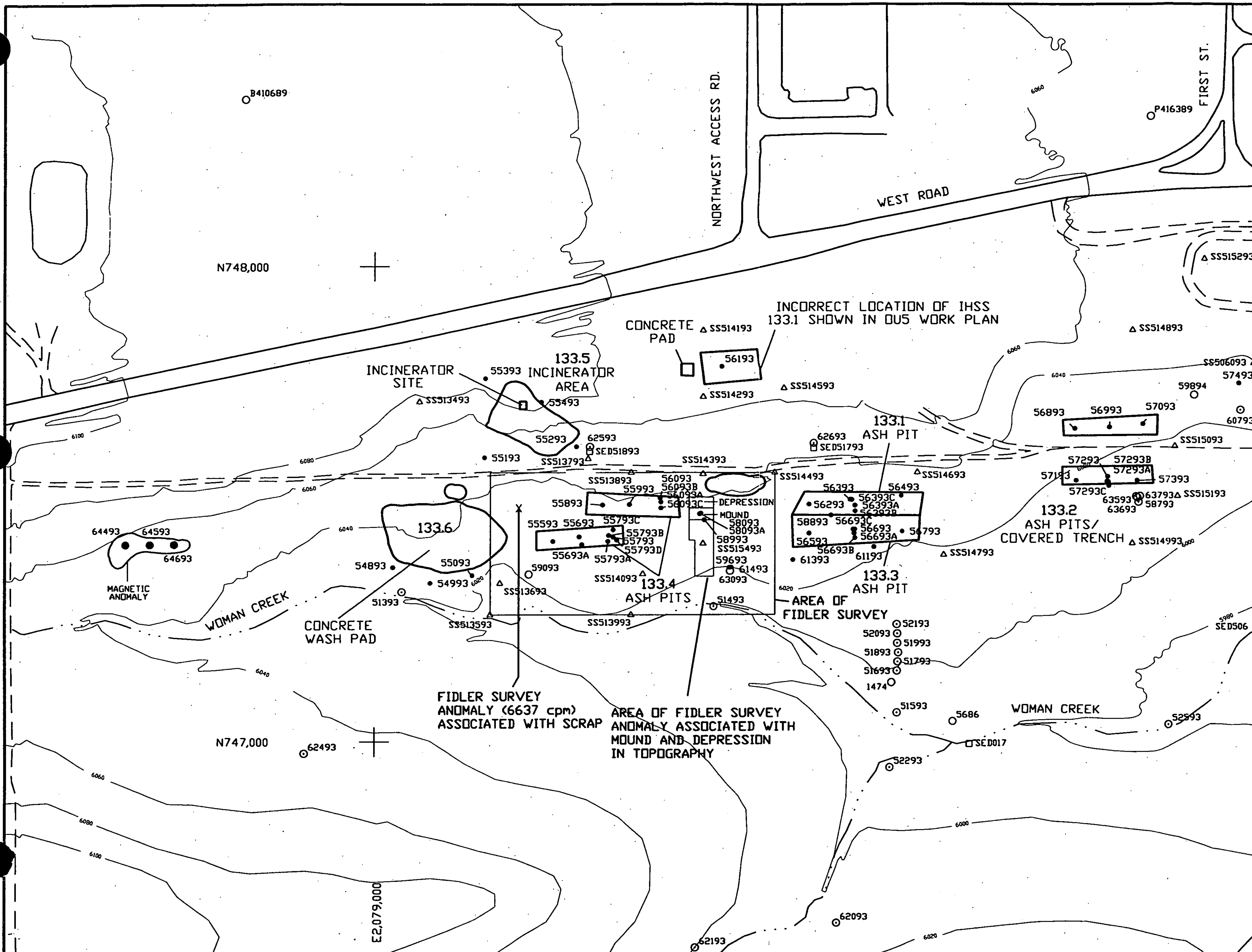
OU5 WIND RESUSPENSION POTENTIAL STUDY LOCATIONS IN IHSS 209 AND SURFACE DISTURBANCE WEST OF IHSS 209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-9



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- 133.1 INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- 59193 BOREHOLE LOCATION
- SED51893 SEDIMENT SAMPLING LOCATION
- SS513793 SURFACE SOIL SAMPLING LOCATION
- 59894 MONITORING WELL LOCATION
- 60793 WELL POINT LOCATION

-N-

0 100 200

SCALE: 1" = 200'

Drawn NAM 9/29/95 Date
Checked [signature] 10/1/95 Date
Approved MRW 10/10/95 Date

File OU5-2-10.DWG

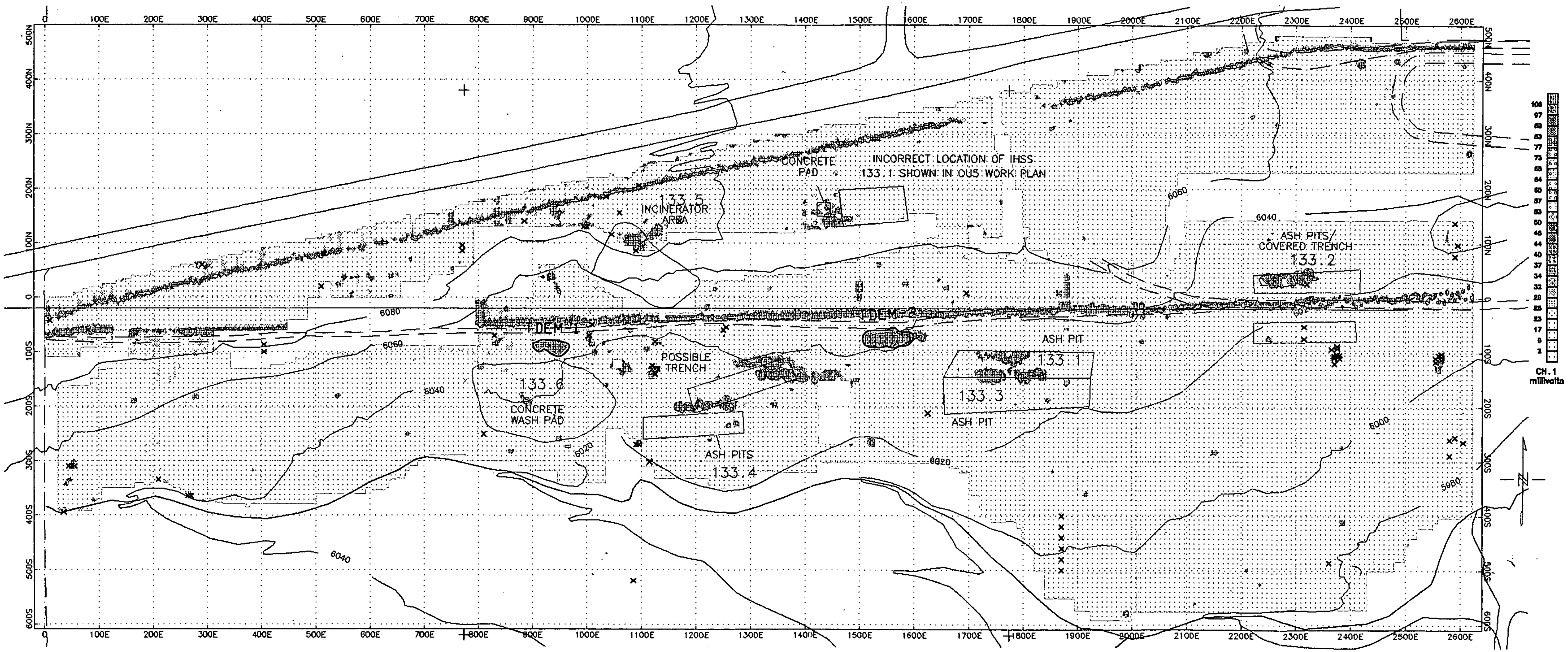
PRE-TM15 SAMPLE LOCATIONS AT IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-10



IHSS LOCATIONS SHOWN ON THIS FIGURE WERE SUBSEQUENTLY REVISED (SEE FIGURE 1-2)

X = SURFACE METALLIC DEBRIS IDENTIFIED DURING SURVEY

0 100 200

SCALE: 1" = 200'

Drawn	SAB 8/1/95 Date
Checked	TEJ 8/1/95 Date
Approved	MRW 10/10/95 Date
FILE OU5-2-11.DWG	

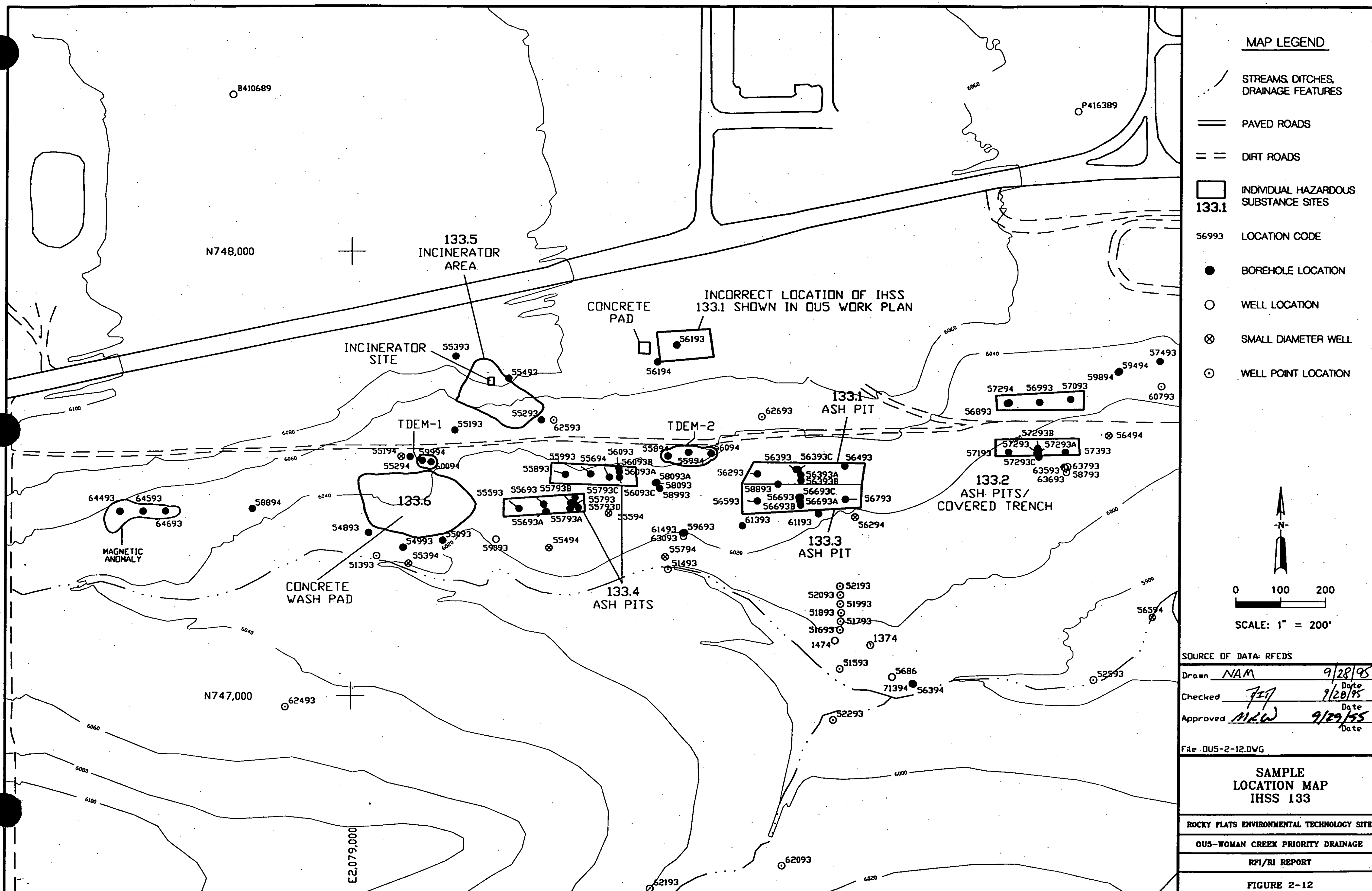
TIME-DOMAIN EM CONDUCTIVITY - IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

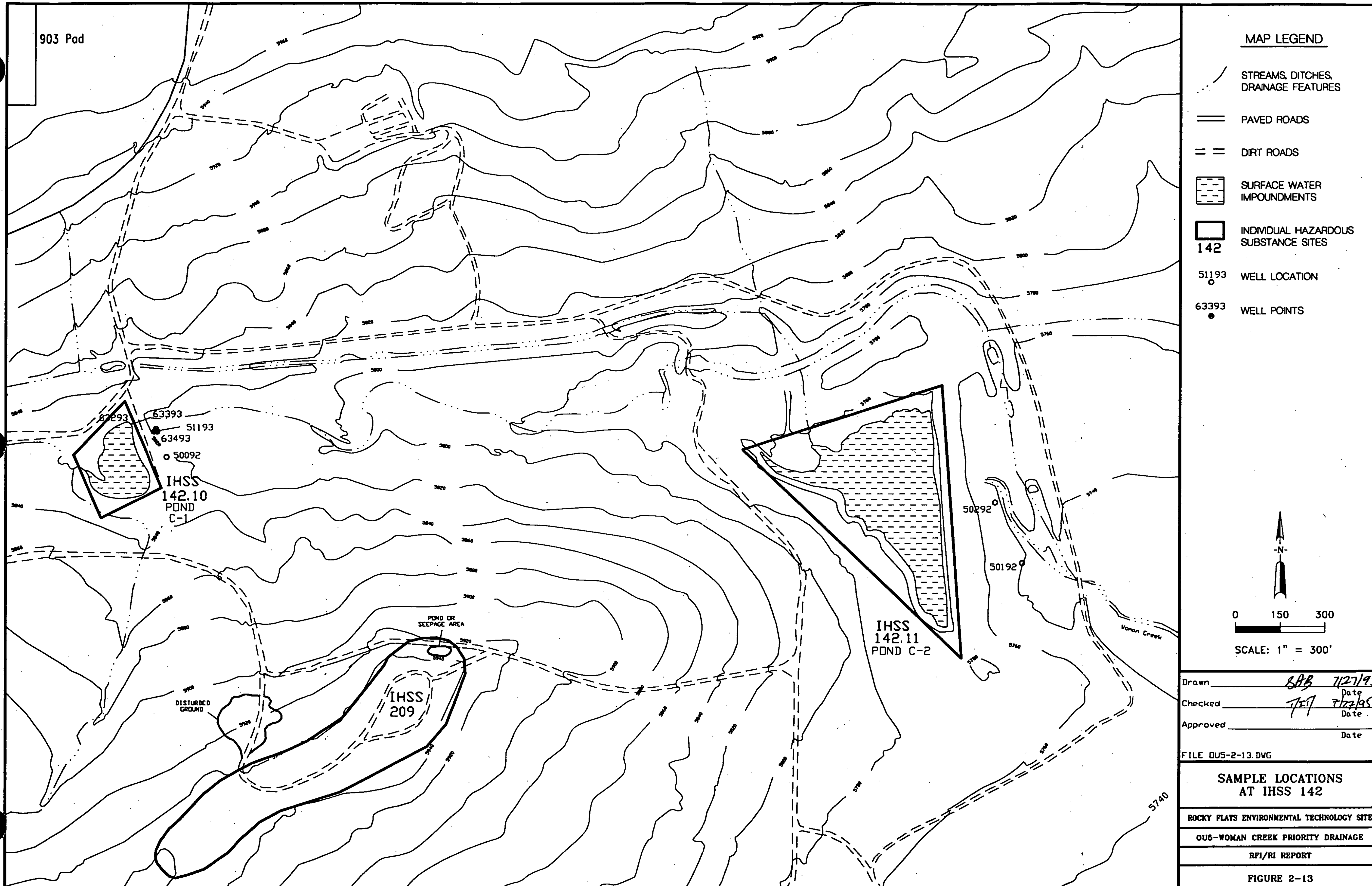
OU5 - WOMAN CREEK PRIORITY DRAINAGE

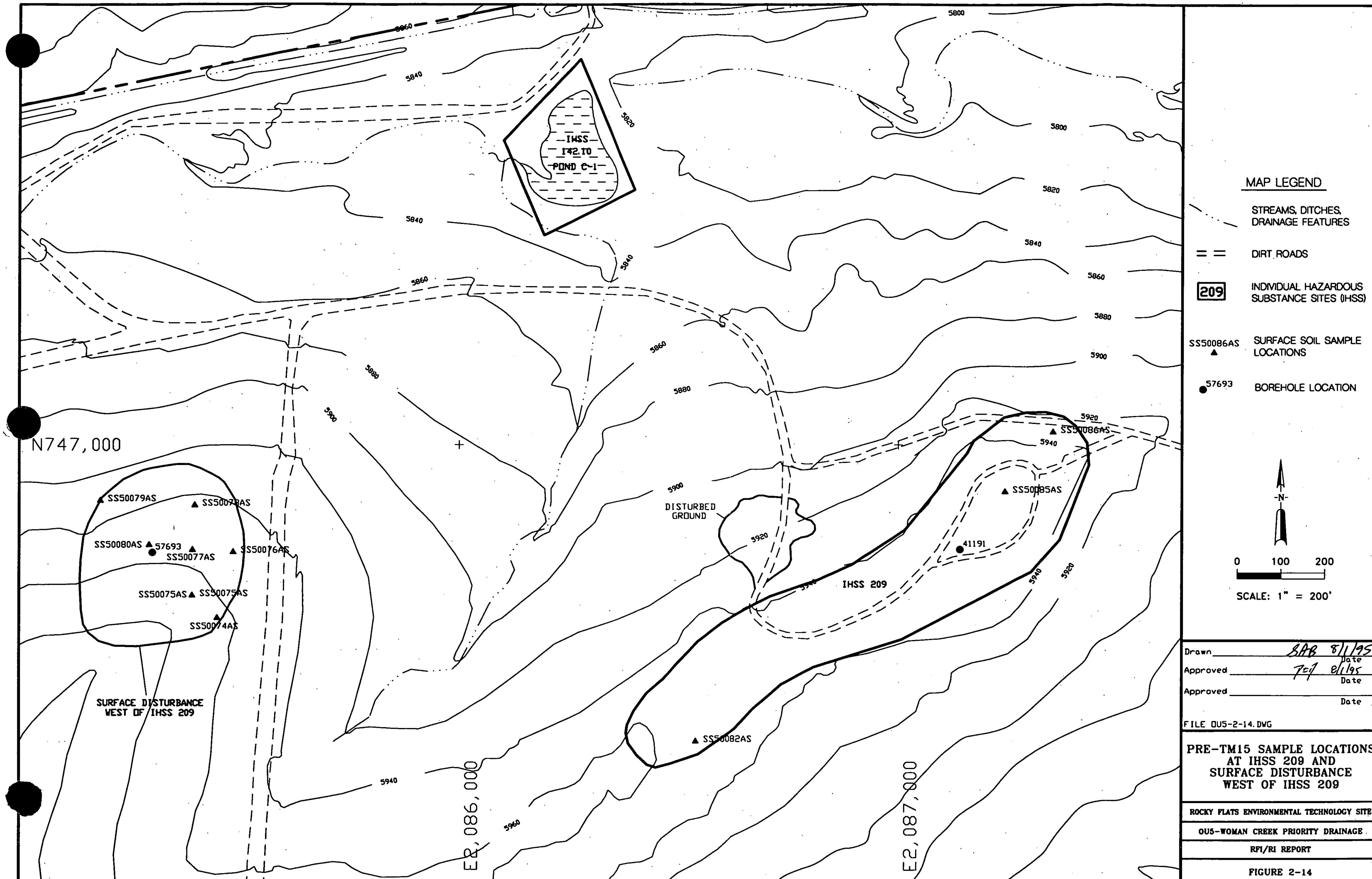
RFI/RI REPORT

FIGURE 2-11



MAP LEGEND
STREAMS, DITCHES, DRAINAGE FEATURES
PAVED ROADS
DIRT ROADS
133.1
INDIVIDUAL HAZARDOUS SUBSTANCE SITES
56993
LOCATION CODE
BOREHOLE LOCATION
WELL LOCATION
SMALL DIAMETER WELL
WELL POINT LOCATION
N
0 100 200
SCALE: 1" = 200'
SOURCE OF DATA: RFEDS
Drawn NAM 9/28/95 Date
Checked 9/28/95 Date
Approved MKW 9/29/95 Date
File OU5-2-12.DWG
SAMPLE LOCATION MAP IHSS 133
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
OU5-WOMAN CREEK PRIORITY DRAINAGE
RFI/RI REPORT
FIGURE 2-12
N748,000
N747,000
E2,079,000
B410689
P416389
133.5 INCINERATOR AREA
INCINERATOR SITE
CONCRETE PAD
INCORRECT LOCATION OF IHSS 133.1 SHOWN IN OU5 WORK PLAN
133.1 ASH PIT
TDEM-1
TDEM-2
133.6
133.2 ASH PITS/ COVERED TRENCH
133.3 ASH PIT
133.4 ASH PITS
CONCRETE WASH PAD
MAGNETIC ANOMALY
56193
56194
55393
55493
55293
62593
55193
62693
57294
56993
57093
56893
57493
59494
59894
60793
56494
57293B
57293
57293A
57193
57393
57293C
63593
63793
63693
58793
55194
59994
55294
60094
55993
55694
56093
56093B
56093A
55893
55894
56094
55994
58093A
58093
58993
56093C
55593
55693
55793B
55793C
55793
55793D
55693A
55793A
55594
56393
56393C
56493
56293
56393A
56393B
58893
56693C
56593
56693
56693B
56693A
56793
61393
61193
56294
64493
64593
64693
58894
54893
54993
55093
55394
51393
59093
55494
61493
63093
59693
55794
51493
52193
52093
51993
51893
51793
51693
1474
1374
51593
5686
71394
56394
52593
56594
52293
62493
62093
62193


903 Pad
MAP LEGEND
STREAMS, DITCHES, DRAINAGE FEATURES
PAVED ROADS
DIRT ROADS
SURFACE WATER IMPOUNDMENTS
142
INDIVIDUAL HAZARDOUS SUBSTANCE SITES
51193
WELL LOCATION
63393
WELL POINTS
-N-
0 150 300
SCALE: 1" = 300'
63293
63393
51193
63493
50092
IHSS 142.10 POND C-1
IHSS 142.11 POND C-2
50292
50192
POND OR SEEPAGE AREA
DISTURBED GROUND
IHSS 209
Woman Creek
5740
Drawn SAB 7/27/95 Date
Checked 7/27/95 Date
Approved Date
FILE OU5-2-13.DWG
SAMPLE LOCATIONS AT IHSS 142
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
OU5-WOMAN CREEK PRIORITY DRAINAGE
RFI/RI REPORT
FIGURE 2-13



Drawn SAB 8/1/95 Date
Approved TCJ 8/1/95 Date
Approved Date

FILE OU5-2-14.DWG

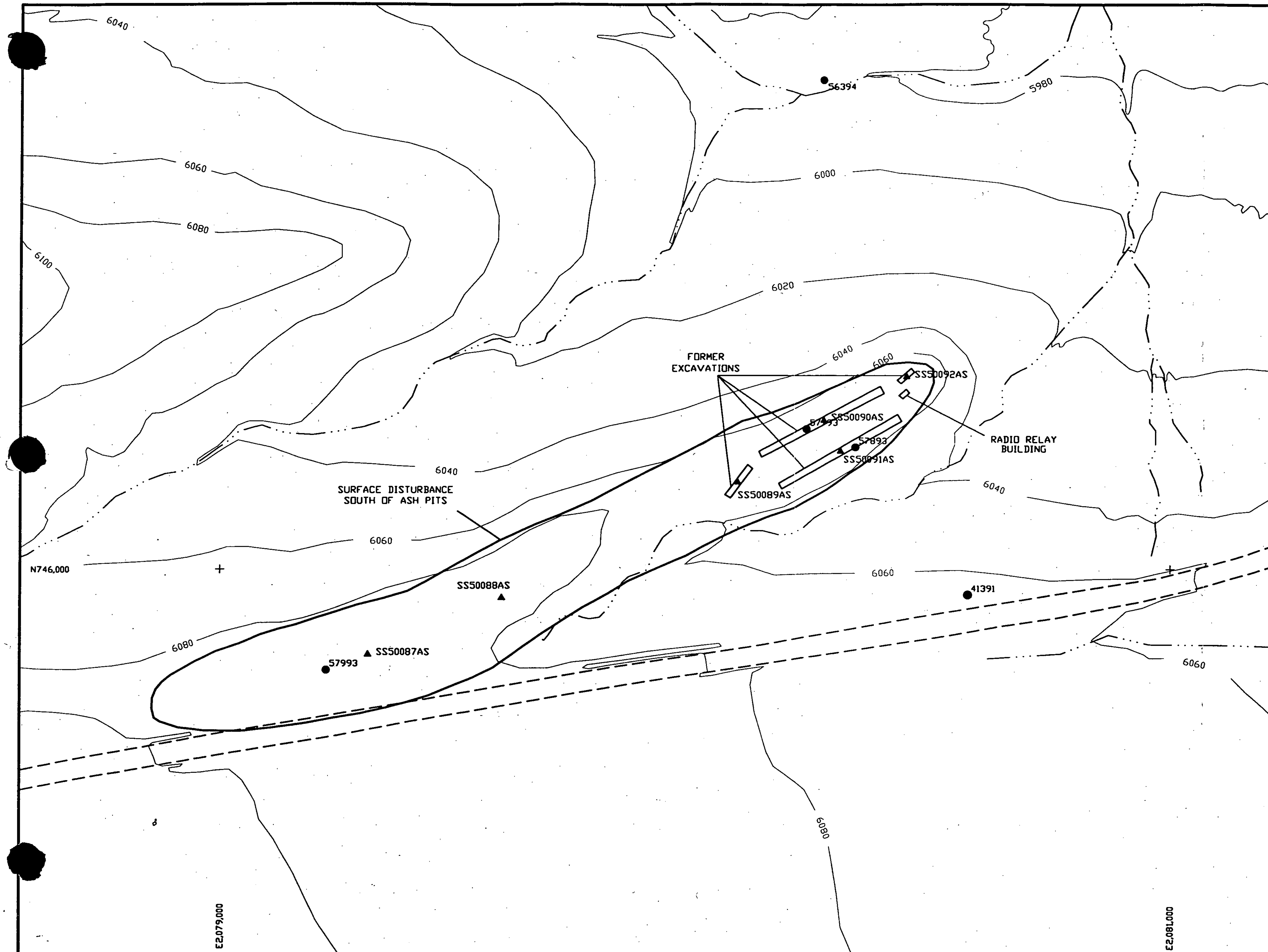
PRE-TM15 SAMPLE LOCATIONS AT IHSS 209 AND SURFACE DISTURBANCE WEST OF IHSS 209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-14



MAP LEGEND

STREAMS, DISTCHES, DRAINAGE FEATURES

DIRT ROADS

209 INDIVIDUAL HAZARDOUS SUBSTANCE SITES (IHSS)

SS50089AS SURFACE SOIL SAMPLING LOCATION

57993 BOREHOLE LOCATION

-N-

0 100 200

SCALE: 1" = 200'

Drawn	NAM	9/28/95 Date
Checked	JEJ	9/28/95 Date
Approved	MLW	9/29/95 Date

FILE OU5-2-15.DWG

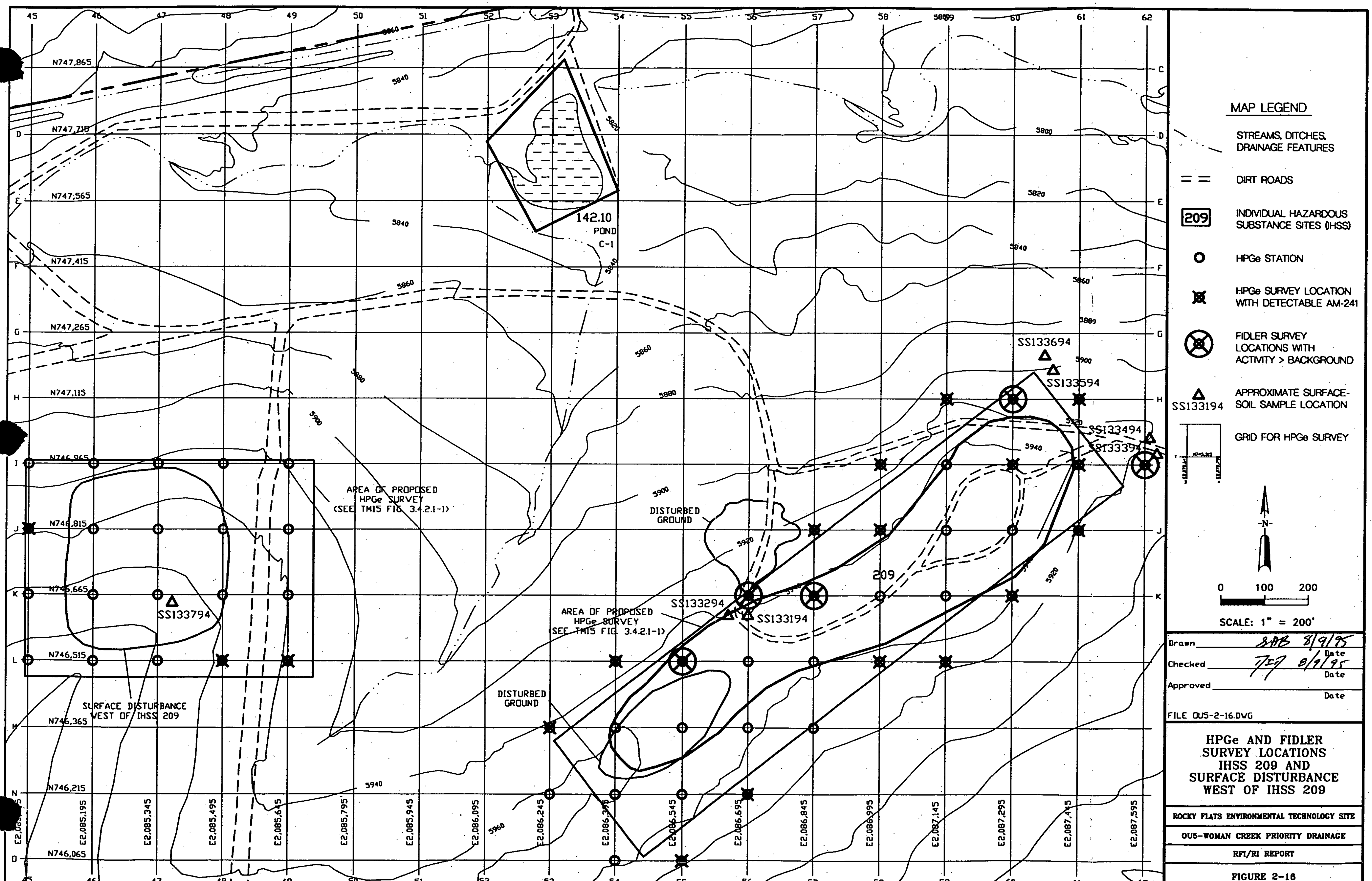
PRE-TM15 SAMPLE LOCATIONS AT SURFACE DISTURBANCE SOUTH OF THE ASH PITS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-15



Drawn SAB 8/9/95 Date
Checked TEJ 8/9/95 Date
Approved Date

FILE OU5-2-16.DWG

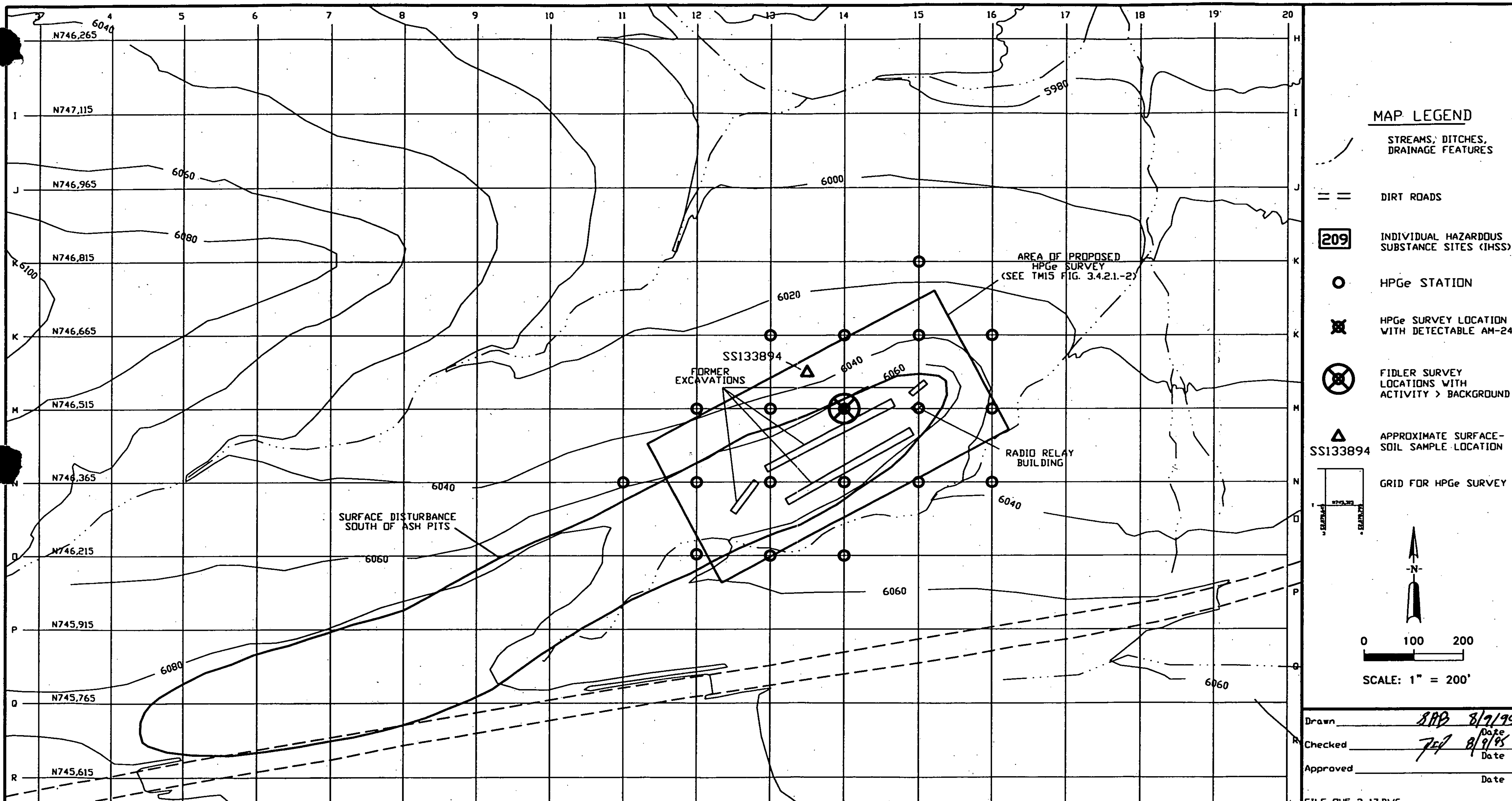
HPGe AND FIDLER SURVEY LOCATIONS IHSS 209 AND SURFACE DISTURBANCE WEST OF IHSS 209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-16



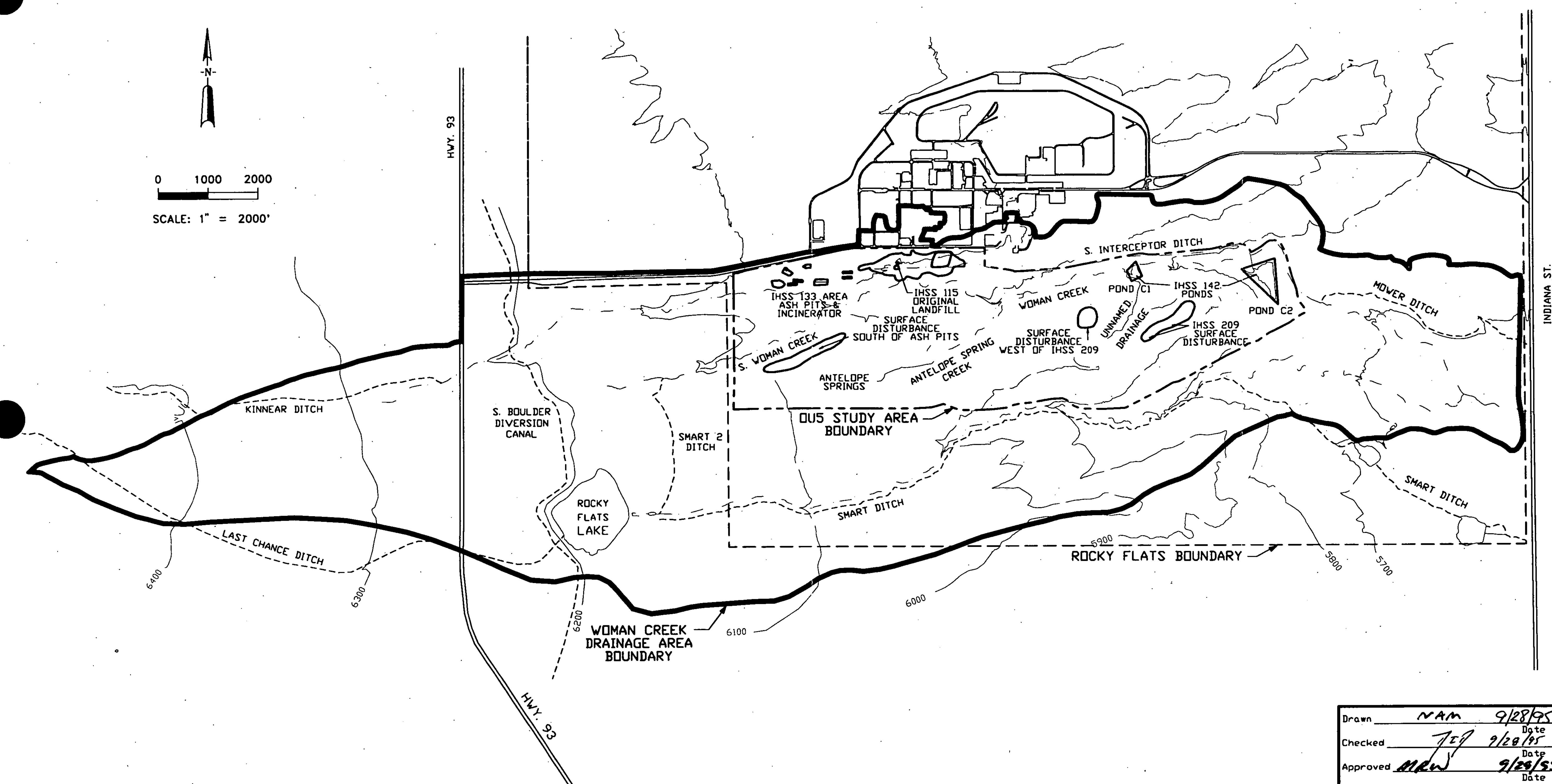
HPGe AND FIDLER SURVEY LOCATIONS SURFACE DISTURBANCE SOUTH OF THE ASH PITS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 2-17



Drawn NAM	9/28/95 Date
Checked TI?	9/28/95 Date
Approved MRW	9/28/95 Date

File OU5-31

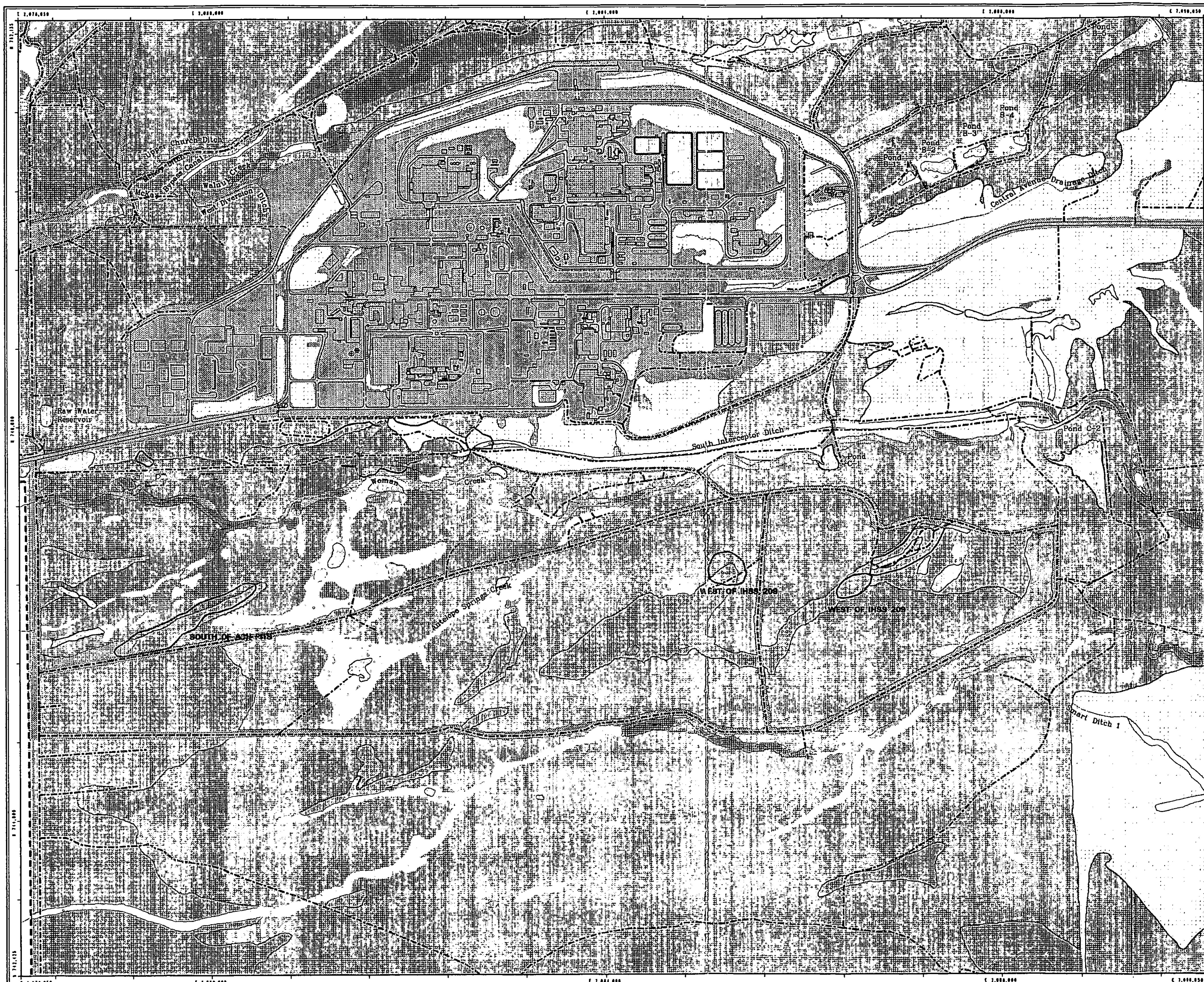
WOMAN CREEK DRAINAGE

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-1



Vegetation Types Identified in Woman Creek Watershed in Vicinity of OU5 IHSSs

Figure 3-12

Vegetation Types

- Annual grass/forb
- Disturbed/barren lands
- Developed areas
- Short grass
- Mesic mixed grassland
- Xeric mixed grassland
- Reclaimed mixed grass
- Sensitive habitats
- Bottomland shrub
- Upland shrub, short
- Upland shrub, tall
- Upland shrub, short
- Wet meadow/marsh ecotone
- Short marsh
- Tall marsh
- Open water
- Deciduous woodland
- Ponderosa woodland
- Tree plantings
- Ponderosa woodland
- Tree plantings
- OU5 IHSSs
- Ou5 Surface Disturbance

