

NOTICE

All drawings located at the end of the document.

TECHNICAL MEMORANDUM NO. 11

CONTAMINANTS OF CONCERN

**HUMAN HEALTH RISK ASSESSMENT
WOMAN CREEK PRIORITY DRAINAGE
OPERABLE UNIT NO. 5**

DRAFT FINAL

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

**U.S. DEPARTMENT OF ENERGY
Rocky Flats
Golden, Colorado**

ENVIRONMENTAL RESTORATION PROGRAM DEPARTMENT

October 1994

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EXECUTIVE SUMMARY

This Contaminants of Concern Technical Memorandum is part of the Baseline Risk Assessment for the Woman Creek Priority Drainage, Operable Unit No. 5 (OU5), located at the Department of Energy Rocky Flats Environmental Technology Site (formerly Rocky Flats Plant) in Golden, Colorado.

The technical memorandum identifies contaminants of concern that will be included in the Human Health Risk Assessment (HHRA) to assess potential health risk from assumed exposure to the chief contaminants detected in soil, groundwater, and other media sampled in OU5. Contaminants of concern are metals or radionuclides whose concentrations exceed background concentrations, or organic contaminants that are not naturally occurring, but that could pose a health risk under the assumed exposure conditions. They are selected from all analytes detected in each medium using risk-based and other screening methods that identify contaminants that would pose the greatest risk and therefore warrant inclusion in the HHRA. Contaminants of concern also provide the focus for fate and transport modeling and remedy selection.

Contaminants of concern were selected for the following media: surface soil, subsurface soil, groundwater, surface water, pond and seep water, pond and seep sediment and stream sediment. Contaminants of concern in each media were selected on an OU-wide basis; that is, data collected at Individual Hazardous Substance Sites (IHSSs) were pooled for each medium so that the chief contributors to risk could be identified for the entire OU.

The following general steps were used to identify contaminants of concern:

- Metals and radionuclides whose concentrations are greater than background level concentrations were identified as potential contaminants of concern and retained for further evaluation.
- The essential nutrients calcium, iron, potassium, magnesium, and sodium were eliminated from further evaluation.
- Professional judgement, such as geochemical evaluation or statistical analysis, was applied to eliminate some analytes as contaminants of concern.

- Contaminants whose concentrations are greater than background level concentrations and detected at five-percent or greater frequency were included in concentration/toxicity screens to identify the chief contributors to potential risk. The PCOCs which had maximum concentrations that did not pass the concentration/toxicity screen were retained as COCs for the HHRA.
- Contaminants detected at less than five-percent frequency were not included in the selection of OU-wide contaminants of concern but were evaluated in a separate risk-based screen to identify special-case contaminants of concern that warrant separate evaluation in the HHRA.

Table ES-1 summarizes the contaminants of concern identified for each medium in OU5.

Table ES-1
RFETS OU5 Summary of Contaminants of Concern by Medium

Contaminant of Concern	Surface Soil	Subsurface Soil	Ground-water	Surface Water	Seep Water ^a	Pond Sediment	Seep Sediment	Stream Sediment
Acenaphthene	X							
Acetone					X ^b			
Aroclor-1254	X							
Arsenic								X
Benzo(a)anthracene	X							
Benzo(a)pyrene	X							
Cadmium	X							X
Chromium		X						
Copper	X							X
Dibenzo(a,h)anthracene	X							
1,1-Dichloroethene					X			
Fluoranthene	X							
Fluorene	X							
Indeno(1,2,3-cd)pyrene	X							
Manganese								
Mercury	X							X
Molybdenum								X
Naphthalene	X							
Pentachlorophenol				X				
Pyrene	X							
Silver	X							X
Strontium				X				
Tetrachloroethene					X			
Trichloroethene					X			
Zinc	X						X	X

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Table ES-1
RFETS OU5 Summary of Contaminants of Concern by Medium

Contaminant of Concern	Surface Soil	Subsurface Soil	Ground-water	Surface Water	Seep Water ^a	Pond Sediment	Seep Sediment	Stream Sediment
Americium-241, total			X	X		X		X
Plutonium-239/240, total		X	X	X		X		X
Radium-226			X					
Strontium-89/90			X					
Uranium-233/234, total	X		X	X		X	X	
Uranium-235, total	X	X	X			X	X	
Uranium-238	X	X	X	X		X	X	

^a Radionuclides in seep water samples were not detected above the background upper tolerance limit (BUTL).
^b Possible laboratory contaminant.

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ACRONYMS

BRA	Baseline Risk Assessment
CDPHE	Colorado Department of Public Health and Environment
COC	contaminant of concern
CSF	cancer slope factor
DOE	U.S. Department of Energy
ECAO	Environmental Criteria and Assessment Office
EE	environmental evaluation
EPA	U.S. Environmental Protection Agency
FIDLER	Field Instrument for Detection of Low Energy Radiation
FOD	frequency of detection
g	gram
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HPGe	High-purity Germanium
IHSS	individual hazardous substance sites
IRIS	Integrated Risk Information System
kg	kilogram
L	liter
m	meter
m ³	cubic meter
mg	milligram
µg	microgram
OU	Operable Unit
pCi	picocurie
PA	protected Area
PCB	polychlorinated biphenyl
PCE	perchloroethylene
PCOC	potential contaminant of concern
PPRG	programmatic preliminary remediation goals
RBC	risk-based concentrations
RCRA	Resource Conservation and Recovery Act
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
SID	South Interceptor Ditch
SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TOC	total organic carbon
UTL	upper tolerance limit

1.0 INTRODUCTION

This Contaminants of Concern (COC) Technical Memorandum is presented as part of the Baseline Risk Assessment (BRA) for the Woman Creek Priority Drainage, Operable Unit 5 (OU5), located at Rocky Flats Environmental Technology Site (RFETS) in Golden, Colorado. The BRA, which consists of the Human Health Risk Assessment (HHRA) and the Environmental Evaluation (EE), will be included in the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) report for OU5. The RFI/RI is being conducted pursuant to the U.S. Department of Energy (DOE) Environmental Restoration Program; a Compliance Agreement among DOE, the U.S. Environmental Protection Agency (EPA), and the Colorado Department of Public Health and Environment (CDPHE); and the Federal Facility Agreement and Consent Order (Interagency Agreement) signed in 1991.

This technical memorandum has been developed to select COCs to be evaluated in the HHRA. The HHRA will evaluate potential human health risks for on-site and off-site receptors under current land-use and potential future land-use conditions, assuming no remedial action takes place at OU5. Contaminants of concern are metals or radionuclides whose concentrations exceed background concentration levels, or organic contaminants that are not naturally occurring, but could be a significant threat to human health under the exposure conditions evaluated. Contaminants of concern are identified on an OU-wide basis for each medium (e.g., groundwater, soil) through which exposure to contaminants 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.

Contaminants of concern are selected for surface soil, subsurface soil, groundwater, surface water, seep water, and pond and seep sediment. These media were sampled during the Phase I RFI/RI, in accordance with the *Phase I RFI/RI Work Plan for Operable Unit 5* (DOE, 1992). Contaminants of concern are identified on an OU-wide basis, by pooling analytical results for samples collected from the various sampling locations for each medium.

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RFI/RI Work Plan for OU5

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The RFETS is located on approximately 2,653 hectare (6,550 acres) of federally owned land in northern Jefferson County, Colorado, approximately 26 kilometers (16 miles) northwest of Denver (Figure 1-1). The RFETS consists of approximately 162 hectares (400 acre) of Protected Area (PA) or security area surrounded by a buffer zone of approximately 2,489 hectares (6,150 acres). Located primarily in the buffer zone on the southern side of the plant, the OU5 study area consists of approximately 292 hectares (720 acres) (Figure 1-1). Eleven individual hazardous substance sites (IHSSs) have been identified in OU-5. They are the Original Landfill and Filter Backwash Pond (IHSSs 115 and 196), the Ash Pits (IHSS 133.1-133.4), 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), and the Surface Disturbances (IHSS 209).

Physical site characteristics such as meteorological, geological, hydrological characteristics must be considered in the evaluation of fate and transport of contaminants to potential receptors. Detailed information on these site characteristics, as well as detailed information on local geography and IHSS histories, is presented in the *Phase I RFI/RI Work Plan for OU5* (DOE, 1992).

This technical memorandum is organized in the following sections. Section 2.0 describes the general process used to select COCs. Sections 3.0 through 10.0 present decision criteria specific to each medium, identify the COCs selected for each medium, and present the spatial and temporal distribution and geochemical characteristics of certain metals and radionuclides. References are listed in Section 11.0.

Appendix A, "Analytical Data Evaluation for Development of Potential Contaminants of Concern" summarizes the statistical methodology used to compare OU5 data to background data, and includes tables showing the results of the statistical tests. Statistical tests were used to identify metals and radionuclides whose concentrations exceed background levels and which may be environmental contaminants. These metals and radionuclides are retained for further evaluation as potential contaminants of concern (PCOCs).

2.0 SELECTION PROCESS FOR CONTAMINANTS OF CONCERN

The process for selection of COCs includes the following elements:

- evaluation of data
- comparison to background concentration levels
- elimination of essential nutrient and major ions
- evaluation of detection frequency
- concentration/toxicity screen
- application of professional judgement
- evaluation of risk-based concentrations for infrequently detected contaminants and identification of special-case COCs.

2.1 EVALUATION OF DATA

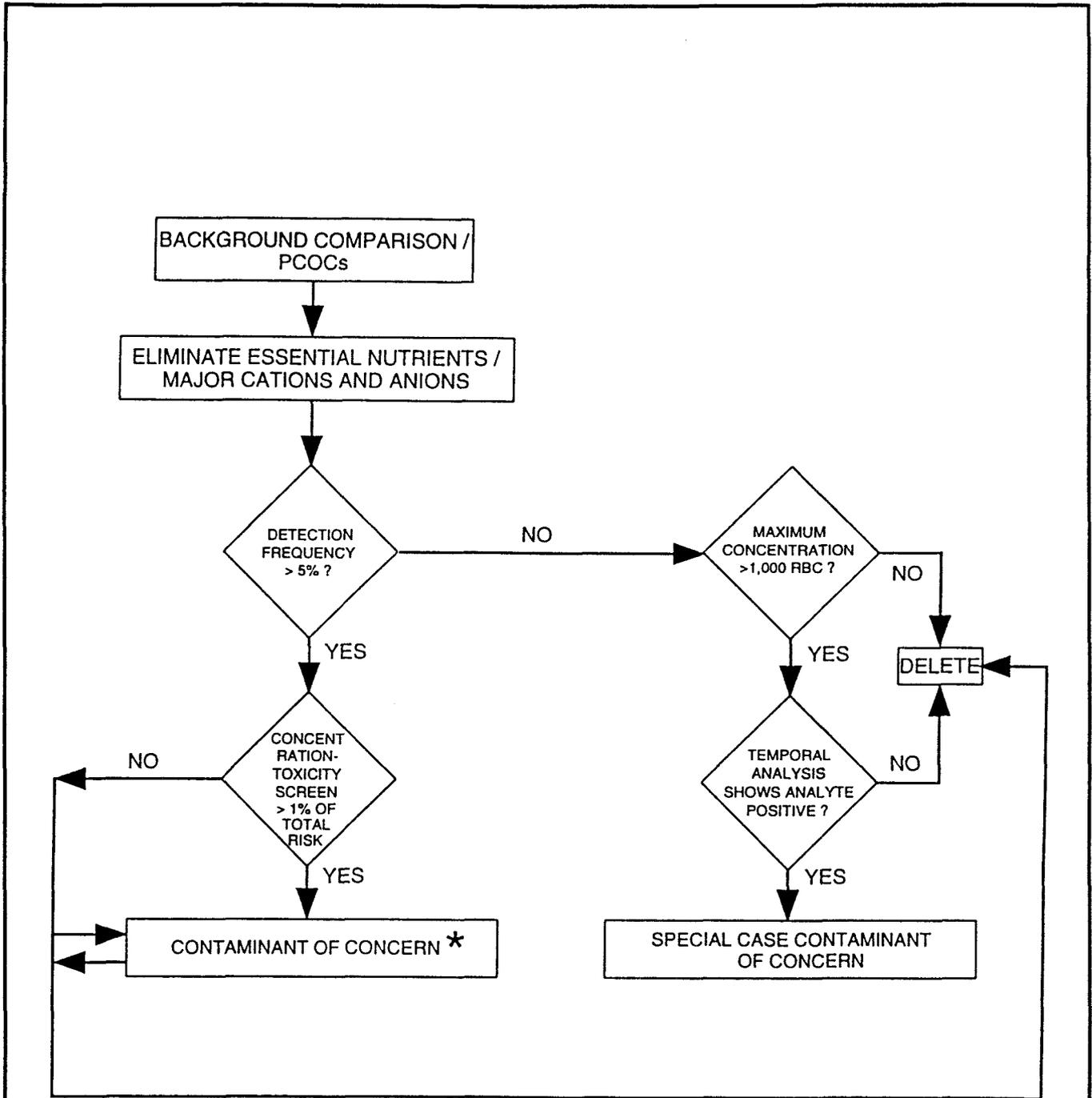
The preliminary step in the process for selection of COCs selection process is the evaluation of analytical data for samples collected from each environmental media. This process is described here, followed by the COC selection procedures.

Analytical data from environmental samples collected during the OU5 field sampling program and the site-wide sampling programs were used to characterize potential contamination at OU5. The samples used in this evaluation were collected between October 1992 and November 1993. Sampling is ongoing as data gaps are identified. The number of samples, sampling locations, and other features of the sampling and analytical program are discussed in *Phase I RFI/RI Work Plan for Operable Unit No. 5*, various technical memoranda (TMs), and summarized in *Draft Final Technical Memorandum No. 15* (DOE, 1994a). Sampling and analytical programs separated by media are described in Appendix A. Samples were collected from the following medium:

- surface soil
- subsurface soil
- groundwater
- surface water
- seep water
- pond sediment
- seep sediment
- stream sediment

The data set described in Appendix A is used to determine COCs. The flow chart for selecting COCs for OU5 is presented in Figure 2-1, Process for Selection of COCs. The process is intended to identify the chief environmental contaminants in each medium that could have adverse impacts on public health. The risk assessment focusses on OU5 contaminants that are potentially significant health hazards. Inorganic contaminants whose concentrations are within background range or that are essential nutrients or major ions are excluded from the risk assessment. Organic contaminants that would contribute insignificantly to overall risk are identified but are not included in the quantitative risk assessment. Contaminants of concern were selected on an OU-wide basis for each medium. The following procedures shown in Figure 2-1 are listed below and described in the following sections:

- 2.2 Comparison to Background Levels
- 2.3 Elimination of Essential Nutrients and Major Ions
- 2.4 Evaluation of Detection Frequency
- 2.5 Concentration/Toxicity Screen
- 2.6 Application of Professional Judgment
- 2.7 Risk-Based Concentration Evaluation of Infrequently Detected Contaminants and Identification of Special-Case Contaminants of Concern



* PROFESSIONAL JUDGEMENT APPLIED TO THESE ANALYTES

PROCESS FOR SELECTION OF COCs	
CHEMICALS OF CONCERN (COC) TM	
U.S. DEPARTMENT OF ENERGY ROCKY FLATS, GOLDEN, COLORADO	
	Figure 2-1

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2.2 COMPARISON TO BACKGROUND LEVELS

The evaluation of analytical data for the development of PCOCs is presented in Appendix A and summarized briefly in this section. Analytical results are also given in Appendix A. Analytical results for metals and radionuclides were compared to background levels derived from data from subsurface soils, groundwater, seeps/springs, and stream sediment reported in the *Background Geochemical Characterization Report* (DOE, 1993) 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 exceed background levels were eliminated from further consideration as potential COCs.