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)
The vegetation data from Ebasco AutoCAD DXF file which was generate using aerial photos and digitizing hand drawn field maps.
Ebasco - 1993

Scale = 1 : 12000
1 inch represents 1000 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

MAP ID: fig-3-12 August 07, 1995

/gis/data/rfp-map-ambs/vegetation-maps/fig-3-12.aml

LEGEND

SURFICIAL DEPOSITS

QUATERNARY

RECENT

- af — artificial fill
- Qa — Valley-fill Alluvium
- Qls — Landslide, slump

PLEISTOCENE

- Qta — Rocky Flats Alluvium
- Qrf — Undifferentiated Terrace Alluvium includes: Broadway, Louviers, Slocum and Verdos Alluvium

SEDIMENTARY ROCKS

UPPER CRETACEOUS

- Ka — Arapahoe Formation
- Kl — Laramie Formation

MAP SYMBOLS

Fault

U, upthrown side
D, downthrown side

ROAD CLASSIFICATION

- Heavy Duty
- Medium Duty
- Light Duty
- Unimproved Dirt
- Rocky Flats Boundary
- IHSS Boundaries

Source: Geologic Characterization Report by EG&G. March 1995

N

1 : 12000

Drawn	NAM	9/29/95 Date
Checked	TEQ	10/1/95 Date
Approved	MLW	10/16/95 Date

FILE OU5-3-4.DWG AND AML

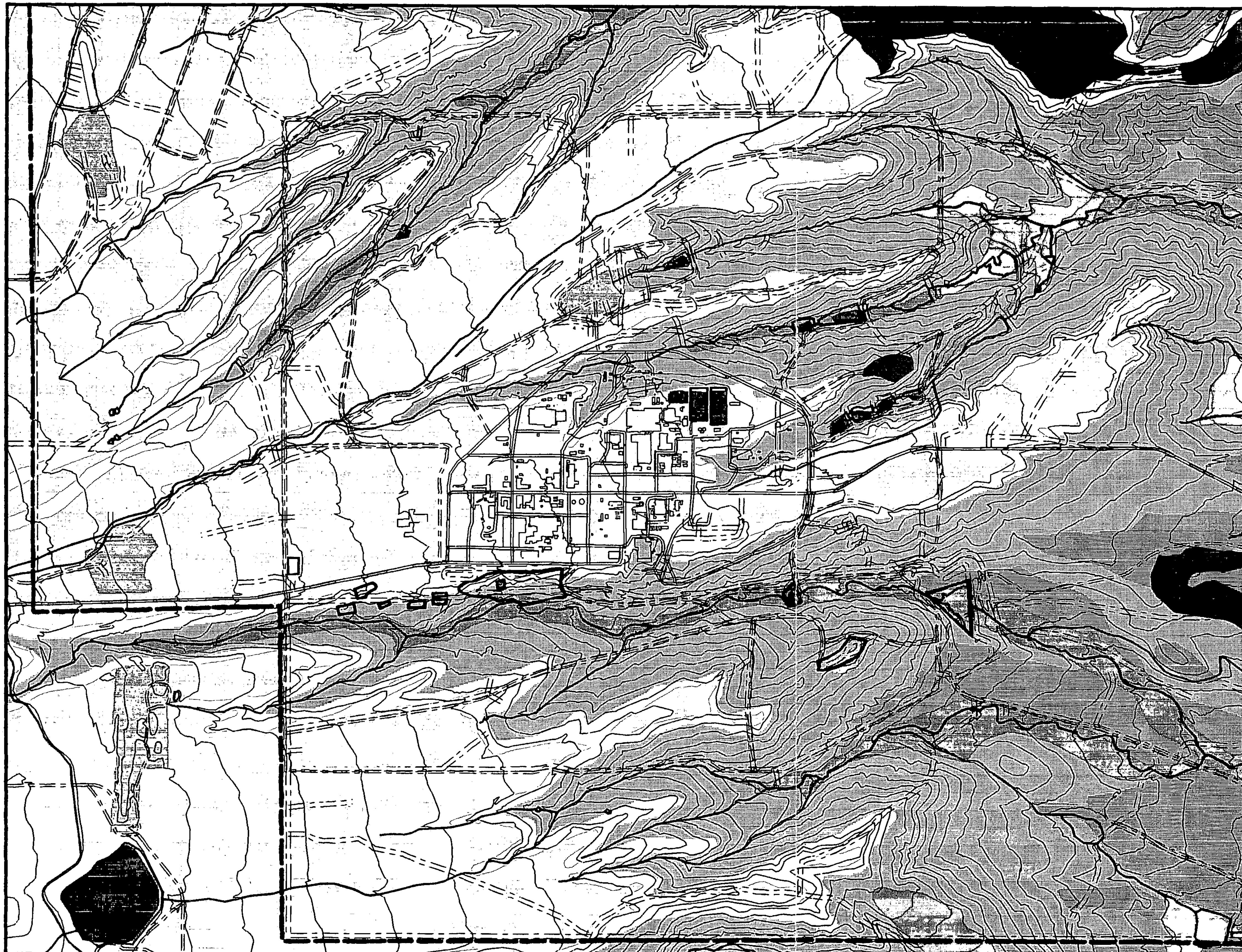
OPERABLE UNIT 5
BEDROCK MAP

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-4



OU5 SURFACE SOILS MAP

- Veldkamp-Nederland very cbly sdy loams
- Flatirons very cbly sdy loam
- Valmont clay loam
- Leyden-Primen-Standley cbly clay loams
- Denver-Kutch clay loams
- Rock outcrop, sedimentary
- Midway clay loam
- Pits, gravel
- Denver clay loam
- Englewood clay loam
- Nederland very cobly sdy loam
- Haverson loam
- Nunn clay loam
- Willowman-Leyden cbly loams
- McClave clay loam
- Water

ROAD CLASSIFICATION

- Heavy Duty
- Medium Duty
- Light Duty
- Unimproved Dirt
- Rocky Flats Boundary

Source: USDA SCS
Soil Survey of
Golden Area, CO
1980

-N-

1 : 6000

Drawn NAM 9/29/95 Date
Checked 7C7 10/2/95 Date
Approved MRW 10/10/95 Date

FILE OU5-3-6.DWG AND AML

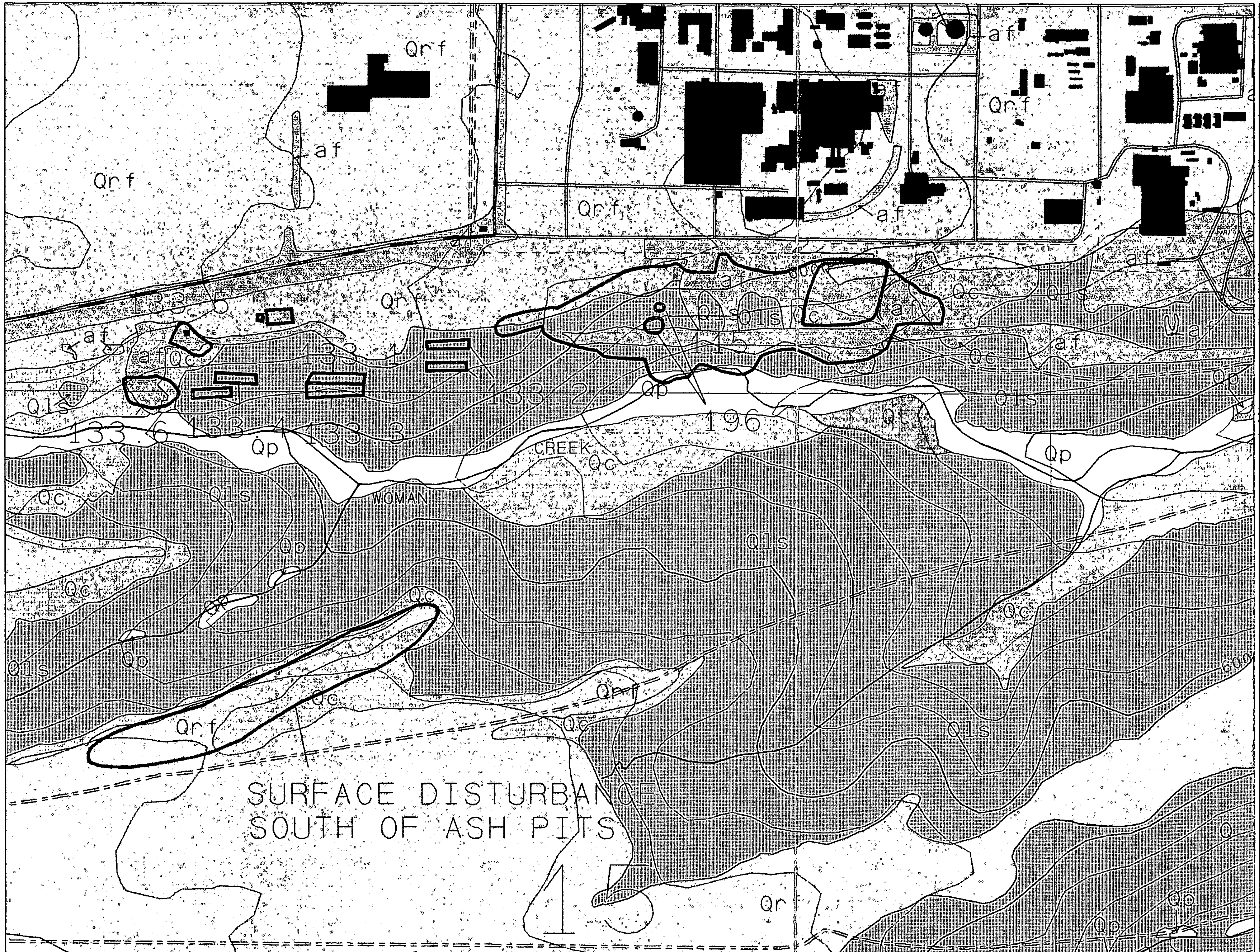
OPERABLE UNIT 5
SURFACE SOIL MAP

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-6



LEGEND

SURFICIAL DEPOSITS

QUATENARY

RECENT
- Qp — Piney Creek and Post-Piney Creek Alluvium
- af — artificial fill

RECENT AND PLEISTOCENE
- Qc — Colluvium undivided
- Qls — Landslide, slump

PLEISTOCENE
- Qt — Terrace Alluvium undivided
- Qs — Slocum Alluvium
- Qrf — Undifferentiated Terrace Alluvium includes: Broadway, Louviers, Slocum and Verdos Alluvium

BEDROCK

UPPER CRETACEOUS / CRETACEOUS
- Kl — Laramie Formation

MAP SYMBOLS

ROAD CLASSIFICATION

- Heavy Duty
- Medium Duty
- Light Duty
- Unimproved Dirt
- Rocky Flats Boundary
- IHSS Boundaries

Source: Geologic Characterization Report by EG&G. March 1995

1 : 6000

-N-

Drawn SAB 8/9/95 Date

Checked TEP 8/9/95 Date

Approved MQW 9/29/95 Date

FILE OU5-3-9.DWG AND AML

OPERABLE UNIT 5
WESTERN PORTION
SURFICIAL GEOLOGIC MAP

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-9

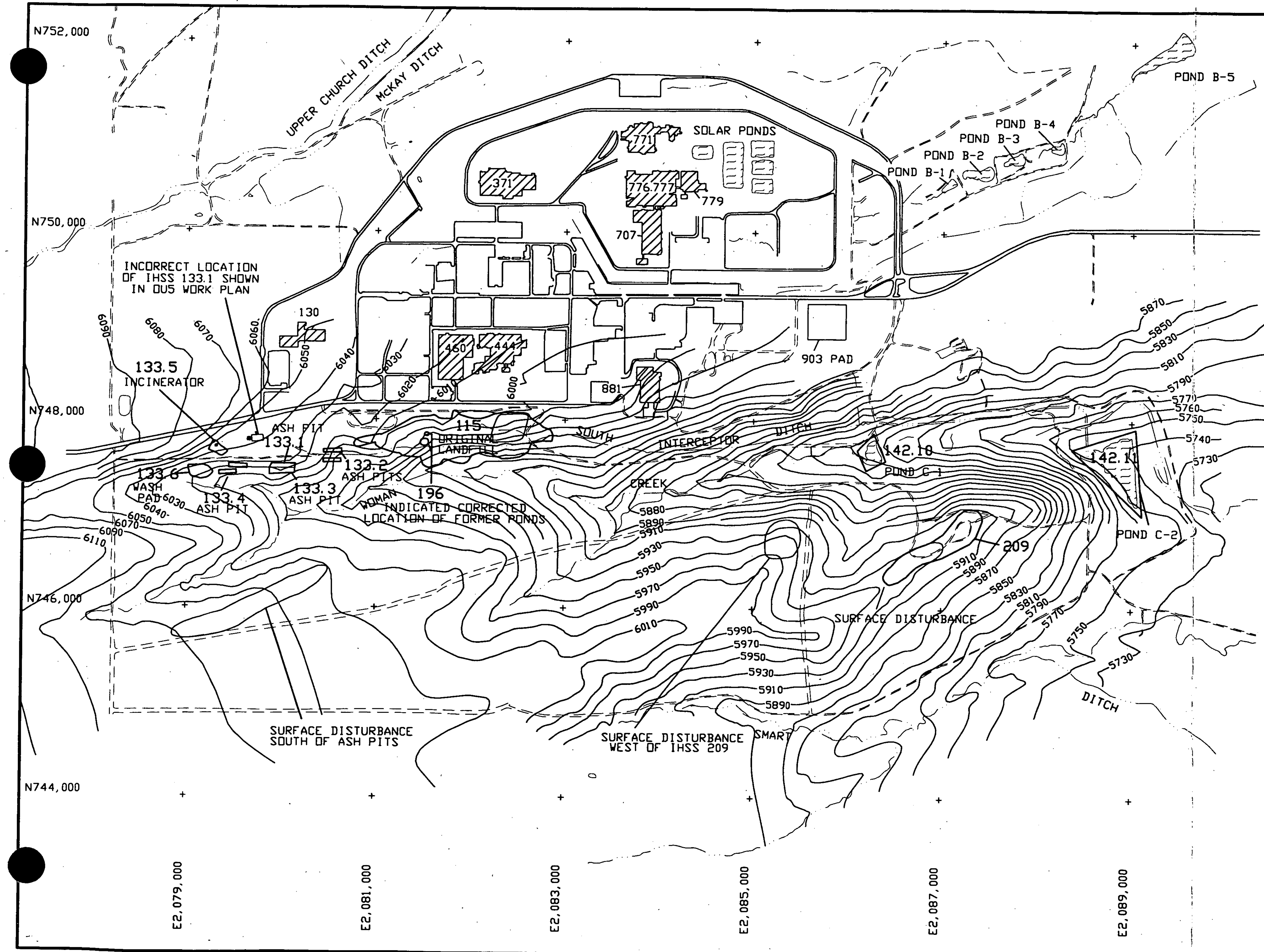
OPERABLE UNIT 5
EASTERN PORTION
SURFICIAL GEOLOGIC MAP

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-10



Drawn	NHM 8/1/95 Date
Checked	TJP 8/1/95 Date
Approved	Date

FILE OU5-3-5.DWG

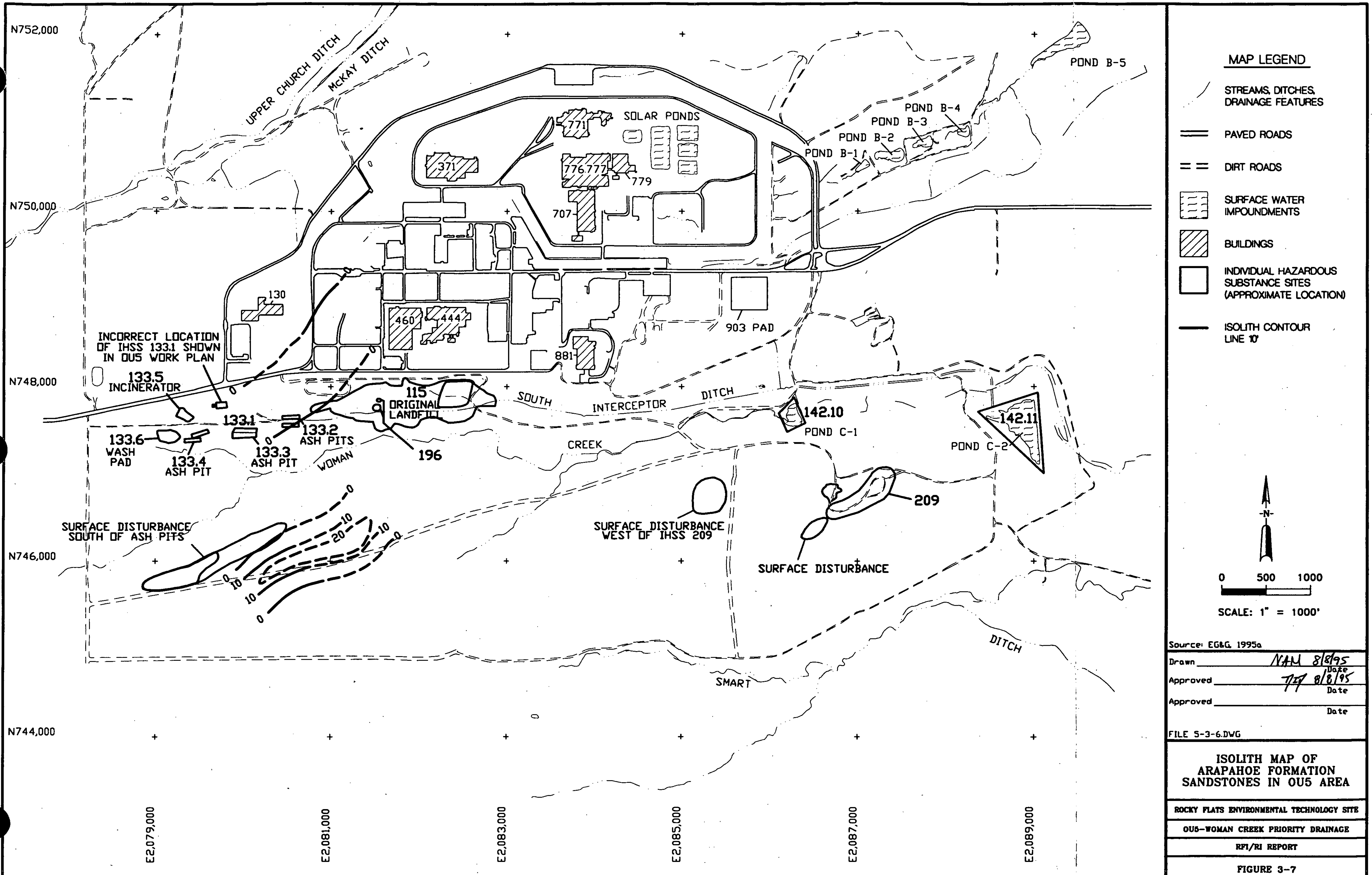
BEDROCK ELEVATION MAP
OPERABLE UNIT 5

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-5



Source: EG&G, 1995a

Drawn NAM 8/8/95 Date

Approved TLP 8/8/95 Date

Approved ________ Date

FILE 5-3-6.DWG

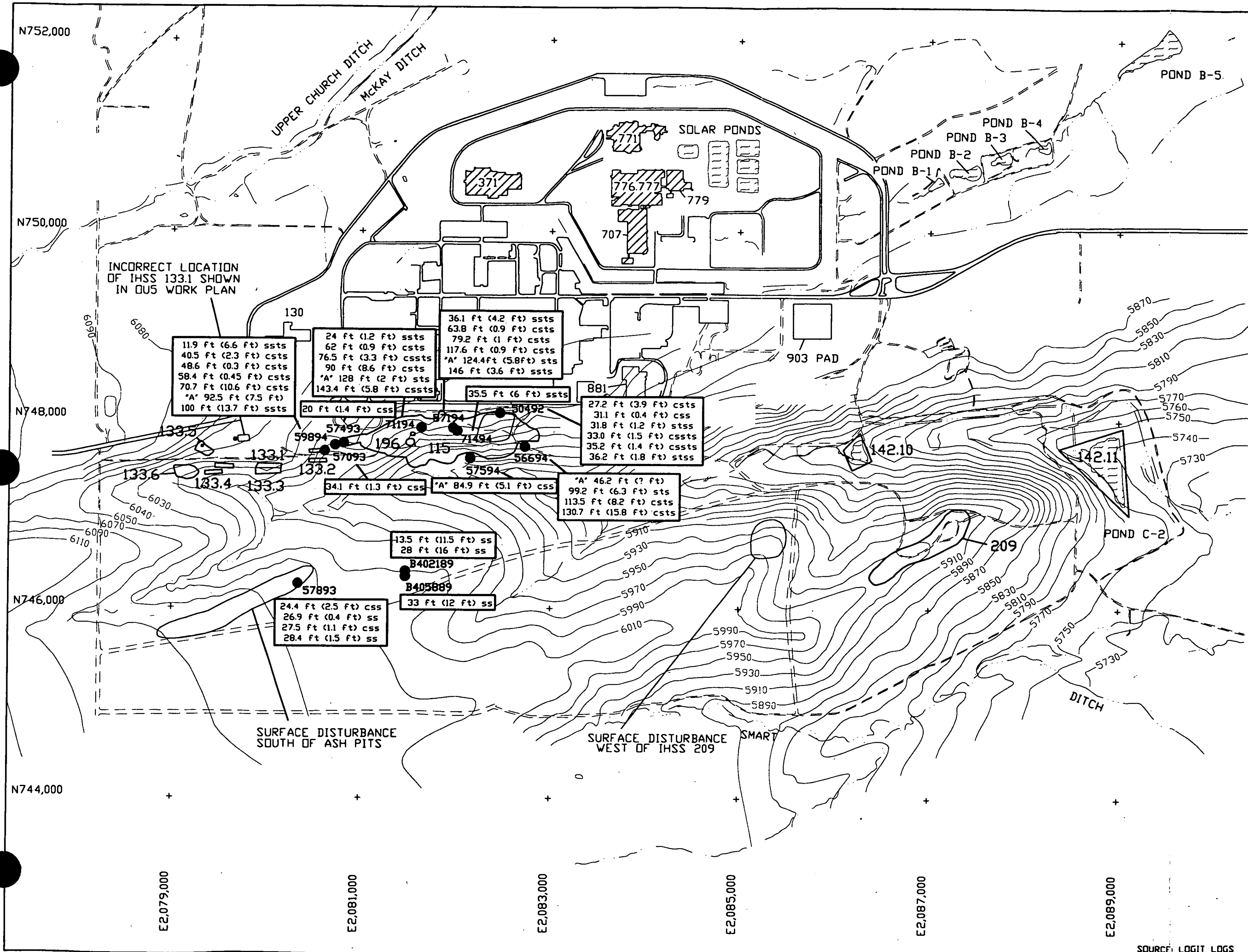
ISOLITH MAP OF ARAPAHOE FORMATION SANDSTONES IN OU5 AREA

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-7



Drawn NAM 10/1/95 Date
Checked 10/2/95 Date
Approved 10/10/95 Date

FILE 5-3-8.DWG

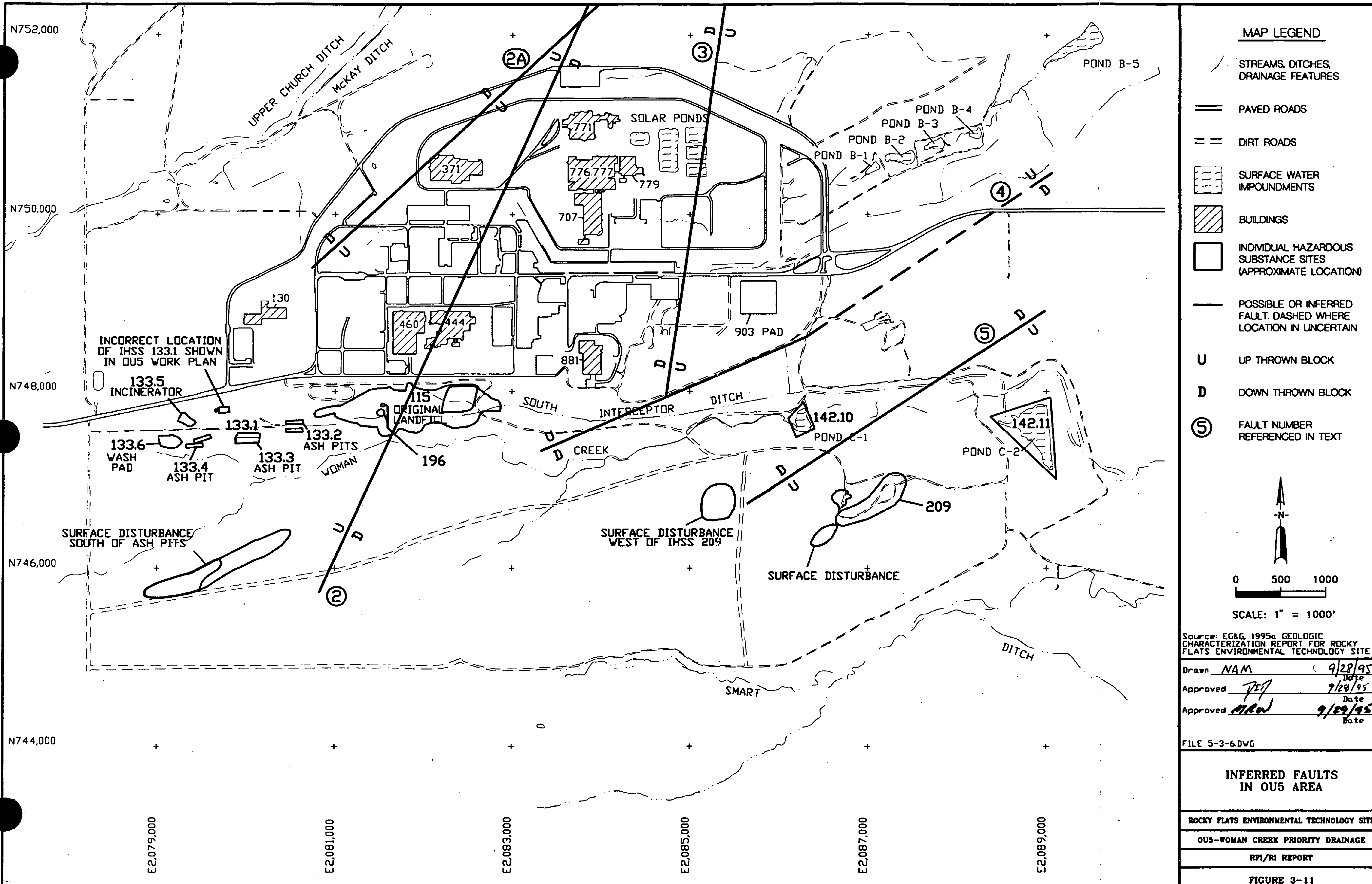
LOCATION OF SANDSTONES AND SILTSTONES ENCOUNTERED IN AND ADJACENT TO OU5

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-8



Source: EG&G, 1995a GEOLOGIC CHARACTERIZATION REPORT FOR ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Drawn NAM Date 9/28/95
Approved Date 9/28/95
Approved MRW Date 9/29/95

FILE 5-3-6.DWG

INFERRED FAULTS IN OU5 AREA

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

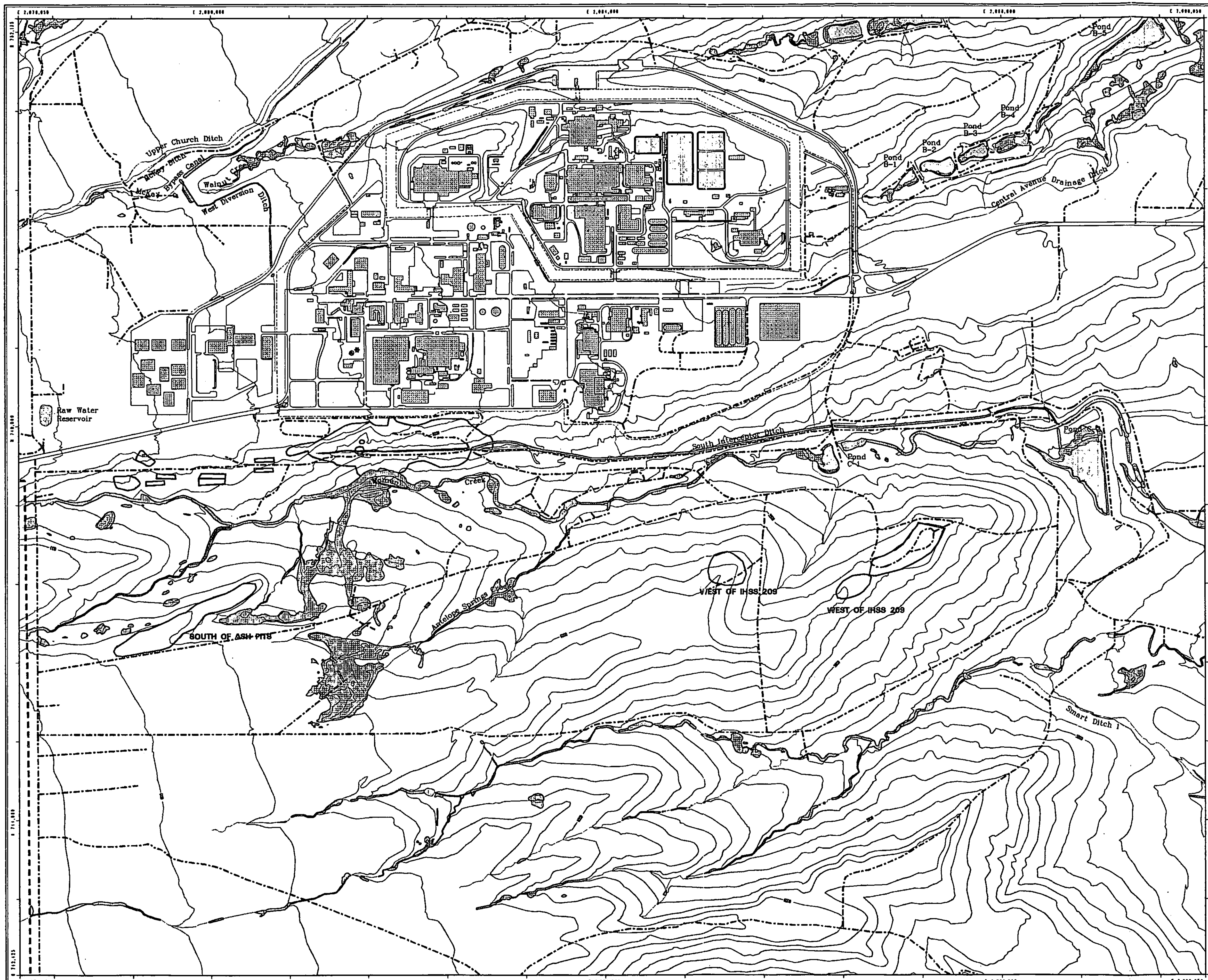
OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-11

Wetlands Identified in Woman Creek Watershed in Vicinity of OU5 IHSSs

Figure 3-13



- Wetlands
- OU5 IHSSs
- Ou5 Surface Disturbance

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20' Intervals)
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Wetlands data surveyed, compiled, and assembled by the U.S. Army Corps of Engineers; 1994.
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)

Scale = 1 : 12000
1 inch represents 1000 feet

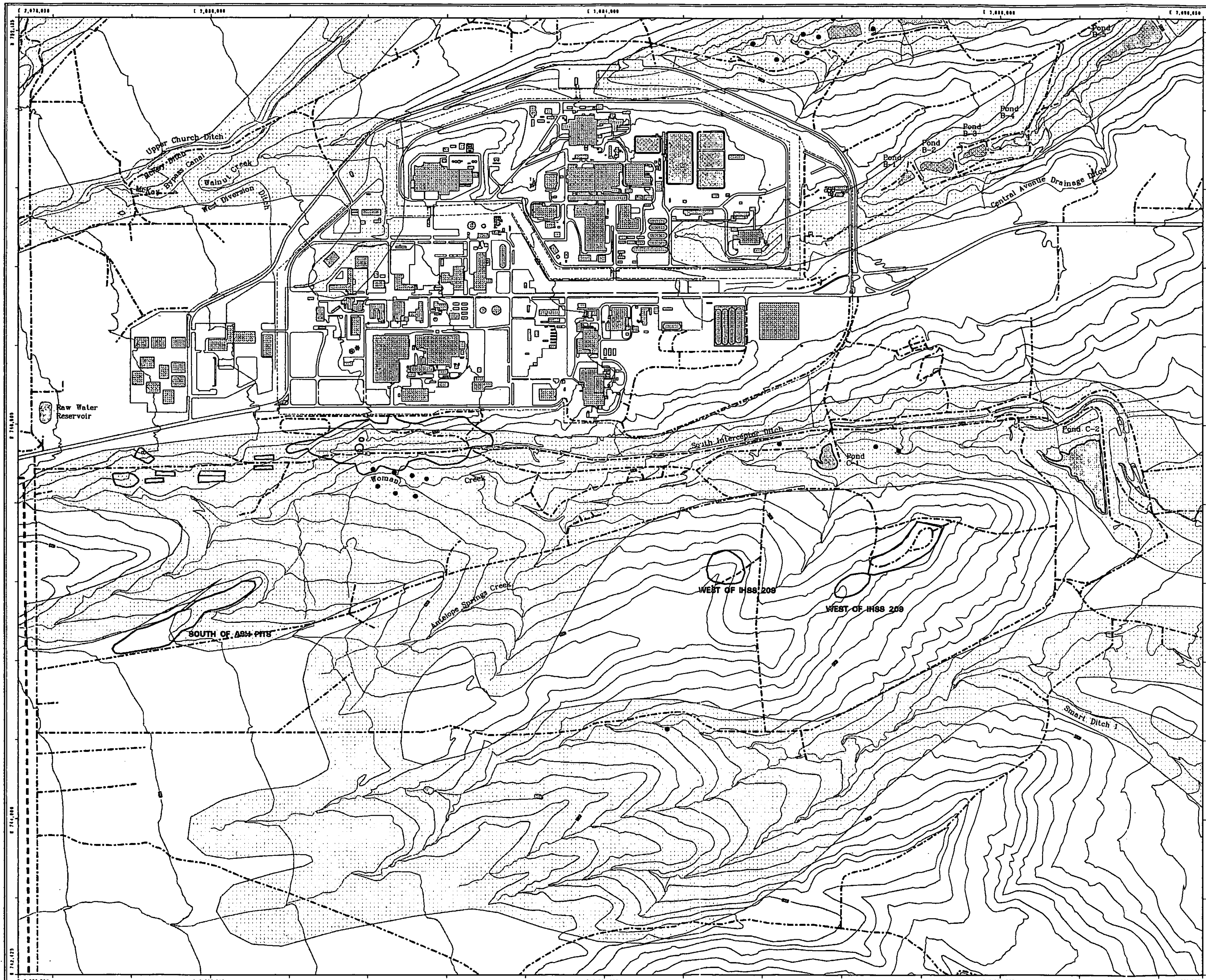
250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

MAP ID: fig-3-13 August 07, 1995

/home/f61162/projects/ou5/new-lhss/fig-3-13.aml



Capture Locations and Probable Range of Preble's Meadow Jumping Mouse in OU5 Vicinity

Figure 3-14

- Probable Range
- Records of (PMJM) (Zapus hudsonius preblei)
- OU5 IHSSs
- Ou5 Surface Disturbance

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20' Intervals)
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)
Records of Preble's Meadow Jumping Mouse & Probable Range, provided by Alison Deans of EP/EWM - 1994.

Scale = 1 : 12000
1 inch represents 1000 feet

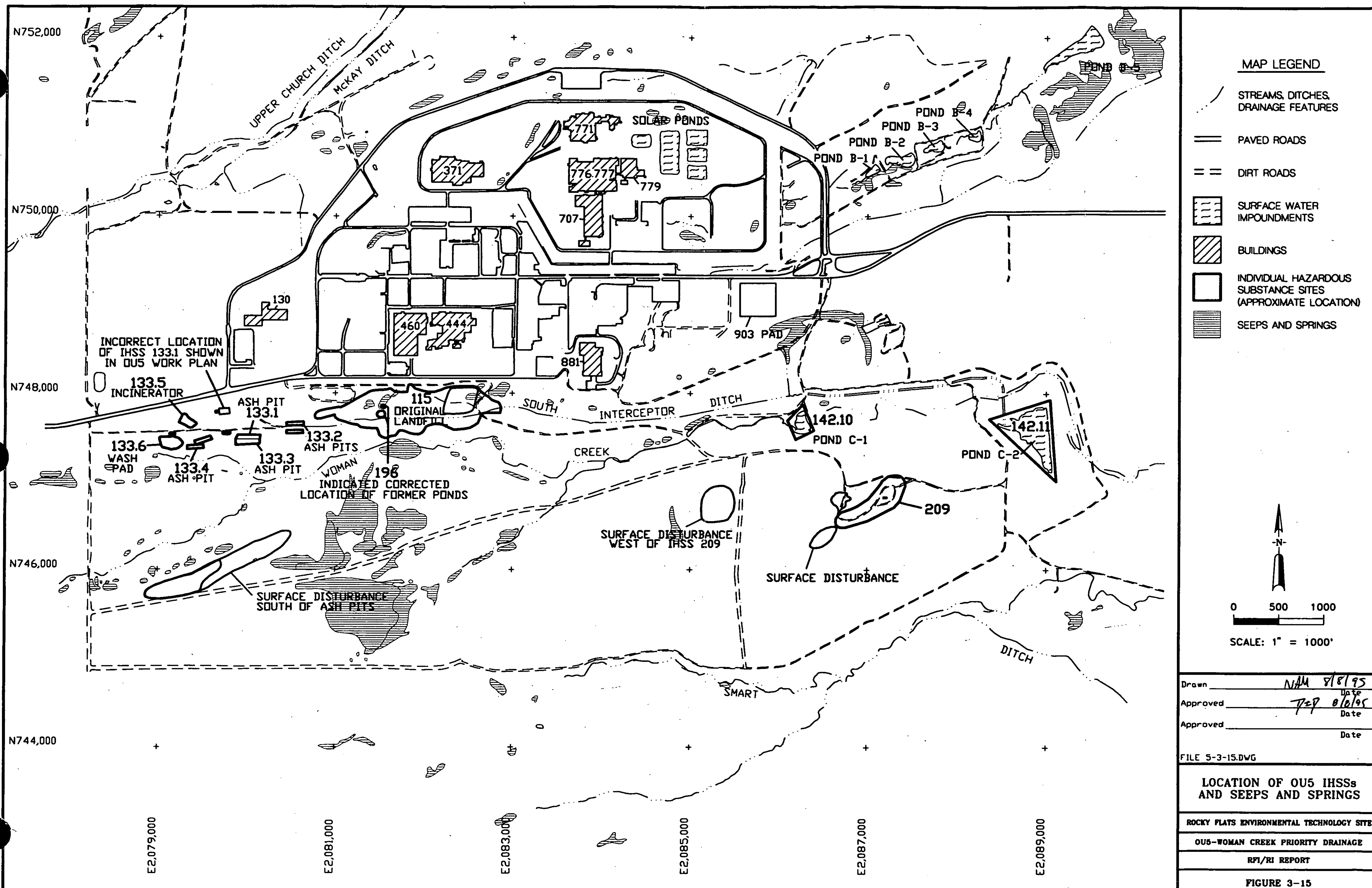
200 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

MAP ID: fig-3-14 August 07, 1995

/home/t5161621/projects/ou5/new-lhas/fig-3-14.aml



Drawn NAM 8/8/95 Date
Approved TEP 8/8/95 Date
Approved ______ Date

FILE 5-3-15.DWG

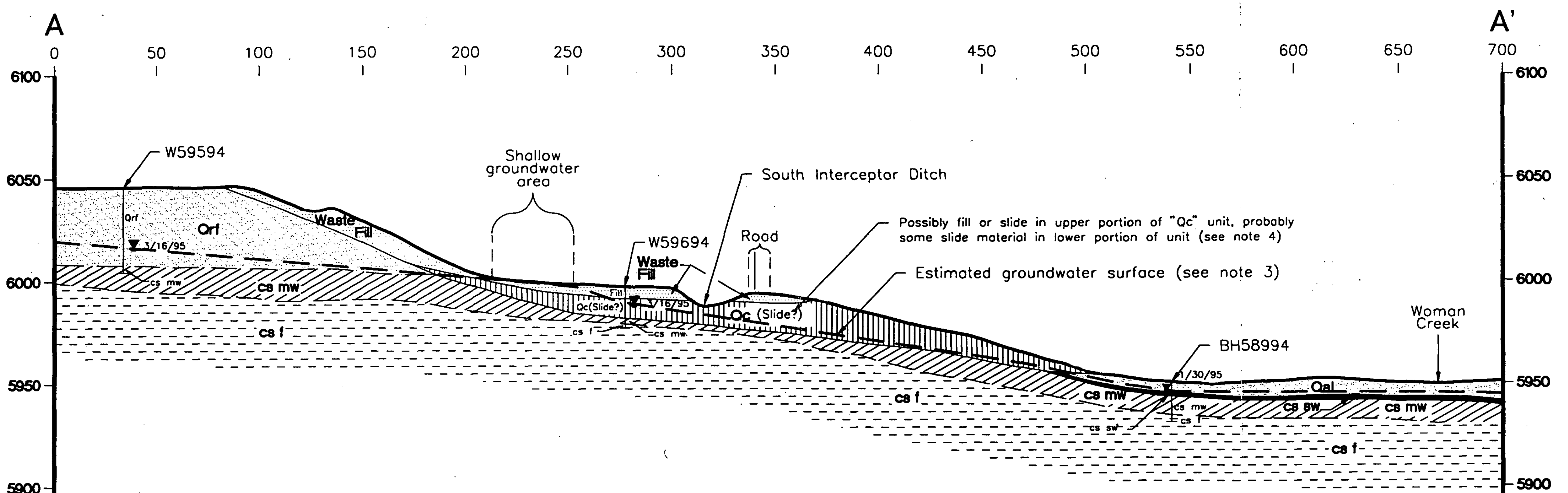
LOCATION OF OU5 IHSSs AND SEEPS AND SPRINGS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-15



LEGEND

Symbol	Description
Waste Fill	Waste fill
Qc	Colluvium
Qal	Valley Fill Alluvium
Qrf	Rocky Flats Alluvium
cs	Laramie Formation Claystone: sw - severely weathered mw - moderately weathered f - fresh
W59694 (Qc, 3/16/95, cs mw)	Geotechnical boring with monitoring well, showing geologic units, groundwater elevation and date measured.
BH58994 (1/30/95, Qal, cs sw)	Geotechnical boring, backfilled, showing geologic units, groundwater elevation and date encountered.