Appendix A presents the background comparison methodology in detail, and contains summary tables of statistical results for metals and radionuclides in all media. Organic contaminants were assumed to be anthropogenic in origin and attributable to background, therefore, any organic contaminant detected is considered a potential contaminant of concern (PCOC). The following criteria are used to evaluate whether a metal or radionuclide exceeded background levels.

- a. Analytical results for metals and radionuclides were compared to the background data using four statistical tests: the Quantile test, Slippage test, Student's t-test, and the Gehan test as described in the *letter report of Gilbert* (Gilbert, 1993). Test conditions and treatment of non-detect values are discussed in Appendix A. The analyte was considered to be above background if it failed any test at the $p \leq 0.05$ level.
- b. Upper tolerance limit (UTL)_{99/99} comparison: Analytical results for each metal and radionuclide were compared to the 99-percent UTL of background data calculated at the 99-percent confidence level (UTL_{99/99}). The UTL_{99/99} test is an indicator of possible hot spots (Gilbert, 1993), but with large sample sizes of 100 to 200, it is to be expected that one or two data points would exceed the UTL_{99/99} value. Nevertheless, if any result exceeded the UTL_{99/99}, the analyte was identified as a PCOC, subject to spatial and temporal analysis.

2.3 ELIMINATION OF ESSENTIAL NUTRIENTS AND MAJOR IONS

Calcium, iron, magnesium, potassium, and sodium were eliminated from further consideration as COCs because they are essential nutrients, they occur naturally in the environment, and they are toxic only at very high doses. Anions in groundwater other than nitrates were not evaluated. The elimination of essential nutrients and major cations and anions is applied to all media presented in Section 2.1.

2.4 EVALUATION OF DETECTION FREQUENCY

All metals and radionuclides whose concentrations exceed background concentrations, and all detected organic contaminants are evaluated for frequency of detection. Contaminants that were detected at a frequency of greater than five percent were considered potential OU-wide COCs. These contaminants were included in concentration/toxicity screens to identify contaminants that could contribute significantly to total risk. Contaminants detected at and less than five percent frequency are not characteristic of OU-wide contamination and the potential for exposure is low. Maximum concentrations of infrequently detected organic contaminants and metals were compared to risk-based concentrations 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. These contaminants were retained as special-case COCs for evaluation in the risk assessment. Because DOE Order 5400.1 stipulates the use of all data for radionuclides, negative values were used as reported and radionuclides were considered to be detected at 100-percent frequency.

2.5 CONCENTRATION/TOXICITY SCREEN

Contaminants of concern in each medium were selected using separate concentration/toxicity screens for noncarcinogens, carcinogens, and radionuclides. The screens included inorganics above background levels and organic contaminants that were detected at greater than five-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

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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 contaminant. The risk factor for carcinogenic effects (and for radionuclides) is the maximum detected concentration (or activity) multiplied by the EPA cancer slope factor (CSF) for that contaminant (or radionuclide). The contaminant-specific risk factors are summed to calculate total risk factors for the noncarcinogenic, carcinogenic, or radioactive 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 contaminants and metals and for carcinogenic effects of radionuclides. Several contaminants have both noncarcinogenic and carcinogenic effects and are compared in both concentration/toxicity screens.

Each PCOC that comprised less than one percent of the total risk factor was not considered a COC for evaluation in the quantitative risk assessment. This approach reduces the number of contaminants to be carried through a risk assessment. However, the approach is conservative (i.e., health protective) because it retains some contaminants that contribute as little as one percent of the total potential risk in that medium. In most cases, only a few contaminants contribute the majority of potential risk in each medium.

EPA-recommended toxicity factors (RfDs and CSFs) were used in the concentration/toxicity screens. RfDs, expressed as milligrams per kilogram of body weight per day (mg/kg-d), and CSFs, expressed as per mg/kg-d or risk per picocurie (risk/pCi), were taken from EPA sources, if available, and the RFETS programmatic preliminary remediation goals (PPRGs) document (DOE, 1994b). The PPRG document presents RfDs and CSFs determined from *Integrated Risk Information System (IRIS)* (EPA, 1994a), *Health Effects Assessment Summary Tables (HEAST)* (EPA, 1994b), and other EPA sources. The toxicity factors used in the screens are listed in Tables 2-1 and 2-2.

Table 2-1
RFETS OU5
Toxicity Factors for
Organic Contaminants and Metals

Analyte	CSFs 1/(mg/kg-day)		EPA Cancer Weight of Evidence	RfDs (mg/kg-day)	
	Oral	Inhalation		Oral	Inhalation *
1,1-Dichloroethene	6.0E-01 (1)	1.2E+00 (2)	C	9.0E-03 (1)	-
1,1,1-Trichloroethane	-	-	-	-	-
1,2-Dichloroethene	-	-	-	9.0E-03 (2)	-
2-Butanone	-	-	D	6.0E-01 (1)	2.9E-01
2-Hexanone	-	-	-	-	-
2-Methylnaphthalene	-	-	-	-	-
4-Methyl-2-pentanone	-	-	-	5.0E-02 (2)	2.3E-02
4,4-DDT	3.4E-01 (1)	3.4E-01 (1)	B2	5.0E-04 (1)	-
Acenaphthene	-	-	-	6.0E-02 (1)	-
Acenaphthylene	-	-	D	-	-
Acetone	-	-	-	1.0E-01 (1)	-
Aldrin	1.7E+01 (1)	1.7E+01 (1)	B2	3.0E-05 (1)	-
Alpha-BHC	6.3E+00 (2)	6.3E+00 (2)	-	-	-
Aluminum	-	-	-	2.9E+00 (6)	-
Anthracene	-	-	-	3.0E-01 (1)	-
Antimony	-	-	-	4.0E-04 (1)	-
Arsenic	1.7E+00 (7)	1.5E+01 (7)	A	3.0E-04 (1)	-
Barium	-	-	-	7.0E-02 (1)	1.4E-04
Benzo(a)anthracene	7.3E-01 (4)	-	B2	-	-
Benzo(a)pyrene	7.3E+00 (1)	-	B2	-	-
Benzo(b)fluoranthene	7.3E-01 (4)	-	B2	-	-
Benzo(g,h,i)perylene	-	-	D	-	-
Benzo(k)fluoranthene	7.3E-02 (4)	-	B2	-	-
Benzoic Acid	-	-	-	4.0E+00 (1)	-
Beryllium	4.3E+00 (1)	8.4E+00 (1)	B2	5.0E-03 (1)	-

**Table 2-1
(continued)**

Analyte	CSFs 1/(mg/kg-day)		EPA Cancer Weight of Evidence	RfDs (mg/kg-day)	
	Oral	Inhalation		Oral	Inhalation *
Bis(2-ethylhexyl)phthalate	1.4E-02 (1)	-	B2	2.0E-02 (1)	-
Butylbenzylphthalate	-	-	C	2.0E-01 (1)	-
Cadmium (food)	-	6.3E+00 (1)	B1	1.0E-03 (1)	-
Cadmium (water)	-	-	B1	5.0E-04 (1)	-
Cesium	-	-	-	-	-
Chromium III	-	-	-	1.0E+00 (1)	-
Chromium VI	-	4.1E+01	A	5.0E-03 (1)	-
Chrysene	7.3E-03 (4)	-	B2	-	-
Cobalt	-	-	-	6.0E-02 (6)	-
Copper	-	-	D	4.0E-02 (2)	-
Di-n-butylphthalate	-	-	D	1.0E-01 (1)	-
Di-n-octylphthalate	-	-	D	2.0E-02 (2)	-
Dibenzo(a,h)anthracene	7.3E+00 (4)	-	B2	-	-
Dibenzofuran	-	-	D	-	-
Dieldrin	1.6E+01 (1)	2.9E-02 (1)	B2	5.0E-05 (1)	-
Diethylphthalate	-	-	-	8.0E-01 (1)	-
Endosulfan sulfate	-	-	-	5.0E-05 (1)	-
Endrin ketone	-	-	-	-	-
Ethylbenzene	-	-	D	1.0E-01 (1)	2.9E-01
Fluoranthene	-	-	-	4.0E-02 (1)	-
Fluorene	-	-	-	4.0E-02 (1)	-
Heptachlor epoxide	9.1E+00 (1)	9.1E+00 (1)	B2	1.3E-05 (1)	-
Isophorone	9.5E-04 (1)	-	C	2.0E-01 (1)	-
Indeno(1,2,3-c,d)pyrene	7.3E-01 (4)	-	B2	-	-
Lead	-	-	B2	-	-
Lithium	-	-	-	2.0E-02 (6)	-

**Table 2-1
(continued)**

Analyte	CSFs 1/(mg/kg-day)		EPA Cancer Weight of Evidence	RfDs (mg/kg-day)	
	Oral	Inhalation		Oral	Inhalation *
Manganese (food)	-	-	D	1.4E-01 (1)	1.4E-05
Manganese (water)	-	-	D	5.0E-03 (1)	-
Mercury	-	-	D	3.0E-04 (2)	8.6E-05
Methoxychlor	-	-	D	5.0E-03 (1)	-
Methylene chloride	7.5E-03 (1)	1.6E-03 (1)	B2	6.0E-02 (1)	8.6E-01
Molybdenum	-	-	-	5.0E-03 (1)	-
Naphthalene	-	-	-	4.0E-02 (6)	-
Nickel (salts)	-	-	-	2.0E-02 (1)	-
Pentachlorophenol	1.2E-01 (1)	-	B2	3.0E-02 (1)	-
Phenanthrene	-	-	D	-	-
Phenol	-	-	D	6.0E-01 (1)	-
Polychlorinated biphenyls	7.7E+00 (1)	-	B2	7.0E-05 (1)	-
Pyrene	-	-	D	3.0E-02 (1)	-
Selenium	-	-	-	5.0E-03 (1)	-
Silicon	-	-	-	-	-
Silver	-	-	D	5.0E-03 (1)	-
Strontium	-	-	-	6.0E-01 (1)	-
Tetrachloroethene	5.2E-02 (5)	2.0E-03 (5)	B2	1.0E-02 (1)	-
Thallium	-	-	-	-	-
Tin	-	-	-	6.0E-01 (2)	-
Toluene	-	-	D	2.0E-01 (1)	1.1E-01
Trichloroethene	1.1E-02 (5)	6.0E-03 (5)	B2	-	-
Vanadium	-	-	-	7.0E-03 (2)	-
Xylenes	-	-	-	2.0E+00 (1)	-
Zinc	-	-	D	3.0E-01 (1)	-

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Sources:

- (1) = IRIS
- (2) = HEAST 1994 and Supplement (EPA, 1994b)
- (3) = HEAST 1994 Table 2 (EPA, 1994b)
- (4) = EPA, 1992
- (5) = Joan S. Dollarhide, Superfund Health Risk Technical Support Center. "*Carcinogenicity Characterization of Perchloroethylene (PCE) and Trichloroethylene (TCE) (Luke Air Force Base, Arizona). Environmental Criteria and Assessment Office (ECAO).*"
- (6) = Provisional values for aluminum, cobalt, lithium, and naphthalene, USEPA, ECAO.
- (7) = Converted from IRIS unit risks. Oral proposed Unit Risk Factor = $4.00E-05/\mu\text{g}/\text{L}$. Inhalation Unit Risk Factor = $4.30E-03/\mu\text{g}/\text{m}^3$.

Oral CSF = $5.00E-05 \times 1000\mu\text{g}/\text{mg} \times 70\text{kg}/2\text{L}$. Inhalation CSF = $4.30E-03/\mu\text{g}/\text{m}^3 \times 1000\mu\text{g}/\text{mg} \times 70\text{kg}/20\text{m}^3$.

* Calculated from reference concentration (RfC). RfD = $\text{RfC} \times 20\text{m}^3/\text{day}/70\text{kg}$.

EPA Cancer Weight of Evidence Codes:

Group A = Human carcinogen (sufficient evidence of carcinogenicity in humans)

Group B = Probable human carcinogen

B1 = Limited evidence of carcinogenicity in humans

B2 = Sufficient evidence of carcinogenicity in animals with inadequate or evidence in humans

Group C = Possible human carcinogen (limited evidence of carcinogenicity in animals inadequate or lack of human data)

Group D = Not classifiable as a human carcinogen (inadequate or no evidence)

Group E = Evidence of noncarcinogen for humans (no evidence of carcinogenicity in adequate studies)

Table 2-2
RFETS OU5
Cancer Slope Factors for Radionuclides

Analyte	Oral (Risk/pCi)	Inhalation (Risk/pCi)	External (Risk/yr/pCi/g)	EPA Cancer Weight of Evidence
Americium-241	2.4E-10	3.2E-08	4.9E-09	A
Cesium-137 +D	2.8E-11	1.9E-11	2.0E-06	A
Plutonium-238	2.2E-10	3.9E-08	2.8E-11	-
Plutonium-239	2.3E-10	3.8E-08	1.7E-11	A
Plutonium-240	2.3E-10	3.8E-08	2.7E-11	A
Radium-226 +D	1.2E-10	3.0E-09	6.0E-06	A
Strontium-89	3.0E-12	2.9E-12	4.7E-10	A
Strontium-90 +D	3.6E-11	6.2E-11	0.0E+00	A
Uranium-233, 234*	1.7E-11	2.6E-08	3.0E-11	A
Uranium-235 +D	1.6E-11	2.5E-08	2.4E-07	A
Uranium-238 +D	2.0E-11	2.4E-08	5.1E-08	A

Source: HEAST 1994 (EPA, 1994b)

* = Slope factors shown are for U-233 because they are the most conservative values.

pCi = picocurie

+D = Risks from radioactive decay products included.

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If toxicity values were available for both inhalation and oral exposure routes, the more conservative value was used in the screen, unless that route was negligible. These exceptions are noted in the concentration/toxicity values. For all media, the more conservative chromium VI RfD is used. The only CSF for chromium is an inhalation CSF for chromium VI. This value is used for carcinogens. The use of the more conservative chromium VI toxicity values may be overly conservative, however, it is prudent to assume chromium VI in the absence of further information.

For metals and radionuclides in groundwater, only oral toxicity values will be used because these contaminants do not volatilize in groundwater. An inhalation CSF specific to nickel sulfide, which occurs in nickel refinery dust, is available. However, it is considered inappropriate to apply the inhalation CSF for nickel sulfide to nickel detected in soil at RFETS because no nickel refining occurred at RFETS, and nickel in soils at RFETS most likely occurs in minerals or in anthropogenic salts related to industrial processes other than refining. Therefore, nickel is not evaluated as a carcinogen.

EPA-established toxicity factors are not available for some of the PCOCs. Therefore, these analytes cannot be included in the concentration/toxicity screens, in other toxicity-based screens, or in the quantitative risk assessment. OU5 contaminants without toxicity factors were identified for each medium and are listed in each section. The potential impact of these contaminants on overall risk will be addressed qualitatively in the HHRA.

2.6 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 evaluated with professional judgement to support a conclusion as to whether they were likely to be naturally occurring or due to environmental contamination. For example, all metals are concluded to be naturally occurring based on spatial, temporal, and geochemical evaluation. This judgment process resulted in removing several metals and radionuclides as COCs in various media. The evaluation and professional judgment are described in the following paragraphs.

The spatial and temporal distribution and geochemical characteristics of certain metals and radionuclides detected above background levels and identified as chemicals of concern (COCs) were evaluated to determine whether these constituents are related to environmental contamination. Based on the known histories of the OU5 IHSSs as well as the operational history of the Rocky Flats Plant, none of the radionuclides identified as COCs were eliminated through this process. The primary radionuclides identified as COCs, Americium-241, Plutonium-239/240, and the uranium isotopes, are expected as site contaminants. The following sections discuss the evaluation of the spatial and temporal distribution and geochemical characteristics of certain metals in each of the environmental media applicable to OU5. Much of this discussion is based on the information presented in Technical Memorandum No. 15 (TM15), Amended Field Sampling Plan (DOE, 1994a).

SURFACE SOILS

The spatial distribution of metals in surface soils was evaluated in TM15. Several metals were identified in TM15 as being present at concentrations greater than background at several locations in IHSSs 115, 133, and 209 and the other surface disturbances (DOE, 1994a). The distribution of the metals identified as COCs for surface soil (cadmium, copper, mercury, silver and zinc) were reevaluated to determine whether any could be eliminated as COCs.

SUBSURFACE SOILS

The spatial distribution, both aerially and vertically with depth, of the metals identified as COCs for subsurface soils (barium, chromium, and manganese) was evaluated.

GROUNDWATER

As shown in Appendix A, several metals were identified as being above background levels in unfiltered groundwater samples. The distribution of metals in groundwater was evaluated to determine the reasonableness of excluding or retaining them as COCs. This evaluation consisted primarily of a

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comparison of metals concentrations with total suspended solids (TSS) along with limited temporal evaluations of the data and comparison of concentrations of some metals to those detected at other locations at Rocky Flats.

SURFACE WATER

Detailed evaluations of the concentrations of metals in surface-water samples are presented in TM15 (DOE, 1994a) and in the Hydrologic Data Summary Report for OU5 (DOE, 1994d). All available data for surface-water samples are contained in those two documents. As discussed in Section 6.3 these data were further evaluated to determine if the metals identified as COCs for surface water (arsenic, barium, lithium, and selenium) are attributable to environmental contamination.

SEEP WATER

No metals were identified as COCs for seep water. No further evaluation of the distribution of metals in seep water was conducted.

POND AND SEEP SEDIMENTS

Pond Sediments Concentrations of arsenic in the six pond-sediment samples collected were all below the UTL_{99/99} for both stream sediments and seep sediments.

Seep Sediments Samples of sediment were collected from four seeps, two near IHSS 115 (locations SED51593 and SED51693) and two near IHSS 133 (locations SED51793 and SED51893). Antimony, beryllium, and zinc are identified as COCs for seep sediments based upon the data for these four samples. The concentrations of these metals in the samples was evaluated to determine if they should be considered site contaminants for seep sediments.

STREAM SEDIMENTS

Six stream sediment samples were collected along Woman Creek and its tributaries and two sediment samples were collected from the SID (SED025 and SED507). Arsenic, copper, mercury, molybdenum, selenium, and zinc have been identified as COCs for stream sediments. The spatial distribution of these constituents and their concentrations are discussed below to evaluate if they should continue to be considered COCs.

2.7 RISK-BASED EVALUATION OF INFREQUENTLY DETECTED CONTAMINANTS AND IDENTIFICATION OF SPECIAL-CASE COCS

Contaminants detected infrequently (in less than five percent of all samples in the medium) are not characteristic of OU-wide contamination and the potential for exposure is low. These contaminants were further screened to include any infrequently detected contaminant 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 1,000 times risk-based concentrations (RBCs) (DOE, 1994b).

For screening purposes, RBCs were defined as contaminant concentrations associated with an excess cancer risk of 10^{-6} (one in one million) or a hazard index of one for noncarcinogenic effects, assuming residential exposure to surface soil and groundwater, and assuming construction worker exposure to subsurface soil. Any infrequently detected contaminant measured at a concentration greater than 1000 times the respective RBC was identified as representing a potentially significant health threat if exposure were to occur and was included in the list of special-case COCs for evaluation in the risk assessment.

RBCs have been calculated specifically for RFETS and are presented in DOE (1994b). These values, referred to as PPRGs in the DOE (1994b) document, are used in this identification of special-case COCs. PPRGs for contaminants in surface soil were calculated for residential receptors assuming multiple pathway exposure (ingestion, inhalation of particulates, and external radiation exposure). PPRGs for contaminants in subsurface soil were calculated for construction workers, assuming ingestion of soil,

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inhalation of particulates and VOCs, and external radiation exposure. PPRGs for contaminants in groundwater were calculated for residential use, assuming ingestion of water and inhalation of VOCs released during domestic use. PPRGs for contaminants in surface water were calculated for the residential use, assuming ingestion while swimming.

3.0 CONTAMINANTS OF CONCERN IN SURFACE SOIL

This section describes the concentration/toxicity screen and the risk-based evaluation of infrequently detected contaminants for the surface soil COC identification process. Data evaluation, background comparison, and detection frequency methodology and results are presented in Appendix A. PCOCs with greater than five-percent frequency of detection (FOD) presented in Table A-9 of Appendix A are used as inputs to the concentration/toxicity screen.

3.1 CONCENTRATION/TOXICITY SCREENS

Concentration/toxicity screens for surface soils are presented in Table 3-1 (noncarcinogens), Table 3-2 (carcinogens) and Table 3-3 (radionuclides). All analytes that contribute at least 1 percent of the total risk factor are retained as OU-wide COCs. Those PCOCs which contributed greater than one percent of the total risk factor for surface soil are listed as follows.

RFETS OU5
Contaminants of Concern following Con/Tox Screen
Surface Soil

-
- Acenaphthene
 - Aroclor-1254
 - Benzo(a)anthracene
 - Benzo(a)pyrene
 - Cadmium
 - Copper
 - Dibenzo(a,h)anthracene
 - Fluoranthene
 - Fluorene
 - Indeno(1,2,3-cd)pyrene
 - Mercury
 - Naphthalene
 - Pyrene
 - Silver
 - Zinc
 - Uranium-233/234
 - Uranium-235
 - Uranium-238

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Table 3-1
 RFETS OUS
 Concentration/Toxicity Screen
 Surface Soil Noncarcinogens

PCOC	Maximum Concentration (mg/kg)	RfD (mg/kg-day) (a)	Type of RfD (b)	Chemical-specific Risk Factor (Rf)	Ratio of Rf/Rj	Percentage of Total Risk Factor	Consider a COC?
Non-Carcinogens							
Acenaphthene	44	6.00E-02	o	7.33E+02	1.45E-02	1.45%	YES
Anthracene	47	3.00E-01	o	1.57E+02	3.09E-03	0.31%	NO
Benzo(g,h,i)perylene	6.9	n/a		-	-	-	NO
Benzoic Acid	0.8	4.00E+00	o	2.00E-01	3.95E-06	0.00%	NO
Cadmium	4.1	5.00E-04	o	8.20E+03	1.62E-01	16.19%	YES
Cobalt	13.7	6.00E-02	o	2.28E+02	4.51E-03	0.45%	NO
Copper	184	4.00E-02	o	4.60E+03	9.08E-02	9.08%	YES
Di-n-butylphthalate	0.2	1.00E-01	o	2.00E+00	3.95E-05	0.00%	NO
Dibenzofuran	20	n/a		-	-	-	NO
Fluoranthene	140	4.00E-02	o	3.50E+03	6.91E-02	6.91%	YES
Fluorene	39	4.00E-02	o	9.75E+02	1.93E-02	1.93%	YES
Lead	129	n/a		-	-	-	NO
Mercury	0.66	8.57E-05	i	7.70E+03	1.52E-01	15.21%	YES
2-Methylnaphthalene	12	n/a		-	-	-	NO
Naphthalene	41	4.00E-02	o	1.03E+03	2.02E-02	2.02%	YES
Phenanthrene	170	n/a		-	-	-	NO
Pyrene	120	3.00E-02	o	4.00E+03	7.90E-02	7.90%	YES
Silver	94.3	5.00E-03	o	1.89E+04	3.72E-01	37.24%	YES
Zinc	199	3.00E-01	o	6.63E+02	1.31E-02	1.31%	YES
		Total Risk Factor (Rf)	=	5.06E+04	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

(n/a) Applicable toxicological criteria is not available.

Table 3-2
 RFETS OUS
 Concentration/Toxicity Screen
 Surface Soil Carcinogens

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	3.9	7.70E+00	o	3.00E+01	6.43E-02	6.43%	YES
Benzo(a)anthracene	45	7.30E-01	o	3.29E+01	7.03E-02	7.03%	YES
Benzo(a)pyrene	41	7.30E+00	o	2.99E+02	6.41E-01	64.09%	YES
Benzo(b)fluoranthene	5.5	7.30E-01	o	4.02E+00	8.60E-03	0.86%	NO
Benzo(k)fluoranthene	2.1	7.30E-02	o	1.53E-01	3.28E-04	0.03%	NO
Bis(2-Ethylhexyl)phthalate	0.165	1.40E-02	o	2.31E-03	4.95E-06	0.00%	NO
Cadmium	4.1	6.30E+00	i	2.58E+01	5.53E-02	5.53%	YES
Chrysene	46	7.30E-03	o	3.36E-01	7.19E-04	0.07%	NO
4,4-DDT	0.021	3.40E-01	o,i	7.14E-03	1.53E-05	0.00%	NO
Dibenzo(a,h)anthracene	7	7.30E+00	o	5.11E+01	1.09E-01	10.94%	YES
Indeno(1,2,3-cd)pyrene	32	7.30E-01	o	2.34E+01	5.00E-02	5.00%	YES
		Total Risk Factor (Ri)	=	4.67E+02	Total %	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

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Table 3-3
 RFETS OUS
 Concentration/Toxicity Screen
 Surface Soil Radionuclides

PCOC	Maximum Concentration (pCi/g)	Slope Factor (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, Total	0.80	3.20E-08	i	2.56E-08	2.55E-05	0.00%	NO
Plutonium - 239/240, Total	5.01	3.80E-08	i	1.90E-07	1.90E-04	0.02%	NO
Uranium - 233/234, Total	2800.00	2.70E-08	i	7.56E-05	7.53E-02	7.53%	YES
Uranium - 235, Total	670.00	2.50E-08	i	1.68E-05	1.67E-02	1.67%	YES
Uranium - 238	38000	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) o = oral, i = inhalation

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PCOCs in surface soil that do not have EPA-established toxicity criteria are benzo(g,h,i)perylene, dibenzofuran, 2-methylnaphthalene, and phenanthrene. While there are no toxicity criteria established for lead, EPA recommends screening levels for lead in soil for residential land use of 400 ppm (EPA, 1994c). This value cannot be used in this concentration/toxicity screen. These contaminants cannot be evaluated in a toxicity- or risk-based screen to select COCs. However, their potential contribution to overall risk will be evaluated qualitatively in the risk assessment for OU5.

3.2 RISK-BASED EVALUATION OF INFREQUENTLY DETECTED CONTAMINANTS

Maximum concentrations of 11 VOCs and SVOCs (detected at less than 5-percent frequency) are compared to values equivalent to 1000 times contaminant-specific PPRGs (DOE 1994b) and presented in Table 3-4. The comparison to RBCs is used to identify special-case COCs (i.e., infrequently detected contaminants), that could pose a health risk if long-term exposure were to occur to the maximum detected concentration.

None of the maximum concentrations of contaminants detected at low frequency in surface soil exceeded 1000 times the PPRG. Therefore, no special-case COCs were identified for surface soils.

3.3 APPLICATION OF PROFESSIONAL JUDGEMENT

The spatial/temporal distribution and geochemical characteristics of certain inorganics evaluated with professional judgement are presented as follows.

With few exceptions, the highest concentrations of all of the metals occur near the center of IHSS 115. In fact, the majority of the samples that contained detectable concentrations of these metals occurred in this area. This area of IHSS 115 also has relatively high levels of radionuclides, semi-volatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs) in surface soils. In addition, volatile organic compounds (VOCs) were detected in soil gas and subsurface soil samples within this area. This information indicates that this area of IHSS 115 is a likely source of contaminants. Therefore, none

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of these metals were eliminated as COCs. None of the radionuclides in surface soils identified as COCs were eliminated through this process. The COCs presented at the beginning of this section, therefore, are the COCs for surface soils at OU5.