NOTES:

1. See Figure 3-21 for location of section.
2. See Figure 3-21 for description of geologic units.
3. Groundwater is apparently perched on underlying claystone.
4. Interpretation of the unit shown as Qc on this section is tentative and based on materials encountered in W59694; the location of pre-landfill ground surface along this section is needed to more confidently interpret origin of these materials.

50 0 50
SCALE IN FEET

SOURCE: EG&G, 1995e: PRELIMINARY ROCKY FLATS TECHNOLOGY SITE GEOTECHNICAL INVESTIGATION (DRAFT)

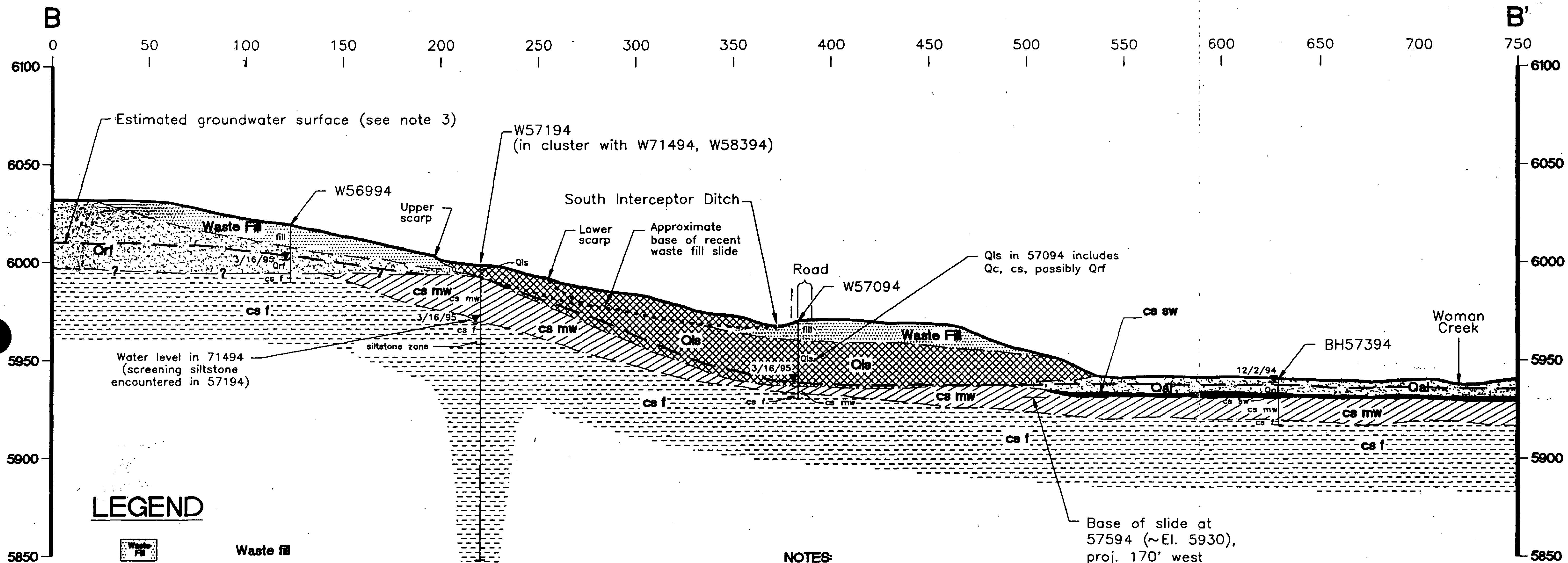
Drawn NAM Date 9/28/95
Checked Date 9/29/95
Approved MRW Date 9/29/95

FILE OU5-3-17.DWG

GEOLOGIC CROSS SECTION A-A'
IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
OU5-WOMAN CREEK PRIORITY DRAINAGE
RFI/RI REPORT

FIGURE 3-17



LEGEND

Symbol	Description
Waste Fill	Waste fill
Qls	Landslide Deposits (unit may contain material from several discrete landslides)
Qal	Valley Fill Alluvium
Qrf	Rocky Flats Alluvium
cs	Laramie Formation Claystone: sw = severely weathered; mw = moderately weathered; f = fresh
W57094 (Qls, 3/16/95, cs mw)	Geotechnical boring, with monitoring well, showing geologic units, groundwater elevation and date measured.
BH57394 (12/2/94, Qal, cs sw)	Geotechnical boring, backfilled, showing geologic units, groundwater elevation and date encountered.

NOTES:

1. See Figure 3-21 for location of section.
2. See Figure 3-21 for description of geologic units.
3. Groundwater is apparently perched on underlying claystone.

50 0 50
SCALE IN FEET

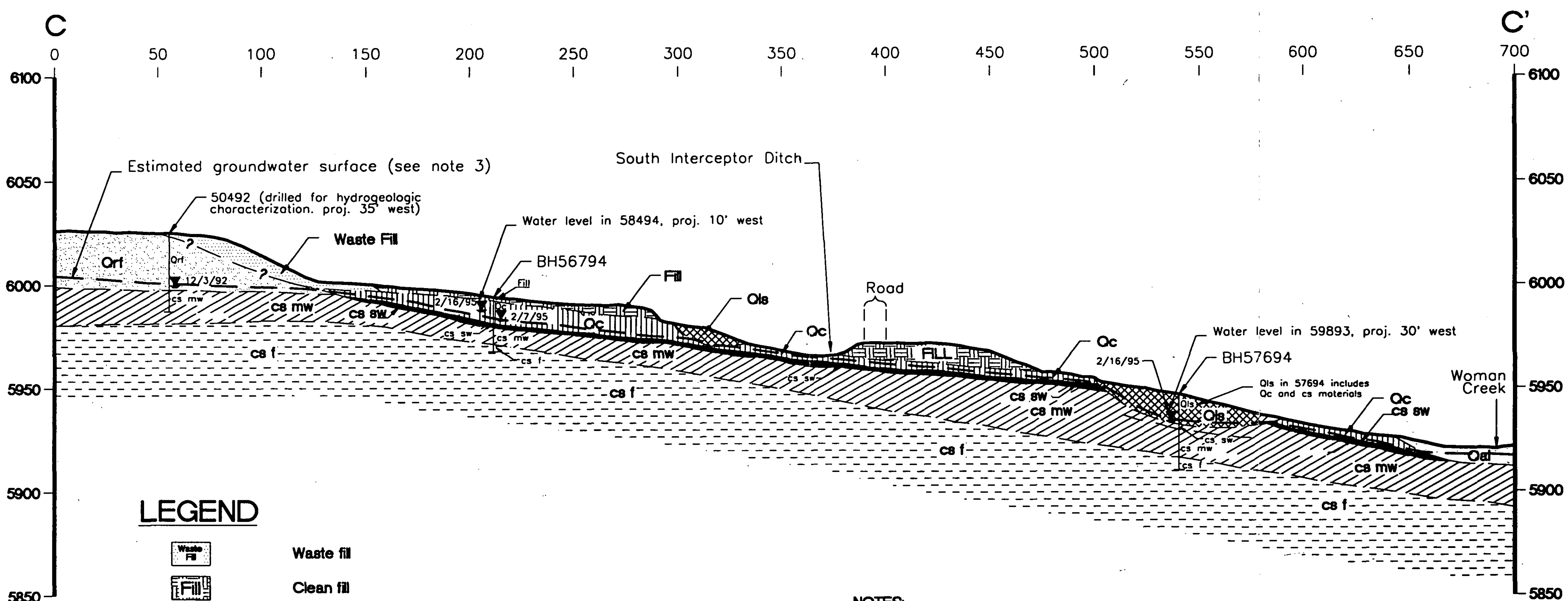
SOURCE: EG&G, 1995e: PRELIMINARY ROCKY FLATS TECHNOLOGY SITE GEOTECHNICAL INVESTIGATION (DRAFT)

Drawn NAM 9/28/95 Date
Checked [signature] 9/28/95 Date
Approved [signature] 9/29/95 Date

FILE 5-3-18.DWG

GEOLOGIC CROSS SECTION B-B' IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
OU5-WOMAN CREEK PRIORITY DRAINAGE
RFI/RI REPORT
FIGURE 3-18



LEGEND

- Waste fil — Waste fill
- Fill — Clean fill
- Qc — Colluvium
- Qls — Landslide Deposits (unit may contain material from several discrete landslides)
- Qal — Valley Fill Alluvium
- Qrf — Rocky Flats Alluvium
- cs — Laramie Formation Claystone:
  - sw = severely weathered
  - mw = moderately weathered
  - f = fresh

BH57694 — 3/16/95 — Qls, cs sw, cs mw, cs f

Geotechnical boring, backfilled, showing geologic units, groundwater elevation and date encountered.

NOTES:

1. See Figure 3-21 for location of section.
2. See Figure 3-21 for description of geologic units.
3. Groundwater is apparently perched on underlying claystone.

50 0 50
SCALE IN FEET

SOURCE: EG&G, 1995e: PRELIMINARY ROCKY FLATS TECHNOLOGY SITE GEOTECHNICAL INVESTIGATION (DRAFT)

Drawn	NAM	9/28/95 Date
Checked	TJA	9/28/95 Date
Approved	MRW	9/29/95 Date

FILE OU5-3-19.DWG

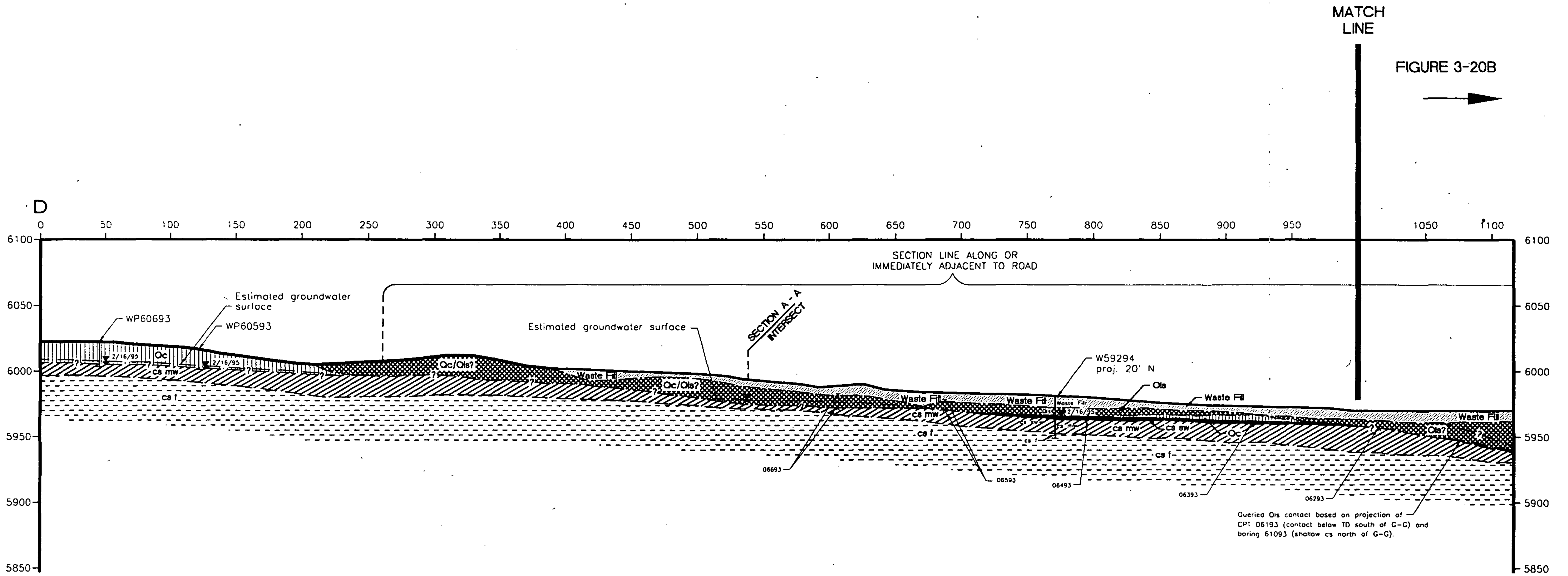
GEOLOGIC CROSS SECTION C-C' IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-19



NOTES:
1. See Figure 3-21 for location of section.
2. See Figure 3-21 for description of geologic units.
3. Geologic contacts from projected exploration locations are adjusted to assumed elevation along line of section.

LEGEND

- Waste fill: road fill probably including some waste material
- Clean road fill
- Waste fill, clean fill, undifferentiated
- Colluvium
- Landslide Deposits (unit may contain material from several descrete landslides)
- Claystone: sw = severely weathered; mw = moderately weathered; f = fresh

- W57094 — Geotechnical boring with monitoring well, showing geologic units, groundwater elevation, and date measured.
- BH57494 — Geotechnical boring, backfilled, showing geologic units: groundwater not encountered.
- 06393 — Interpreted geologic contact based on projected CPT (Cone Penetration Test), with sounding number.
- WP60693 — Well point installed for hydrogeologic characterization, showing groundwater elevation and date measured.

80 0 80
SCALE IN FEET

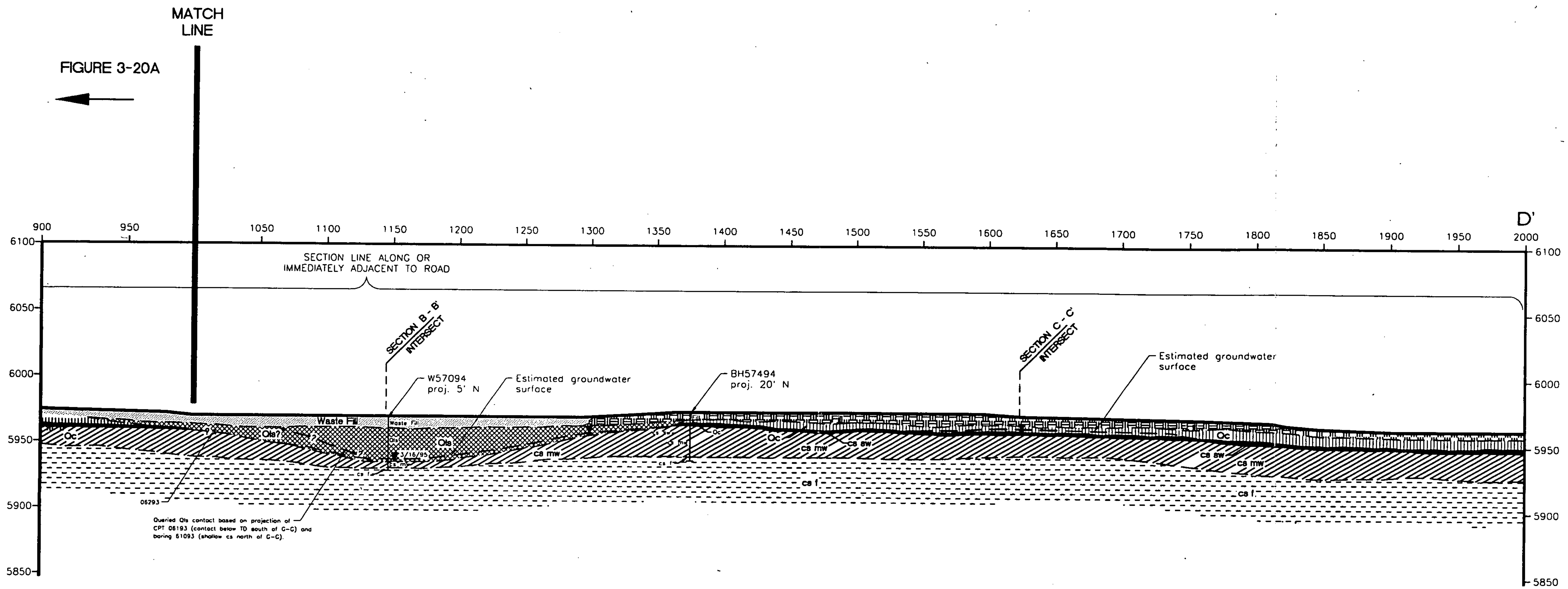
SOURCE: EG&G, 1995e: PRELIMINARY ROCKY FLATS TECHNOLOGY SITE GEOTECHNICAL INVESTIGATION (DRAFT)

Drawn NAM	9/28/95 Date
Checked [signature]	9/28/95 Date
Approved MRW	9/29/95 Date

FILE 5-3-20A.DWG

GEOLOGIC CROSS SECTION D-D' IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
OU5-WOMAN CREEK PRIORITY DRAINAGE
RFI/RI REPORT
FIGURE 3-20A



NOTES:

1. See Figure 3-21 for location of section.
2. See Figure 3-21 for description of geologic units.
3. Geologic contacts from projected exploration locations are adjusted to assumed elevation along line of section.

LEGEND

- Waste fill: road fill probably including some waste material
- Clean road fill
- Waste fill, clean fill, undifferentiated
- Colluvium
- Landslide Deposits (unit may contain material from several descrete landslides)
- Claystone: sw - severely weathered; mw - moderately weathered; f - fresh

- W57094 (Qls, 3/16/95, cs mw): Geotechnical boring with monitoring well, showing geologic units, groundwater elevation, and date measured.
- BH57494 (Fill, cs sw, cs mw): Geotechnical boring, backfilled, showing geologic units: groundwater not encountered.
- 06393 —x—: Interpreted geologic contact based on projected CPT (Cone Penetration Test), with sounding number.
- WP60693 (2/16/95): Well point installed for hydrogeologic characterization, showing groundwater elevation and date measured.

80 0 80
SCALE IN FEET

SOURCE: EG&G, 1995e: PRELIMINARY ROCKY FLATS TECHNOLOGY SITE GEOTECHNICAL INVESTIGATION (DRAFT)

Drawn	NAM	9/28/95 Date
Checked	TEP	9/28/95 Date
Approved	MRW	9/29/95 Date

FILE 5-3-20B.DWG

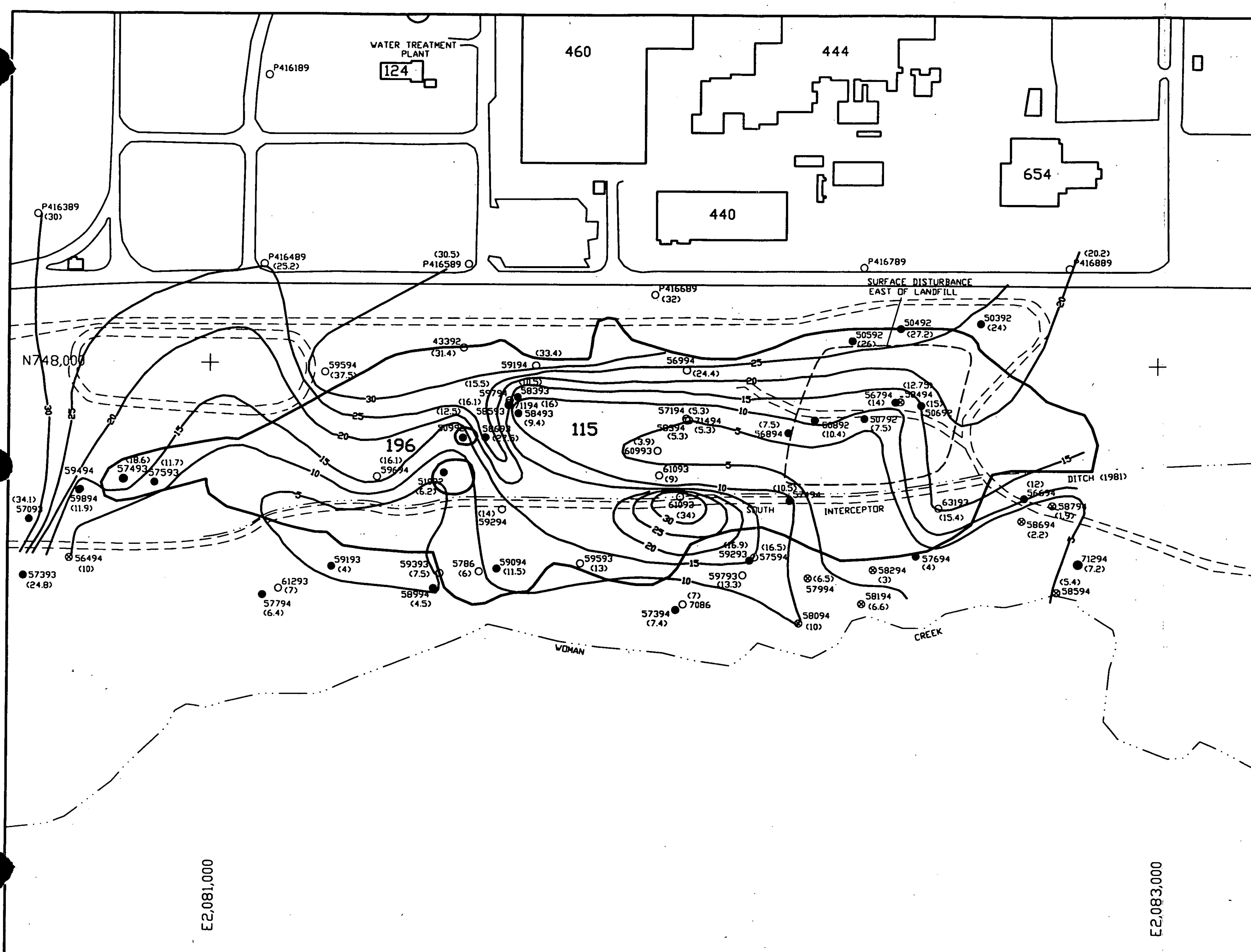
GEOLOGIC CROSS SECTION D-D' IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-20B



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES
PAVED ROADS
DIRT ROADS
ORIGINAL LANDFILL AND SURFACE DISTURBANCE, PRE - SID
50392 BOREHOLE LOCATION
63193 WELL LOCATION
58694 MINI WELL
(7.2) ALLUVIAL THICKNESS
15 ALLUVIAL THICKNESS CONTOUR 5'

N

0 100 200

SCALE: 1" = 200'

Drawn NAM Date 9/29/95
Checked TJT Date 10/1/95
Approved MRW Date 10/10/95

FILE OU5-3-16.DWG

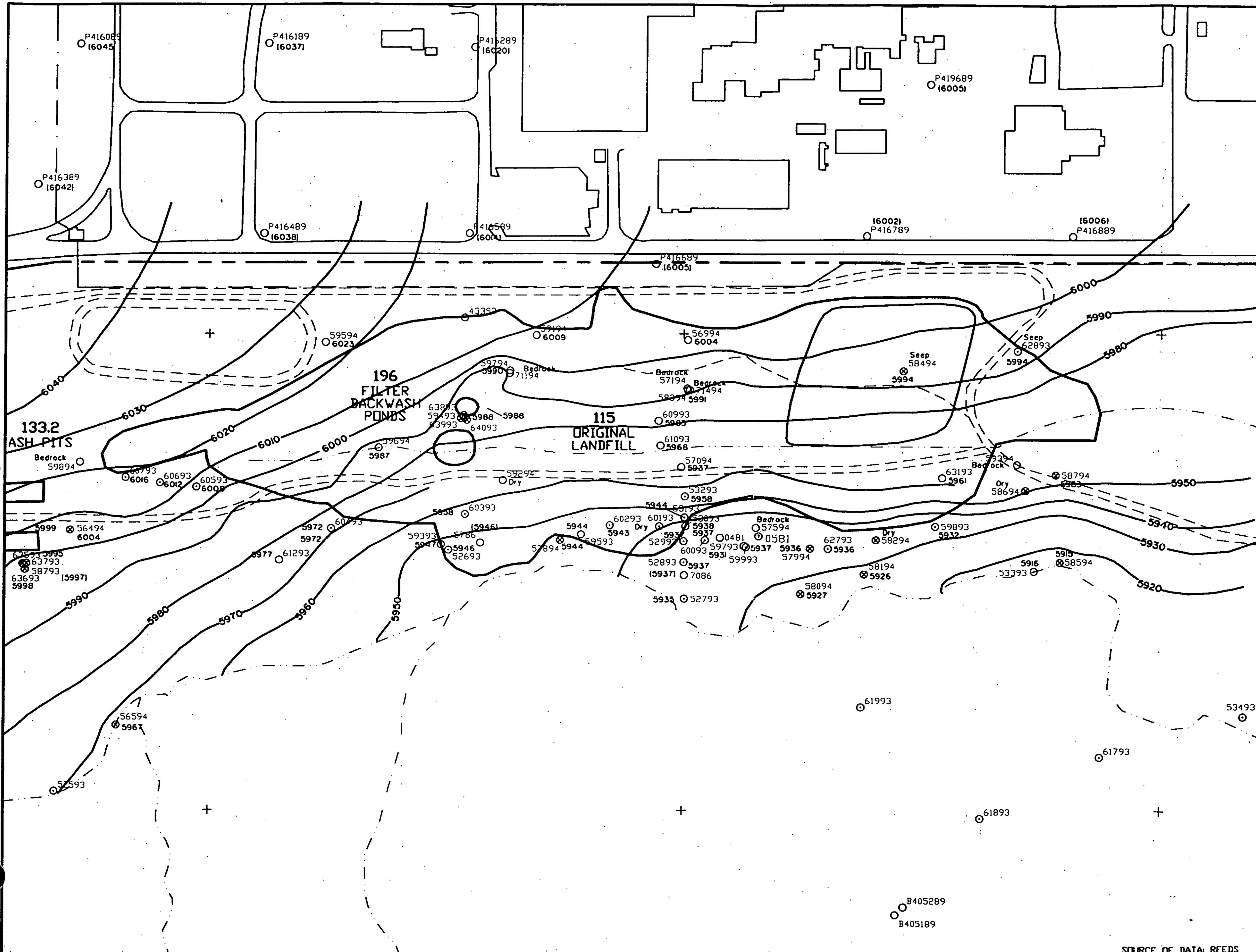
UNCONSOLIDATED MATERIALS ISOPACH MAP IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-21



Drawn NAM 9/28/95 Date
Checked TIA 9/28/95 Date
Approved MRW 9/29/95 Date
File 5-3-24

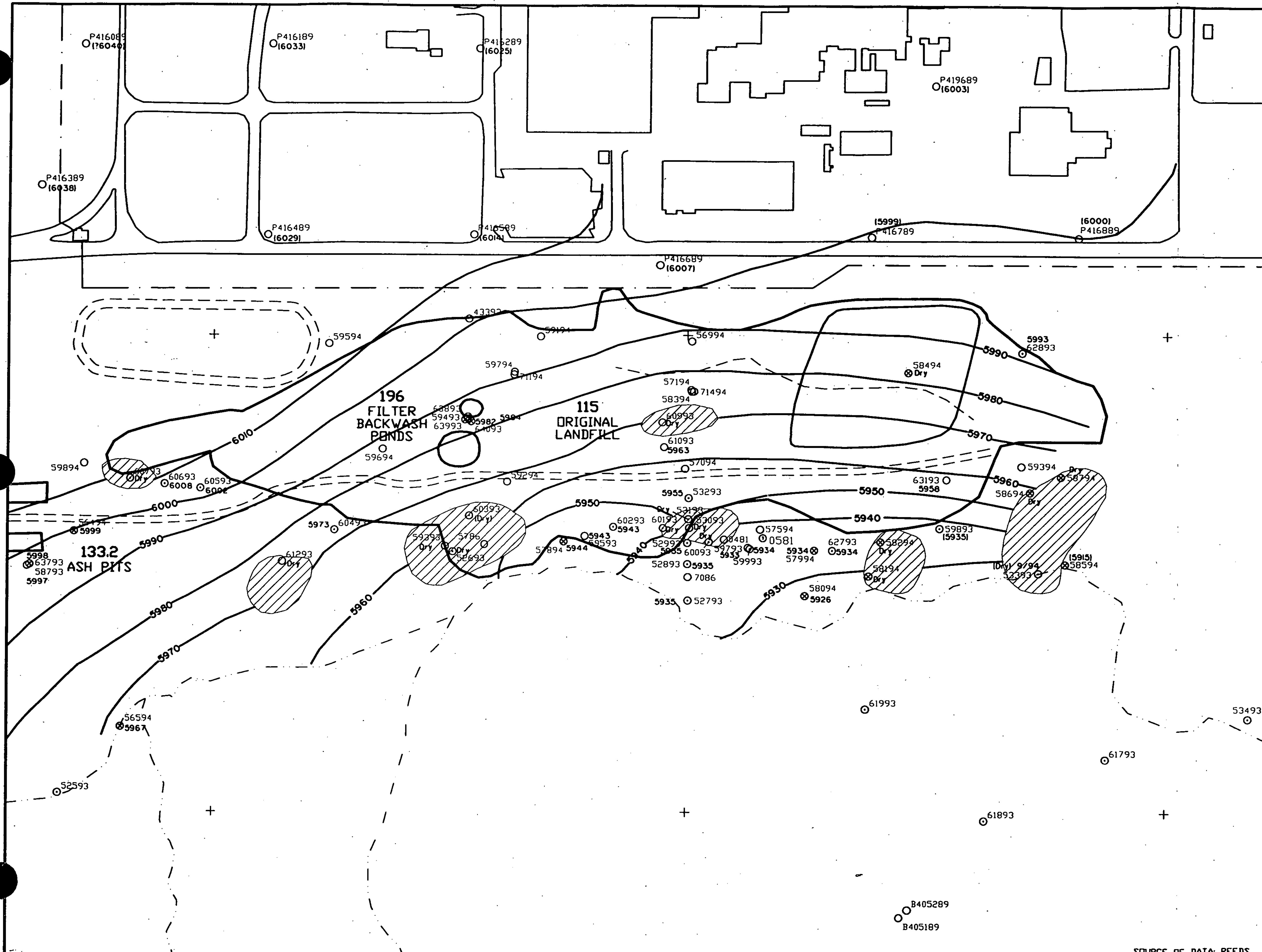
IHSS 115 HIGH-WATER-LEVEL UHSU POTENTIOMETRIC-SURFACE MAP OF MAY 16-19, 1995

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-24



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES (APPROXIMATE LOCATION)
- DRY AREA
- WATER LEVEL CONTOUR
- 5961 WATER LEVEL ELEVATION
- 5961 WATER LEVEL NOT MEASURED OCT. 19-24
- WELL
- WELLPOINT
- SMALL DIAMETER WELL

-N-

0 100 200

SCALE: 1" = 200'

Drawn	NAM	9/29/95 Date
Checked	TEJ	10/1/95 Date
Approved	MRW	10/10/95 Date

File 5-3-25

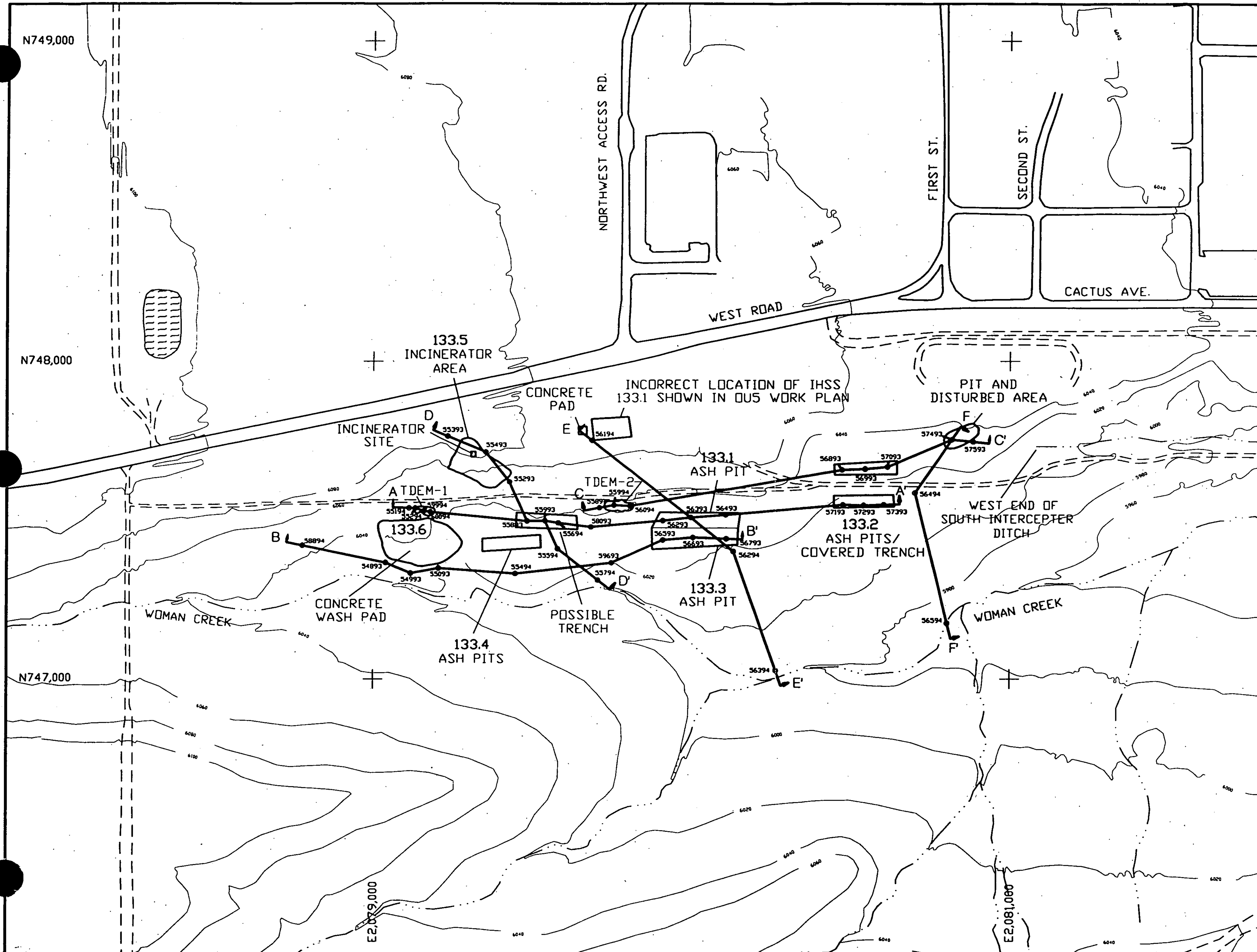
IHSS 115 LOW-WATER-LEVEL UHSU POTENTIOMETRIC-SURFACE MAP OF OCT. 19-24, 1994

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-25



Drawn NAM 9/28/95 Date
Checked 9/28/95 Date
Approved MRW 9/28/95 Date

FILE OU5-3-27.DWG

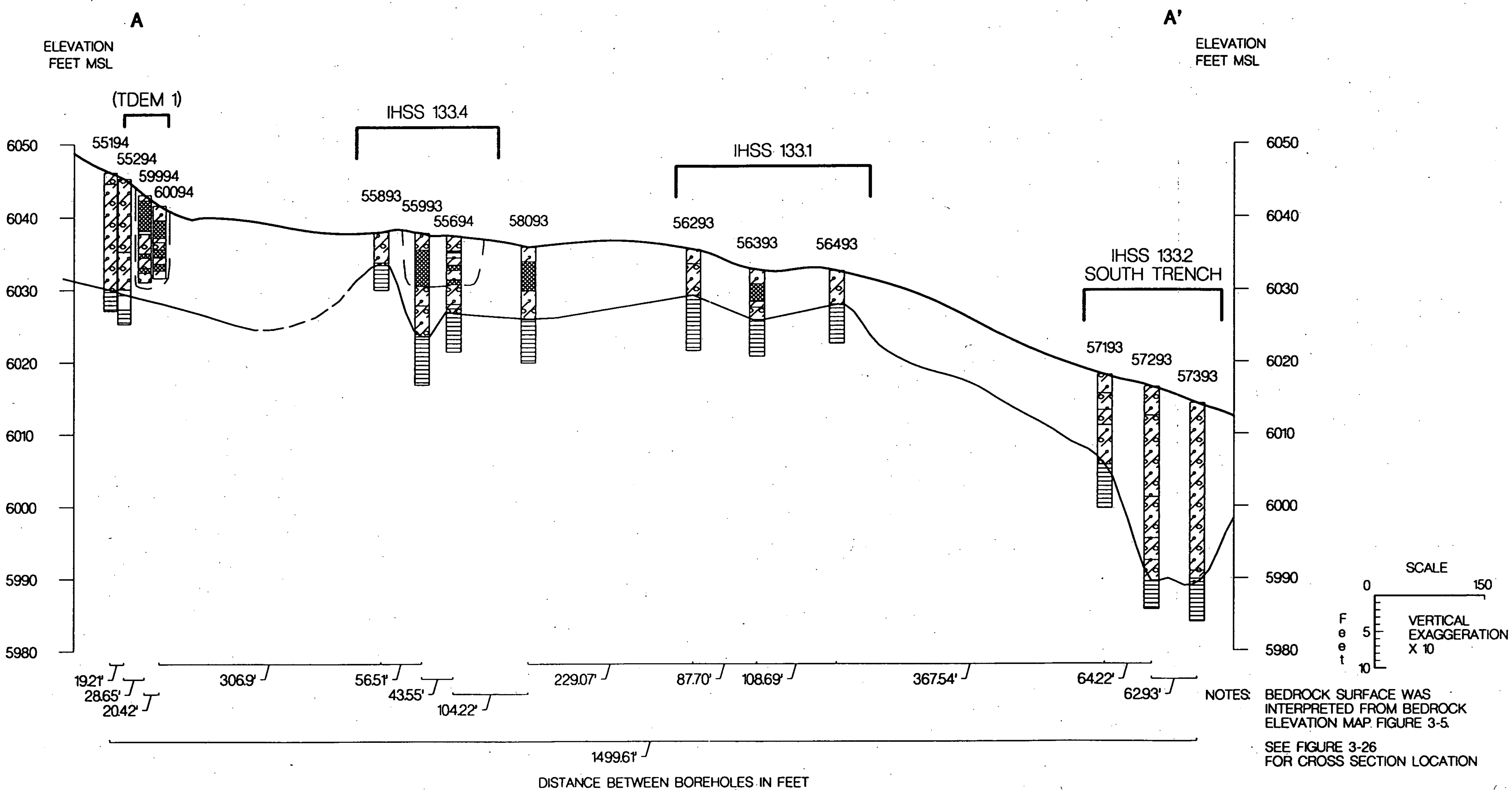
CROSS SECTION LOCATION MAP IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-26



NOTES: BEDROCK SURFACE WAS INTERPRETED FROM BEDROCK ELEVATION MAP FIGURE 3-5.

SEE FIGURE 3-26 FOR CROSS SECTION LOCATION

SOURCE OF DATA: LOGIT LOGS

Drawn NAM	9/29/95 Date
Checked	10/1/95 Date
Approved	10/10/95 Date
File 5-3-31	

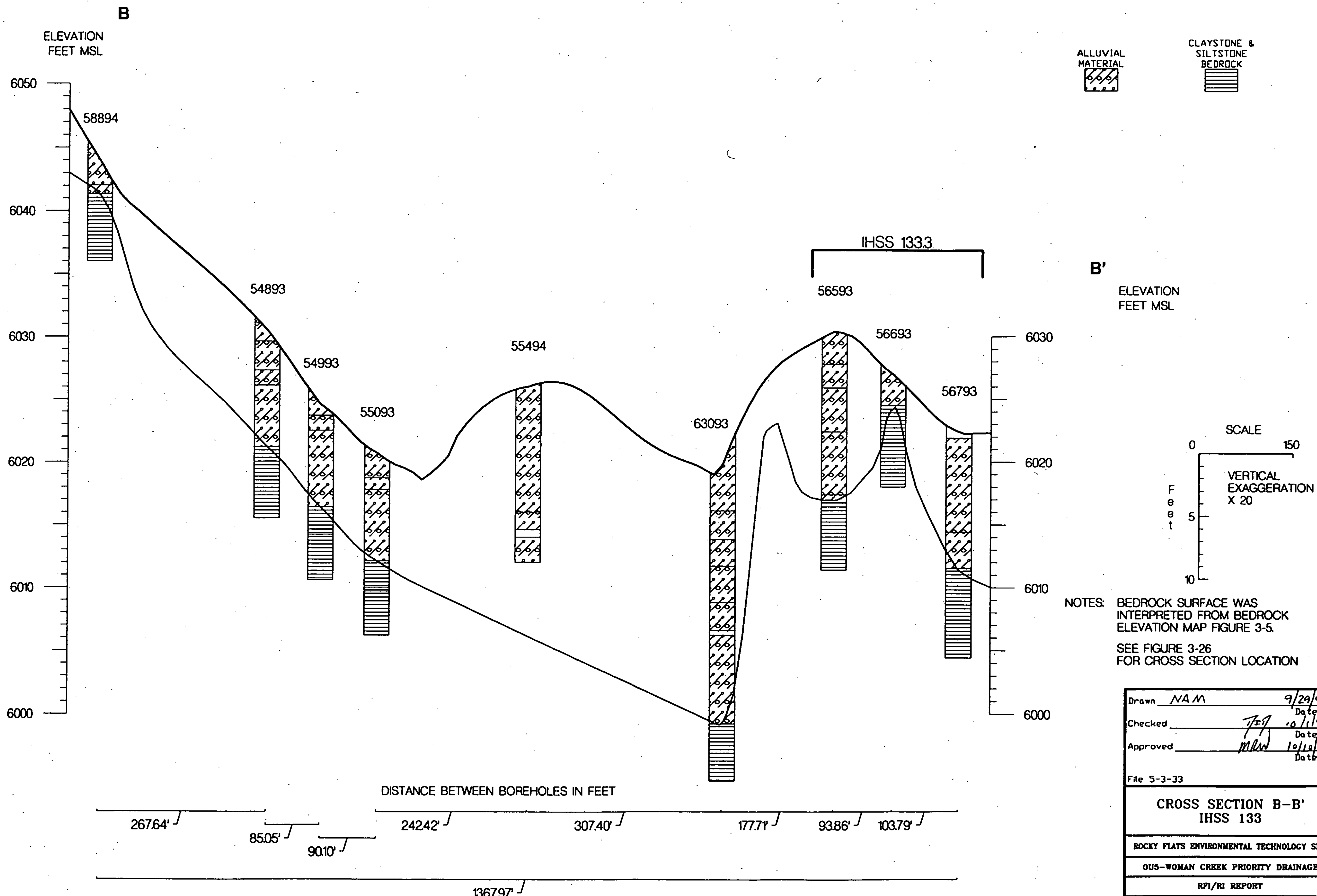
CROSS SECTION A-A'
IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-27



NOTES: BEDROCK SURFACE WAS INTERPRETED FROM BEDROCK ELEVATION MAP FIGURE 3-5.

SEE FIGURE 3-26 FOR CROSS SECTION LOCATION

Drawn NAM	9/29/95 Date
Checked TJ	10/1/95 Date
Approved MRW	10/10/95 Date
File 5-3-33	

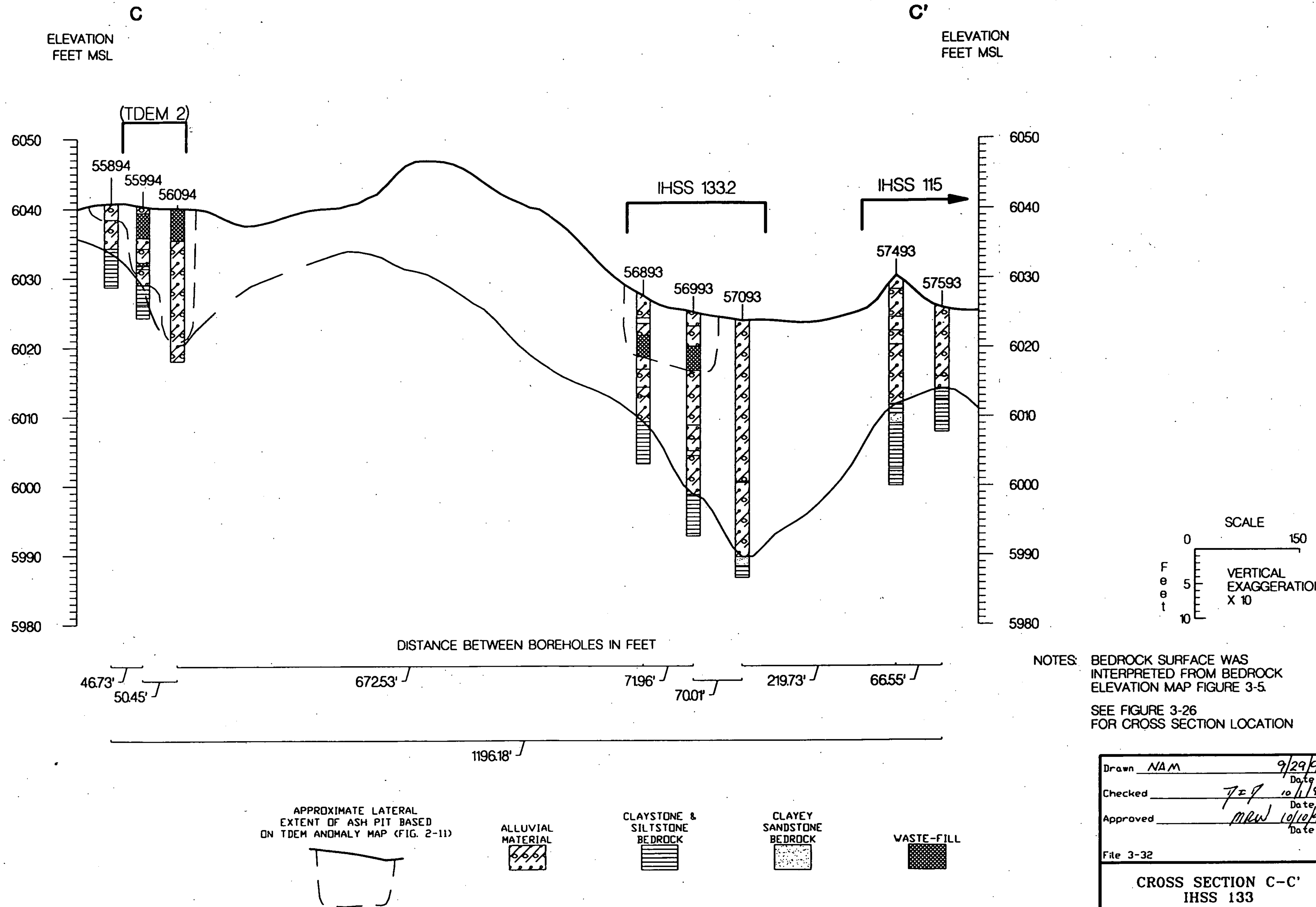
CROSS SECTION B-B'
IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-28



SOURCE OF DATA: LOGIT LOGS

Drawn NAM	9/29/95 Date
Checked TEF	10/1/95 Date
Approved MRW	10/10/95 Date
File 3-32	

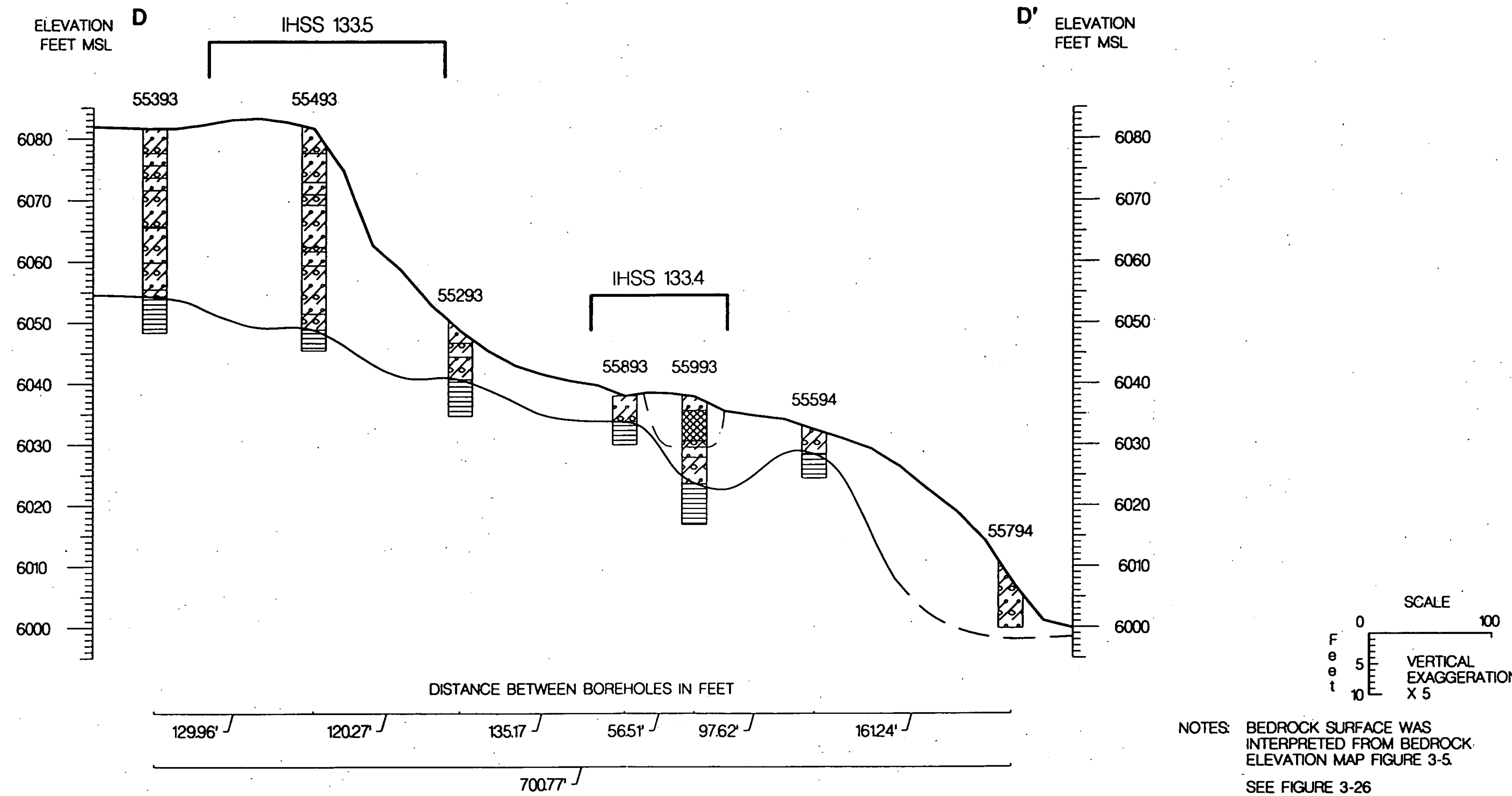
CROSS SECTION C-C'
IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-29



NOTES: BEDROCK SURFACE WAS INTERPRETED FROM BEDROCK ELEVATION MAP FIGURE 3-5.

SEE FIGURE 3-26 FOR CROSS SECTION LOCATION

SOURCE OF DATA: LOGIT LOGS

Drawn NAM	9/29/95 Date
Checked FEF	10/1/95 Date
Approved MRW	10/10/95 Date
File 5-3-27	

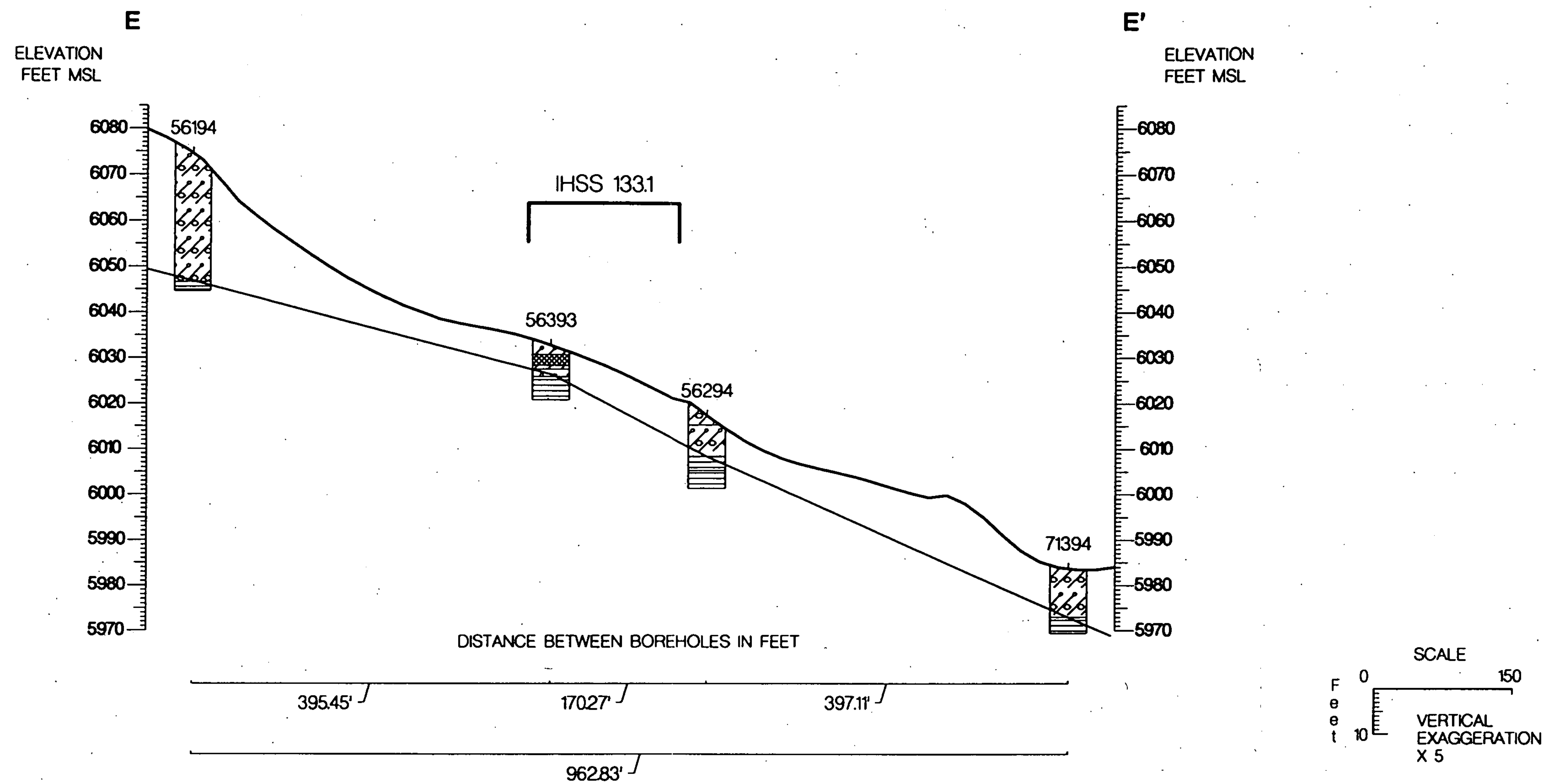
CROSS SECTION D-D'
IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-30



NOTES: BEDROCK SURFACE WAS INTERPRETED FROM BEDROCK ELEVATION MAP FIGURE 3-5.

SEE FIGURE 3-26 FOR CROSS SECTION LOCATION

SOURCE OF DATA: LOGIT LOGS

Drawn NAM	9/29/95 Date
Checked [signature]	10/1/95 Date
Approved MRW	10/10/95 Date
File 5-3-28	

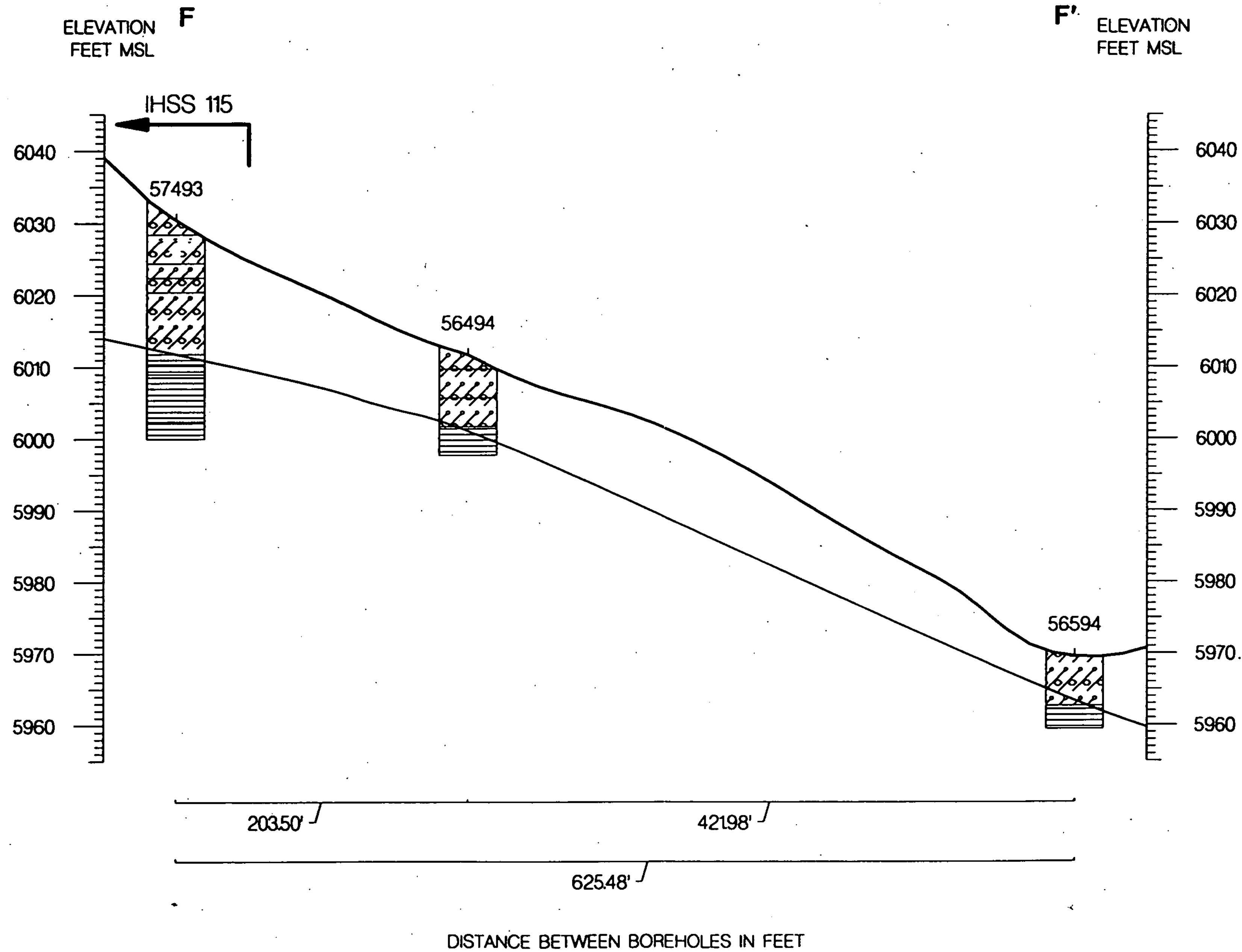
CROSS SECTION E-E'
IHSS 133

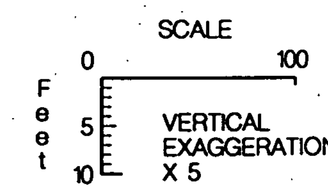
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

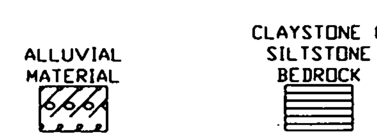
FIGURE 3-31





NOTES: BEDROCK SURFACE WAS INTERPRETED FROM BEDROCK ELEVATION MAP FIGURE 3-5.

SEE FIGURE 3-26 FOR CROSS SECTION LOCATION



Drawn NAM	9/29/95 Date
Checked [signature]	10/1/95 Date
Approved MRW	10/10/95 Date
File 5-3-29	

CROSS SECTION F-F'
IHSS 133

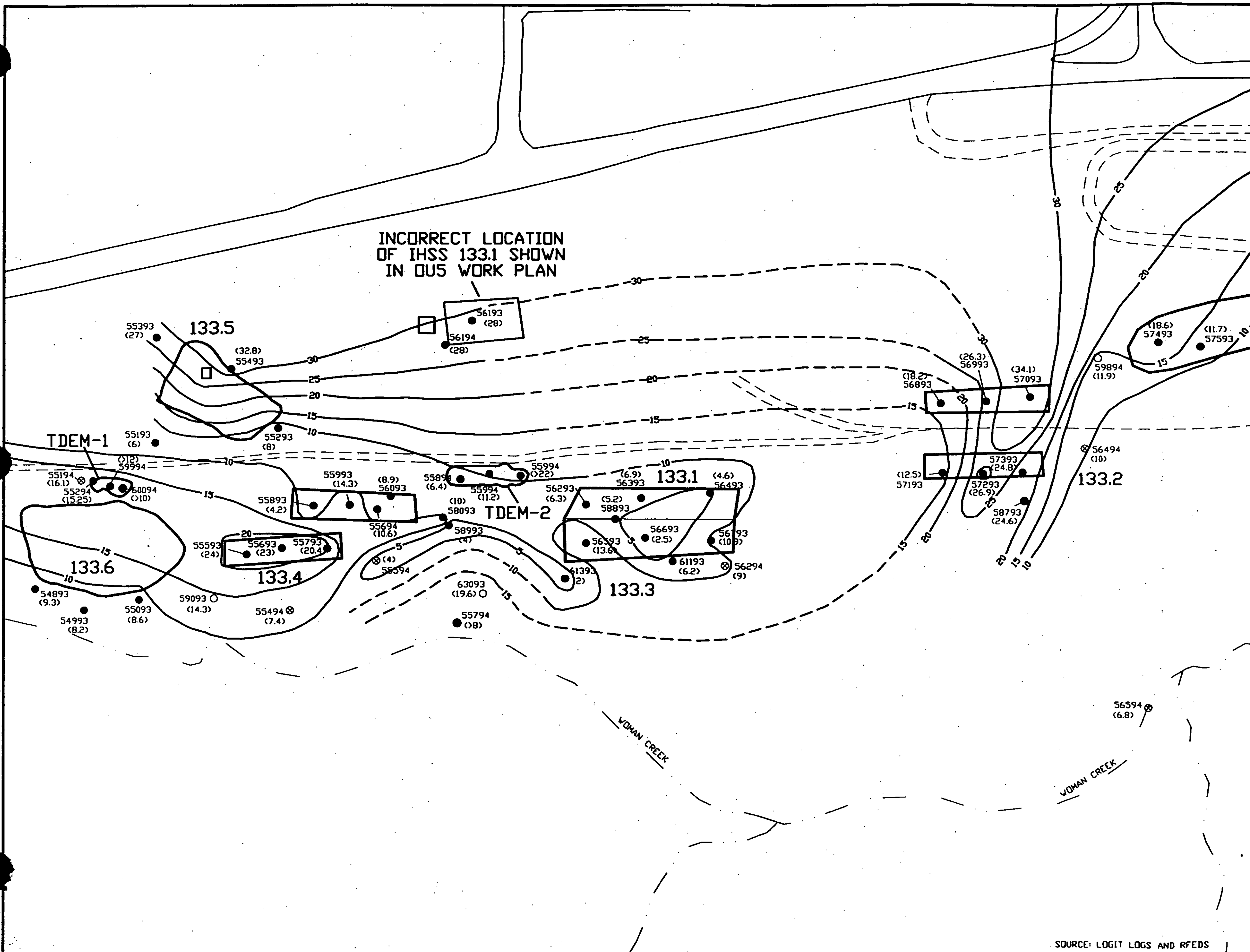
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-32

SOURCE OF DATA: LOGIT LOGS



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

ORIGINAL LANDFILL AND SURFACE DISTURBANCE, PRE - SID OR TDEM

57493 BOREHOLE LOCATION

59093 WELL LOCATION

55494 MINI WELL

(7.2) UNCONSOLIDATED MATERIALS THICKNESS

15 UNCONSOLIDATED MATERIALS THICKNESS CONTOUR (5' INTERVAL)

-N-

0 75 150

SCALE: 1" = 150'

Drawn NAM 10/11/95 Date

Checked 10/11/95 Date

Approved 10-16-95 Date

FILE 5-3-26.DWG

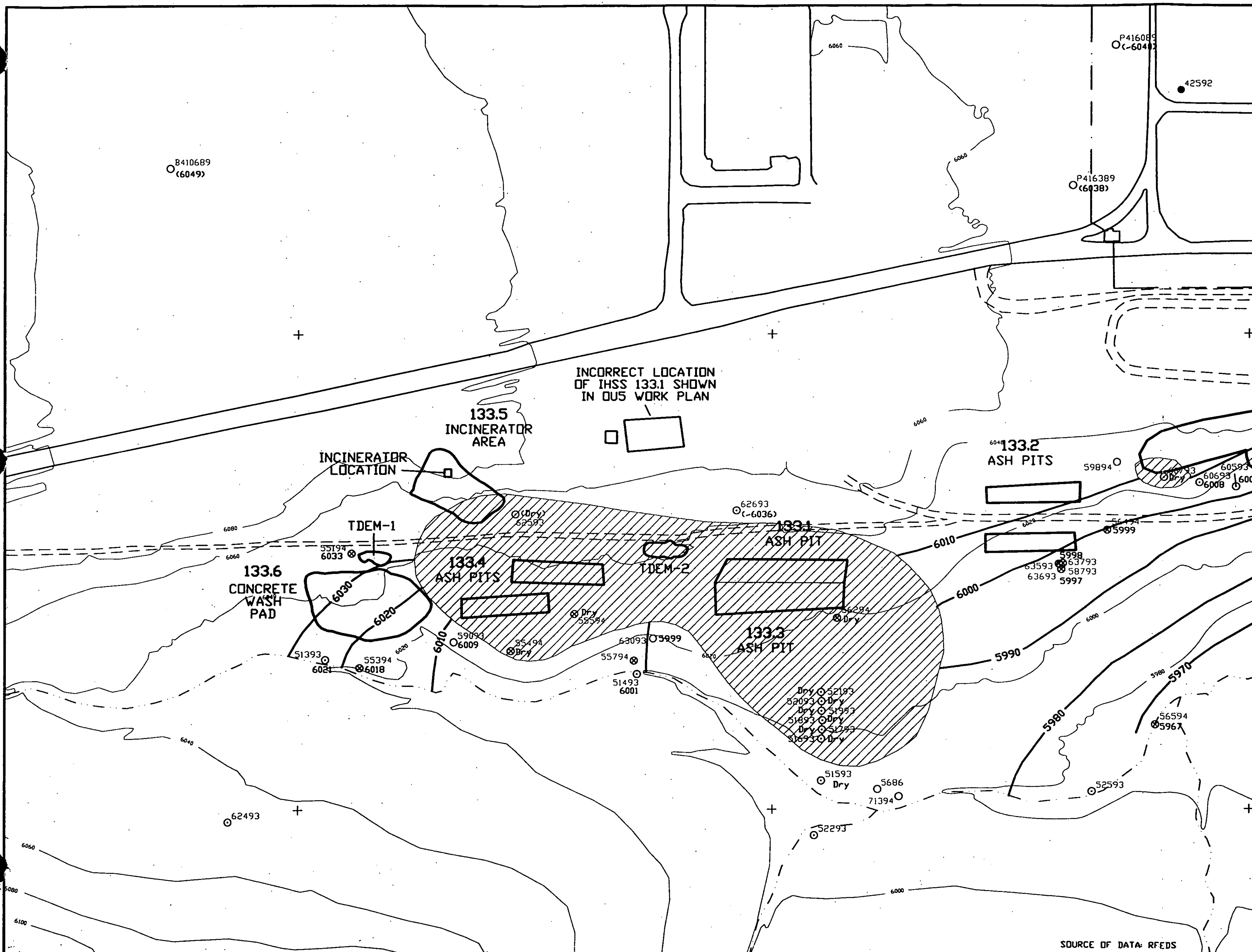
UNCONSOLIDATED MATERIALS ISOPACH MAP IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-33



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES (APPROXIMATE LOCATION)
- DRY AREA
- WATER LEVEL CONTOUR
- 55594 LOCATION CODE
- 5961 WATER LEVEL ELEVATION
- WELL
- WELLPOINT
- SMALL DIAMETER WELL

-N-

0 100 200

SCALE: 1" = 200'

Drawn NAM 9/28/95 Date

Checked [signature] 9/28/95 Date

Approved MRW 9/25/95 Date

File 5-3-36

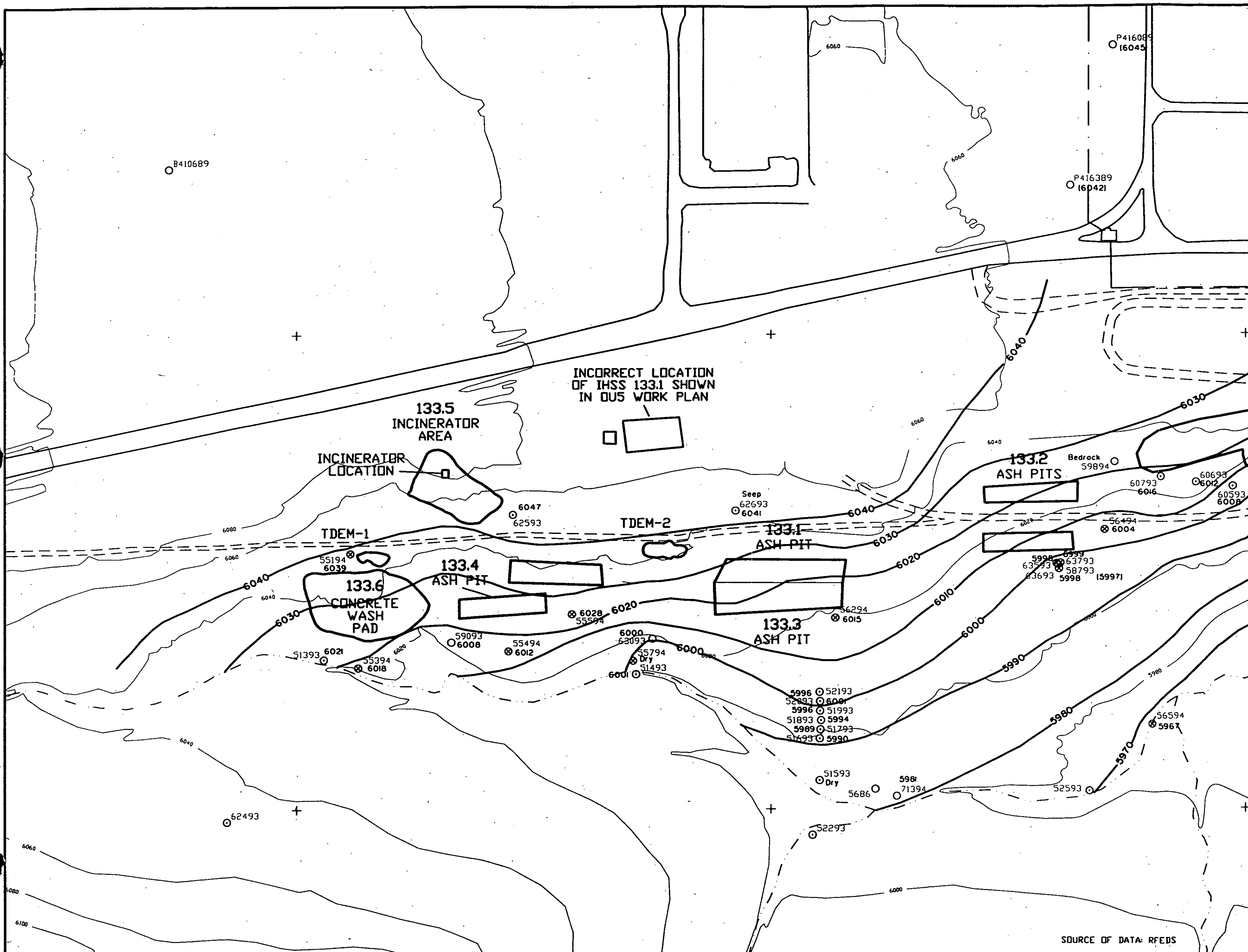
IHSS 133 LOW-WATER-LEVEL UHSU POTENTIOMETRIC-SURFACE MAP OF OCT. 19-24, 1994

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-34



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

INDIVIDUAL HAZARDOUS SUBSTANCE SITES (APPROXIMATE LOCATION)

WATER LEVEL CONTOUR

55594 LOCATION CODE

5961 WATER LEVEL ELEVATION

WELL

WELLPOINT

SMALL DIAMETER WELL

N

0 100 200

SCALE: 1" = 200'

Drawn NAM 9/29/95 Date

Checked [signature] 10/1/95 Date

Approved [signature] 10/10/95 Date

File 5-3-35

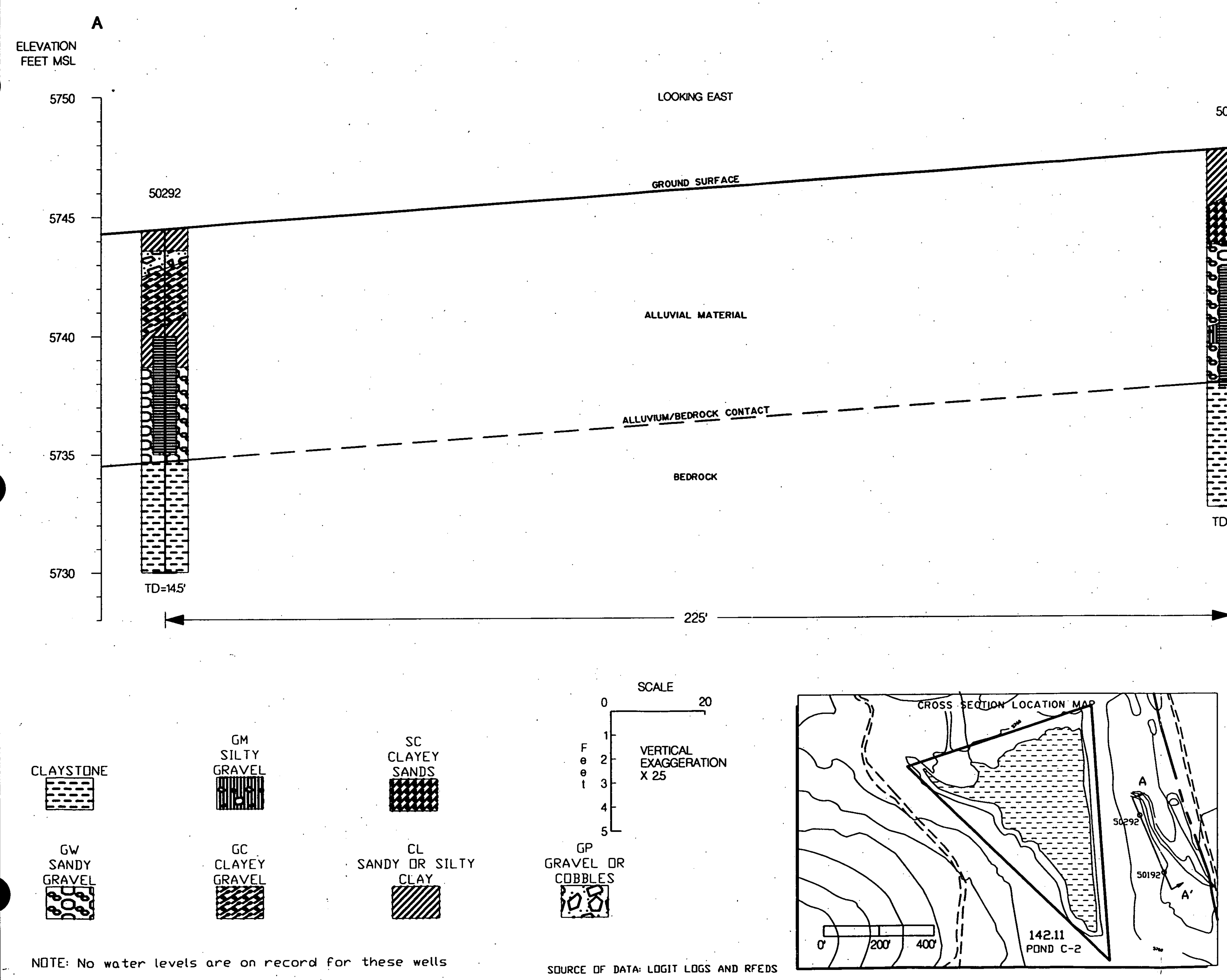
IHSS 133
HIGH-WATER-LEVEL UHSU
POTENTIOMETRIC-SURFACE
MAP OF MAY 16-19, 1995

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-35



Drawn NAM 9/28/95 Date
Checked [signature] 9/28/95 Date
Approved [signature] 9/29/95 Date
FILE OU5-3-37.DWG

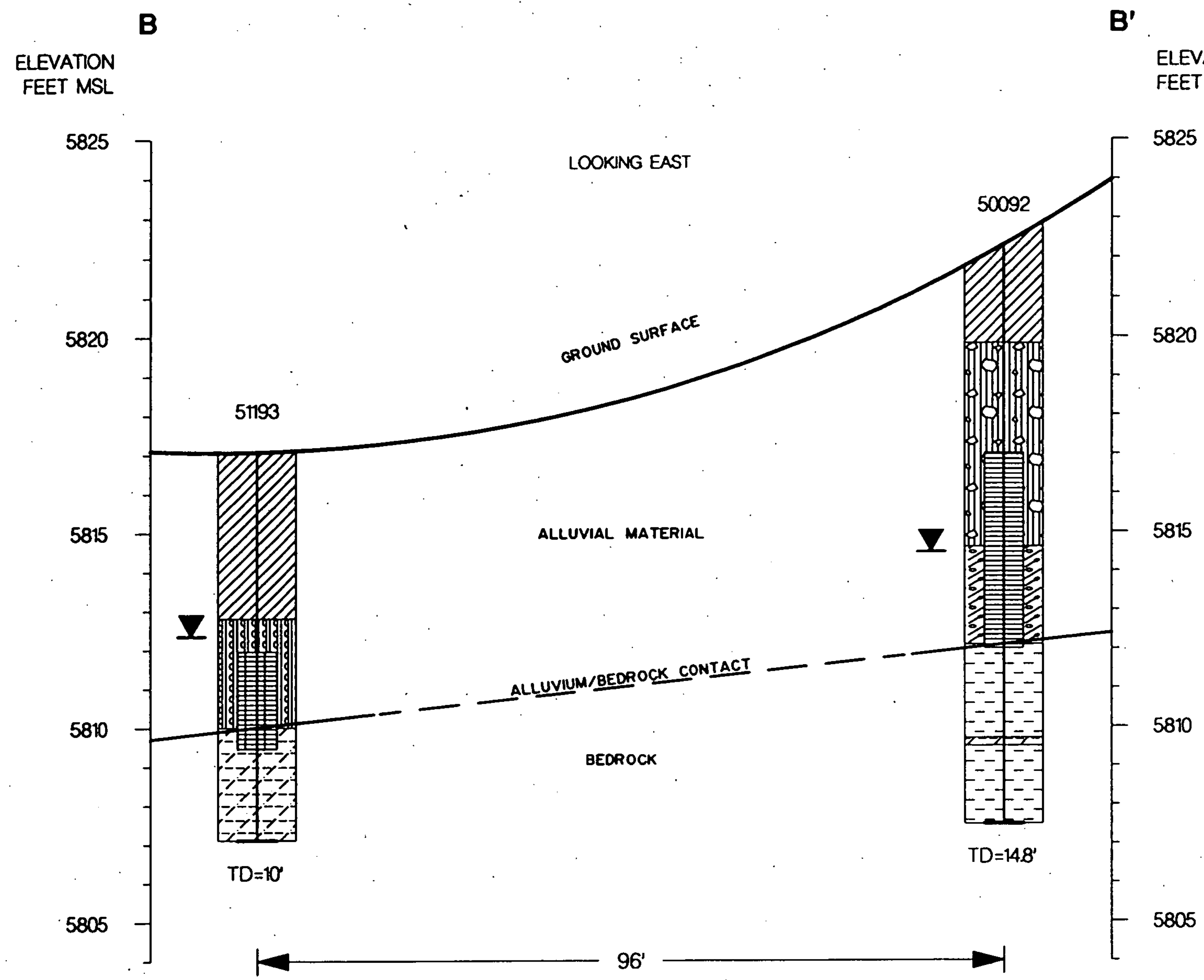
GENERALIZED GEOLOGIC CROSS SECTION A-A' IHSS 142

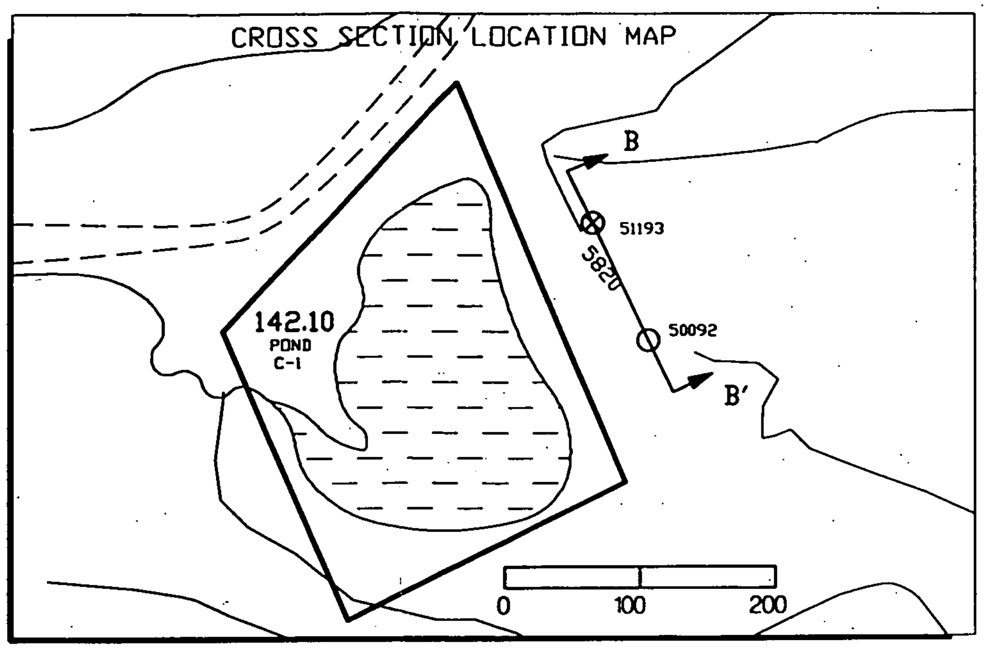
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-37





LEGEND

57593 BOREHOLE IDENTIFICATION NUMBER

SCREENED INTERVAL

STATIC WATER LEVEL (04/07/93)