Table 3-4
RFETS OU5
Risk-Based Evaluation of Infrequently Detected Contaminants
Surface Soils

Contaminant	Maximum Concentration (mg/kg)	RBC ^(a) (mg/kg)	1000 x RBC (mg/kg)	Consider Anomaly ?
Organics				
Acenaphthylene	6.00E-01	-	-	-
Aldrin	1.70E-02	3.77E-02	3.77E+01	No
Butylbenzophthalate	2.20E-01	5.49E+04	5.49E+07	No
4,4-DDT	2.10E-02	1.88E+00	1.88E+03	No
Di-n-octyl Phthalate	1.65E-01	2.74E+04	2.74E+07	No
Dieldrin	3.40E-02	4.00E-02	4.00E+01	No
Endosulfan Sulfate	2.40E-02	1.37E+01	1.37E+04	No
Endrin Ketone	3.60E-02	-	-	-
Heptachlor Epoxide	1.00E-02	7.04E-02	7.04E+01	No
Isophorone	1.65E-01	6.74E+02	6.74E+05	No
Methoxychlor	4.50E-01	1.37E+03	1.37E+06	No
Inorganics				
Antimony	4.98E+01	1.10E+02	1.10E+05	No

(a) - RFETS PPRGs are used as RBCs

4.0 CONTAMINANTS OF CONCERN IN SUBSURFACE SOILS

This section describes the concentration/toxicity screen and the risk-based evaluation of infrequently detected contaminants used to identify COCs in subsurface soils. Data evaluation, background comparison, and detection frequency methodology and results are presented in Appendix A. PCOCs with greater than five-percent FOD are presented in Table A-10 of Appendix A and are used as inputs to the concentration/toxicity screen.

4.1 CONCENTRATION/TOXICITY SCREENS

Concentration/toxicity screens for subsurface soils are presented in Table 4-1 (noncarcinogens), Table 4-2 (carcinogens) and Table 4-3 (radionuclides). All analytes that contribute at least 1 percent of the total risk factor are retained as OU-wide COCs. OU-wide COCs for subsurface soil are listed below.

**RFETS OU5
Contaminants of Concern
following Con/Tox Screen
Subsurface soil**

- Barium
- Chromium
- Manganese
- Plutonium-239/240
- Uranium-235
- Uranium-238

PCOCs in subsurface soil that do not have EPA-established toxicity criteria are benzo(g,h,i)perylene, dibenzofuran, 2-methylnaphthalene, phenanthrene, and thallium. While there are no toxicity criteria established for lead, EPA recommends screening levels for lead in soil for residential land use of 400 ppm (EPA, 1994c). This value cannot be used in this concentration/toxicity screen. These contaminants cannot be evaluated in a toxicity- or risk-based screen to select COCs. However, their potential contribution to overall risk will be evaluated qualitatively in the risk assessment for OU5.

RFETS OUS
Concentration/Toxicity Screen
Subsurface Soil Noncarcinogens

PCOC	Maximum Concentration (mg/kg)	RfD (mg/kg-day) (a)	Type of RfD (b)	Chemical-specific Risk Factor (Rf)	Ratio of Rf/Rj	Percentage of Total Risk Factor	Consider a COC?
Non-Carcinogen							
Acenaphthene	31	6.00E-02	o	5.17E+02	4.48E-06	0.00%	NO
Acetone	0.28	1.00E-01	o	2.80E+00	2.43E-08	0.00%	NO
Anthracene	46	3.00E-01	o	1.53E+02	1.33E-06	0.00%	NO
Antimony	149	4.00E-04	o	3.73E+05	3.23E-03	0.32%	NO
Arsenic	18.9	3.00E-04	o	6.30E+04	5.47E-04	0.05%	NO
Barium	683	1.43E-04	i	4.78E+06	4.14E-02	4.14%	YES
Benzo(g,h,i)perylene	19	n/a		-	-	-	NO
2-Butanone	0.069	2.86E-01	i	2.41E-01	2.09E-09	0.00%	NO
Benzoic Acid	0.974	4.00E+00	o	2.44E-01	2.11E-09	0.00%	NO
Beryllium	131	5.00E-03	o	2.62E+04	2.27E-04	0.02%	NO
Butylbenzylphthalate	0.36	2.00E-01	o	1.80E+00	1.56E-08	0.00%	NO
Cadmium	56.9	5.00E-04	o	1.14E+05	9.88E-04	0.10%	NO
Chromium	8310	5.00E-03	o	1.66E+06	1.44E-02	1.44%	YES
Cobalt	67.6	6.00E-02	o	1.13E+03	9.78E-06	0.00%	NO
Copper	6920	4.00E-02	o	1.73E+05	1.50E-03	0.15%	NO
Di-n-Butylphthalate	0.3	1.00E-01	o	3.00E+00	2.60E-08	0.00%	NO
Dibenzofuran	20	n/a		-	-	-	NO
Fluoranthene	160	4.00E-02	o	4.00E+03	3.47E-05	0.00%	NO
Fluorene	35	4.00E-02	o	8.75E+02	7.59E-06	0.00%	NO
Lead	935	n/a		-	-	-	NO
Manganese	1540	1.43E-05	i	1.08E+08	9.35E-01	93.45%	YES
2-Methylnaphthalene	15	n/a		-	-	-	NO
Molybdenum	190	5.00E-03	o	3.80E+04	3.30E-04	0.03%	NO
Naphthalene	61	4.00E-02	o	1.53E+03	1.32E-05	0.00%	NO
Nickel	4750	2.00E-02	o	2.38E+05	2.06E-03	0.21%	NO
Phenanthrene	220	n/a		-	-	-	NO
Pyrene	150	3.00E-02	o	5.00E+03	4.34E-05	0.00%	NO
Silver	311	5.00E-03	o	6.22E+04	5.40E-04	0.05%	NO
Strontium	148	6.00E-01	o	2.47E+02	2.14E-06	0.00%	NO
Thallium	0.55	n/a	o	-	-	-	NO
Toluene	0.31	1.14E-01	i	2.72E+00	2.36E-08	0.00%	NO
Zinc	2390	3.00E-01	o	7.97E+03	6.91E-05	0.01%	NO
		Total Risk Factor (Rj)	=	1.15E+08	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

(n/a) Applicable toxicological criteria is not available.

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Concentration/Toxicity Screen
Subsurface Soil Carcinogens

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	0.87	7.70E+00	o	6.70E+00	1.95E-05	0.00%	NO
Arsenic	18.9	1.51E+01	i	2.85E+02	8.32E-04	0.08%	NO
Benzo(a)anthracene	48	7.30E-01	o	3.50E+01	1.02E-04	0.01%	NO
Benzo(a)pyrene	43	7.30E+00	o	3.14E+02	9.16E-04	0.09%	NO
Benzo(b)fluoranthene	48	7.30E-01	o	3.50E+01	1.02E-04	0.01%	NO
Benzo(k)fluoranthene	19	7.30E-02	o	1.39E+00	4.05E-06	0.00%	NO
Beryllium	131	8.40E+00	i	1.10E+03	3.21E-03	0.32%	NO
Bis(2-ethylhexyl)phthalate	0.29	1.40E-02	o	4.06E-03	1.18E-08	0.00%	NO
Cadmium	56.9	6.30E+00	i	3.58E+02	1.05E-03	0.10%	NO
Chromium	8310	4.10E+01	i	3.41E+05	9.94E-01	99.37%	YES
Chrysene	53	7.30E-03	o	3.87E-01	1.13E-06	0.00%	NO
Dibenzo(a,h)anthracene	0.7	7.30E+00	o	5.11E+00	1.49E-05	0.00%	NO
Indeno(1,2,3-cd)pyrene	22	7.30E-01	o	1.61E+01	4.68E-05	0.00%	NO
Methylene Chloride	0.066	7.50E-03	o	4.95E-04	1.44E-09	0.00%	NO
Tetrachloroethene	0.92	5.20E-02	o	4.78E-02	1.40E-07	0.00%	NO
Trichloroethene	0.44	1.10E-02	o	4.84E-03	1.41E-08	0.00%	NO
		Total Risk Factor (Rj)	=	3.43E+05	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

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Table 4-3
 RFETS OUS
 Concentration/Toxicity Screen
 Subsurface Soil Radionuclides

PCOC	Maximum Concentration (pCi/g)	Slope Factor (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, Total	0.61	3.20E-08	i	1.95E-08	6.20E-04	0.06%	NO
Plutonium - 239/240, Total	9.84	3.80E-08	i	3.74E-07	1.19E-02	1.19%	YES
Uranium - 233/234, Total	3.20	2.70E-08	i	8.64E-08	2.75E-03	0.27%	NO
Uranium - 235, Total	126.00	2.50E-08	i	3.15E-06	1.00E-01	10.01%	YES
Uranium -238	1160	2.40E-08	i	2.78E-05	8.85E-01	88.47%	YES
		Total Risk Factor (Rj)	=	3.15E-05	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

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4.2 RISK-BASED EVALUATION OF INFREQUENTLY DETECTED CONTAMINANTS

Maximum concentrations of 13 VOCs and SVOCs (detected at less than five-percent frequency) are compared to values equivalent to 1000 times contaminant-specific PPRGs (DOE 1994b) and presented in Table 4-4. The comparison to RBCs is used to identify special-case COCs (i.e., infrequently detected contaminants), that could pose a health risk if long-term exposure were to occur to the maximum detected concentration.

None of the maximum concentrations of contaminants detected at low frequency in subsurface soil exceeded 1000 times the PPRG. Therefore, no special-case COCs were identified for subsurface soils.

4.3 APPLICATION OF PROFESSIONAL JUDGEMENT

The spatial/temporal distribution and geochemical characteristics of certain inorganics evaluated with professional judgement are presented as follows.

Although the highest concentrations of barium detected were in subsurface soil samples collected from boreholes drilled in the IHSS 133 area, there is no apparent correlation between waste material and barium concentrations. At many locations where waste material was identified during drilling, the concentration of barium is relatively low and well below the $UTL_{99/99}$. Conversely, at several locations where waste material was not identified, the concentration of barium is relatively high, generally exceeding the $UTL_{99/99}$. At all locations, the concentrations of barium detected were within the range of background concentrations (DOE, 1993). As discussed below, it appears that relatively high concentrations of barium in subsurface soils appear to be associated with the presence of manganese oxides and are not the result of environmental contamination.

Six samples of subsurface soils collected from five boreholes within IHSS 115 and the IHSS 133 area contained concentrations of manganese exceeding the $UTL_{99/99}$. However, the concentrations of manganese in all of these samples were well within the range of concentrations reported for

Table 4-4
RFETS OU5
Risk-Based Evaluation of Infrequently Detected Contaminants
Subsurface Soils

Contaminant	Maximum Concentration (mg/kg)	RBC (mg/kg)	1000 x RBC (mg/kg)	Consider Anomally ?
Organics				
Acenaphthylene	8.40E-02	-	-	-
Aroclor-1260	1.30E+00	8.32E-02	8.32E+01	No
Alpha-BHC	1.50E-02	1.02E-01	1.02E+02	No
Butylbenzophthalate	3.60E-01	5.49E+04	5.49E+07	No
Di-n-butyl Phthalate	3.00E-01	2.74E+04	2.74E+07	No
Ethylbenzene	6.60E-02	2.74E+04	2.74E+07	No
Heptachlor Epoxide	1.10E-02	7.04E-02	7.04E+01	No
Isophorone	8.20E-02	6.74E+02	6.74E+05	No
4-Methyl-2-Pentanone	2.00E-03	1.37E+04	1.37E+07	No
Pentachlorophenol	1.60E-01	5.34E+00	5.34E+03	No
Phenol	1.40E-01	1.65E+05	1.65E+08	No
1,1,1-Trichloroethane	2.00E-03	-	-	-
Xylenes (Total)	1.50E-01	5.49E+05	5.49E+08	No

(a) - RFETS PPRGs are used as RBCs

background samples (DOE, 1993). The borehole logs for these boreholes were reviewed, and for each of the intervals associated with the samples containing manganese concentrations greater than background, the presence of manganese oxides and weathering was noted. This information, along with the absence of any apparent correlation between the presence of waste material and manganese concentrations greater than background, suggests that manganese concentrations exceeding background in subsurface soils is likely due to the presence of manganese oxides. It is unlikely that the manganese detected in the subsurface soil samples is the result of environmental contamination; in fact, manganese dioxide (pyrolusite) occurs commonly in arid regions and is known as "desert varnish."

At several of the locations where manganese concentrations exceeded the UTL_{99/99}, the same subsurface-soil samples also contained barium concentrations exceeding the UTL_{99/99}. The association of barium and other metals with manganese oxides has been reported by Hem (1989). In addition, in every borehole where the UTL_{99/99} for barium was exceeded, the sample containing barium in a concentration exceeding the UTL_{99/99} also contained the highest concentration of manganese of the samples collected in that borehole. Similarly, in the two boreholes where manganese was present in concentrations exceeding the UTL_{99/99} but was not associated with barium concentrations exceeding the UTL_{99/99}, the highest concentration of barium detected in samples in each borehole was associated with the samples in which manganese exceeded the UTL_{99/99}. This information suggests a possible association of barium with manganese oxides in subsurface soil samples.

Chromium was detected in concentrations exceeding the UTL_{99/99} in subsurface soil samples in three boreholes within IHSS 115/196, two boreholes within the IHSS 133 area, and one borehole within the Surface Disturbance South of the Ash Pits. With the exception of one location within the northern trench of IHSS 133.2, the concentrations detected in samples from the other locations range from 77.3 to 165.0 mg/kg, which exceed the UTL_{99/99} for chromium (76.3 mg/kg) but are within the range of background concentrations (4.1 to 176 mg/kg). At these locations the elevated chromium concentrations do not appear to be associated with waste identified during drilling operations and are likely due to natural variations in chromium concentrations in subsurface soils rather than environmental contamination. One sample collected from borehole 56893, which was drilled in the northern trench of IHSS 133.2 from

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depths of 4 to 8.3 feet, contained a chromium concentration of 8,310 mg/kg. The geologist's log for this borehole indicates that waste material containing ash and metallic debris was encountered at these depths during drilling. Based on this association of a high concentration of chromium with waste material, chromium is retained as a COC for subsurface soils.

None of the radionuclides identified as COCs are eliminated through this process. Barium and manganese are not considered COCs following this process. The following list is the COCs for subsurface soils at OU5.

**RFETS OU5
Contaminants of Concern
Subsurface soil**

- Chromium
- Plutonium-239/240
- Uranium-235
- Uranium-238

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5.0 CONTAMINANTS OF CONCERN IN GROUNDWATER

This section describes the concentration/toxicity screen and the risk-based evaluation of infrequently detected contaminants in groundwater. Data evaluation, background comparison, and detection frequency methodology and results are presented in Appendix A. PCOCs with greater than five-percent FOD are presented in Table A-11 of Appendix A and are used as inputs to the concentration/toxicity screen.