BEDROCK CONTACT LINE DASHED WHERE INFERED

SM SILTY SANDS

CLAYSTONE

SC SILTY GRAVEL

CL SANDY CLAY

SILTY CLAYSTONE

ML SANDY SILTS

GC CLAYEY GRAVEL

SCALE

0 20

Feet 1 2 3 4 5

VERTICAL EXAGGERATION X 25

SOURCE OF DATA: LOGIT LOGS APPENDIX B AND RFEDS

Drawn NAM 9/28/95 Date

Checked [signature] 9/28/95 Date

Approved [signature] 9/29/95 Date

FILE OU5-3-38.DWG

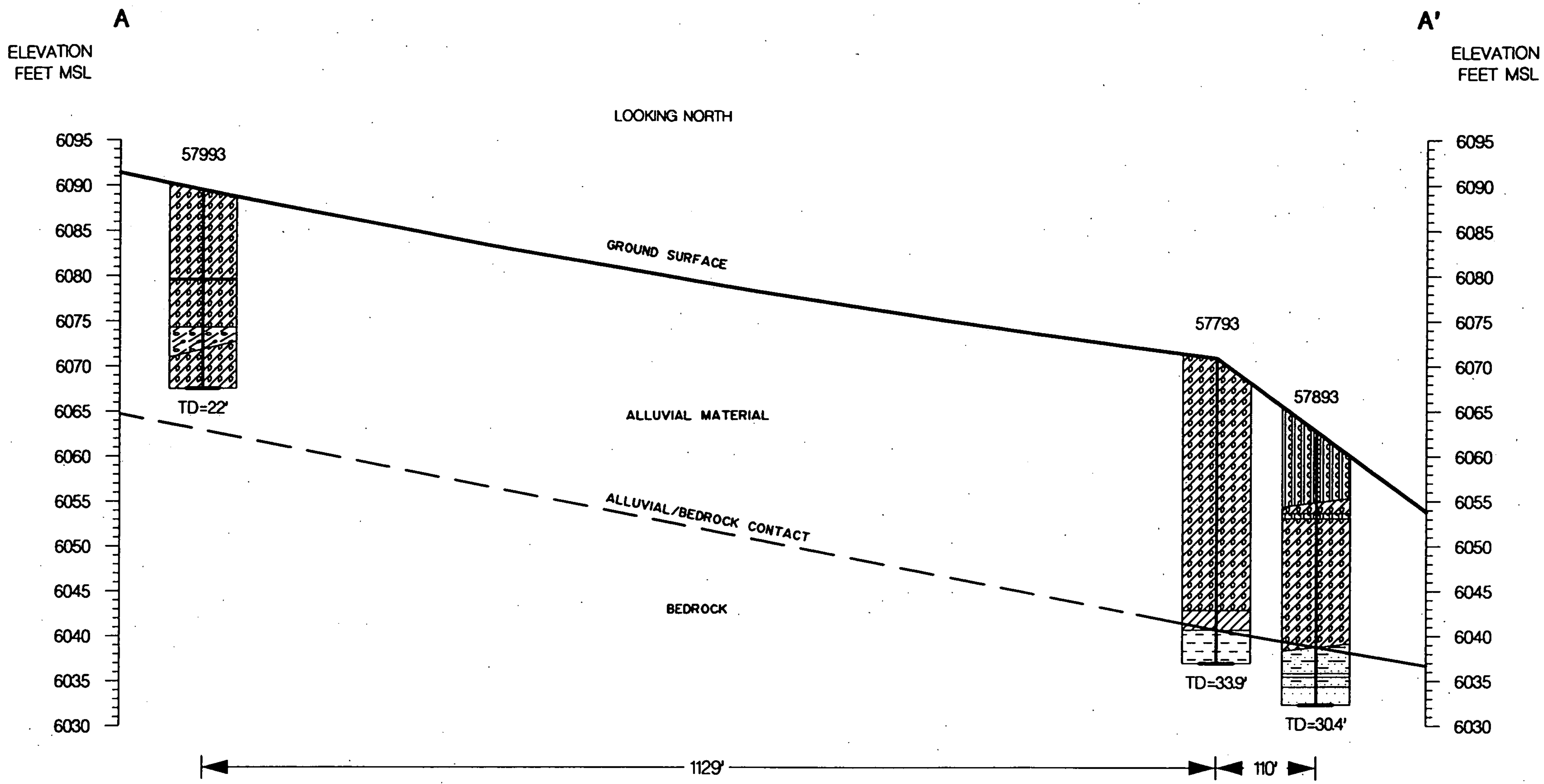
GENERALIZED GEOLOGIC CROSS SECTION B-B' IHSS 142

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-38



LEGEND

57593 BOREHOLE IDENTIFICATION NUMBER

BEDROCK CONTACT-LINE DASHED WHERE INFERRED

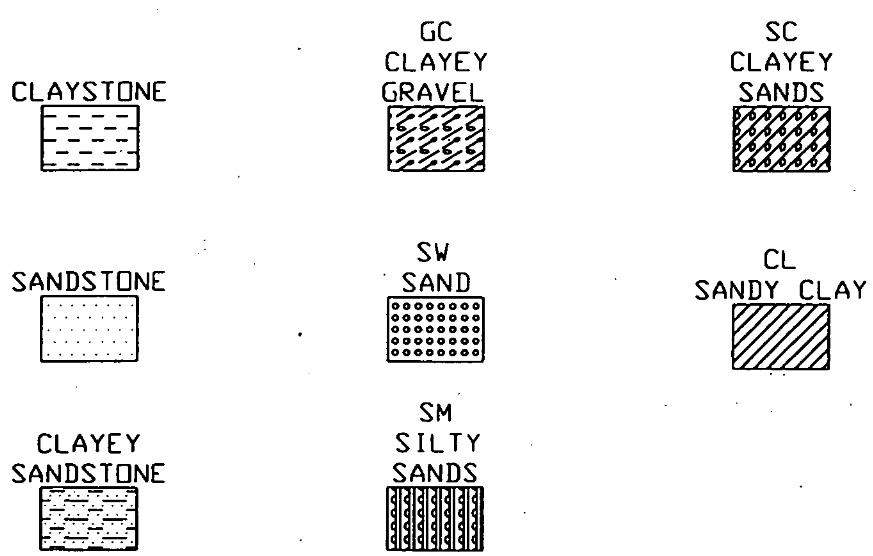
NOTE: NO GROUNDWATER WAS ENCOUNTERED DURING DRILLING OF THESE BOREHOLES

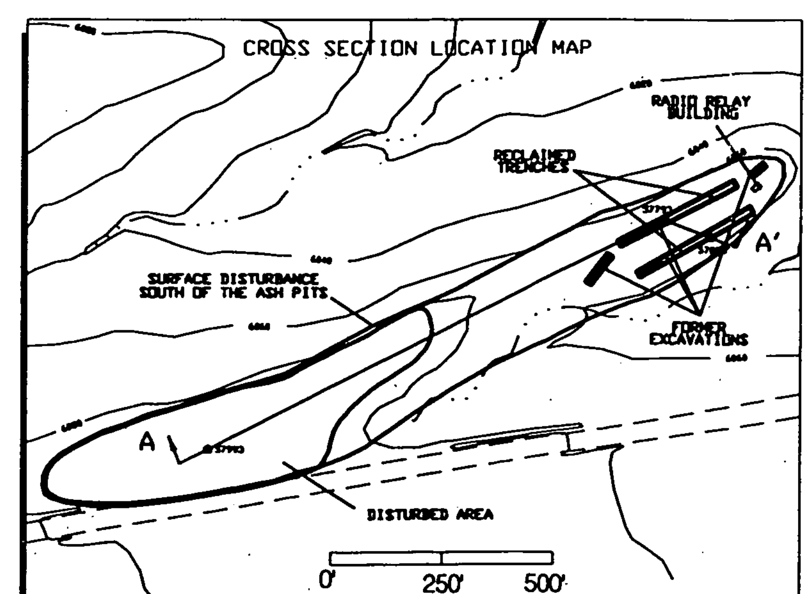
SCALE

0 150

Feet 2 4 6 8 10

VERTICAL EXAGGERATION X 10





SOURCE OF DATA: LOGIT LOGS AND RFEDS

Drawn NAM 9/28/95 Date

Checked TJN 9/28/95 Date

Approved MRW 9/29/95 Date

FILE OU5-3-39.DWG

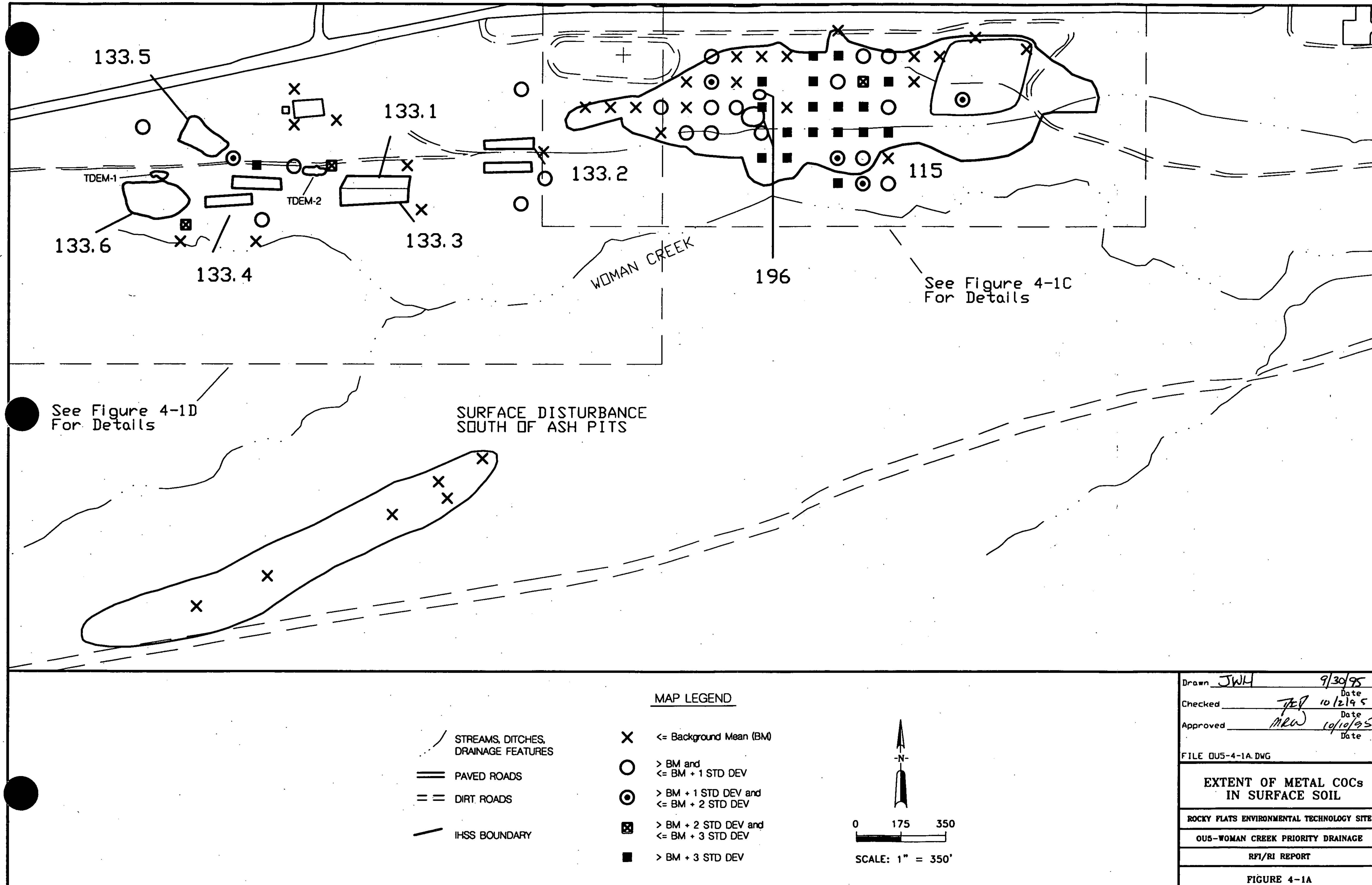
GENERALIZED GEOLOGIC CROSS SECTION A-A' SURFACE DISTURBANCE SOUTH OF THE ASH PITS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 3-39



Drawn JWH	9/30/95 Date
Checked TEP	10/2/95 Date
Approved MRW	10/10/95 Date
FILE OU5-4-1A.DWG	

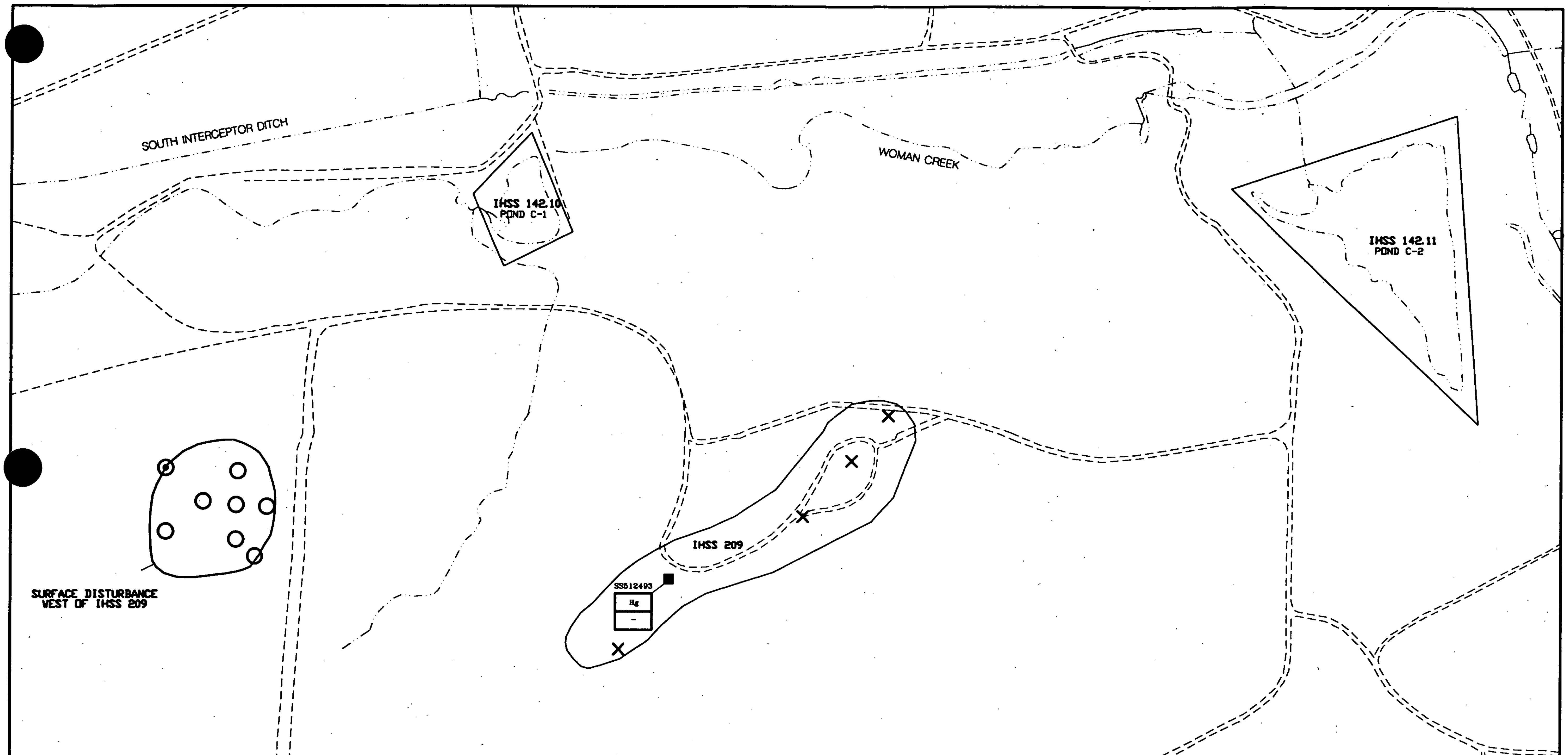
EXTENT OF METAL COCs IN SURFACE SOIL

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-1A



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

<= Background Mean (BM)

> BM and <= BM + 1 STD DEV

> BM + 1 STD DEV and <= BM + 2 STD DEV

> BM + 2 STD DEV and <= BM + 3 STD DEV

> BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV

CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN(mg/kg)	STD. DEV
Cu	Copper	13.41	4.22
Hg	Mercury	0.08	0.03
Ag	Silver	2.80	2.04

-N-

0 150 300

SCALE: 1" = 300'

Drawn JWH 9/30/95 Date

Checked TJQ 10/2/95 Date

Approved MRW 10/10/95 Date

FILE OU5-4-1B.DWG

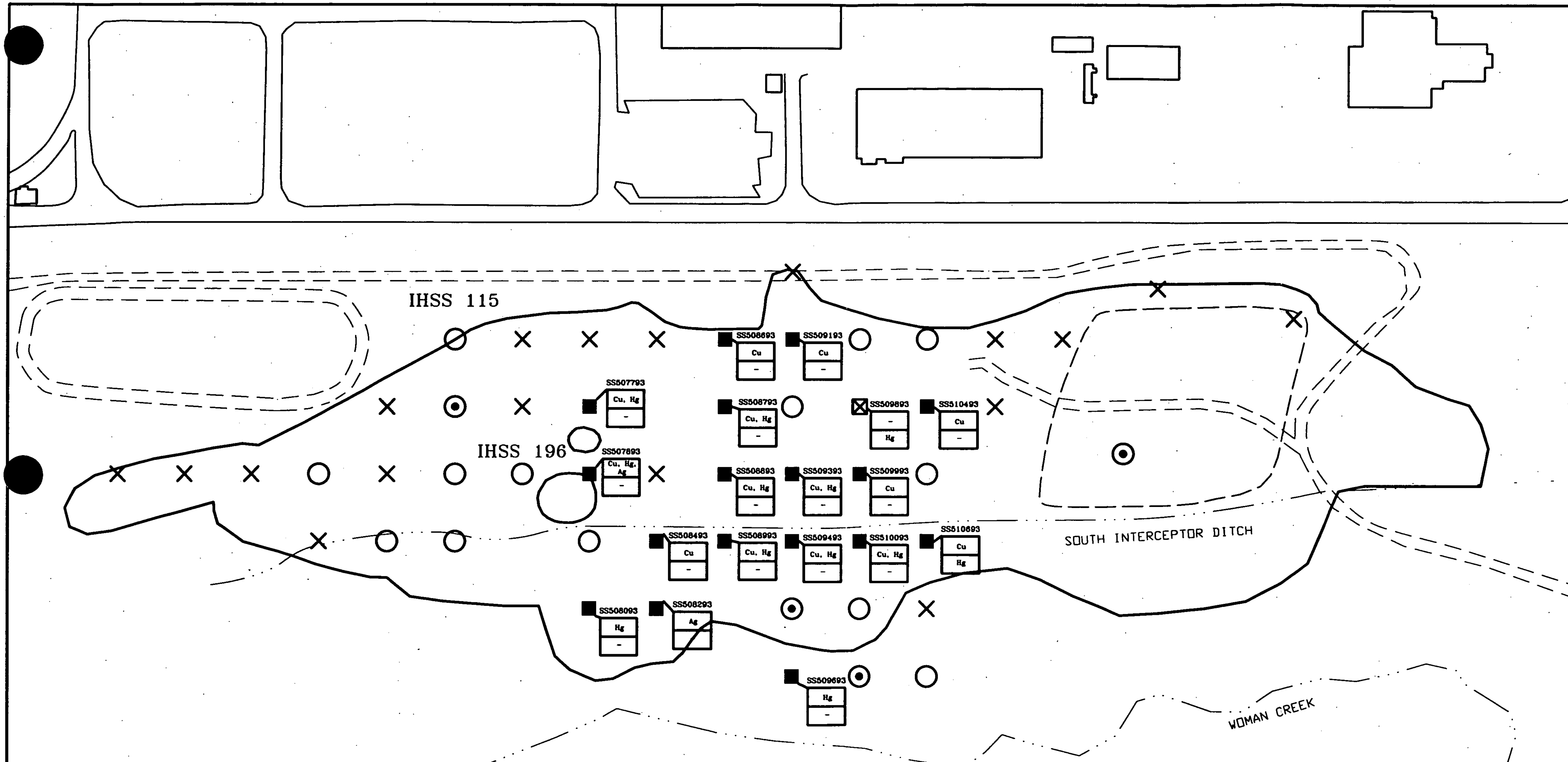
EXTENT OF METAL COCs IN SURFACE SOIL IHSS 142/209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-1B



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY

- X <= Background Mean (BM)
- ○ > BM and <= BM + 1 STD DEV
- ⊙ > BM + 1 STD DEV and <= BM + 2 STD DEV
- ⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV
- ■ > BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN(mg/kg)	STD. DEV
Cu	Copper	13.41	4.22
Hg	Mercury	0.08	0.03
Ag	Silver	2.80	2.04

-N-

0 75 150

SCALE: 1" = 150'

Drawn JWH 9/30/95 Date
Checked TJ? 10/2/95 Date
Approved MRW 10/10/95 Date

FILE OU5-41C.DWG

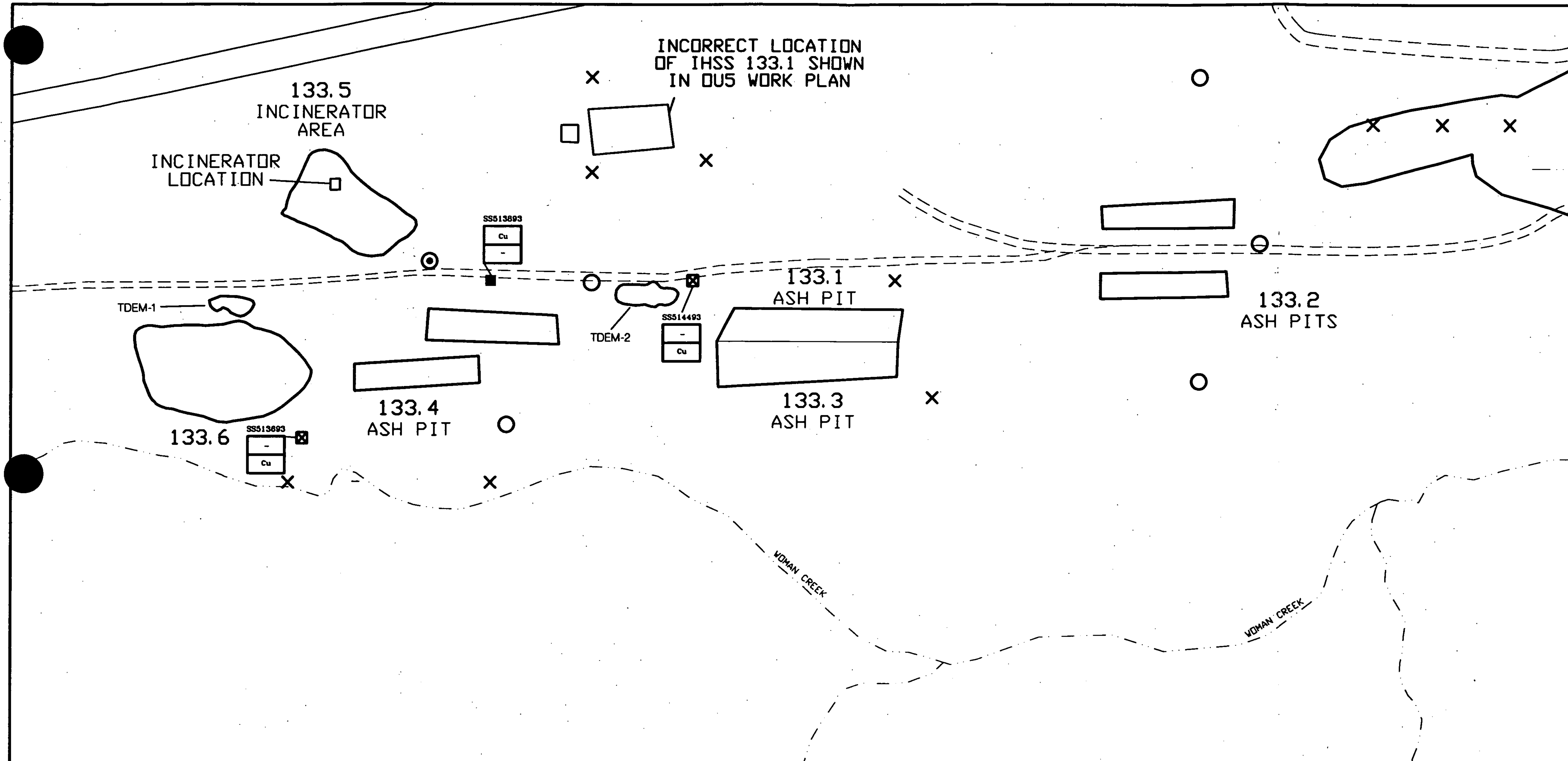
EXTENT OF METAL COCs IN SURFACE SOIL IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-1C



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

X <= Background Mean (BM)

○ > BM and <= BM + 1 STD DEV

◉ > BM + 1 STD DEV and <= BM + 2 STD DEV

⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV

■ > BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN(mg/kg)	STD. DEV
Cu	Copper	13.41	4.22
Hg	Mercury	0.08	0.03
Ag	Silver	2.80	2.04

-N-

0 75 150

SCALE: 1" = 150'

Drawn JWH 9/30/95 Date

Checked TLT 10/2/95 Date

Approved MRW 10/10/95 Date

FILE OU5-4-1D.DWG

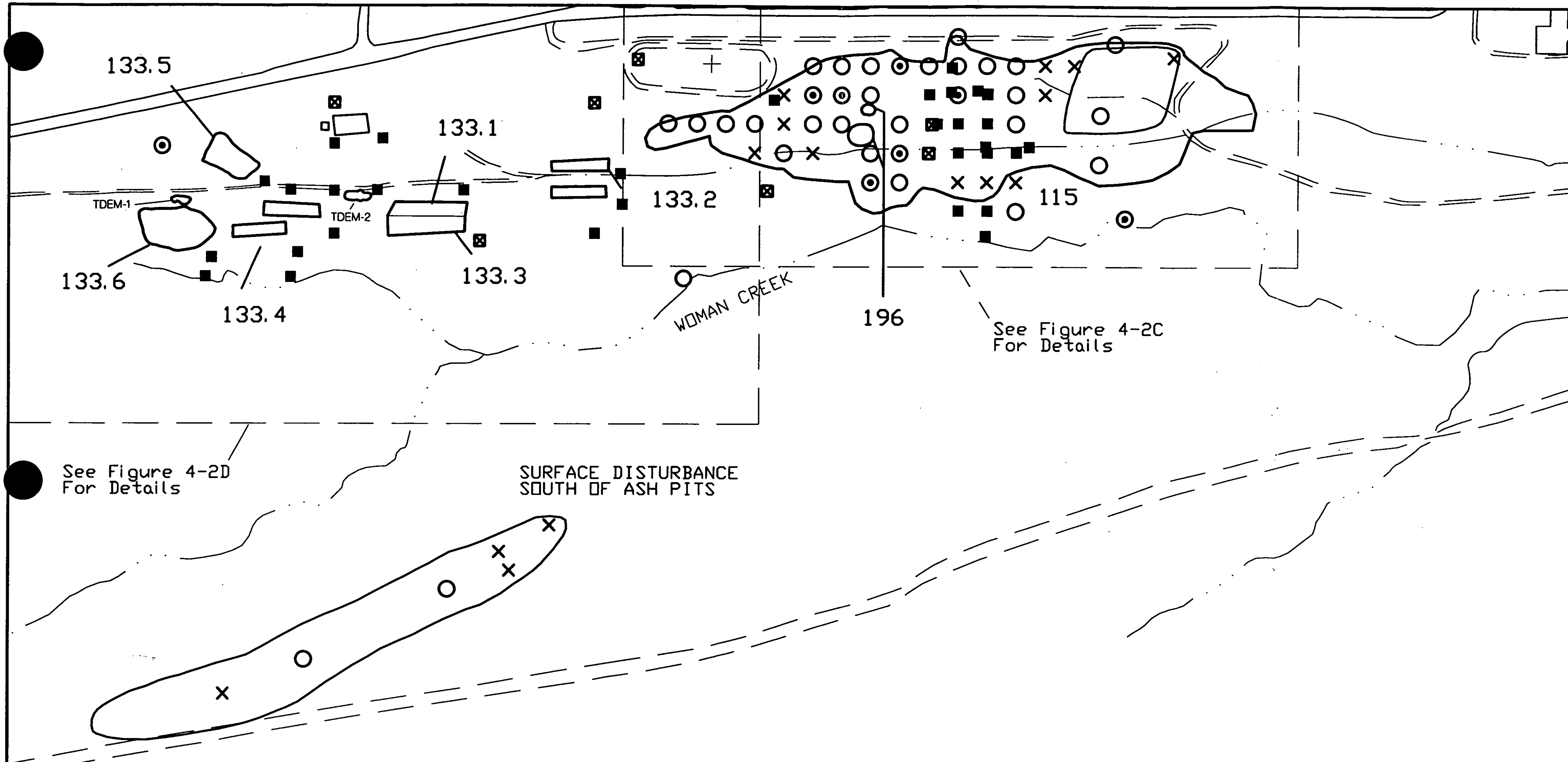
EXTENT OF METAL COCs IN SURFACE SOIL IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-1D



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY

- X <= Background Mean (BM)
- O > BM and <= BM + 1 STD DEV
- ⊙ > BM + 1 STD DEV and <= BM + 2 STD DEV
- ⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV
- ■ > BM + 3 STD DEV

-N-

0 175 350

SCALE: 1" = 350'

Drawn JWH	9/30/95 Date
Checked [signature]	10/2/95 Date
Approved MRW	10/10/95 Date

FILE OU5-4-2A.DWG

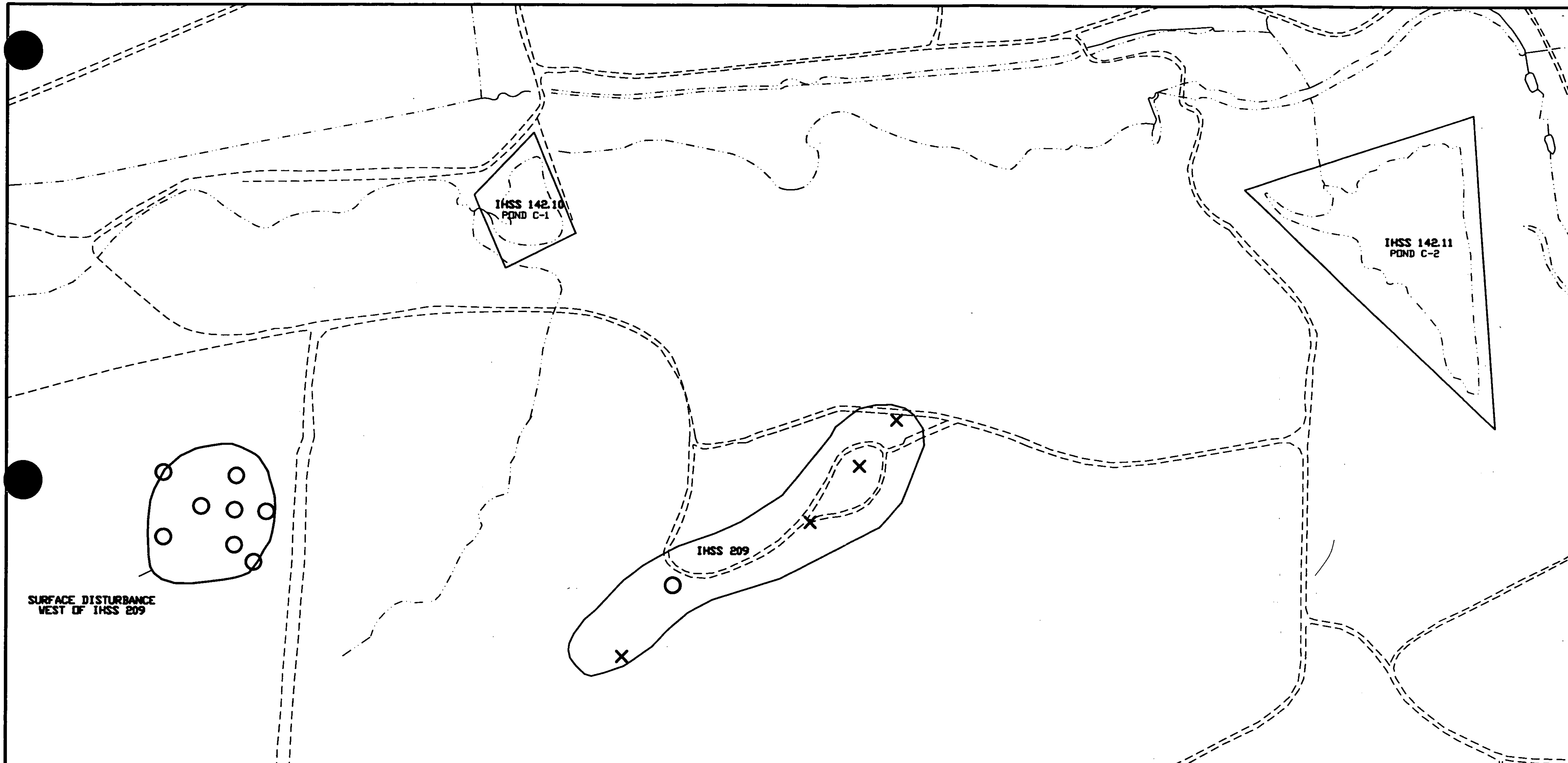
EXTENT OF RADIONUCLIDE COCs IN SURFACE SOIL

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-2A



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY

- X <= Background Mean (BM)
- ○ > BM and <= BM + 1 STD DEV
- ◉ > BM + 1 STD DEV and <= BM + 2 STD DEV
- ⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV
- ■ > BM + 3 STD DEV

-N-

0 150 300

SCALE: 1" = 300'

Drawn JWH	9/30/95 Date
Checked [signature]	10/2/95 Date
Approved MRW	10/10/95 Date

FILE OU5-4-2B.DWG

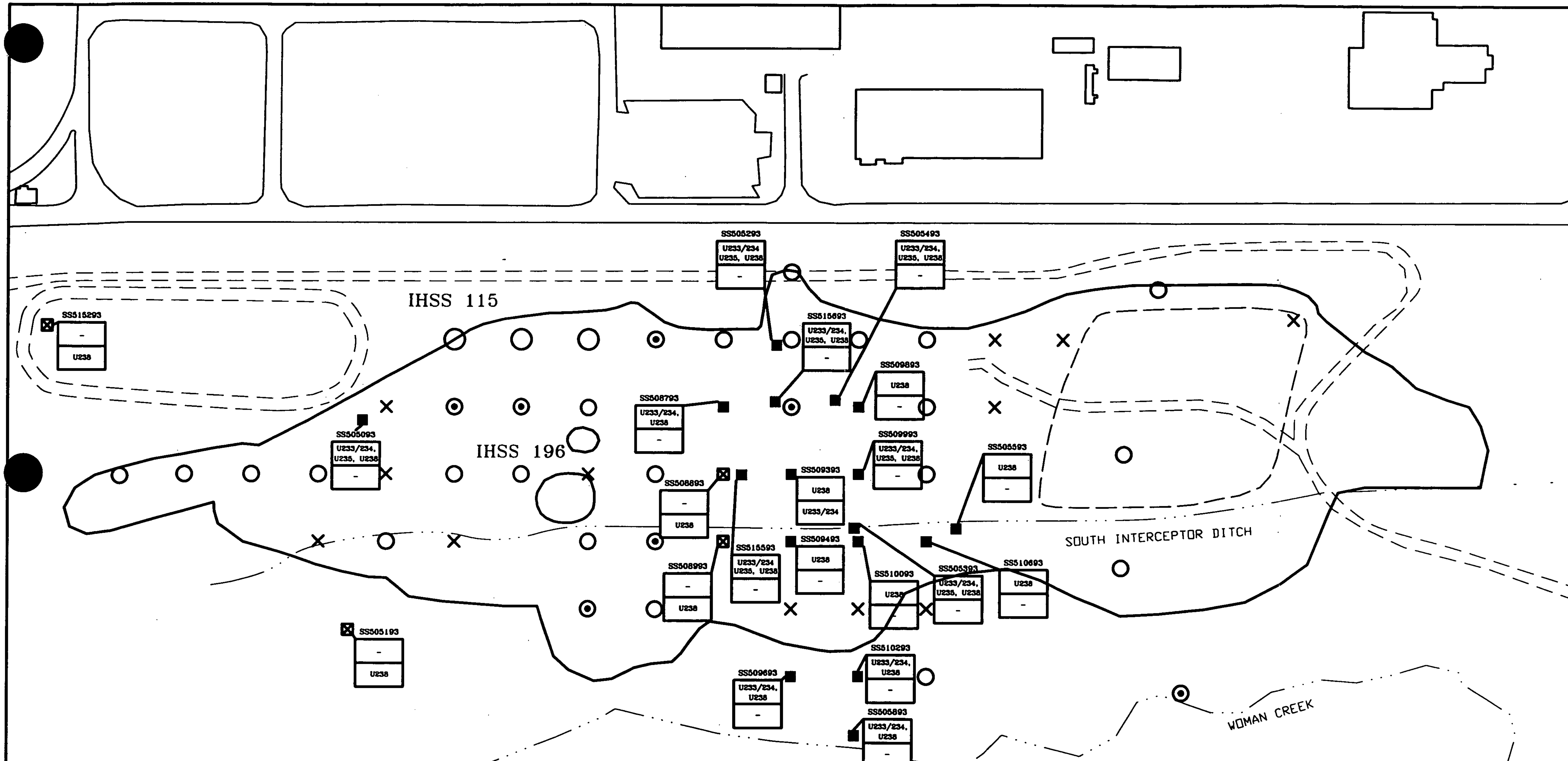
EXTENT OF RADIONUCLIDE COCs IN SURFACE SOIL IHSS 142/209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-2B



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

<= Background Mean (BM)

> BM and <= BM + 1 STD DEV

> BM + 1 STD DEV and <= BM + 2 STD DEV

> BM + 2 STD DEV and <= BM + 3 STD DEV

> BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV

CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN(pCi/g)	STD. DEV.
U233/234	Uranium 233/234	0.822	0.380
U235	Uranium 235	0.039	0.052
U238	Uranium 238	0.733	0.413

N

0 75 150

SCALE: 1" = 150'

Drawn JWH 9/30/95 Date

Checked [initials] 10/2/95 Date

Approved MEW 10/10/95 Date

FILE OU5-4-2C.DWG

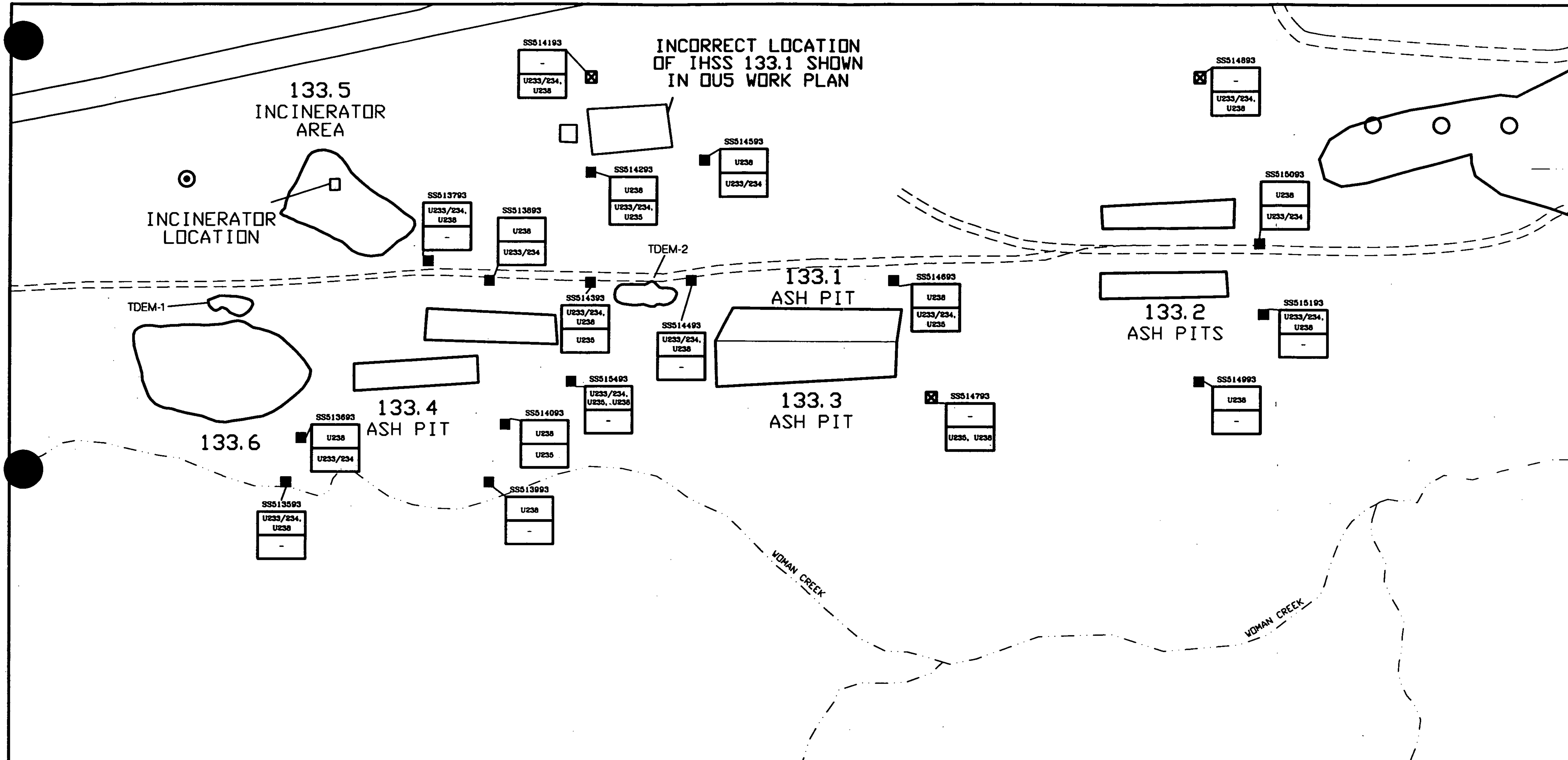
EXTENT OF RADIONUCLIDE COCs IN SURFACE SOIL IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-2C



STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

<= Background Mean (BM)

> BM and <= BM + 1 STD DEV

> BM + 1 STD DEV and <= BM + 2 STD DEV

> BM + 2 STD DEV and <= BM + 3 STD DEV

> BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV

CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

MAP LEGEND

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN(pCi/g)	STD. DEV.
U233/234	Uranium 233/234	0.822	0.380
U235	Uranium 235	0.039	0.052
U238	Uranium 238	0.733	0.413

-N-

0 75 150

SCALE: 1" = 150'

Drawn JWH 9/30/95 Date

Checked TEJ 10/2/95 Date

Approved MRW 10/10/95 Date

FILE OU5-4-2D.DWG

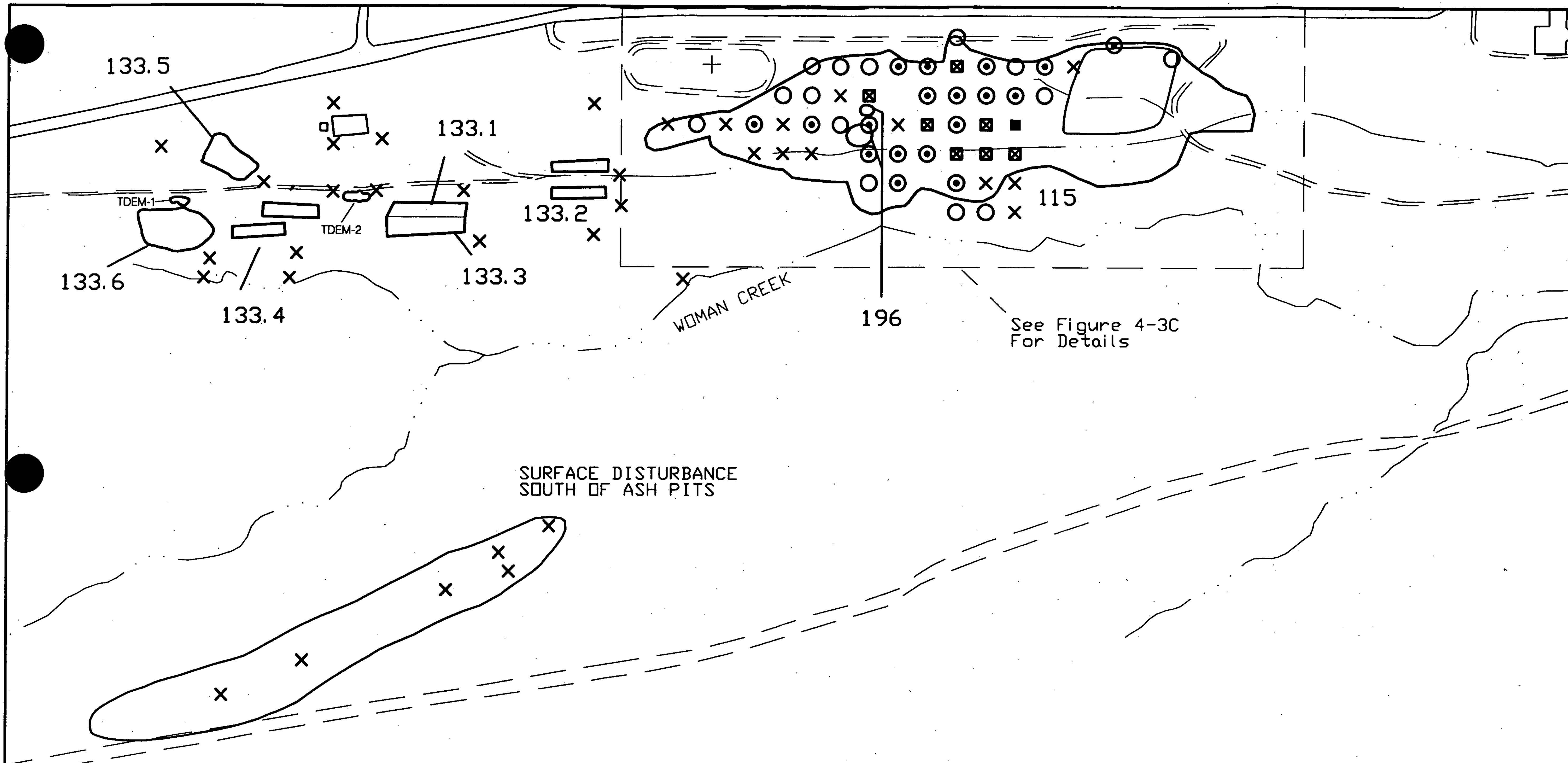
EXTENT OF RADIONUCLIDE COCs IN SURFACE SOIL IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-2D



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES
PAVED ROADS
DIRT ROADS
IHSS BOUNDARY

Sample Location
Detects less than the Reporting Limit (RL)
Detects exceeding RL but less than 10 x RL
Detects exceeding 10 x RL but less than 100 x RL
Detects exceeding 100 x RL

-N-

0 175 350

SCALE: 1" = 350'

Drawn JWH 9/30/95 Date
Checked 10/2/95 Date
Approved MRW 10/10/95 Date

FILE OU5-4-3A.DWG

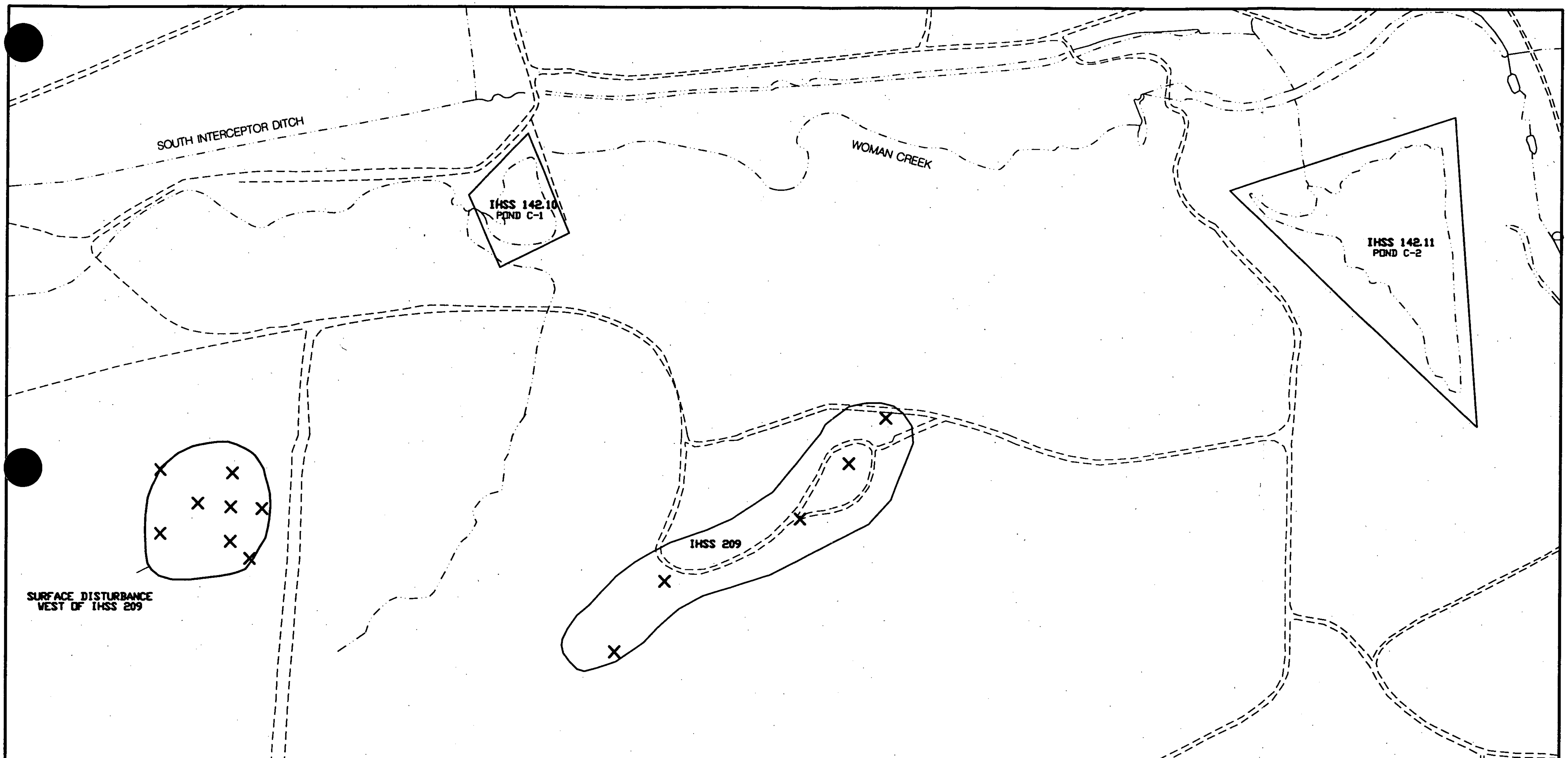
EXTENT OF ORGANIC COCs IN SURFACE SOIL

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-3A



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY
- Sample Location
- Detects less than the Reporting Limit (RL)
- Detects exceeding RL but less than 10 x RL
- Detects exceeding 10 x RL but less than 100 x RL
- Detects exceeding 100 x RL

-N-

0 150 300

SCALE: 1" = 300'

Drawn JWH	9/30/95 Date
Checked	10/2/95 Date
Approved	10/10/95 Date

FILE OU5-4-3B.DWG

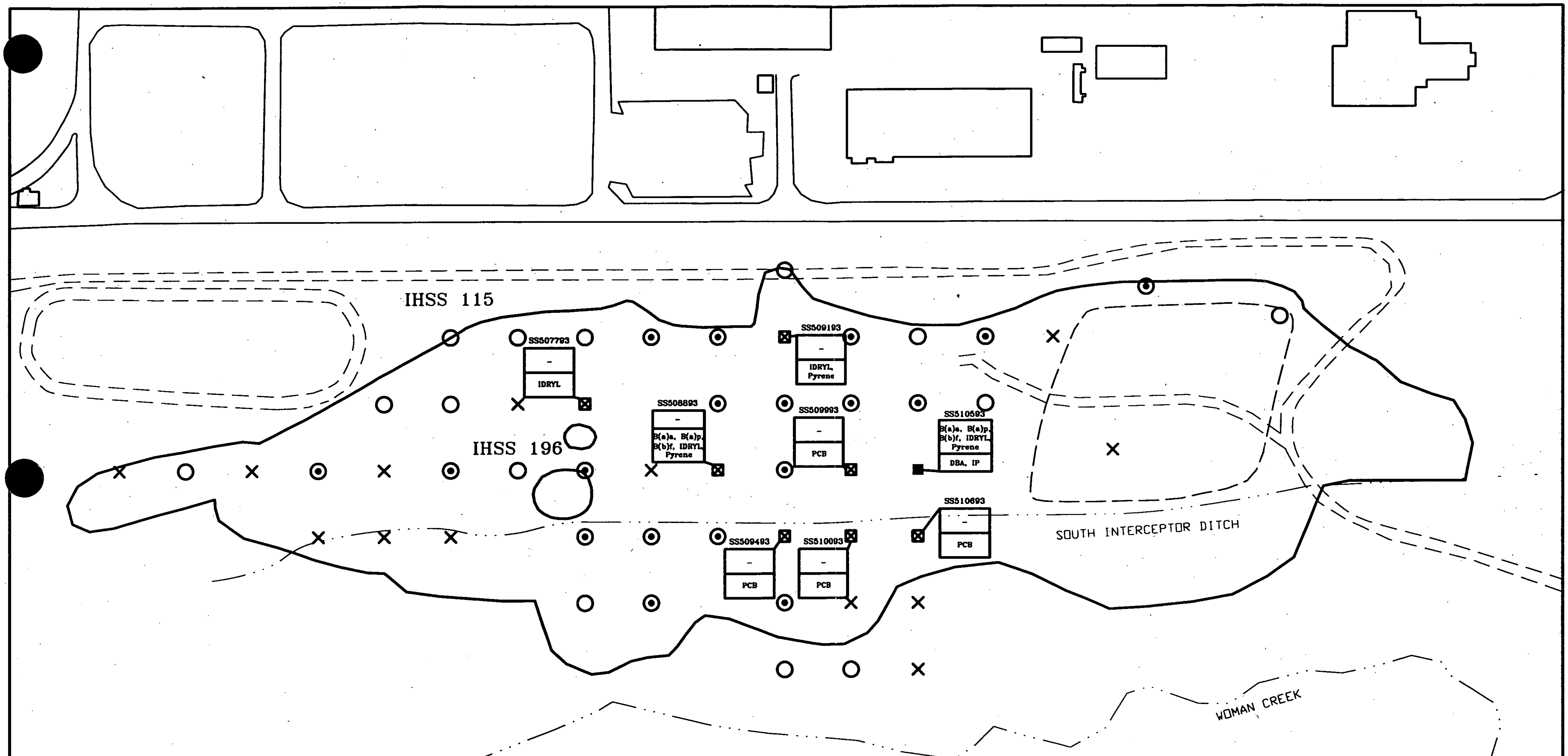
EXTENT OF ORGANIC COCs IN SURFACE SOIL IHSS 142/209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-3B



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES
PAVED ROADS
DIRT ROADS
IHSS BOUNDARY

X Sample Location
○ Detects less than the Reporting Limit (RL)
◉ Detects exceeding RL but less than 10 x RL
⊠ Detects exceeding 10 x RL but less than 100 x RL
■ Detects exceeding 100 x RL

BACKGROUND DATA

SYMBOL	CONSTITUENT	RL (µg/kg)
PCB	Aroclor - 1254	160
B(a)a	Benzo(a)anthracene	330
B(a)p	Benzo(a)Pyrene	330
B(b)f	Benzo(b)Fluoranthene	330

BACKGROUND DATA

SYMBOL	CONSTITUENT	RL (µg/kg)
DBA	Dibenzo(a,h)anthracene	330
IDRYL	Fluoranthene	330
IP	Indeno(1,2,3-cd)Pyrene	330
Pyrene	Pyrene	330

LOCATION

CONSTITUENTS > 100 X RL
CONSTITUENTS > 10 X RL AND <= 100 RL

-N-

0 75 150

SCALE: 1" = 150'

Drawn JWH 10/3/95 Date
Checked 10/3/95 Date
Approved MEW 10/10/95 Date

FILE OU5-4-3C.DWG

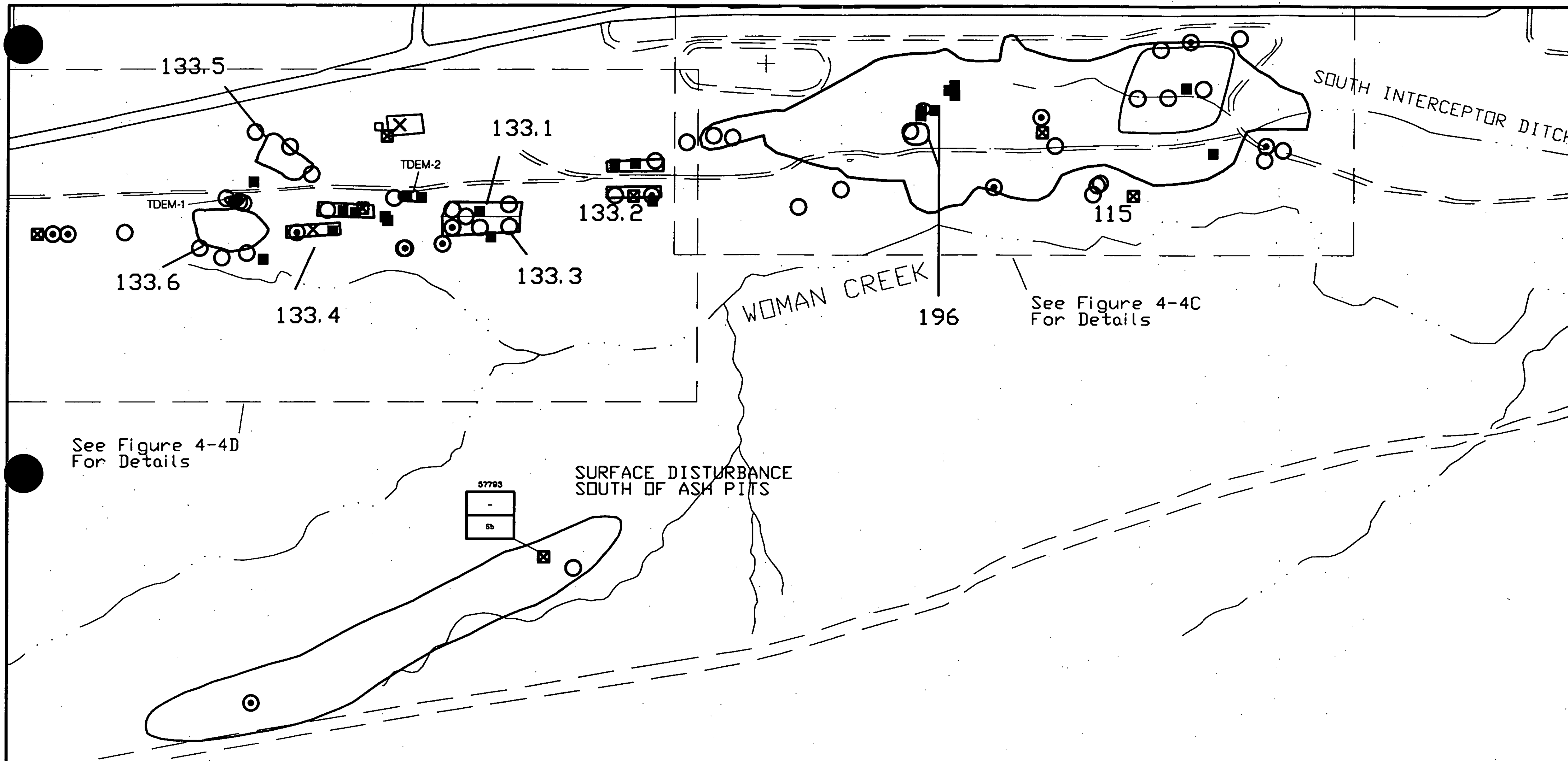
EXTENT OF ORGANIC COCs IN SURFACE SOIL IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-3C



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

X <= Background Mean (BM)

> BM and <= BM + 1 STD DEV

> BM + 1 STD DEV and <= BM + 2 STD DEV

> BM + 2 STD DEV and <= BM + 3 STD DEV

> BM + 3 STD DEV

LOCATION

LOCATION
CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occuring in different concentrations at the same location represent samples from different depths.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (mg/kg)	STD. DEV
Sb	Antimony	6.56	2.84
Be	Beryllium	4.66	4.77
Cd	Cadmium	0.64	0.24
Cu	Copper	12.59	12.77
Mo	Molybdenum	15.39	9.01
Ni	Nickel	19.81	20.56
Ag	Silver	5.70	9.40

-N-

0 175 350

SCALE: 1" = 350'

Drawn JWH 9/30/95 Date

Checked [signature] 10/2/95 Date

Approved MRW 10/10/95 Date

FILE OU5-4-4A.DWG

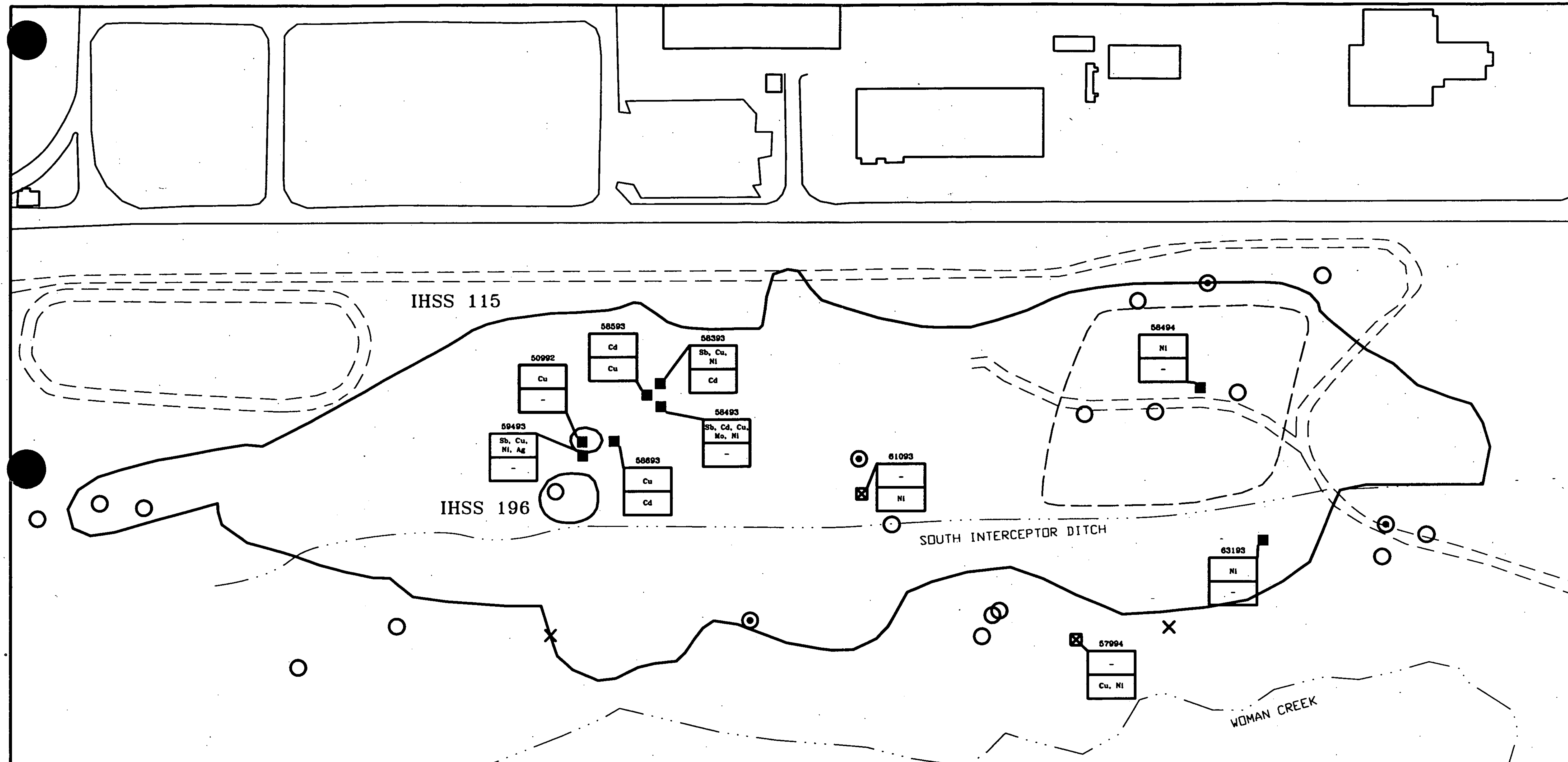
EXTENT OF METAL COCs IN SUBSURFACE SOIL

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-4A



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

X <= Background Mean (BM)

> BM and <= BM + 1 STD DEV

> BM + 1 STD DEV and <= BM + 2 STD DEV

> BM + 2 STD DEV and <= BM + 3 STD DEV

> BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV

CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occuring in different concentrations at the same location represent samples from different depths.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (mg/kg)	STD. DEV
Sb	Antimony	6.56	2.84
Be	Beryllium	4.66	4.77
Cd	Cadmium	0.64	0.24
Cu	Copper	12.59	12.77
Mo	Molybdenum	15.39	9.01
Ni	Nickel	19.81	20.56
Ag	Silver	5.70	9.40

-N-

0 75 150

SCALE: 1" = 150'

Drawn JWH 9/30/95 Date

Checked [signature] 10/2/95 Date

Approved MRW 10/10/95 Date

FILE OU5-4-4C.DWG

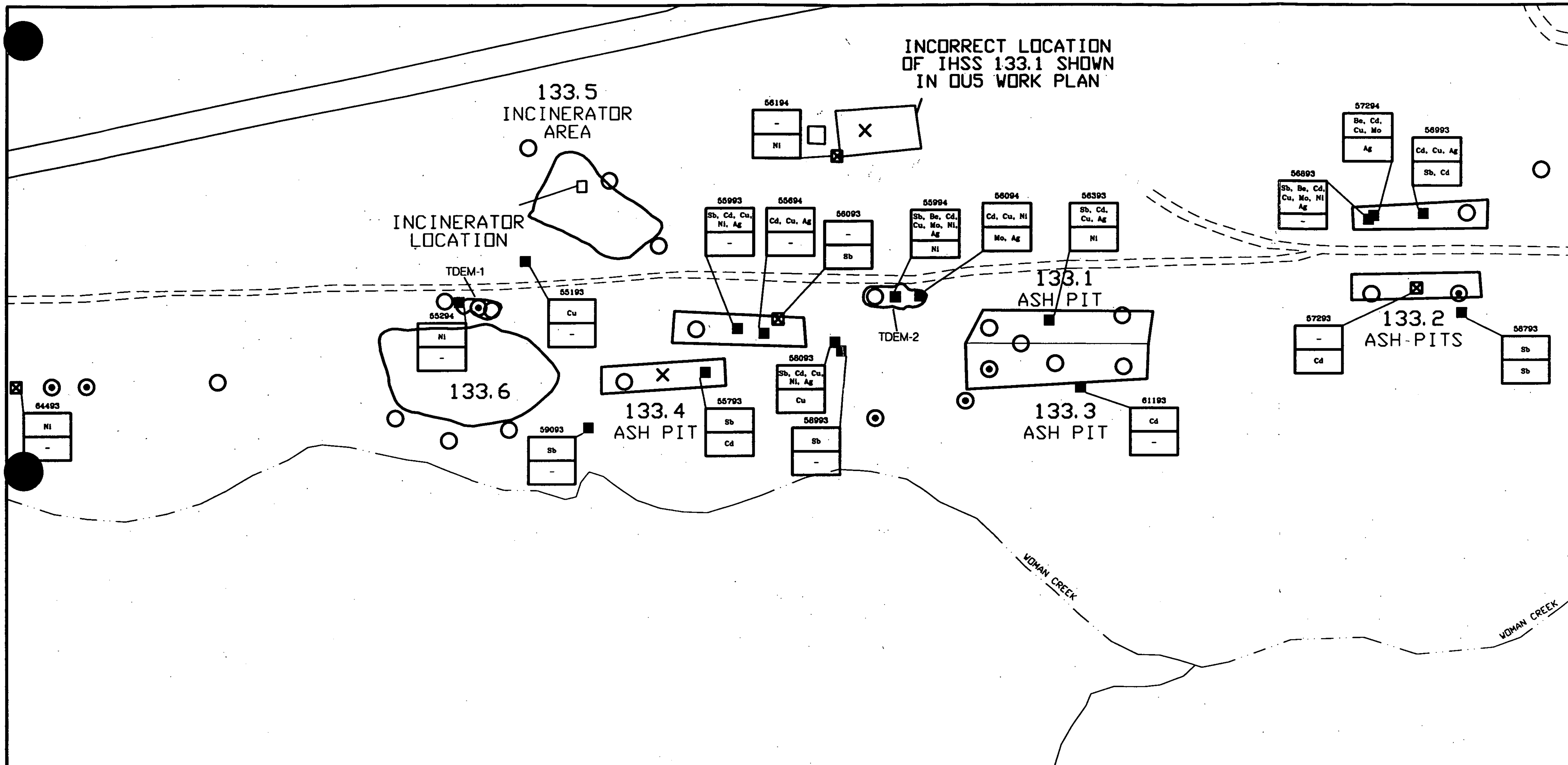
EXTENT OF METAL COCs IN SUBSURFACE SOIL IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-4C



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY

- ✕ <= Background Mean (BM)
- ○ > BM and <= BM + 1 STD DEV
- ◎ > BM + 1 STD DEV and <= BM + 2 STD DEV
- ⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV
- ■ > BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occuring in different concentrations at the same location represent samples from different depths.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (mg/kg)	STD. DEV
Sb	Antimony	6.56	2.84
Be	Beryllium	4.66	4.77
Cd	Cadmium	0.64	0.24
Cu	Copper	12.59	12.77
Mo	Molybdenum	15.39	9.01
Ni	Nickel	19.81	20.56
Ag	Silver	5.70	9.40

-N-

0 75 150

SCALE: 1" = 150'

Drawn JWH 9/30/95 Date
Checked [signature] 10/2/95 Date
Approved MRW 10/10/95 Date

FILE OU5-4-4D.DWG

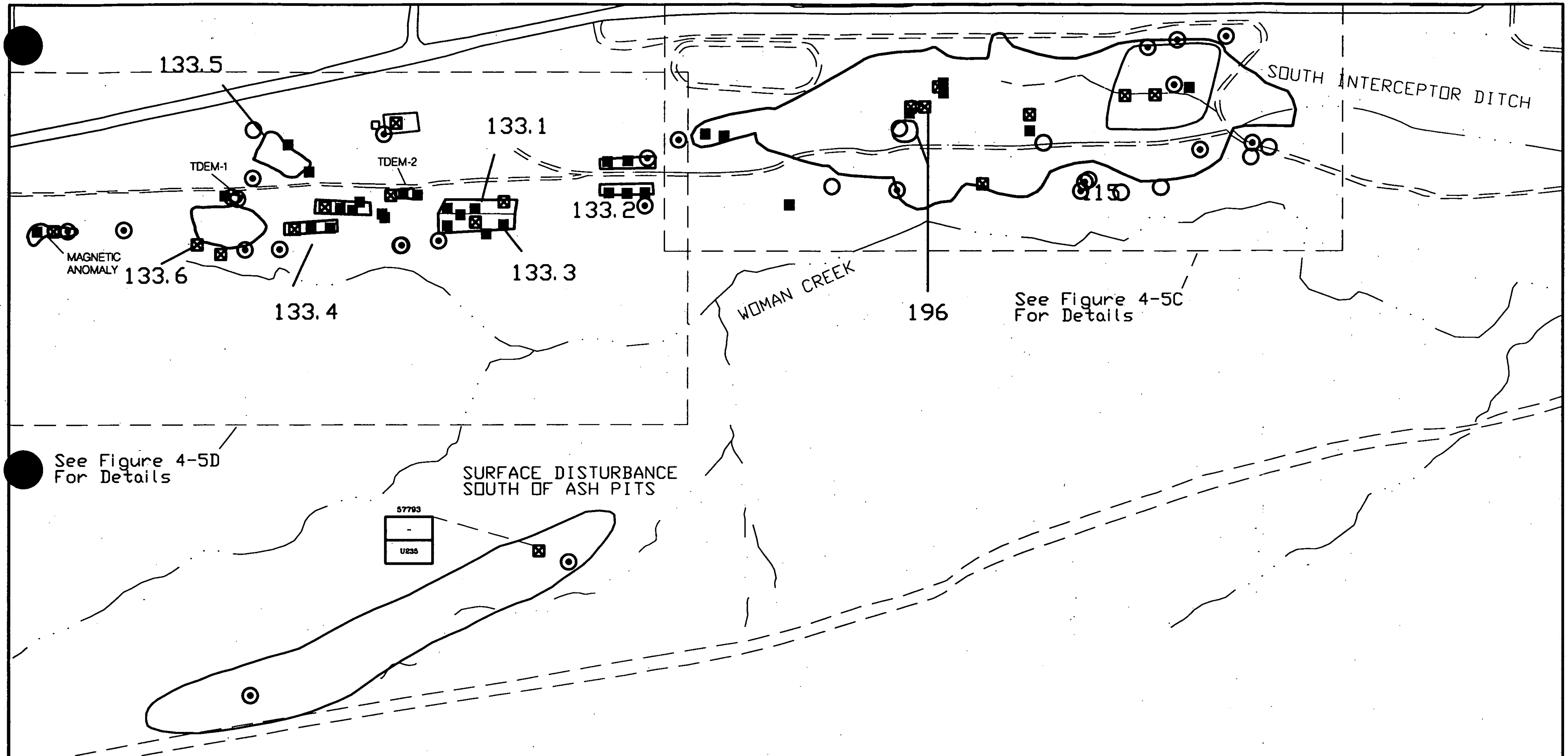
EXTENT OF METAL COCs IN SUBSURFACE SOIL IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-4D



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY

- X <= Background Mean (BM)
- ○ > BM and <= BM + 1 STD DEV
- ◎ > BM + 1 STD DEV and <= BM + 2 STD DEV
- ⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV
- ■ > BM + 3 STD DEV

LOCATION
CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occuring in different concentrations at the same location represent samples from different depths.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (pCi/g)	STD. DEV
U233/234	Uranium 233/234	0.779	0.932
U235	Uranium 235	0.022	0.046
U238	Uranium 238	0.733	0.376

-N-

0 175 350

SCALE: 1" = 350'

Drawn JWH 9/30/95 Date
Checked [signature] 10/2/95 Date
Approved [signature] 10/10/95 Date

FILE OU5-4-5A.DWG

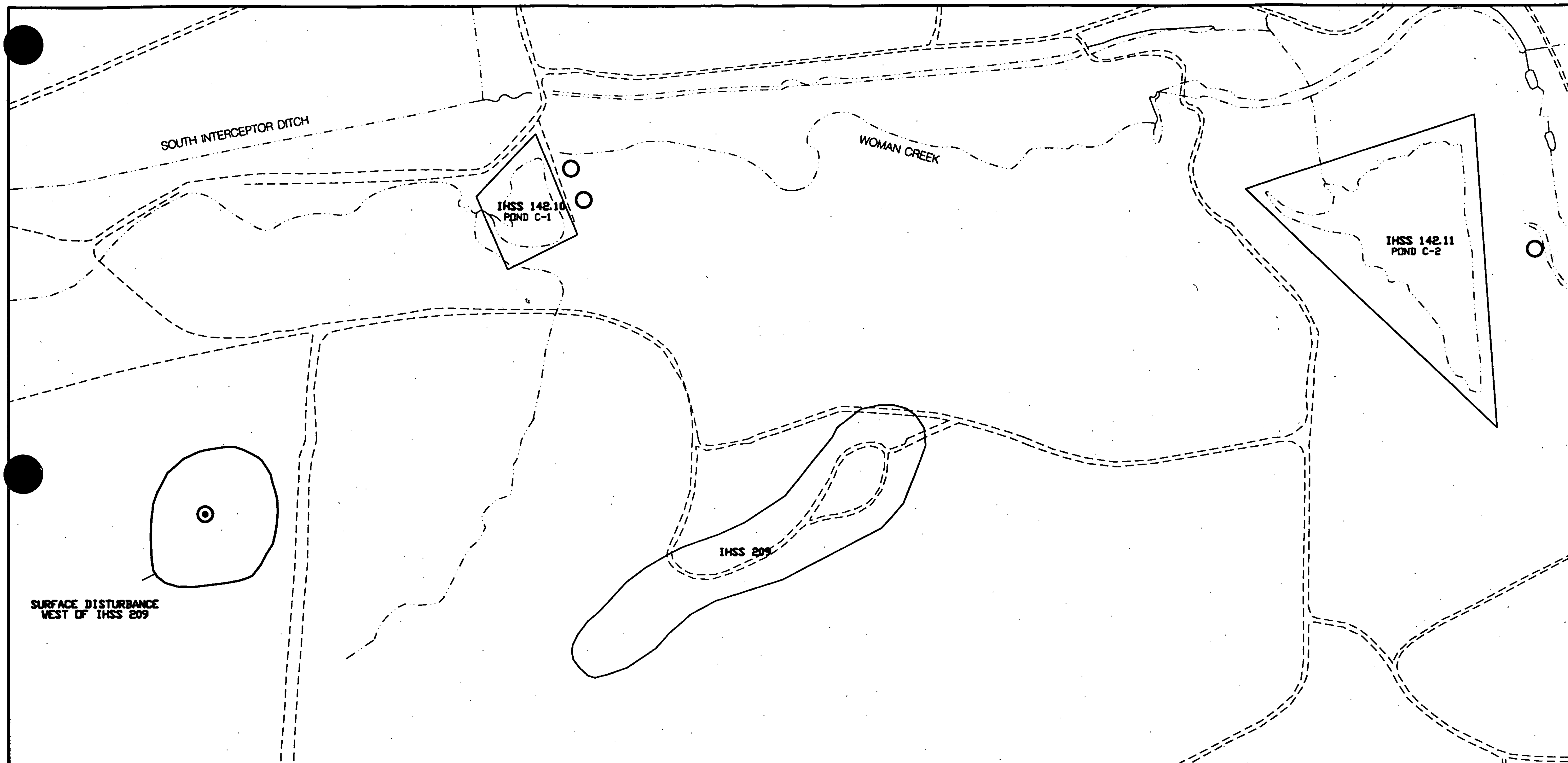
EXTENT OF RADIONUCLIDE COCs IN SUBSURFACE SOIL

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-5A



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY

- X <= Background Mean (BM)
- > BM and <= BM + 1 STD DEV
- > BM + 1 STD DEV and <= BM + 2 STD DEV
- > BM + 2 STD DEV and <= BM + 3 STD DEV
- > BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occuring in different concentrations at the same location represent samples from different depths.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (pCi/g)	STD. DEV
U233/234	Uranium 233/234	0.779	0.932
U235	Uranium 235	0.022	0.046
U238	Uranium 238	0.733	0.376

-N-

0 150 300

SCALE: 1" = 300'

Drawn JWH 9/30/95 Date
Checked 7EP 10/2/95 Date
Approved MRW 10/10/95 Date

FILE OU5-4-5B.DWG

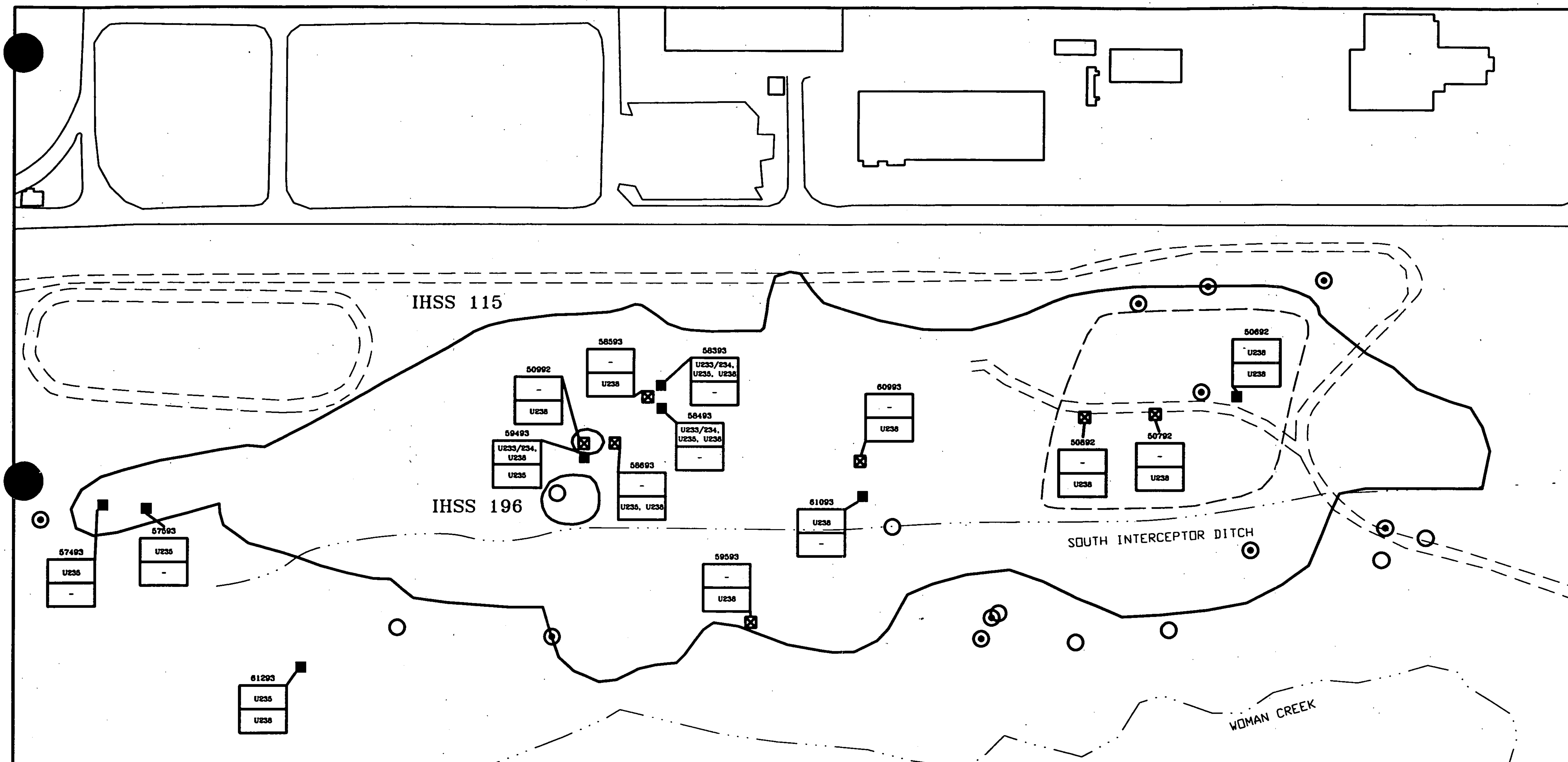
EXTENT OF RADIONUCLIDE COCs IN SUBSURFACE SOIL IHSS 142/209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-5B



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

✕ <= Background Mean (BM)

○ > BM and <= BM + 1 STD DEV

◎ > BM + 1 STD DEV and <= BM + 2 STD DEV

⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV

■ > BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV

CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occuring in different concentrations at the same location represent samples from different depths.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (pCi/g)	STD. DEV
U233/234	Uranium 233/234	0.779	0.932
U235	Uranium 235	0.022	0.046
U238	Uranium 238	0.733	0.376

-N-

0 75 150

SCALE: 1" = 150'

Drawn JWH 9/30/95 Date

Checked [signature] 10/2/95 Date

Approved MRW 10/10/95 Date

FILE OU5-4-5C.DWG

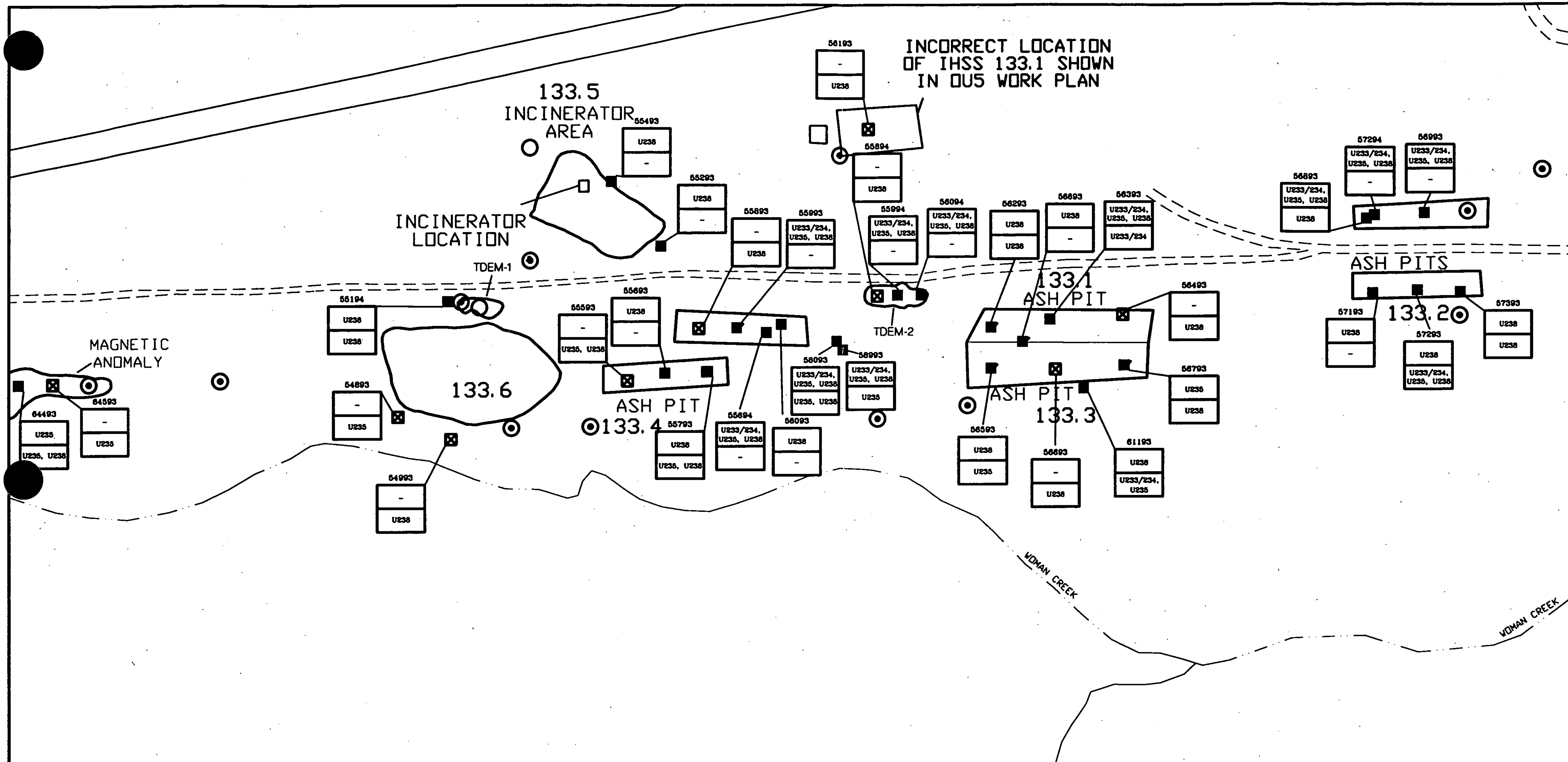
EXTENT OF RADIONUCLIDE COCs IN SUBSURFACE SOIL IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-5C



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

X <= Background Mean (BM)

> BM and <= BM + 1 STD DEV

> BM + 1 STD DEV and <= BM + 2 STD DEV

> BM + 2 STD DEV and <= BM + 3 STD DEV

> BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV

CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occuring in different concentrations at the same location represent samples from different depths.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (pCi/g)	STD. DEV
U233/234	Uranium 233/234	0.779	0.932
U235	Uranium 235	0.022	0.046
U238	Uranium 238	0.733	0.376

-N-

0 75 150

SCALE: 1" = 150'

Drawn JWH 9/30/95 Date

Checked TJ 10/3/95 Date

Approved MEW 10/10/95 Date

FILE OU5-4-5D.DWG

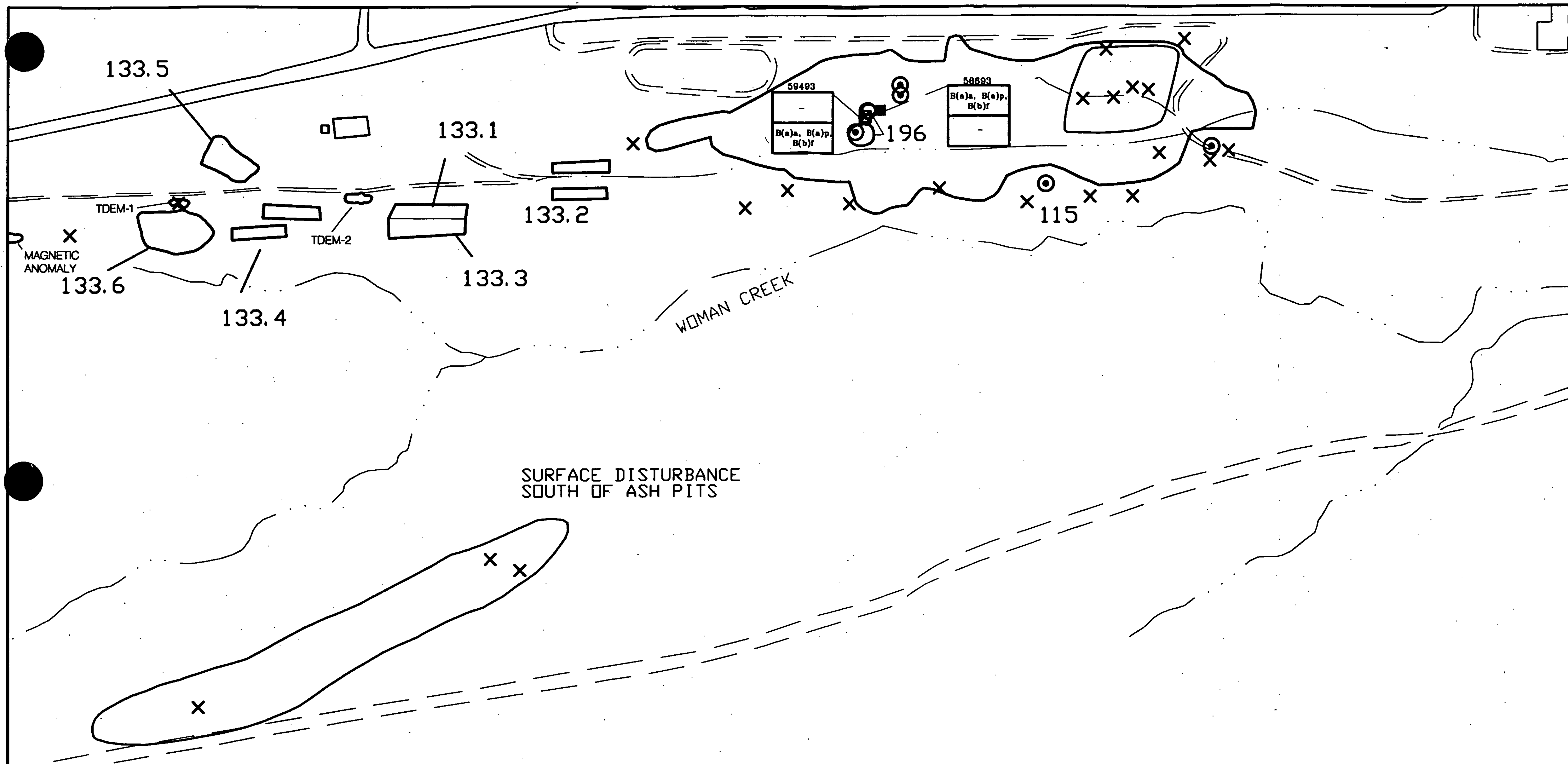
EXTENT OF RADIONUCLIDE COCs IN SUBSURFACE SOIL IHSS 133

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-5D



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY
- × Sample Location
- ○ Detects less than the Reporting Limit (RL)
- ⊙ Detects exceeding RL but below 10 x RL
- ⊠ Detects exceeding 10 x RL but below 100 x RL
- ■ Detects exceeding 100 x RL

LOCATION

CONSTITUENTS > 100 x RL
CONSTITUENTS > 10 x RL AND <= 100 x RL

Note: Constituents occuring in different concentrations at the same location represent samples from different depths.