5.1 CONCENTRATION/TOXICITY SCREENS

Concentration/toxicity screens for groundwater are presented in Table 5-1 (noncarcinogens), Table 5-2 (carcinogens) and Table 5-3 (radionuclides). All analytes that contribute at least one percent of the total risk factor are retained as OU-wide COCs. OU-wide COCs for groundwater are listed as follows.

**RFETS OU5
Contaminants of Concern
following Con/Tox Screen
Groundwater**

- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Chromium
- Manganese
- Vanadium
- Americium-241
- Plutonium-239/240
- Radium-226
- Strontium-89/90
- Uranium-233/234
- Uranium-235
- Uranium-238

Table 5-1
RFETS OUS
Concentration/Toxicity Screen
Groundwater Noncarcinogens

PCOC	Maximum Concentration (mg/l)	RfD (mg/kg-day) (a)	Type of RfD (b)	Chemical-specific Risk Factor (Ri)	Ratio of Ri/Rf	Percentage of Total Risk Factor	Consider a COC?
Non-Carcinogen							
Acenaphthene	0.005	6.00E-02	o	8.33E-02	2.48E-05	0.00%	NO
Aluminum	357	2.90E+00	o	1.23E+02	3.66E-02	3.66%	YES
Antimony	0.0408	4.00E-04	o	1.02E+02	3.03E-02	3.03%	YES
Arsenic	0.0133	3.00E-04	o	4.43E+01	1.32E-02	1.32%	YES
Barium	3.04	7.00E-02	o	4.34E+01	1.29E-02	1.29%	YES
Beryllium	0.0294	5.00E-03	o	5.88E+00	1.75E-03	0.17%	NO
Cadmium	0.0082	5.00E-04	o	1.64E+01	4.88E-03	0.49%	NO
Cesium	n/a	n/a		-	-	-	NO
Chromium	0.442	5.00E-03	o	8.84E+01	2.63E-02	2.63%	YES
Cobalt	0.161	6.00E-02	o	2.68E+00	7.98E-04	0.08%	NO
Copper	0.42	4.00E-02	o	1.05E+01	3.12E-03	0.31%	NO
Di-N-Butylphthalate	0.002	1.00E-01	o	2.00E-02	5.95E-06	0.00%	NO
Diethylphthalate	0.006	8.00E-01	o	7.50E-03	2.23E-06	0.00%	NO
Fluoranthene	0.004	4.00E-02	o	1.00E-01	2.97E-05	0.00%	NO
Fluorene	0.004	4.00E-02	o	1.00E-01	2.97E-05	0.00%	NO
Lead	0.24	n/a		-	-	-	NO
Lithium	0.306	2.00E-02		1.53E+01	4.55E-03	0.46%	NO
Manganese	13.7	5.00E-03	o	2.74E+03	8.15E-01	81.49%	YES
Mercury	0.003	3.00E-04	o	1.00E+01	2.97E-03	0.30%	NO
Molybdenum	0.018	5.00E-03	o	3.60E+00	1.07E-03	0.11%	NO
Naphthalene	0.013	4.00E-02	o	3.25E-01	9.67E-05	0.01%	NO
Nickel	0.313	2.00E-02	o	1.57E+01	4.65E-03	0.47%	NO
Phenanthrene	0.006	n/a		-	-	-	NO
Pyrene	0.0065	3.00E-02	o	2.17E-01	6.44E-05	0.01%	NO
Selenium	0.126	5.00E-03	o	2.52E+01	7.49E-03	0.75%	NO
Silicon	354	n/a		-	-	-	NO
Silver	0.0532	5.00E-03	o	1.06E+01	3.16E-03	0.32%	NO
Strontium	2.575	6.00E-01	o	4.29E+00	1.28E-03	0.13%	NO
Tin	0.3	6.00E-01	o	5.00E-01	1.49E-04	0.01%	NO
Vanadium	0.674	7.00E-03	o	9.63E+01	2.86E-02	2.86%	YES
Zinc	0.982	3.00E-01	o	3.27E+00	9.74E-04	0.10%	NO
		Total Risk Factor (Ri)	=	3.36E+03	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

(n/a) Applicable toxicological criteria is not available.

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Table 5-2
 RFETS OUS
 Concentration/Toxicity Screen
 Groundwater Carcinogens

PCOC	Maximum Concentration (mg/l)	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							
Arsenic	0.0133	1.75E+00	o	2.33E-02	1.55E-01	15.54%	YES
Beryllium	0.0294	4.30E+00	o	1.26E-01	8.44E-01	84.40%	YES
Bis(2-ethylhexyl)phthalate	0.003	1.40E-02	o	4.20E-05	2.80E-04	0.03%	NO
Methylene Chloride	0.006	7.50E-03	o	4.50E-05	3.00E-04	0.03%	NO
		Total Risk Factor (R _i)		1.50E-01	Total %	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

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Table 5-3
 RFETS OUS
 Concentration/Toxicity Screen
 Groundwater Radionuclides

PCOC	Maximum Concentration (pCi/l)	Slope Factor (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, Total	0.20	2.40E-10	o	4.80E-11	1.98E-02	1.98%	YES
Cesium - 137, Total	0.00	2.80E-11	o	0.00E+00	0.00E+00	0.00%	NO
Plutonium - 238	0.01	2.20E-10	o	2.20E-12	9.10E-04	0.09%	NO
Plutonium - 239/240, Total	1.04	2.30E-10	o	2.39E-10	9.89E-02	9.89%	YES
Radium -226	4.4	1.20E-10	o	5.28E-10	2.18E-01	21.83%	YES
Strontium -89/90, Total	1.5	3.30E-11	o	4.95E-11	2.05E-02	2.05%	YES
Uranium - 233/234, Total	49.00	1.60E-11	o	7.84E-10	3.24E-01	32.41%	YES
Uranium - 235, Total	4.00	1.60E-11	o	6.40E-11	2.65E-02	2.65%	YES
Uranium -238	44	1.60E-11	o	7.04E-10	2.91E-01	29.10%	YES
		Total Risk Factor (Rj)	=	2.42E-09	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

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PCOCs in groundwater that do not have EPA-established toxicity criteria are cesium, phenanthrene, and silicon. While there are no toxicity criteria established for lead, EPA recommends screening levels for lead in soil for residential land use of 400 ppm (EPA, 1994c). This value cannot be used in this concentration/toxicity screen. These contaminants cannot be evaluated in a toxicity- or risk-based screen to select COCs. However, their potential contribution to overall risk will be evaluated qualitatively in the risk assessment for OU5.

5.2 RISK-BASED EVALUATION OF INFREQUENTLY DETECTED CONTAMINANTS

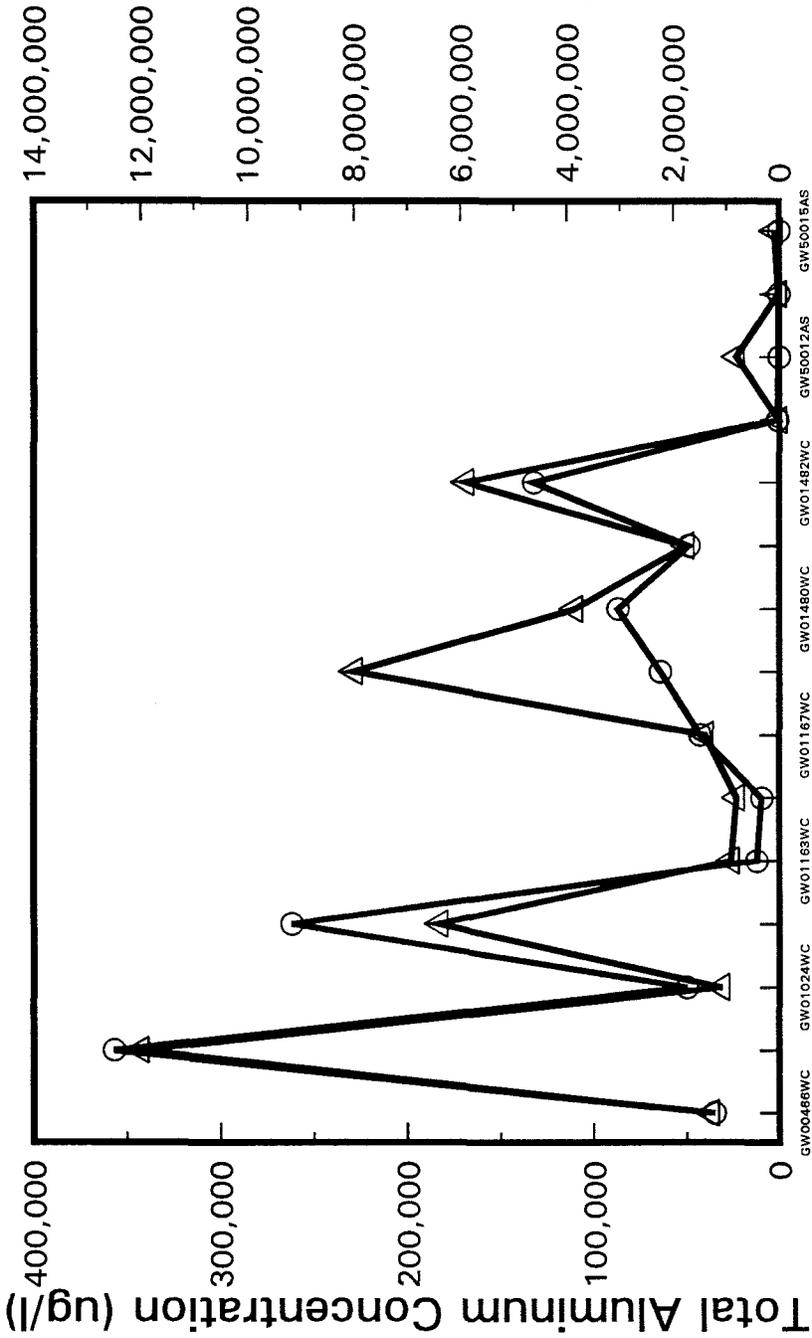
There are no contaminants in groundwater detected at less than five-percent frequency. Therefore the risk-based evaluation of infrequently detected compounds is not performed.

5.3 APPLICATION OF PROFESSIONAL JUDGEMENT

The spatial/temporal distribution and geochemical characteristics of certain inorganics evaluated with professional judgement are presented as follows.

Due to the relatively few groundwater samples that have been collected at OU5, temporal evaluations are necessarily limited and spatial evaluations of the data at this time would be difficult and relatively meaningless.

Figures 5-1 through 5-7 depict the concentrations of the metals identified as COCs (aluminum, antimony, arsenic, barium, chromium, manganese, and vanadium) in groundwater samples from wells in OU5 and the corresponding concentration of TSS for each sample. As shown on these figures, the concentrations of aluminum, barium, chromium, and vanadium correlate strongly with TSS. High TSS appears to be the largest factor contributing to elevated concentrations of aluminum, barium, chromium, and vanadium in groundwater samples. High TSS is not a sign of contamination but rather of sample turbidity resulting from well development and sampling procedures.