BACKGROUND DATA

SYMBOL	CONSTITUENT	Reporting Limit (RL) µg/kg
PCB	Aroclor-1254	160
B(a)a	Benzo(a)anthracene	330
B(a)p	Benzo(a)Pyrene	330
B(b)f	Benzo(b)Fluoranthene	330
DBA	Dibenzo(a,h)anthracene	330
IDRYL	Fluoranthene	330
IP	Indeno(1,2,3-cd)Pyrene	330
Pyrene	Pyrene	330

-N-

0 175 350

SCALE: 1" = 350'

Drawn JWH Date 9/30/95
Checked [signature] Date 10/3/95
Approved MEW Date 10/10/95

FILE OU5-4-6A.DWG

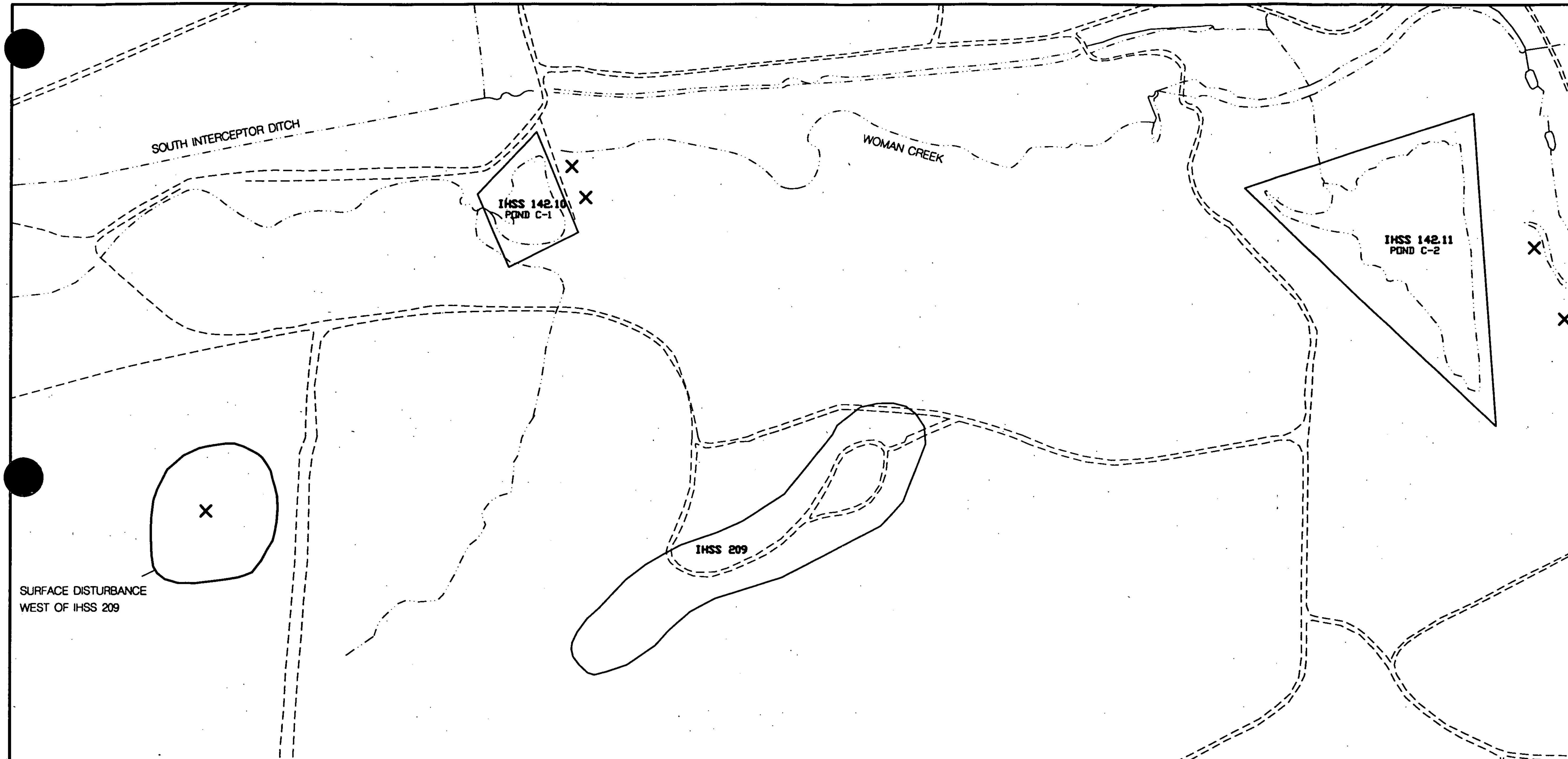
EXTENT OF ORGANIC COCs IN SUBSURFACE SOIL

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-6A



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY
- × Sample Location
- Detects less than the Reporting Limit (RL)
- Detects exceeding RL but below 10 x RL
- Detects exceeding 10 x RL but below 100 x RL
- Detects exceeding 100 x RL

LOCATION

CONSTITUENTS > 100 x RL
CONSTITUENTS > 10 x RL AND <= 100 x RL

Note: Constituents occuring in different concentrations at the same location represent samples from different depths.

BACKGROUND DATA

SYMBOL	CONSTITUENT	Reporting Limit (RL) µg/kg
PCB	Aroclor-1254	160
B(a)a	Benzo(a)anthracene	330
B(a)p	Benzo(a)Pyrene	330
B(b)f	Benzo(b)Fluoranthene	330
DBA	Dibenzo(a,h)anthracene	330
IDRYL	Fluoranthene	330
IP	Indeno(1,2,3-cd)Pyrene	330
Pyrene	Pyrene	330

-N-

0 150 300

SCALE: 1" = 300'

Drawn JWH 10/2/95 Date
Checked [signature] 10/3/95 Date
Approved MRW 10/10/95 Date

FILE OU5-4-6B.DWG

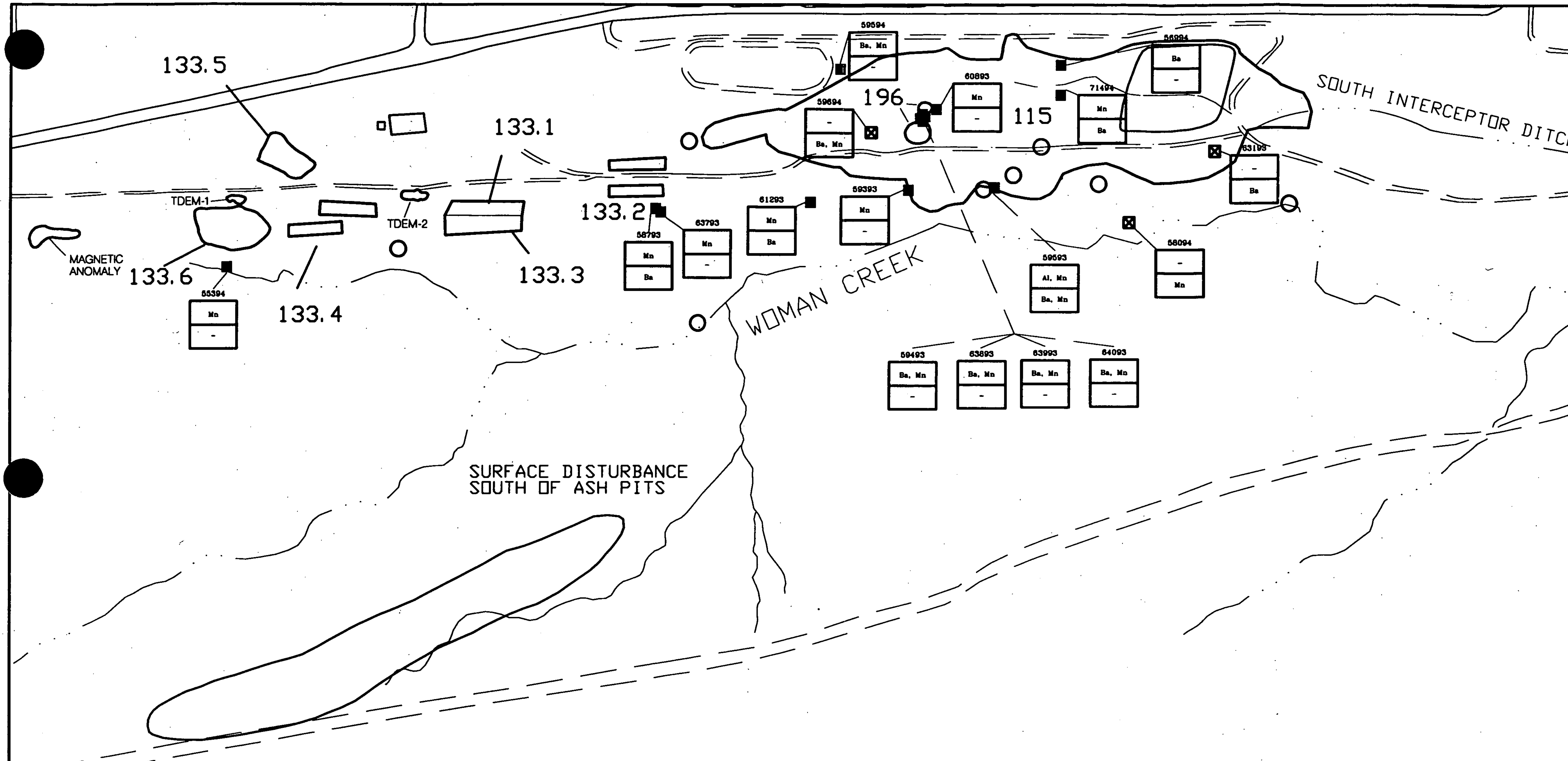
EXTENT OF ORGANIC COCs IN SUBSURFACE SOIL IHSS 142/209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-6B



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY

- X <= Background Mean (BM)
- ○ > BM and <= BM + 1 STD DEV
- ◎ > BM + 1 STD DEV and <= BM + 2 STD DEV
- ⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV
- ■ > BM + 3 STD DEV

LOCATION
CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occurring in different concentrations at the same location represent samples collected on different dates.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (µg/l)	STD. DEV.
Al	Dissolved Aluminum	113.66	594.80
Ba	Dissolved Barium	84.00	33.10
Mg	Dissolved Manganese	32.66	87.43

-N-

0 175 350

SCALE: 1" = 350'

Drawn JWH Date 10/2/95
Checked [signature] Date 10/3/95
Approved MRW Date 10/10/95

FILE OU5-4-7A.DWG

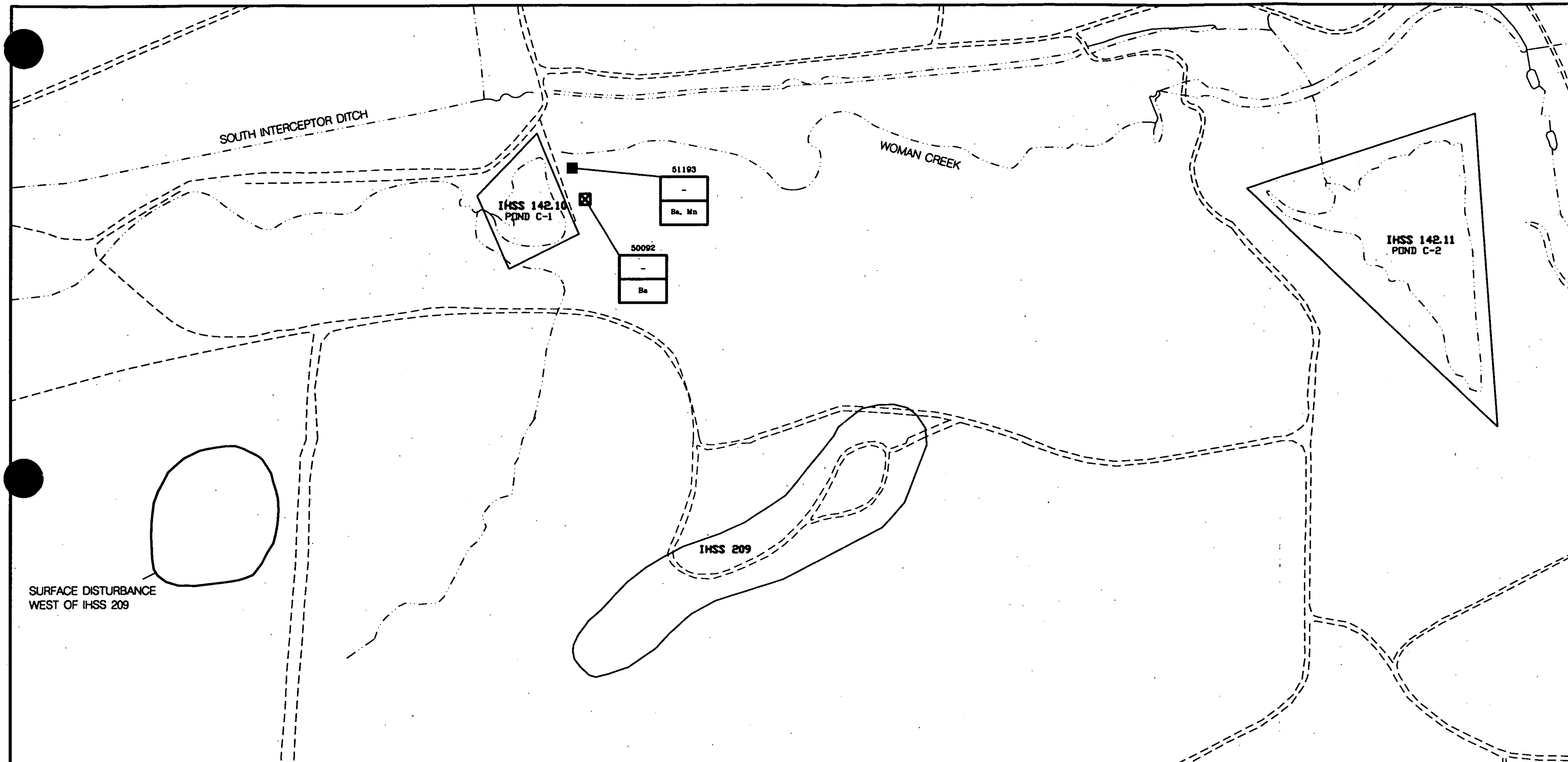
EXTENT OF DISSOLVED METAL COCs IN GROUNDWATER

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-7A



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

X <= Background Mean (BM)

> BM and <= BM + 1 STD DEV

> BM + 1 STD DEV and <= BM + 2 STD DEV

> BM + 2 STD DEV and <= BM + 3 STD DEV

> BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV

CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occurring in different concentrations at the same location represent samples collected on different dates.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (µg/l)	STD. DEV.
Al	Dissolved Aluminum	113.66	594.80
Ba	Dissolved Barium	84.00	33.10
Mn	Dissolved Manganese	32.66	87.43

-N-

0 150 300

SCALE: 1" = 300'

Drawn JWH Date 10/2/95
Checked TIF Date 10/3/95
Approved MEW Date 10/10/95

FILE OU5-4-7B.DWG

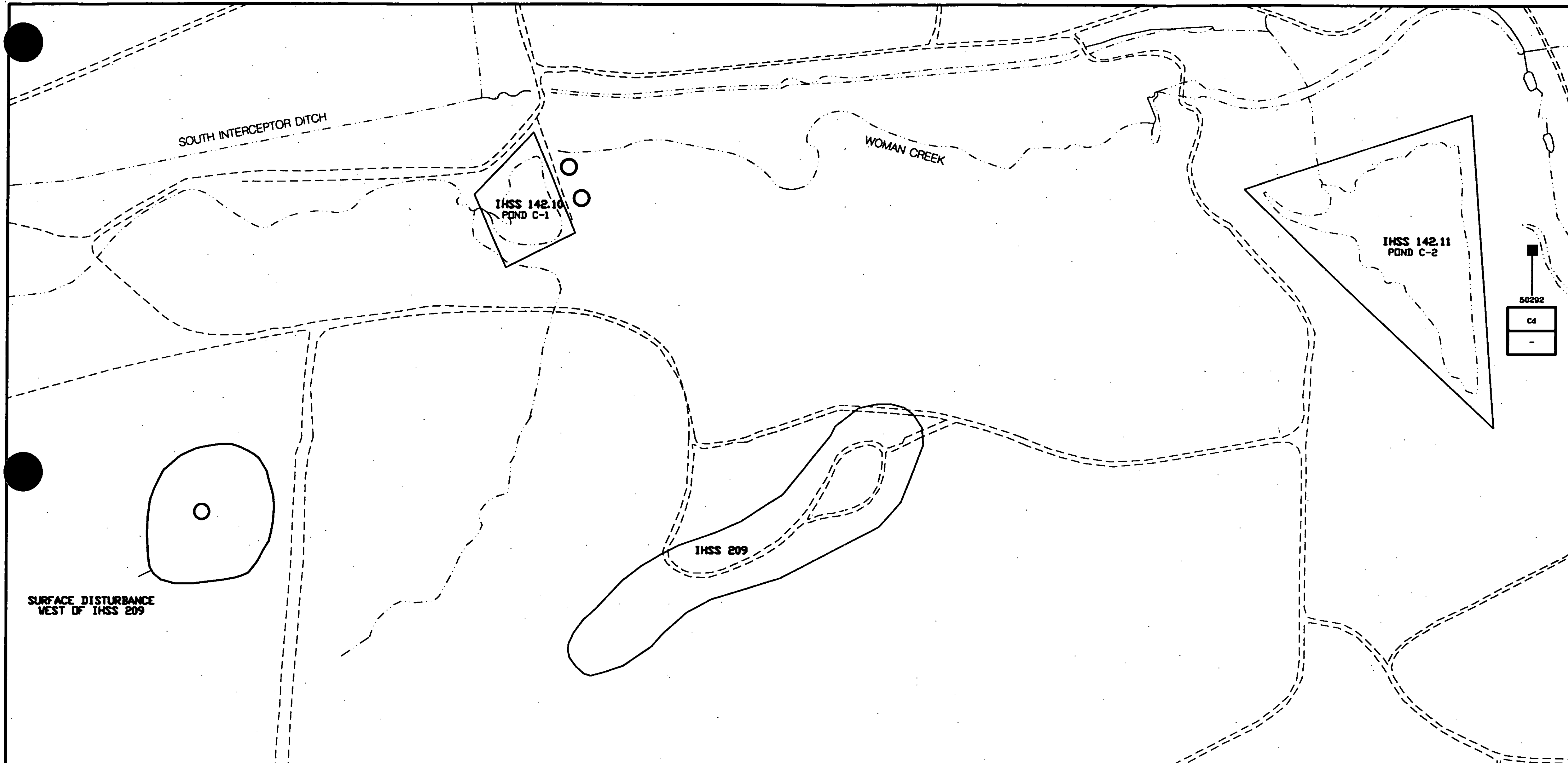
EXTENT OF DISSOLVED METAL COCs IN GROUNDWATER IHSS 142/209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-7B



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY

- X <= Background Mean (BM)
- ○ > BM and <= BM + 1 STD DEV
- ◉ > BM + 1 STD DEV and <= BM + 2 STD DEV
- ⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV
- ■ > BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occuring in different concentrations at the same location represent samples from different depths.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (mg/kg)	STD. DEV
Sb	Antimony	6.56	2.84
Be	Beryllium	4.66	4.77
Cd	Cadmium	0.64	0.24
Cu	Copper	12.59	12.77
Mo	Molybdenum	15.39	9.01
Ni	Nickel	19.81	20.56
Ag	Silver	5.70	9.40

-N-

0 150 300

SCALE: 1" = 300'

Drawn JWH Date 9/30/95
Checked [signature] Date 10/2/95
Approved MRW Date 10/10/95

FILE OU5-4-4B.DWG

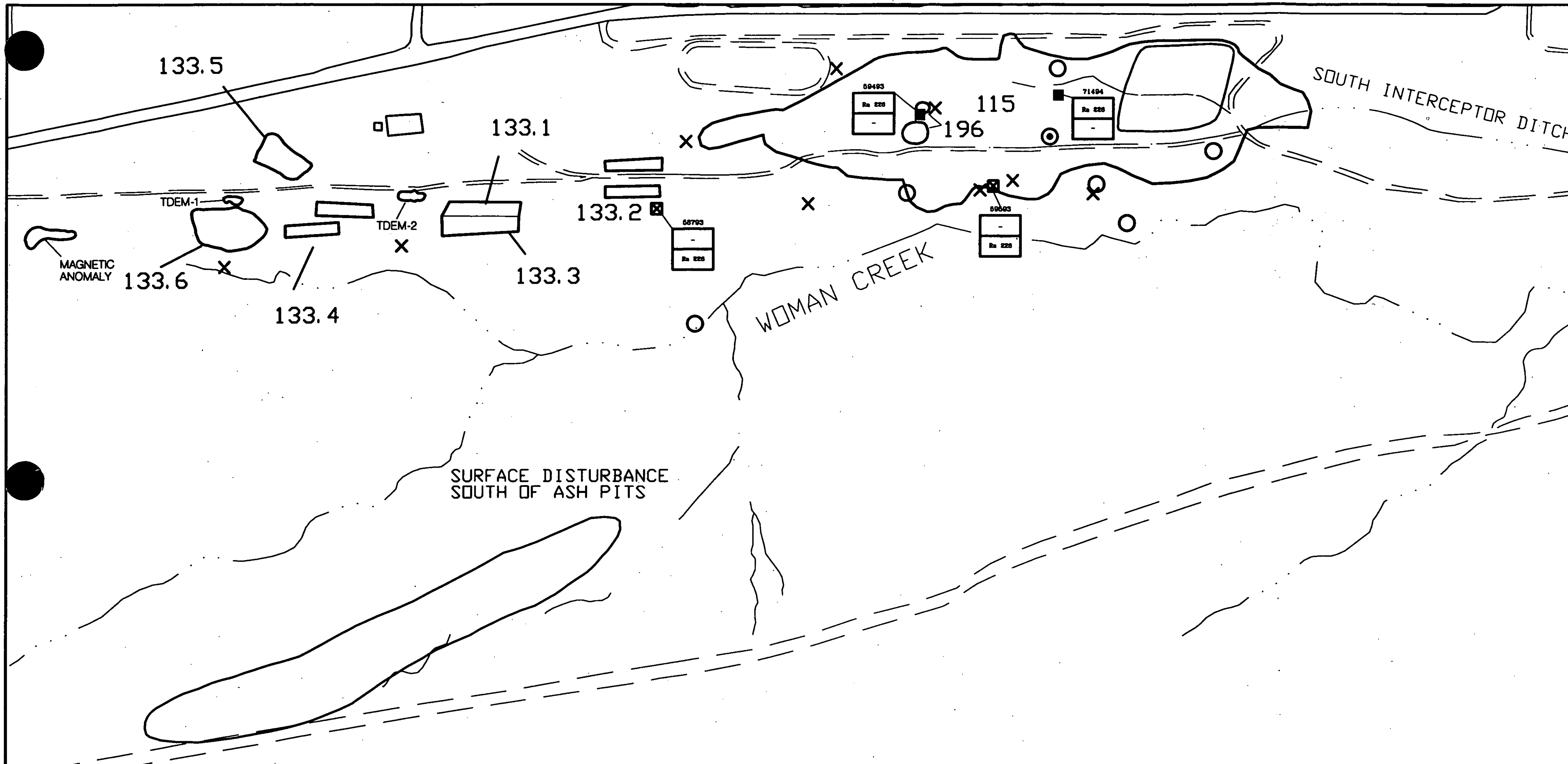
EXTENT OF METAL COCs IN SUBSURFACE SOIL IHSS 142/209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-4B



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

X <= Background Mean (BM)

> BM and <= BM + 1 STD DEV

> BM + 1 STD DEV and <= BM + 2 STD DEV

> BM + 2 STD DEV and <= BM + 3 STD DEV

> BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV

CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occurring in different concentrations at the same location represent samples collected on different dates.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (pCi/l)	STD. DEV.
U233/234	Dissolved U233/234	6.914	25.440
U235	Dissolved U235	0.20	0.640
U238	Dissolved U238	4.832	17.670
Am241	Dissolved Am241	0.011	0.010
Ra226	Dissolved Ra226	0.258	0.110

-N-

0 175 350

SCALE: 1" = 350'

Drawn JWH 10/2/95 Date

Checked TEQ 10/3/95 Date

Approved MRW 10/10/95 Date

FILE OU5-4-8A.DWG

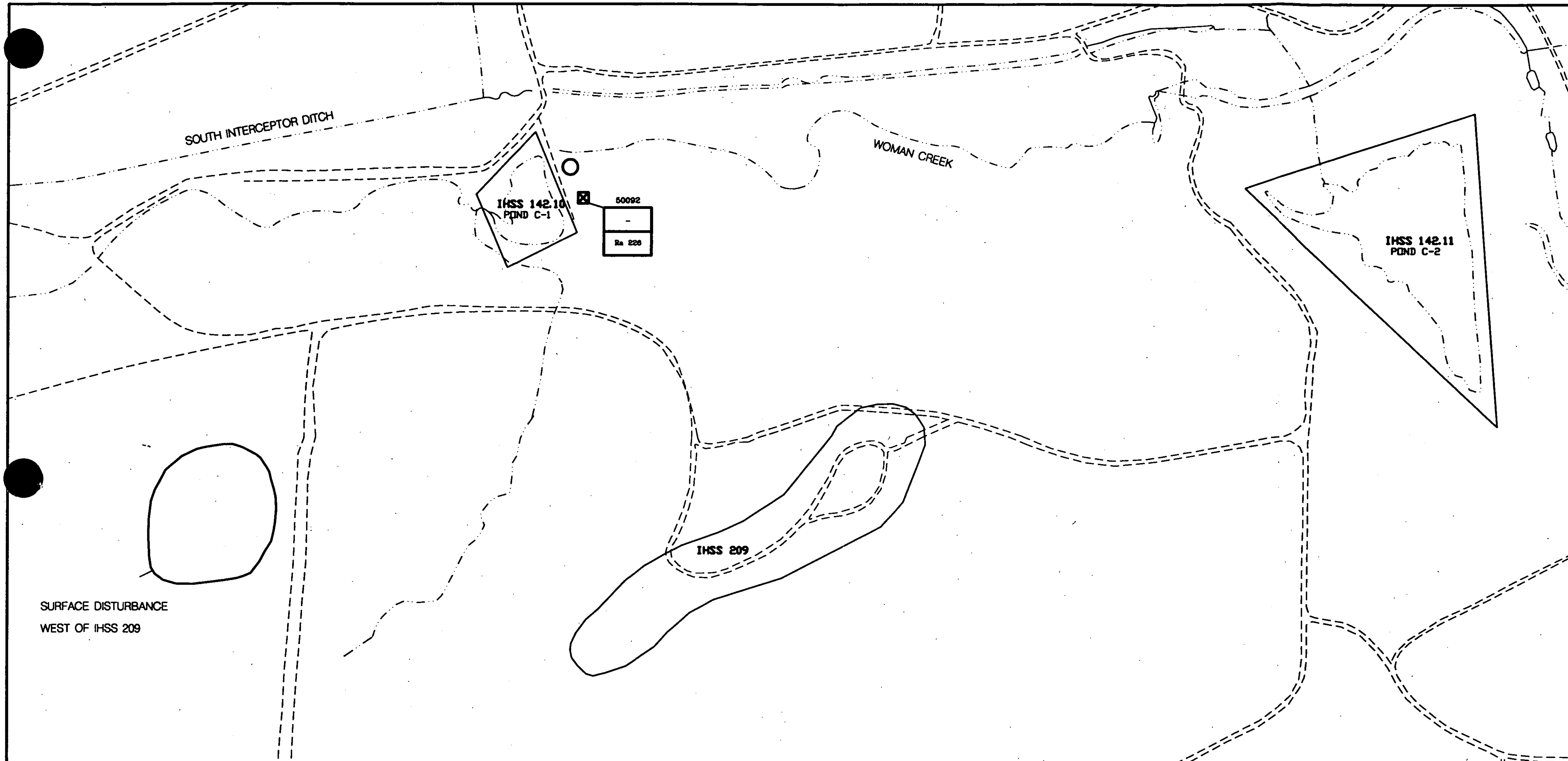
EXTENT OF DISSOLVED RADIONUCLIDE COCs IN GROUNDWATER

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-8A



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY

- X <= Background Mean (BM)
- ○ > BM and <= BM + 1 STD DEV
- ◉ > BM + 1 STD DEV and <= BM + 2 STD DEV
- ⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV
- ■ > BM + 3 STD DEV

LOCATION
CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occurring in different concentrations at the same location represent samples collected on different dates.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (pCi/l)	STD. DEV.
U233/234	Dissolved U233/234	6.914	25.440
U235	Dissolved U235	0.20	0.640
U238	Dissolved U238	4.832	17.670
Am241	Dissolved Am241	0.011	0.010
Ra226	Dissolved Ra226	0.258	0.110

-N-

0 150 300

SCALE: 1" = 300'

Drawn JWH Date 10/2/95
Checked [initials] Date 10/3/95
Approved MEW Date 10/10/95
FILE OU5-4-8B.DWG

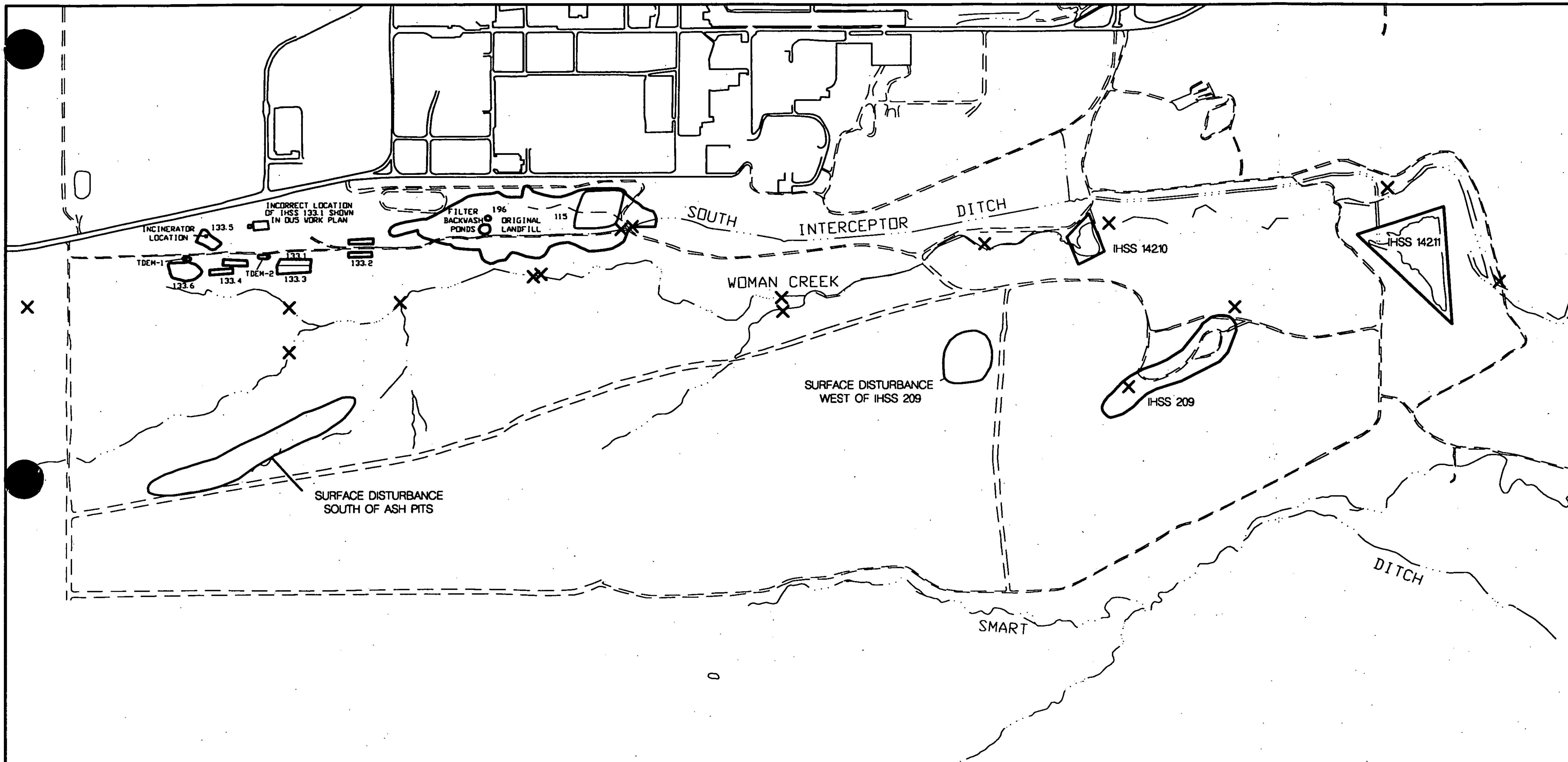
EXTENT OF DISSOLVED RADIONUCLIDE COCs IN GROUNDWATER IHSS 142/209

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-8B



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

<= Background Mean (BM)

> BM and <= BM + 1 STD DEV

> BM + 1 STD DEV and <= BM + 2 STD DEV

> BM + 2 STD DEV and <= BM + 3 STD DEV

> BM + 3 STD DEV

-N-

0 400 800

SCALE: 1" = 800'

Drawn JWH 10/3/95 Date

Checked 10/3/95 Date

Approved 10/10/95 Date

FILE OU5-4-9.DWG

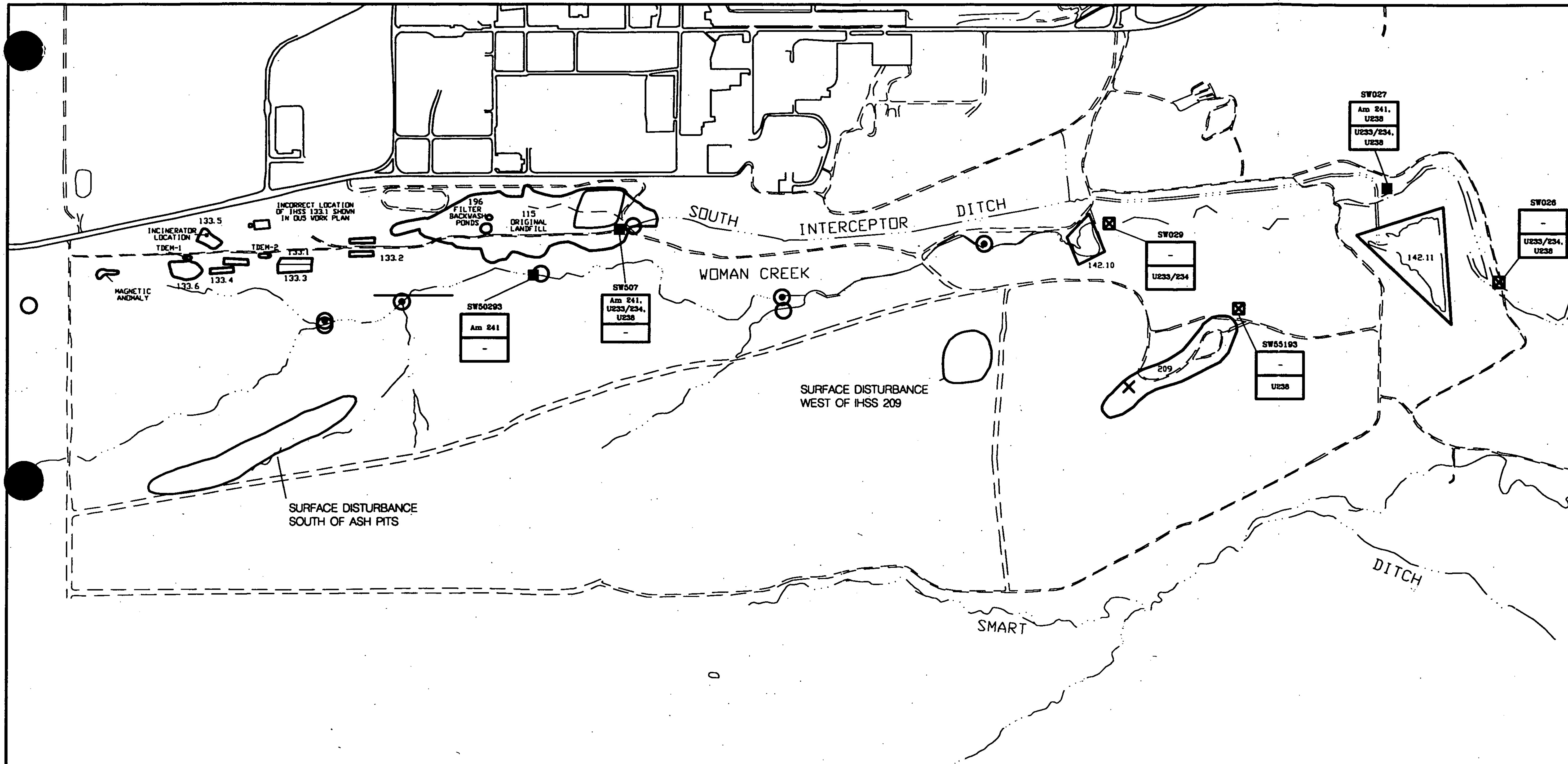
EXTENT OF METAL COCs IN SURFACE WATER

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-9



MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- IHSS BOUNDARY

- X <= Background Mean (BM)
- ○ > BM and <= BM + 1 STD DEV
- ◎ > BM + 1 STD DEV and <= BM + 2 STD DEV
- ⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV
- ■ > BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

Note: Constituents occurring in different concentrations at the same location represent samples collected on different dates.