Sample Number

AI —○—
TSS —△—

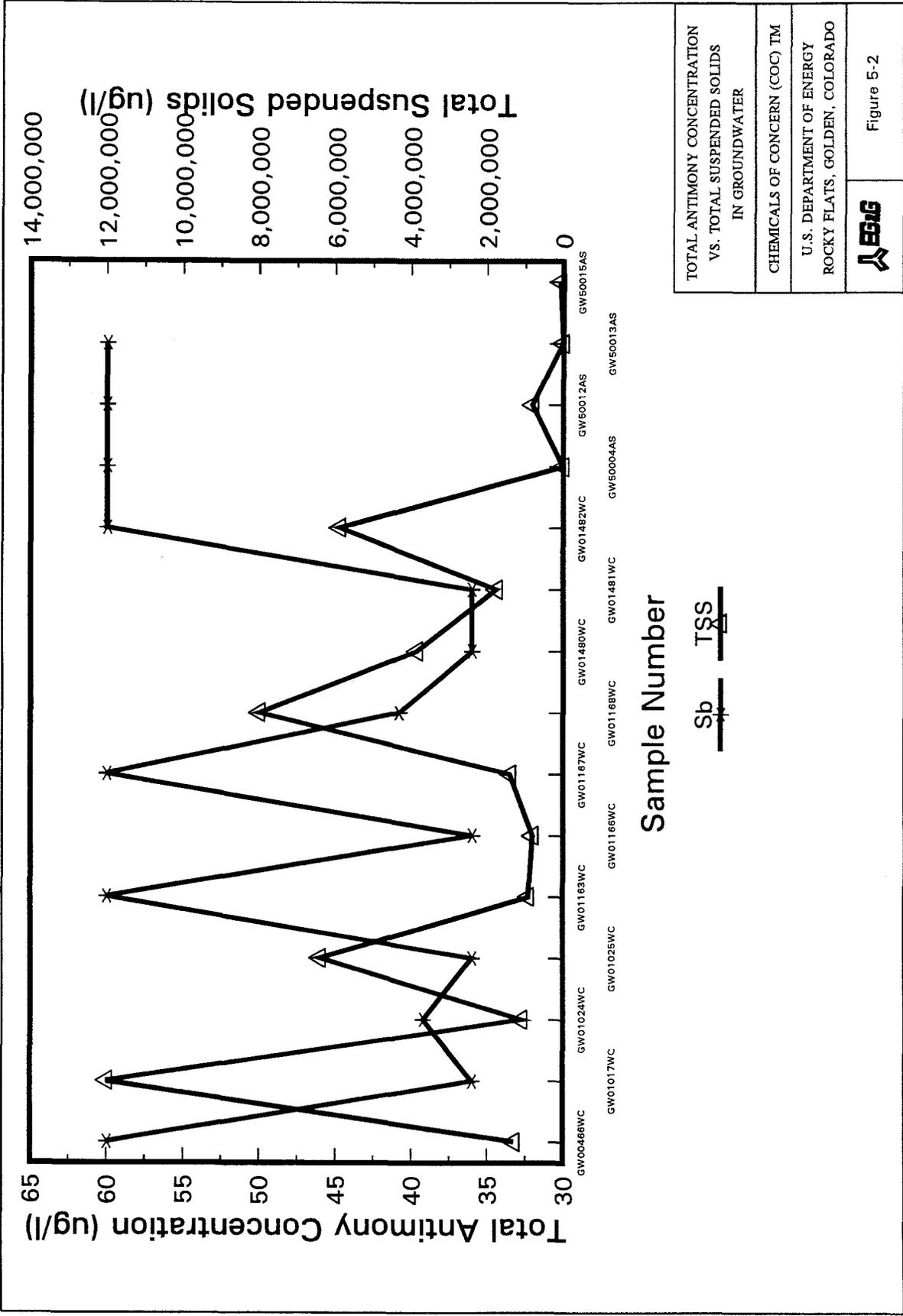
TOTAL ALUMINUM CONCENTRATION
VS. TOTAL SUSPENDED SOLIDS
IN GROUNDWATER

CHEMICALS OF CONCERN (COC) TM

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS, GOLDEN, COLORADO



Figure 5-1



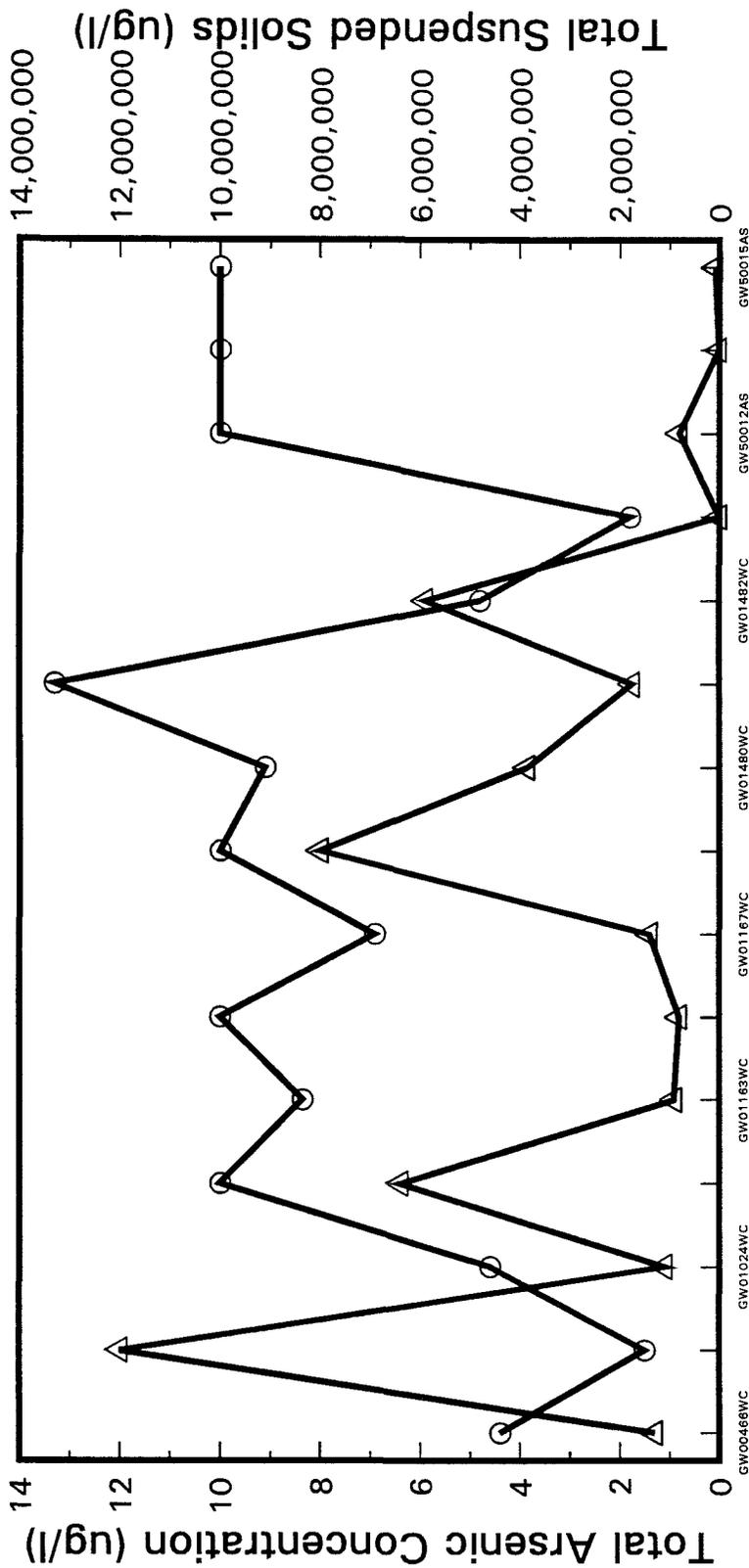
TOTAL ANTIMONY CONCENTRATION
VS. TOTAL SUSPENDED SOLIDS
IN GROUNDWATER

CHEMICALS OF CONCERN (COC) TM

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS, GOLDEN, COLORADO

EBIG

Figure 5-2



Sample Number

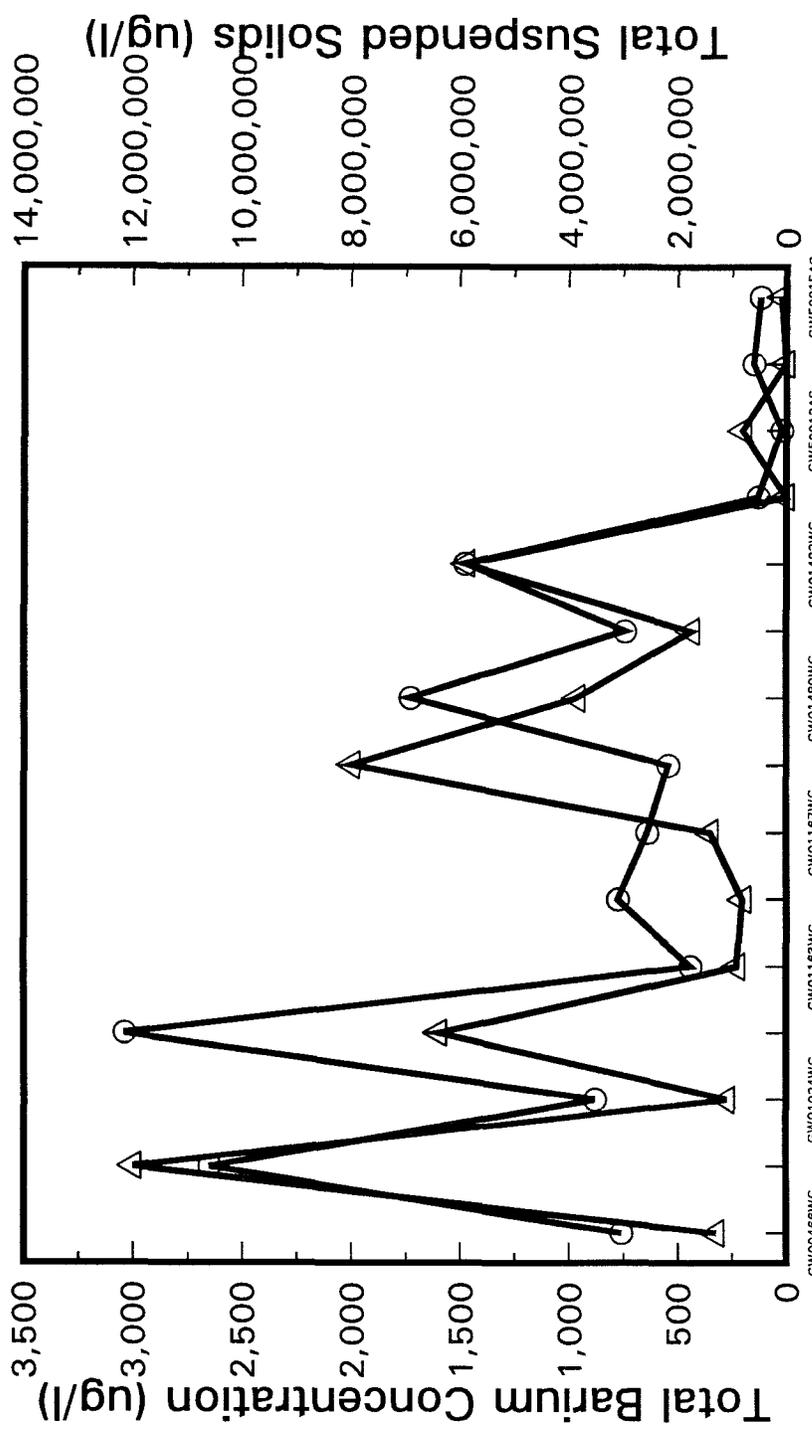
As TSS

TOTAL ARSENIC CONCENTRATION
VS. TOTAL SUSPENDED SOLIDS
IN GROUNDWATER

CHEMICALS OF CONCERN (COC) TM
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS, GOLDEN, COLORADO



Figure 5-3



TOTAL BARIUM CONCENTRATION
VS. TOTAL SUSPENDED SOLIDS
IN GROUNDWATER

CHEMICALS OF CONCERN (COC)™

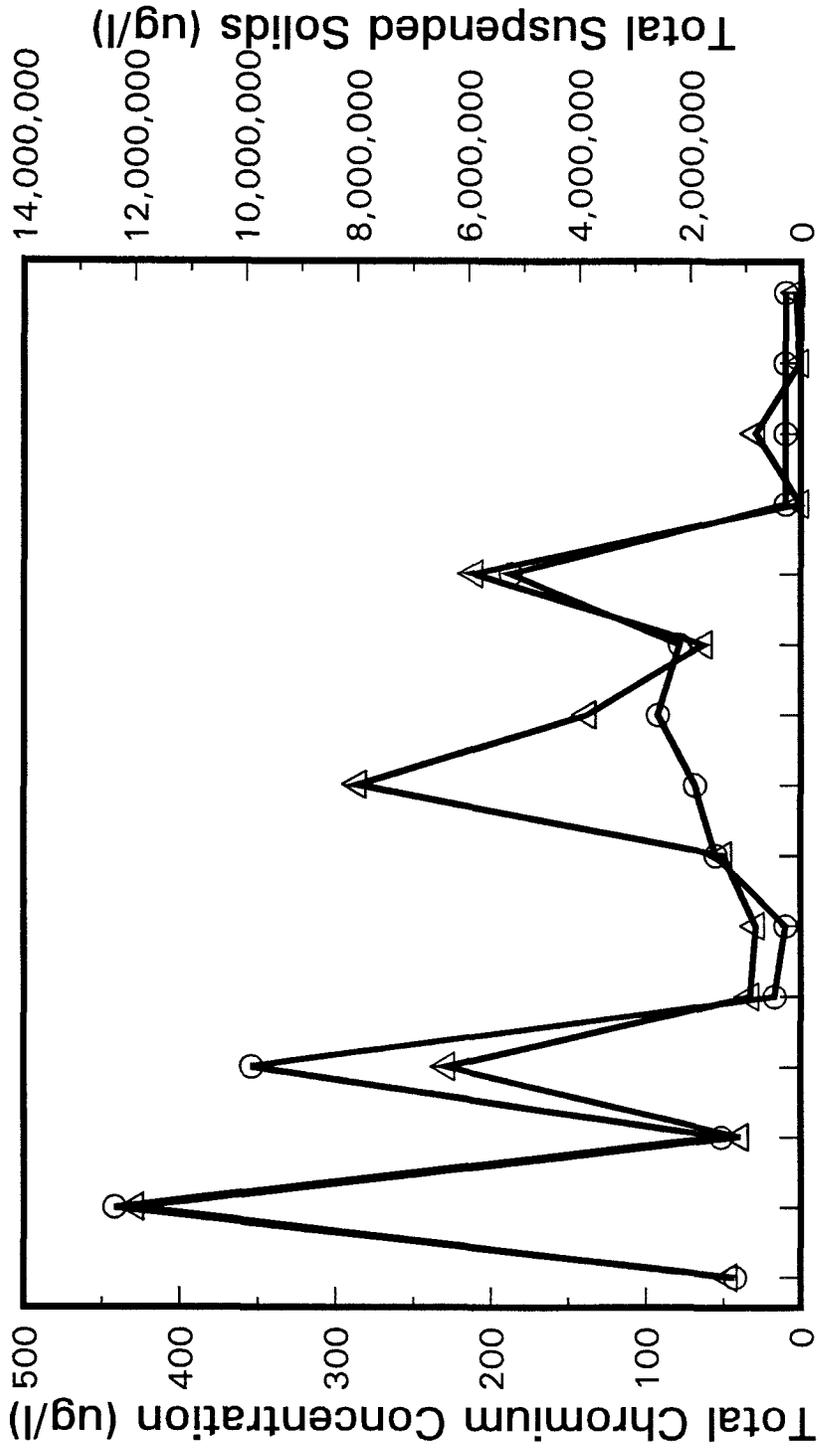
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS, GOLDEN, COLORADO



Figure 5-4

Sample Number

Ba TSS



TOTAL CHROMIUM CONCENTRATION
VS. TOTAL SUSPENDED SOLIDS
IN GROUNDWATER

CHEMICALS OF CONCERN (COC) TM

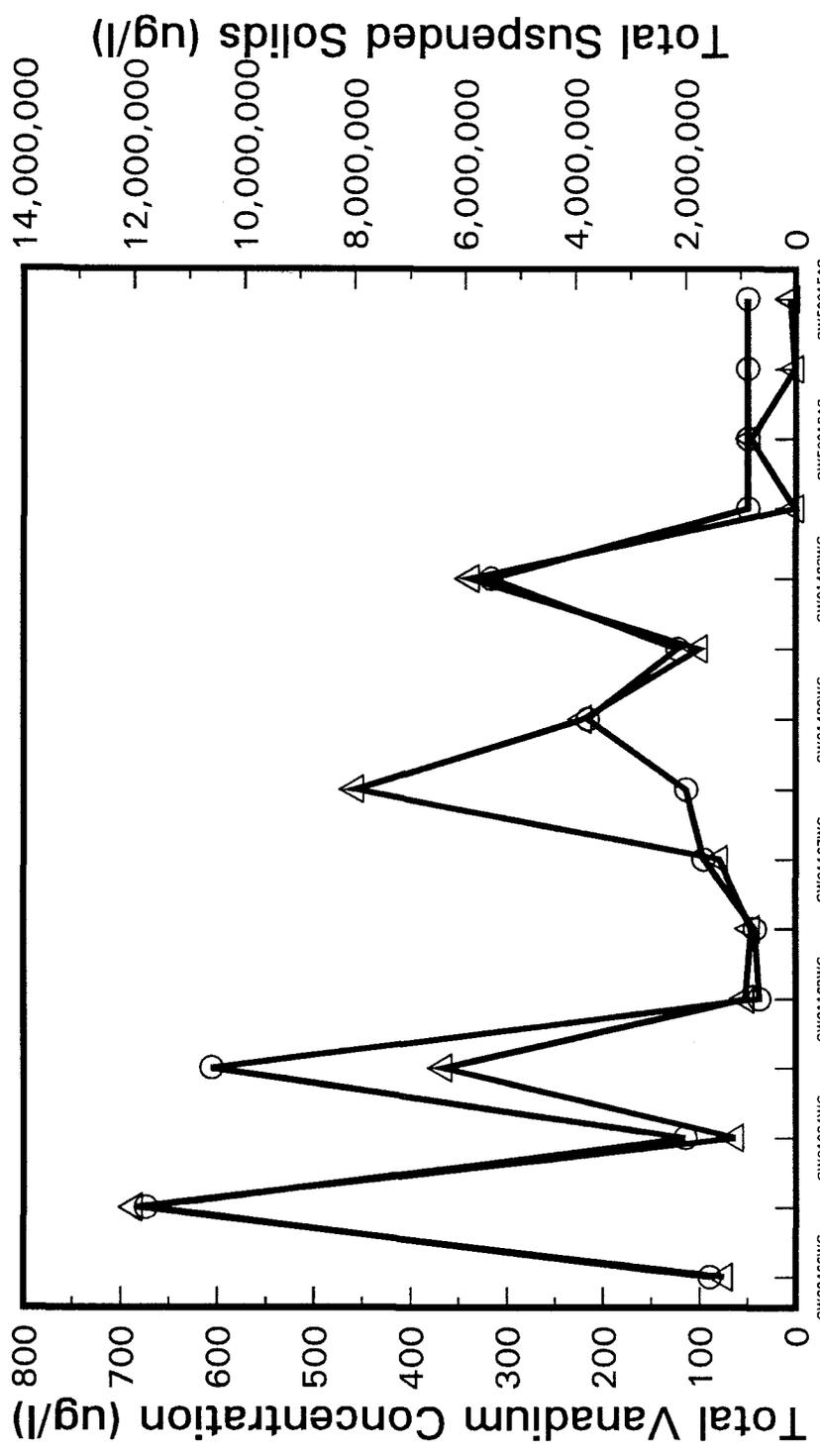
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ROCKY FLATS, GOLDEN, COLORADO

Figure 5-5

Sample Number

Cr —○—

TSS —△—



TOTAL VANADIUM CONCENTRATION
VS. TOTAL SUSPENDED SOLIDS
IN GROUNDWATER

CHEMICALS OF CONCERN (COC)™

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Figure 5-7

Sample Number

V —○—
TSS —△—

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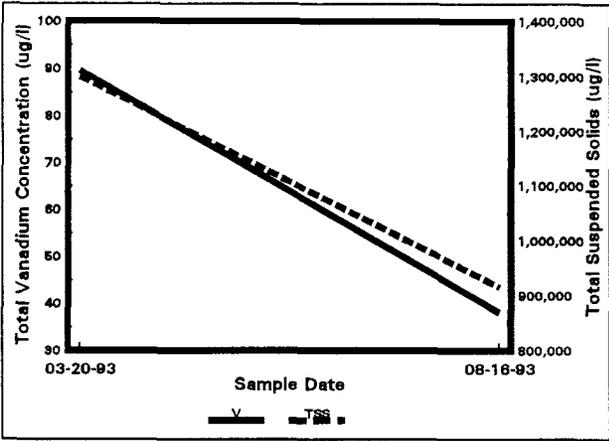
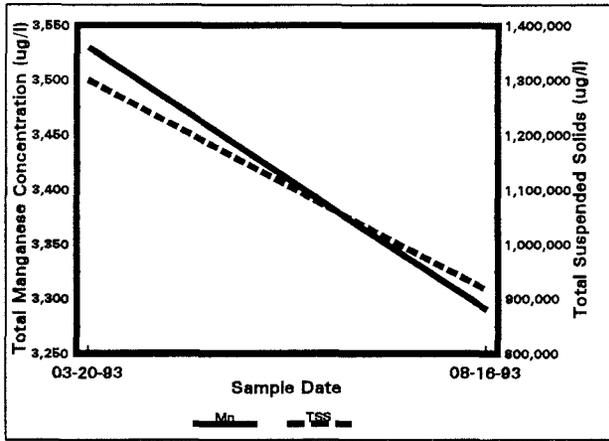
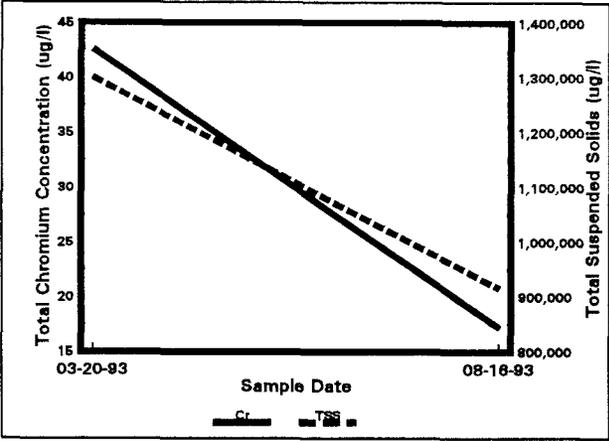
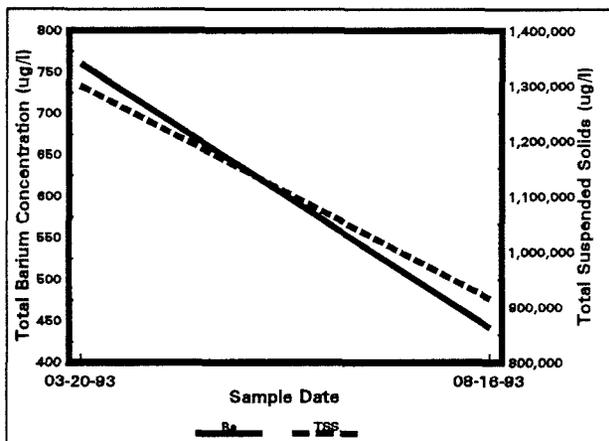
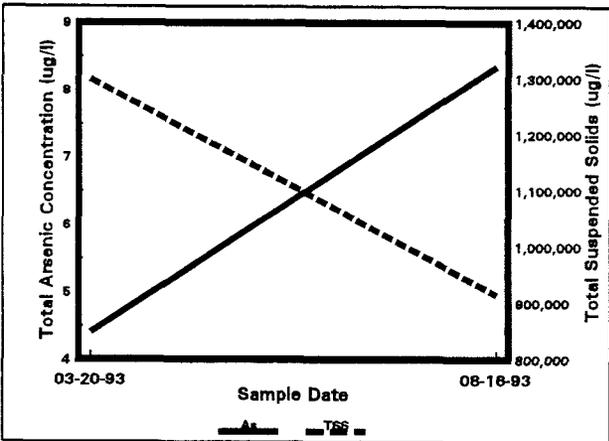
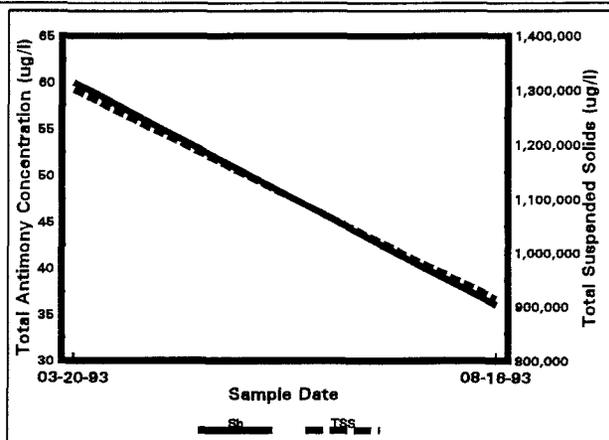
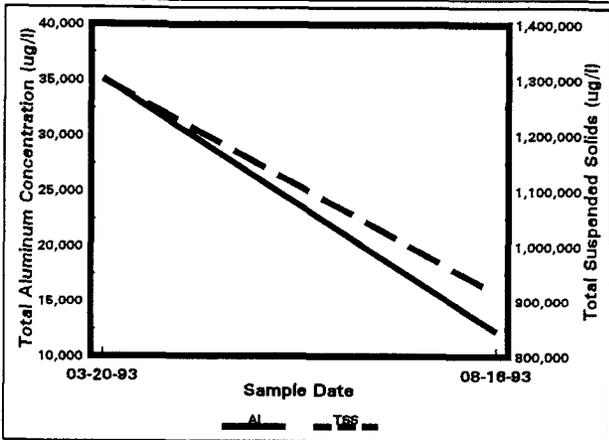
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For the four wells that contain sufficient groundwater to allow quarterly collection of groundwater samples, the trends in concentrations of these metals and TSS with time are shown on Figures 5-8 through 5-11. Well 51193 is located below the dam of Pond C-1, well 58793 is located downgradient (southeast) of IHSS 133.2, well 59493 is located within IHSS 196, and well 59593 is located at the toe of the Original Landfill (IHSS 115).

Analysis of the information presented on Figures 5-8 through 5-11 supports the correlation of concentrations of aluminum, barium, chromium, and vanadium with TSS. In addition, manganese concentrations for these wells also correlates relatively well with TSS. The only exception to the correlation of the concentrations of these metals with TSS is for the November 11, 1993 sample from well 58793. Concentrations of these metals in this sample increased while TSS decreased relative to the previous sample collected from this well. The cause of this divergence in metals concentration and TSS for this sample is not clear. The concentrations manganese detected in groundwater also follow the same trends as the other metals and regions of higher concentrations of naturally occurring manganese have been identified at other locations at Rocky Flats (DOE, 1994c).

The concentrations of antimony and arsenic for the wells depicted on Figures 5-8 through 5-11 do not correlate with TSS. However, the antimony and arsenic concentrations for these wells, which are separated by relatively large distances and located near different IHSSs, are all within a relatively narrow range. It would be expected that if these metals were environmental contaminants, that their concentrations would vary greatly due to varying distances from potential sources of contamination. In addition, only one of the 14 samples presented on these figures contained a detectable concentration of antimony. This information indicates that the concentrations of antimony and arsenic detected in samples from the wells in OU5 are likely due to natural variations in these metals rather than environmental contamination.

It is concluded that elevated metals concentrations in OU5 groundwater samples are related to suspended solids in the samples and natural variations in metals concentrations. Therefore, all metals are eliminated from further consideration as contaminants of concern in groundwater in OU5.



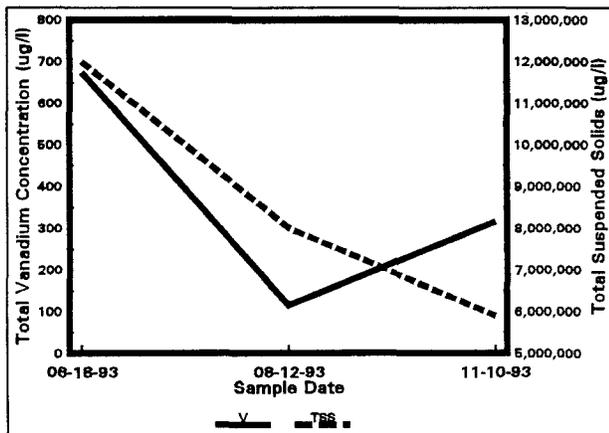
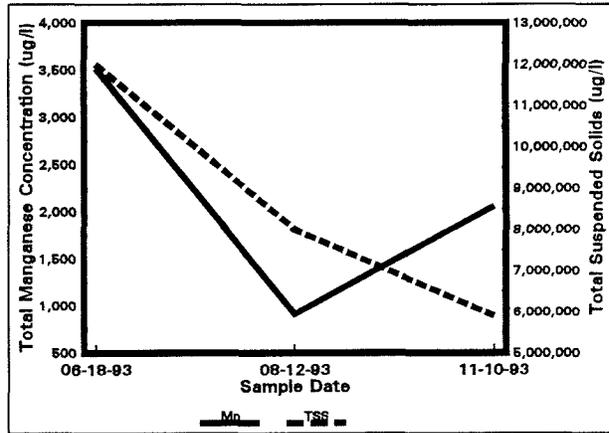
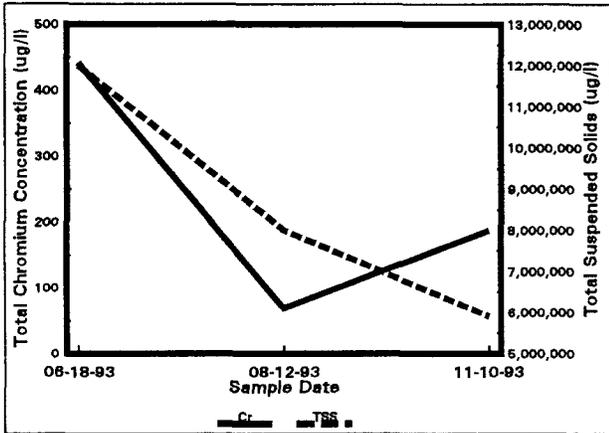
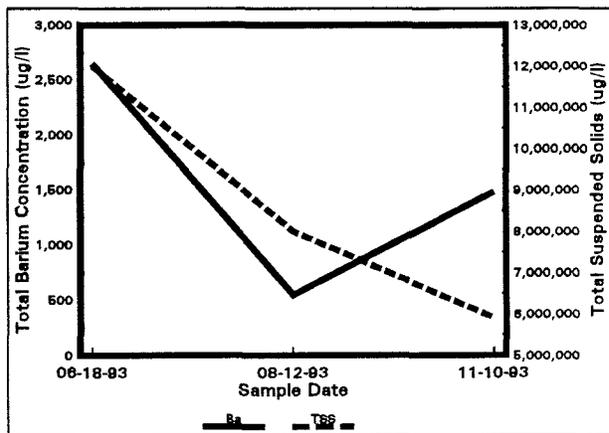
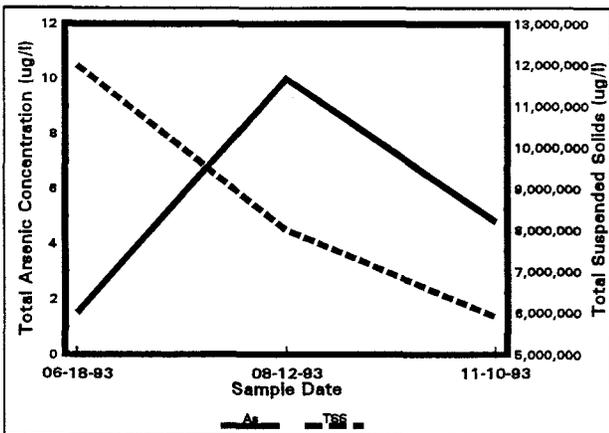
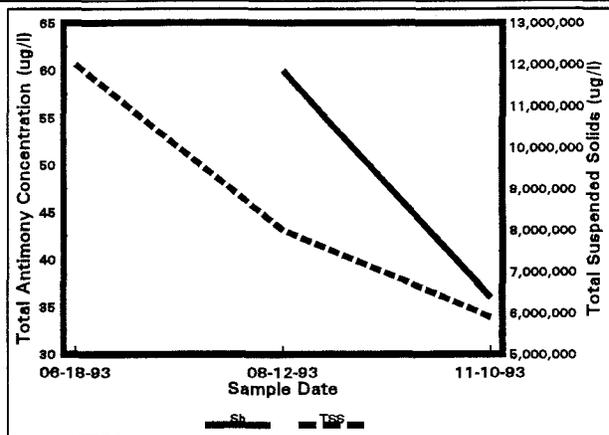
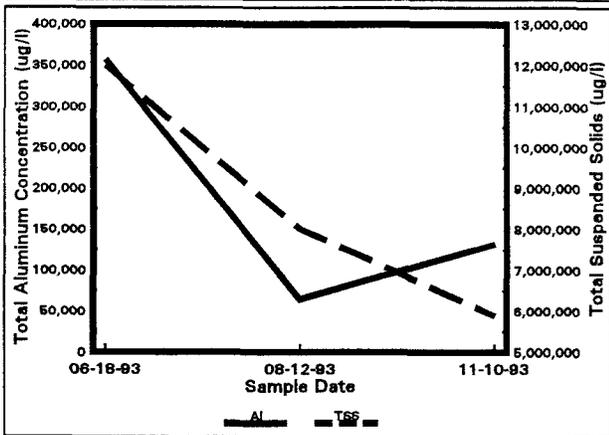
TOTAL METALS AND TOTAL SUSPENDED
SOLIDS IN GROUNDWATER
WELL 51193