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (pCi/l)	STD. DEV.
Am241	Total Am241	0.0039	0.0080
U233/234	Total U233/234	0.4862	0.5500
U238	Total U238	0.3642	0.4320

-N-

0 400 800

SCALE: 1" = 800'

Drawn JWH Date 10/3/95
Checked TZP 10/3/95 Date
Approved MEW 10/10/95 Date

FILE OU5-4-10.DWG

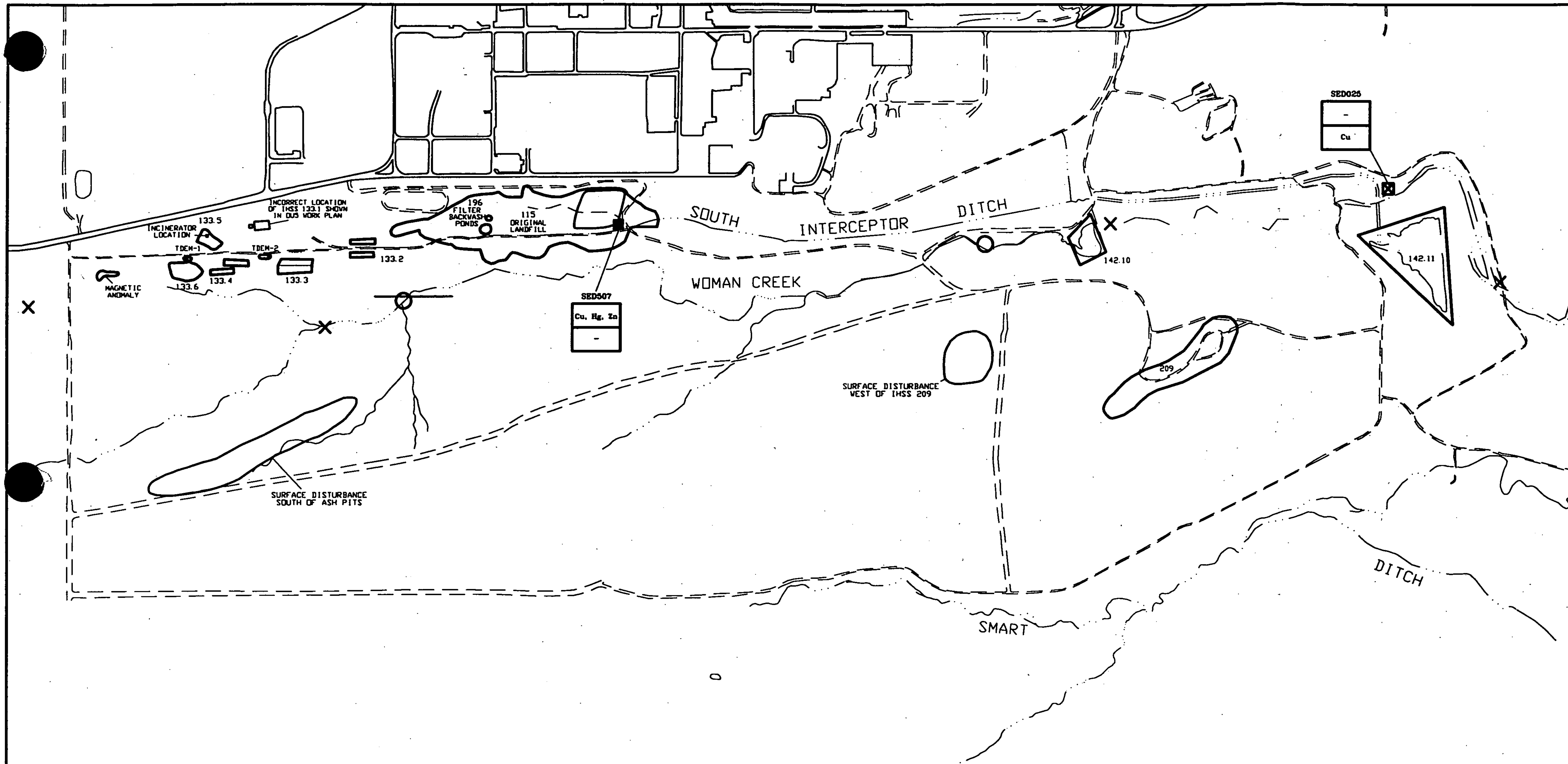
EXTENT OF TOTAL RADIONUCLIDE COCs IN SURFACE WATER

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-10



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

IHSS BOUNDARY

X <= Background Mean (BM)

> BM and <= BM + 1 STD DEV

> BM + 1 STD DEV and <= BM + 2 STD DEV

> BM + 2 STD DEV and <= BM + 3 STD DEV

> BM + 3 STD DEV

LOCATION

CONSTITUENTS >BM+3 STD DEV
CONSTITUENTS >BM+2 STD DEV AND <=BM+3 STD DEV

BACKGROUND DATA

SYMBOL	CONSTITUENT	MEAN (mg/kg)	STD. DEV.
Cu	Copper	10.24	7.77
Hg	Mercury	0.09	0.06
Zn	Zinc	53.86	83.08

-N-

0 400 800

SCALE: 1" = 800'

Drawn JWH 10/3/95 Date
Checked 7EP 10/3/95 Date
Approved MRW 10/10/95 Date

FILE OU5-4-11.DWG

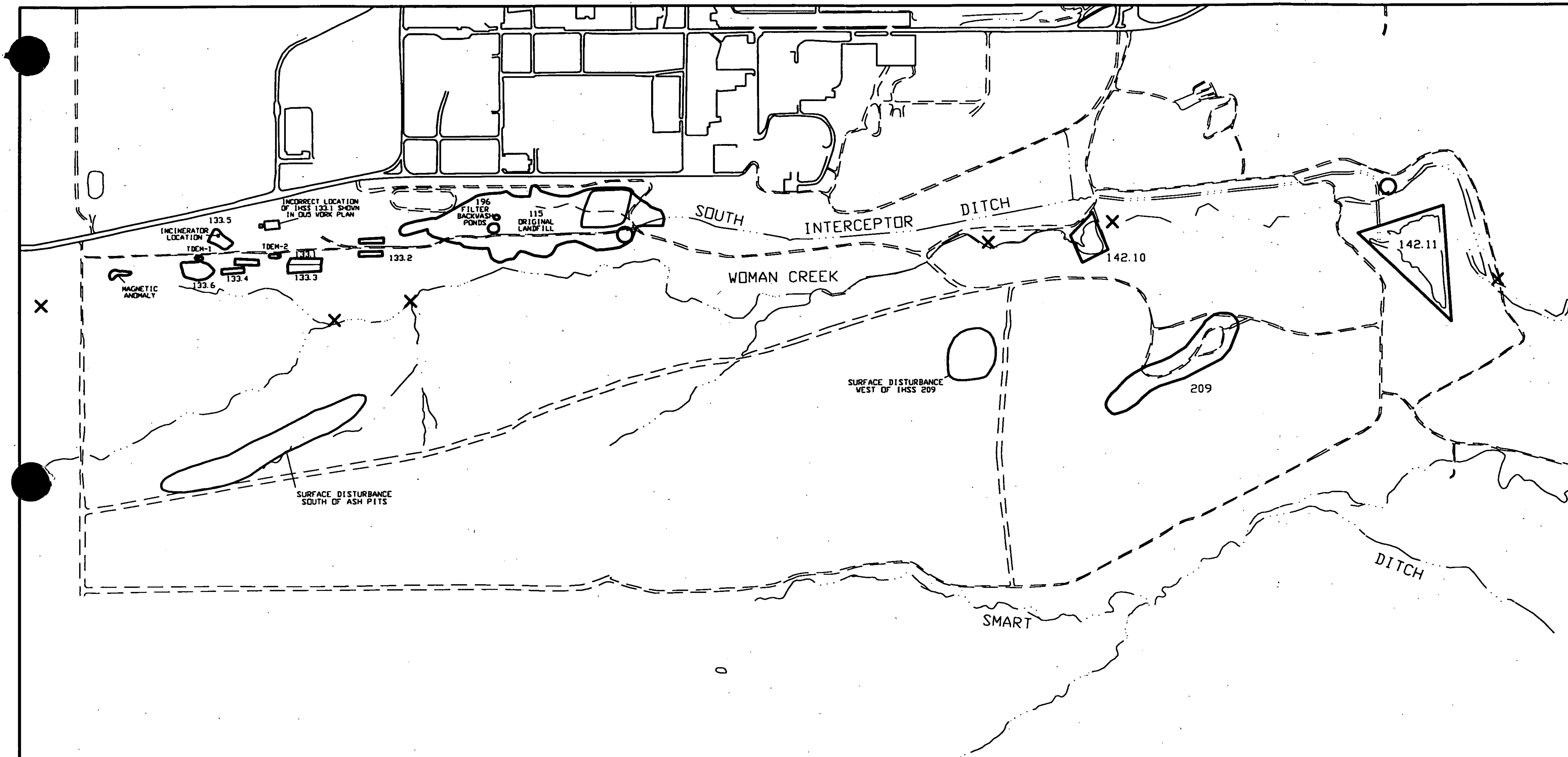
EXTENT OF TOTAL METAL COCs IN STREAM SEDIMENTS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 4-11



MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES	× <= Background Mean (BM)
PAVED ROADS	○ > BM and <= BM + 1 STD DEV
DIRT ROADS	◉ > BM + 1 STD DEV and <= BM + 2 STD DEV
IHSS BOUNDARY	⊠ > BM + 2 STD DEV and <= BM + 3 STD DEV
	■ > BM + 3 STD DEV

-N-

0 400 800

SCALE: 1" = 800'

Drawn JWH Date 10/3/95
Checked TZP Date 10/3/95
Approved MEW Date 10/10/95

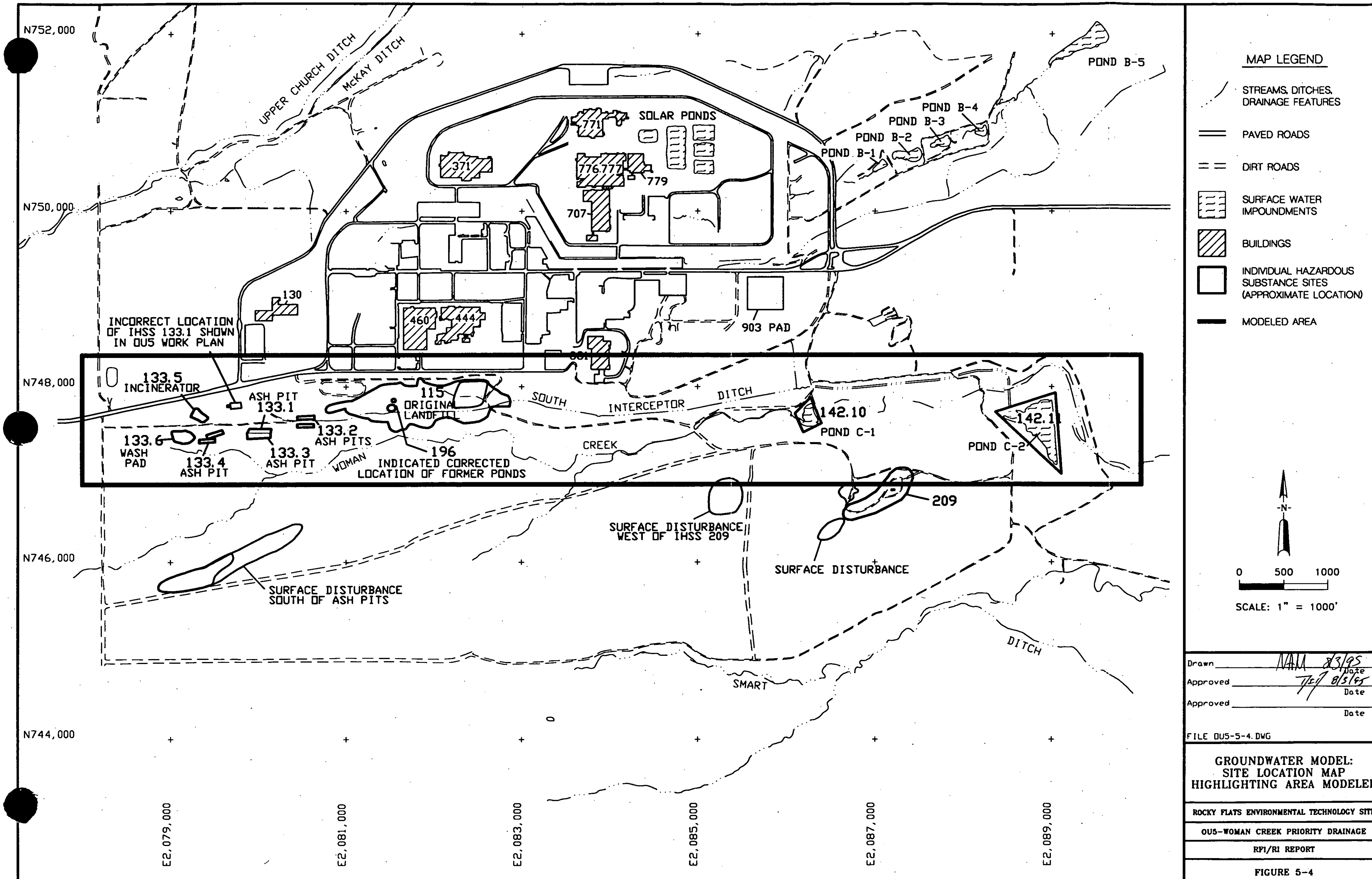
FILE OU5-4-12.DWG

EXTENT OF RADIONUCLIDE COCs IN STREAM SEDIMENTS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE RFI/RI REPORT

FIGURE 4-12



Drawn NAM 8/3/95 Date
Approved 8/3/95 Date
Approved Date

FILE OU5-5-4.DWG

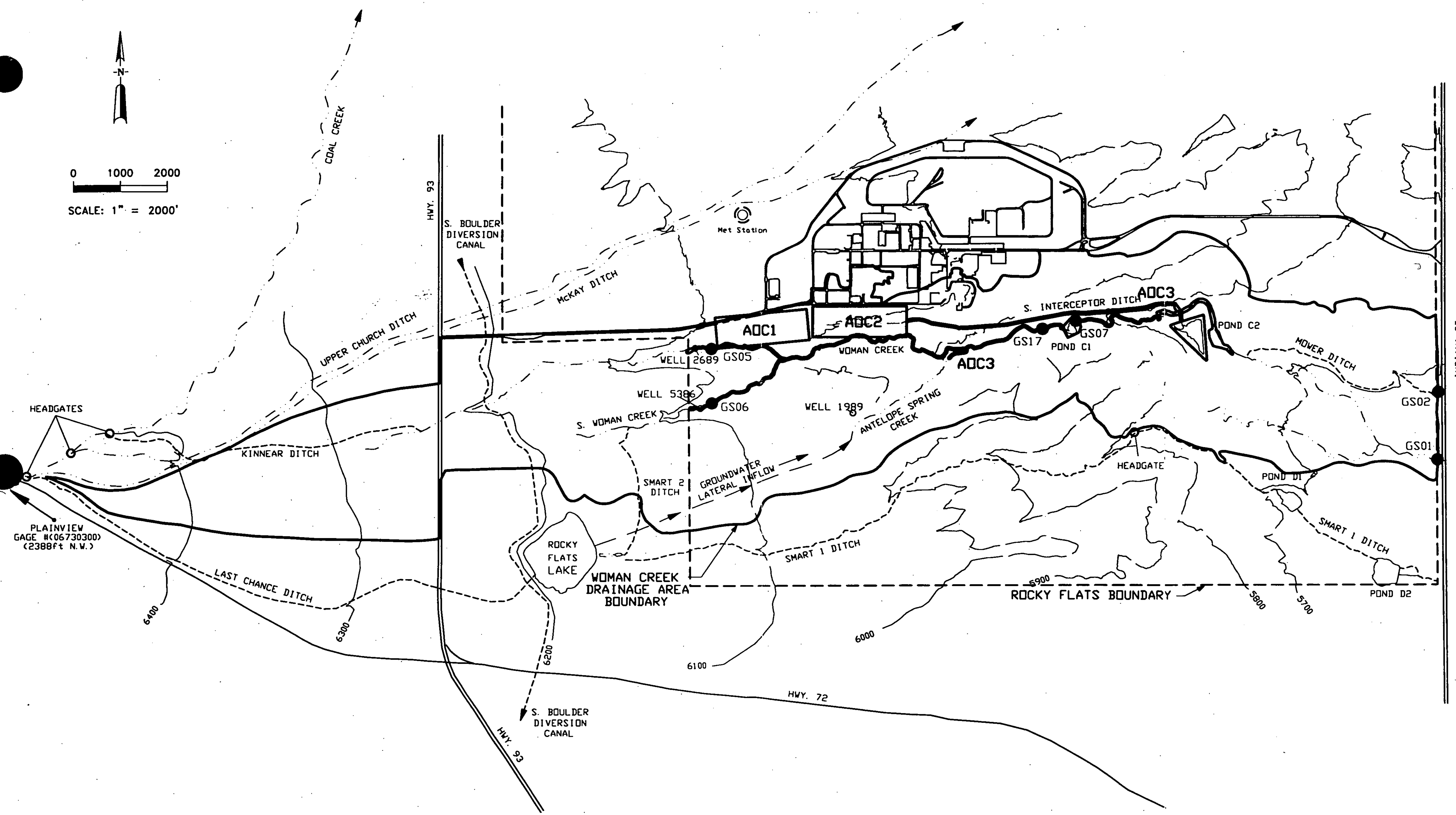
GROUNDWATER MODEL: SITE LOCATION MAP HIGHLIGHTING AREA MODELED

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 5-4



GS = Gage Station (Surface Water Flow Rate)
AOC = Area Of Concern

Drawn NAM 8/4/95 Date
Checked [illegible] 8/4/95 Date
Approved ______ Date
FILE OU5-5-18.DWG

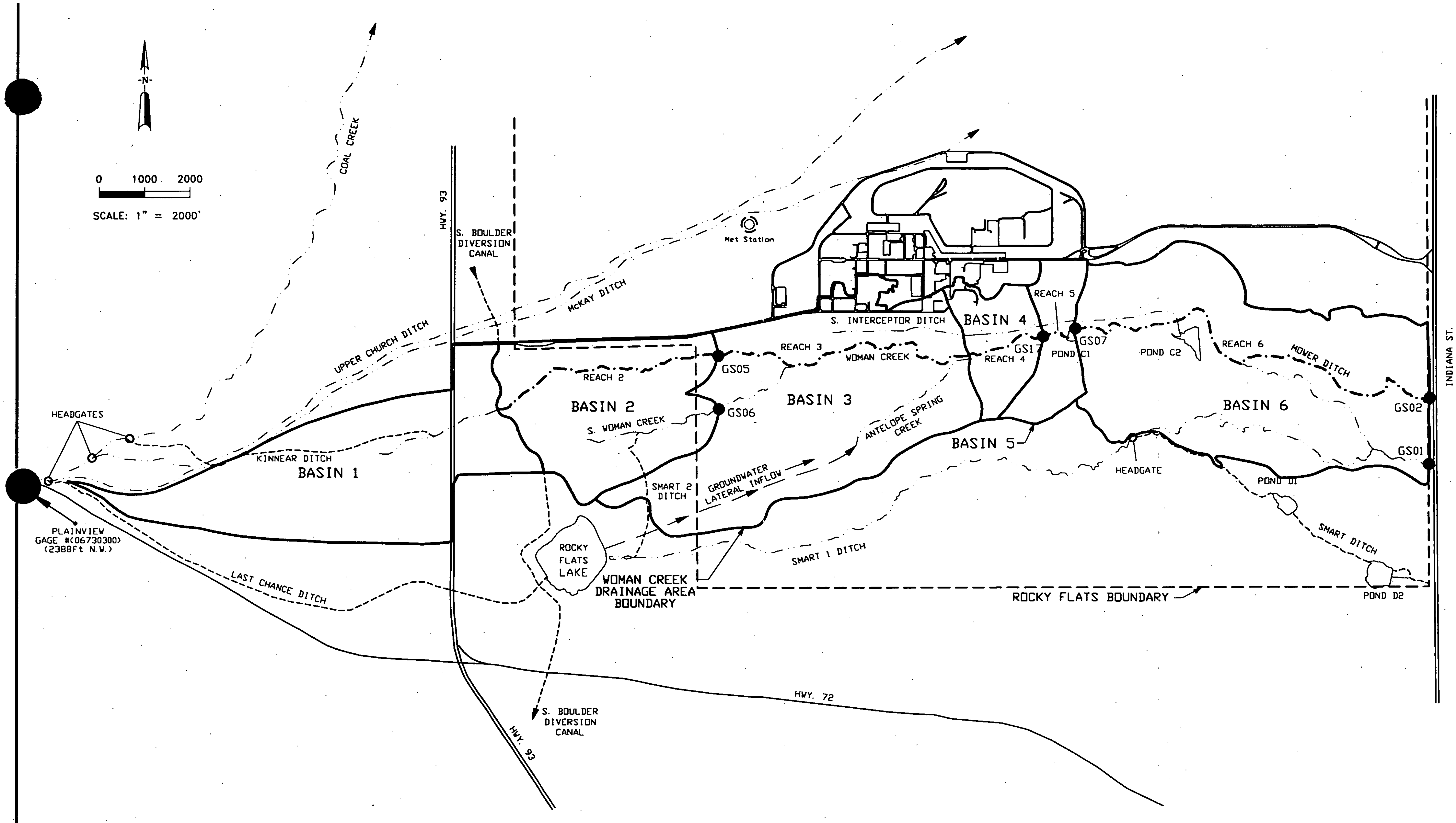
WOMAN CREEK PLAINIMETRIC FEATURES

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

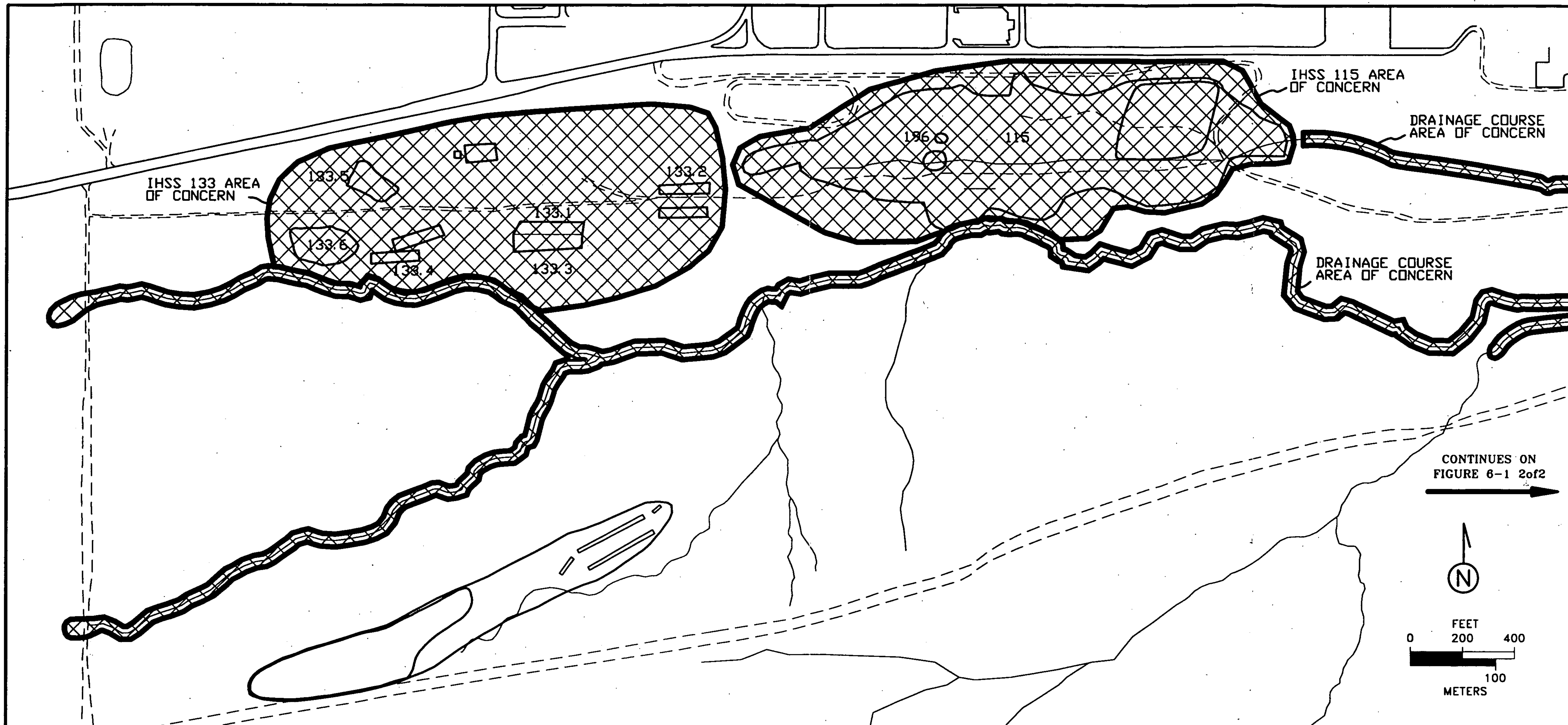
FIGURE 5-18



GS = Gage Station (Surface Water Flow Rate)

NOTE: For geometric properties of sub basins and stream reaches see table 2-1

Drawn NAM 7/31/95 Date	**WOMAN CREEK DRAINAGE BASIN LAYOUT**
Checked 7/31/95 Date	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
Approved Date	OU5 - WOMAN CREEK PRIORITY DRAINAGE
	RFI/RI REPORT
FILE OU5-5-24.DWG	FIGURE 5-24



LEGEND

SOURCE AREA

IHSS BOUNDARY

Note: West end of SID will be covered in IHSS 115 area of concern.

Drainage course area of concern consists of Woman Creek, SID, ponds C-1, and C-2.

Drawn SB 7/26/95 Date

Checked TEF 7/26/95 Date

Approved ________ Date

FILE CDPHE-61.DWG

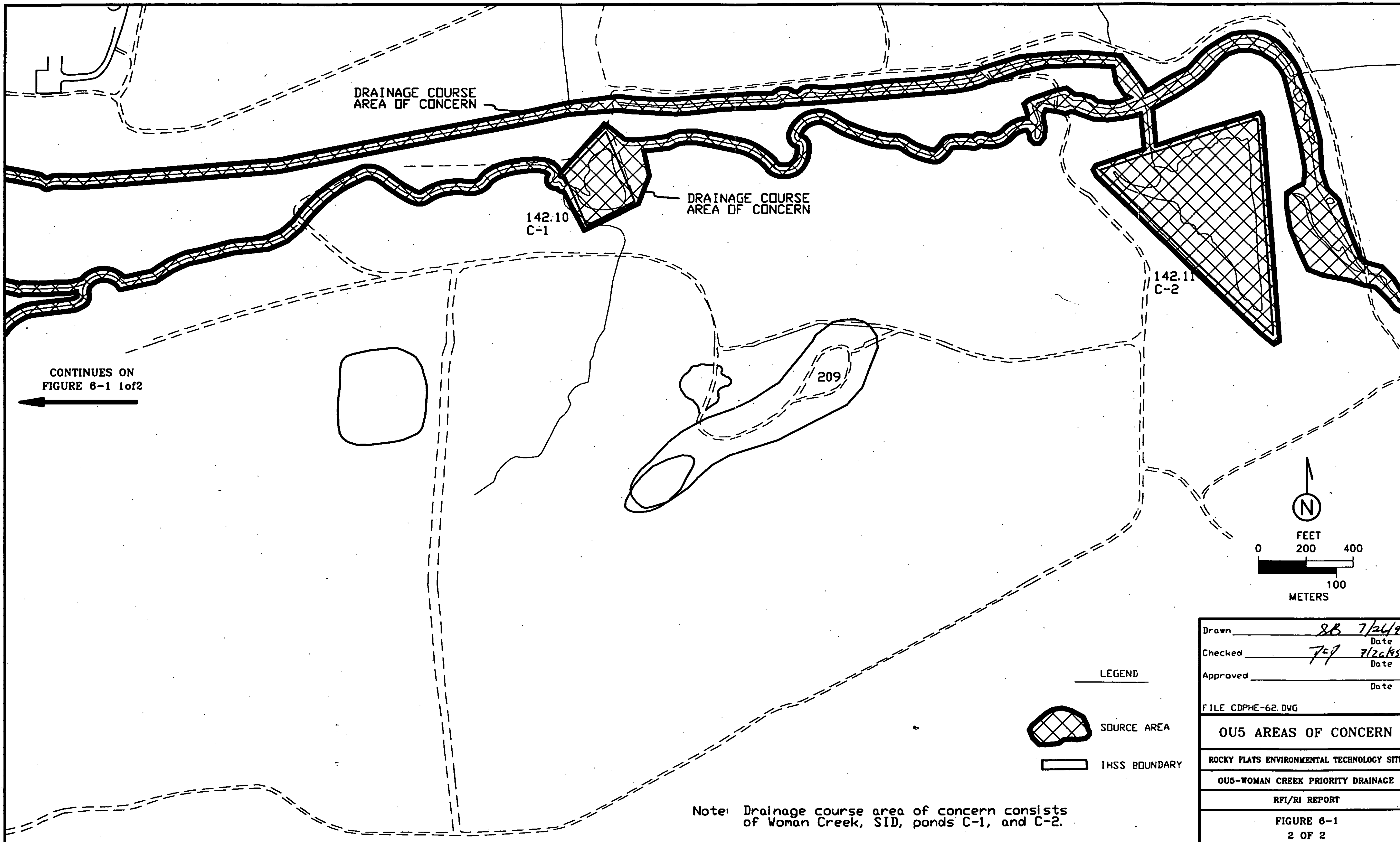
OU5 AREAS OF CONCERN

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 6-1
1 OF 2



Drawn SB 7/26/95 Date
Checked 7/26/95 Date
Approved Date

FILE CDPHE-62.DWG

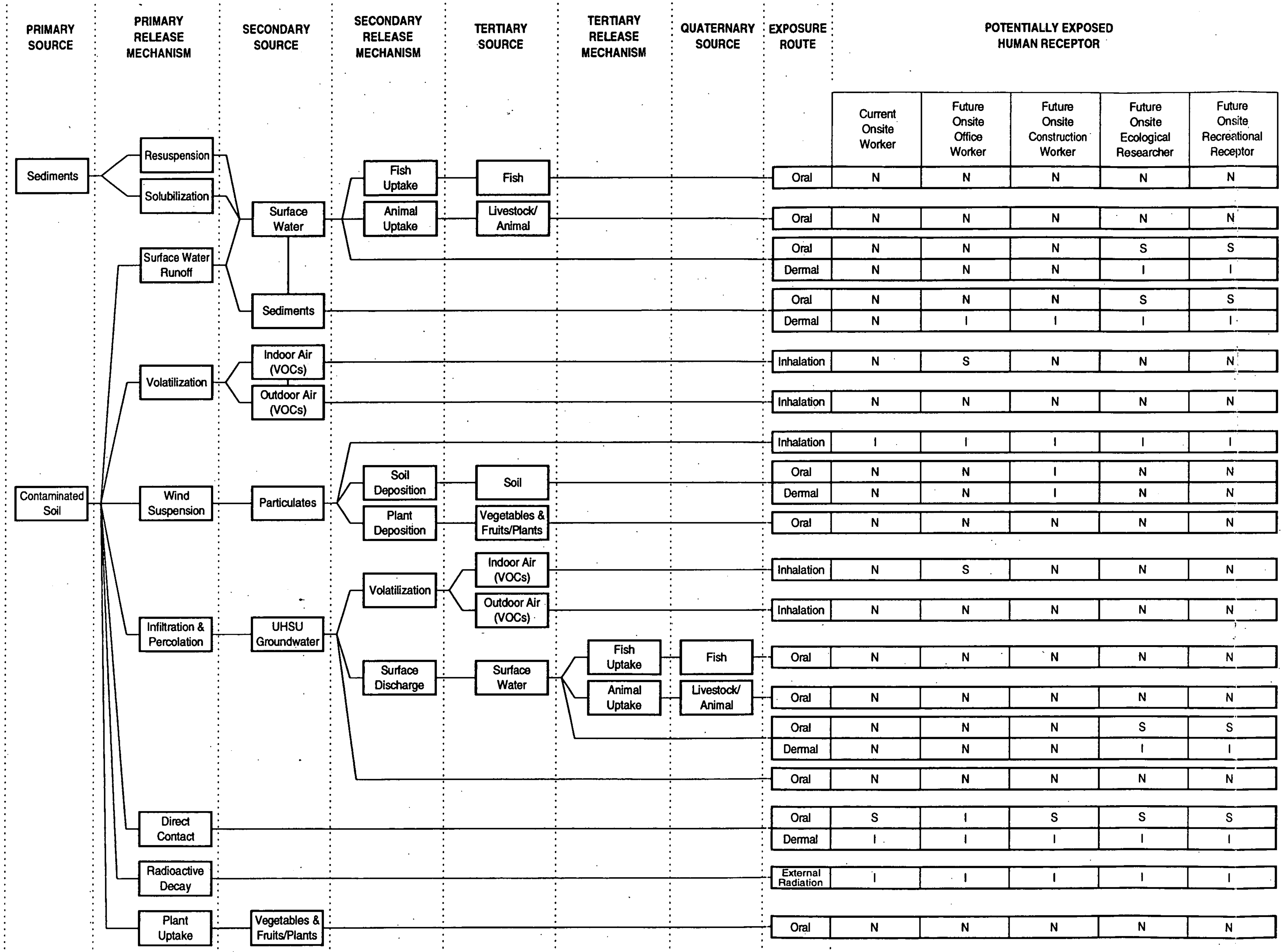
OU5 AREAS OF CONCERN

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5-WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 6-1
2 OF 2



S - Significant Potential Exposure Pathway
I - Insignificant Potential Exposure Pathway
N - Negligible or Incomplete Exposure Pathway
UHSU - Upper Hydrostratigraphic Unit

NOTES:

1. Potentially complete dermal pathways will be quantitatively assessed only if investigation demonstrates presence of organic contaminants of concern.
2. Significant and insignificant potential exposure pathways will be quantitatively evaluated.

CONCEPTUAL SITE MODEL

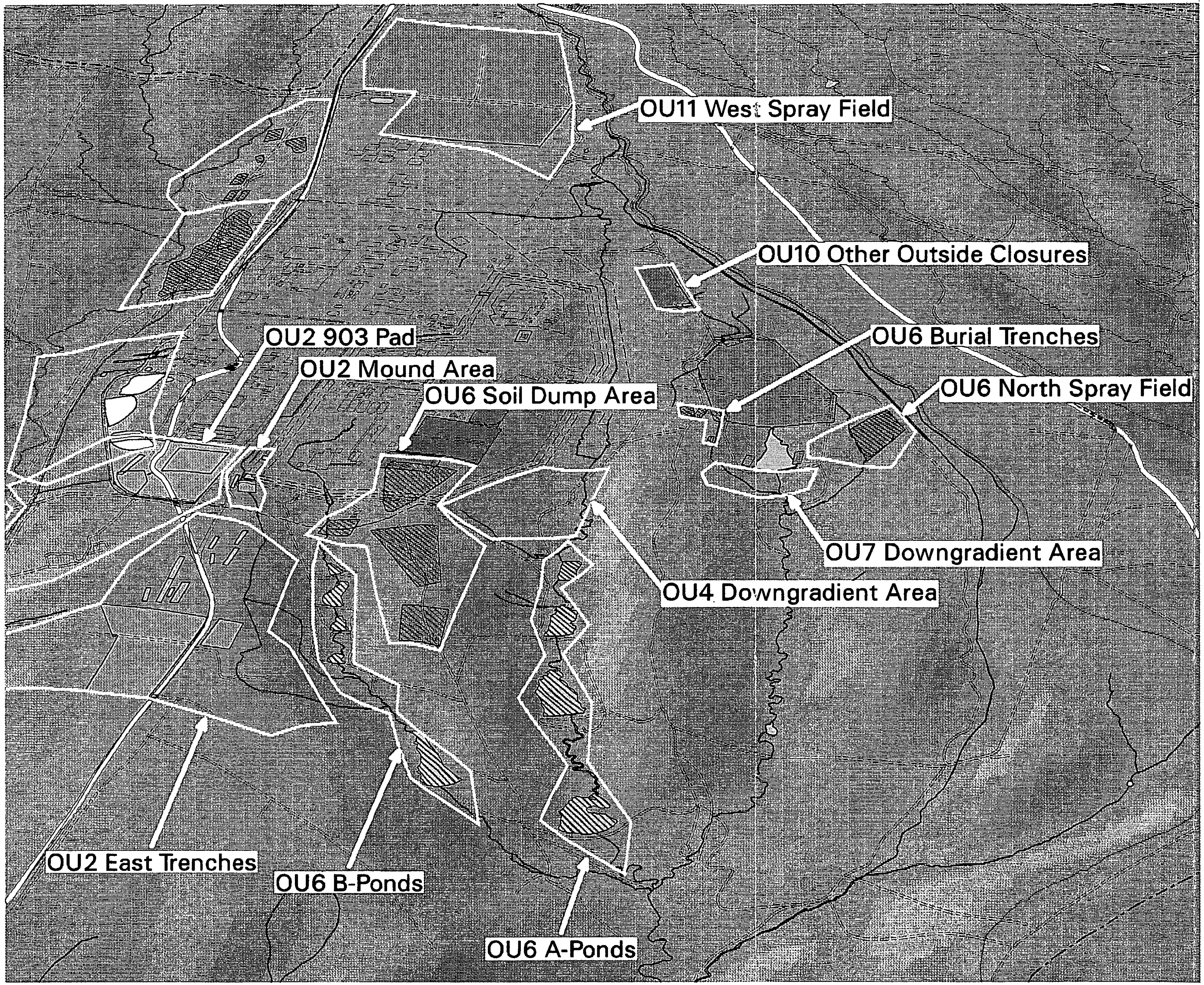
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

FIGURE 6-3

OU5-SM.DWG



EXPLANATION

- Watershed Boundary
- Rock Creek Watershed
- Walnut Creek Watershed
- Woman Creek Watershed
- Central Avenue
- Dirt Roads
- Canals and Ditches
- Security Fences
- Rocky Flats Buffer Zone
- Lakes and Ponds
- Buildings
- Operable Unit 1 881 Hillside
- Operable Unit 2 903 Pad, Mound, and East Trenches
- Operable Unit 4 Solar Ponds
- Operable Unit 5 Woman Creek
- Operable Unit 6 Walnut Creek
- Operable Unit 7 Present Landfill
- Operable Unit 10 Other Outside Closures
- Operable Unit 11 West Spray Field
- ERA Source Areas

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

ERAs for Walnut Creek and Woman Creek Watersheds at RFETS

ERA Source Areas in Walnut Creek Watershed

September 1995 | Figure 7.2-1

20-SEP-1995 GRA: wshed3dwalsrcs.gra • AML: /export/home/data3/swera/srcarea/amls/report/wshed3d.aml

LEGEND

Shallow groundwater area (indicated by thick, tall grass or other distinct vegetation).

Spring

Geologic contact, approximately located; dotted where concealed.

Landslide area (some slide areas concealed by fill); based on examination of historic airphotos, field mapping and/or subsurface exploration; limits are approximately located, dotted where concealed, queried where uncertain. Arrow indicates discrete landslide with surface expression. See Note 1.

Scarp (landslide-related unless noted otherwise).

Waste Fill — Sandy, Clayey Gravel and Cobbles (GC) derived from Qrf and Qc, and mixed with RFP production waste (wood, scrap metal, drums, graphite, concrete, etc.). Usually loose to medium dense; locally very loose. Inside edge of limits shown by

Fill — Road fill, other construction-related fill (e.g. for buried outfall pipe). Presumably clean (i.e., without admixed RFP waste).

Qc — Colluvium: Sandy, Clayey Gravel and Cobbles (GC), and Sandy Clay (CL); finer Qc concentrated on lower slopes below South Interceptor Ditch. Generally medium dense (gravel), stiff to very stiff (clay). Locally less dense / softer.

Qal — Valley Fill Alluvium: Sandy, Silty-Clayey Gravel and Cobbles (GM, GC). Generally medium dense to dense.

Qrf — Rocky Flats Alluvium: Sandy, Clayey Gravel and Cobbles (GC). Generally dense. Includes local interbeds of stiff to hard clays and sandy clays (CL), and medium dense to very dense, fine, clean to clayey sands (SP, SC).

G G' — Geologic Section

56993 — LOCATION CODE

BOREHOLE LOCATION

WELL LOCATION

SMALL DIAMETER WELL

WELL POINT LOCATION

NOTE:
1. OPERABLE UNIT 5 TOPOGRAPHY AS OF JANUARY 4, 1995.
2. SEE FIGURES 3-17 THROUGH 3-20 FOR GEOLOGIC CROSS SECTIONS.

SOURCE: EG&G, 1995e PRELIMINARY ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE OU-5 GEOTECHNICAL INVESTIGATION, DRAFT

Drawn	NAM	10/2/95 Date
Checked	[illegible]	10/3/95 Date
Approved	MRW	10/10/95 Date

FILE OU5-3-16.DWG

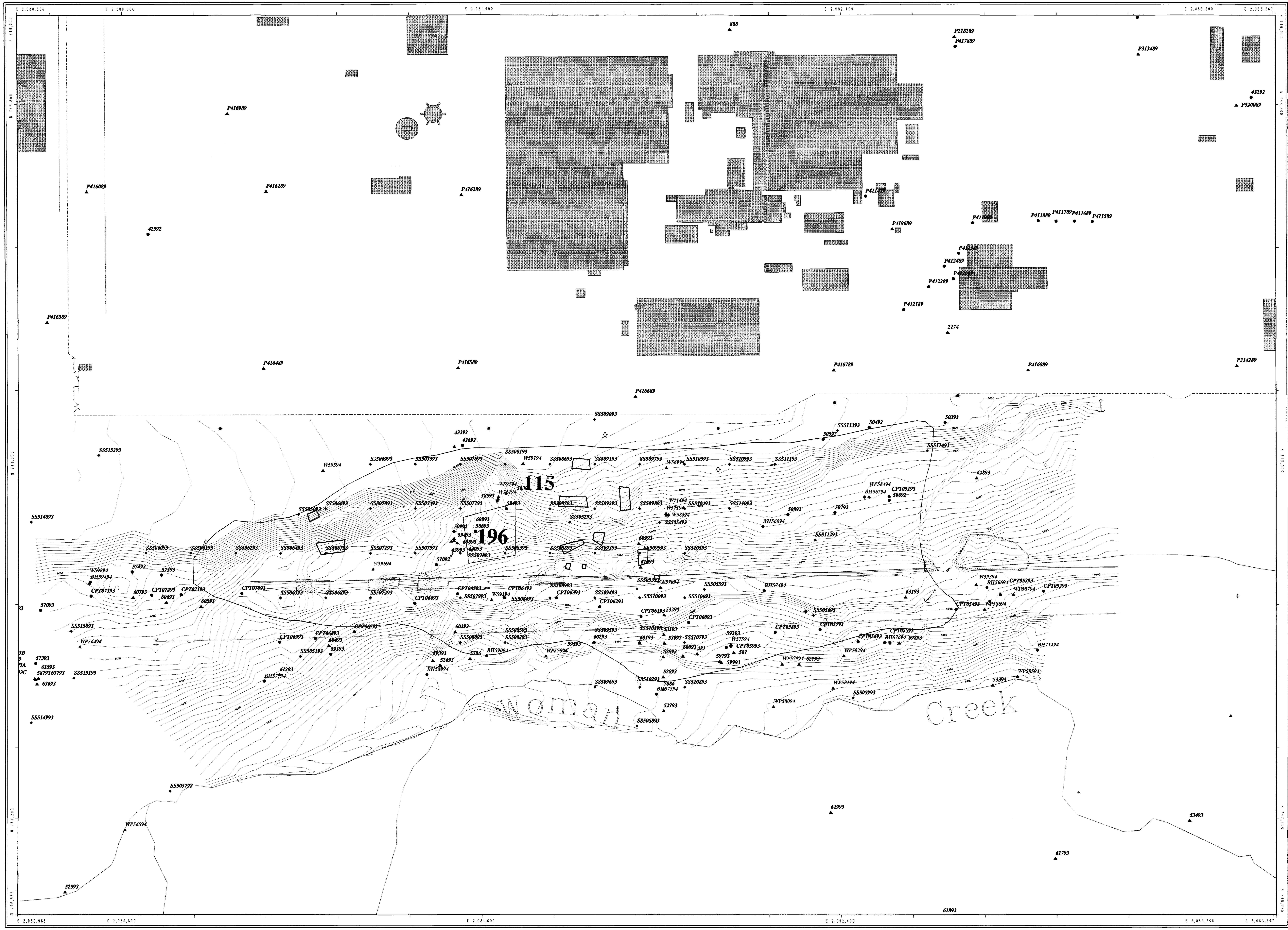
GEOLOGIC CROSS SECTION LOCATION MAP IHSS 115/196

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OU5 - WOMAN CREEK PRIORITY DRAINAGE

RFI/RI REPORT

OU05-A-000534 FIGURE 3-16 1 of 2



Location Map
IHSS 115/196

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences

Map Features

- Individual Hazardous Substance Site
- 2 foot contours
- RCA
- Centerline 115kV Powerline
- RIP RAP areas
- Air Monitoring Station
- Power Poles Locations
- Manhole Locations
- Above Ground Gas line marker
- GUY
- Borehole locations
- Groundwater Well locations
- Surface Soil locations
- 1994 Borehole locations
- 1994 Groundwater Well locations
- 1994 Surface Soil locations

DATA SOURCE:
Contour (2ft.) data provided by Paul Grabowski of Facilities Engr., EG&G Rocky Flats, Inc.- 1995.
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)

Scale = 1 : 960
1 inch represents 80 feet

50 0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

Figure 2-4

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

PROJECT NO.		BY / DEPARTMENT	DATE
OU5	GIS Analyst	W. Cheeks/RMRS/GIS	03/26/96
MAP ID	Checked		
IHSS-115/196	Approved	M. Wood/RMRS	
DATE CREATED			
March 26, 1996			

OU05-A-000594 2of2