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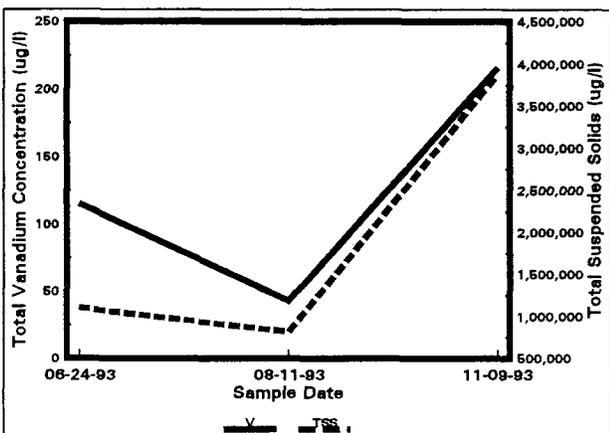
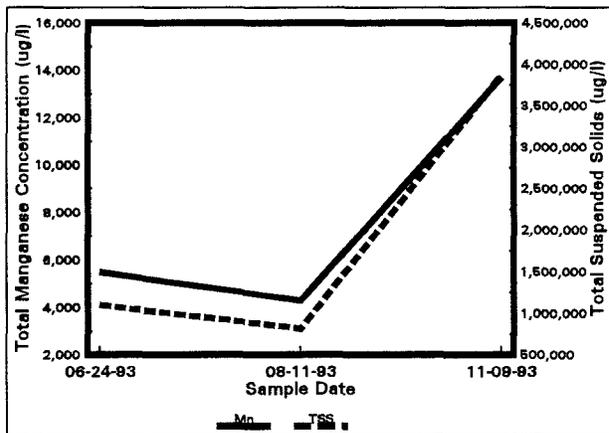
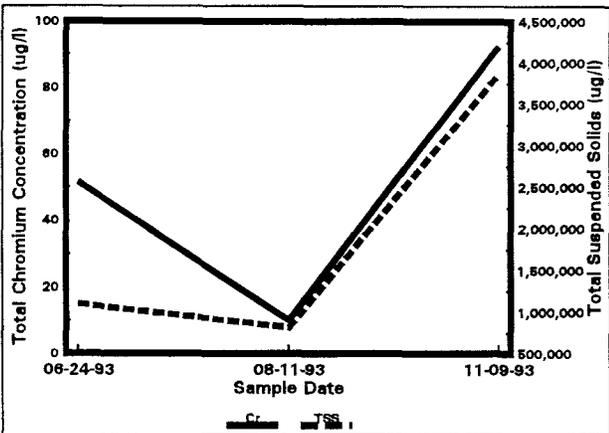
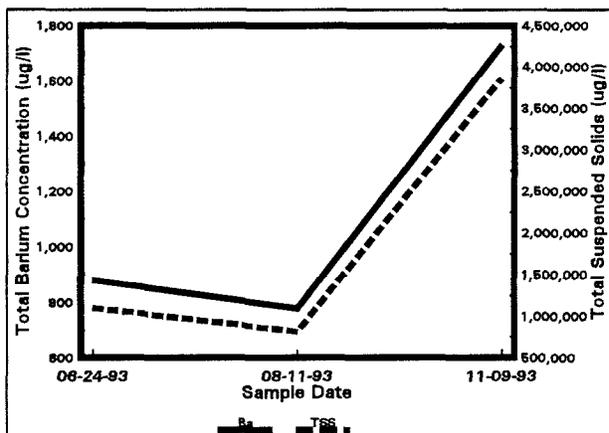
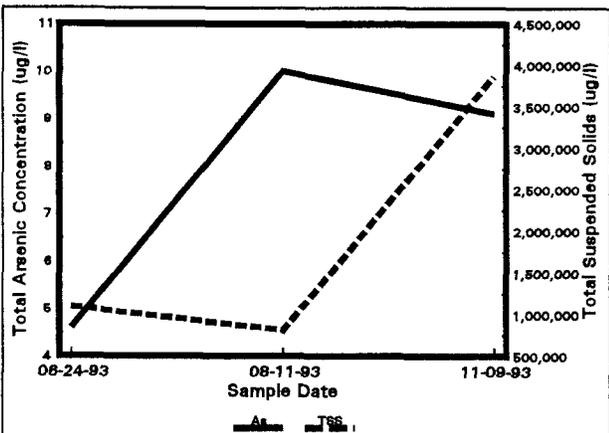
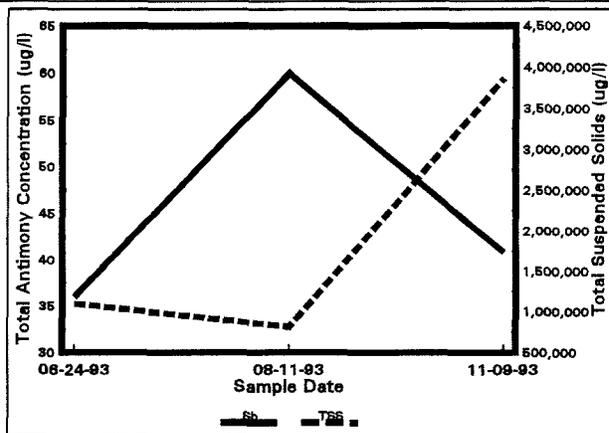
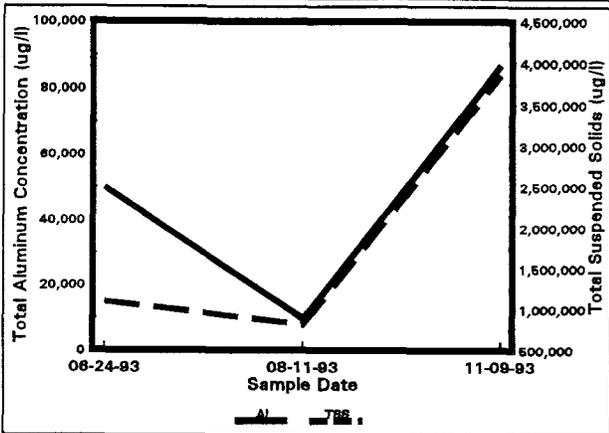


Figure 5-8



TOTAL METALS AND TOTAL SUSPENDED SOLIDS IN GROUNDWATER WELL 58793	
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	Figure 5-9

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TOTAL METALS AND TOTAL SUSPENDED
SOLIDS IN GROUNDWATER
WELL 59493

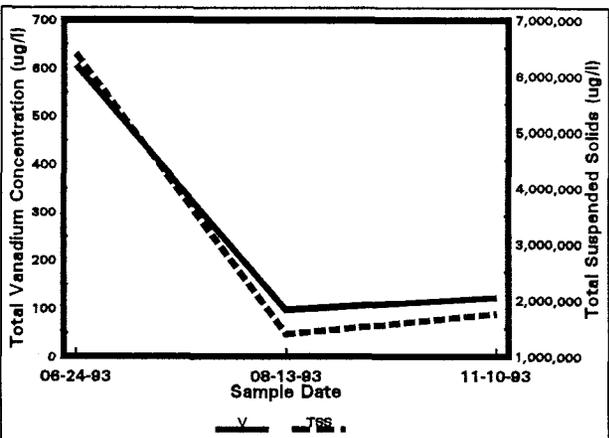
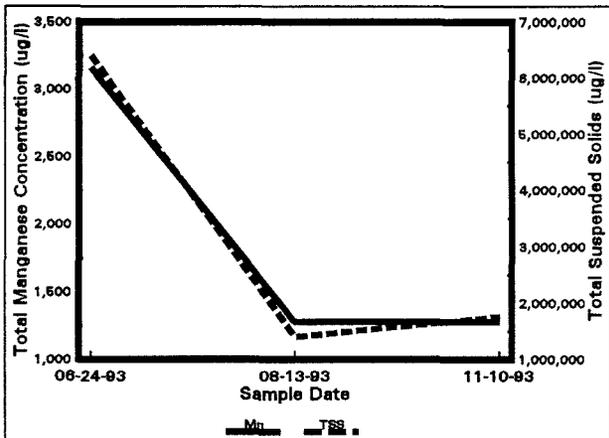
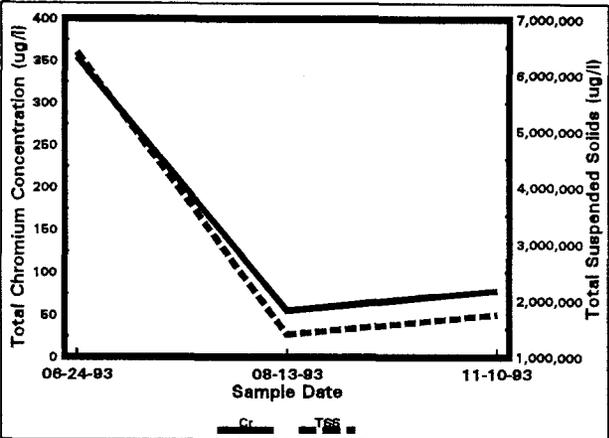
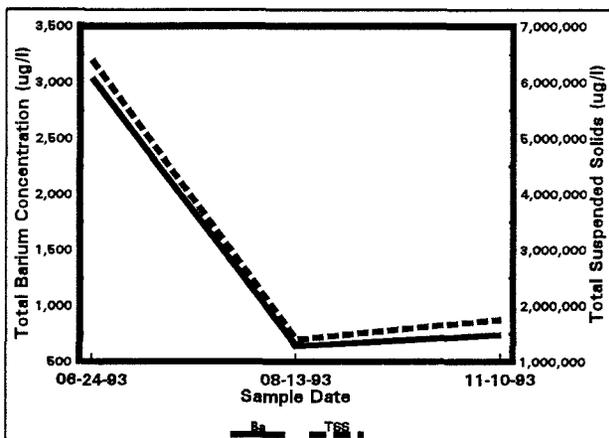
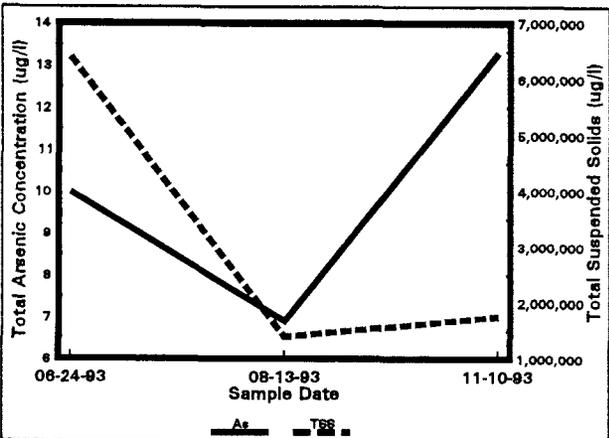
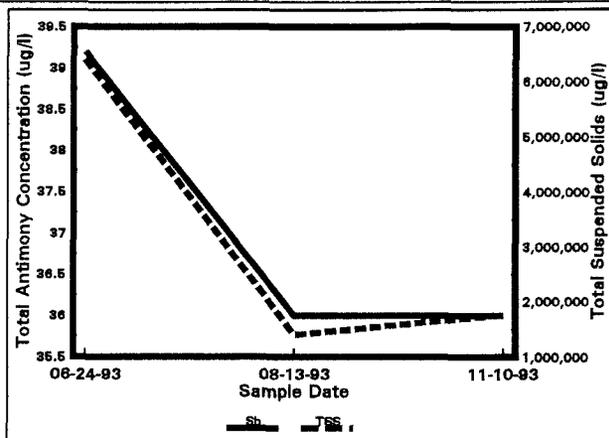
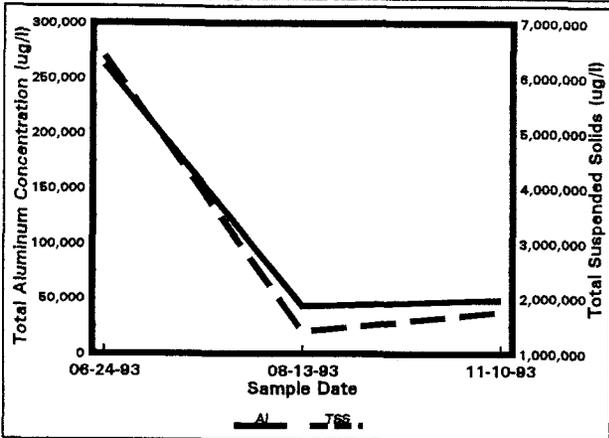
CHEMICALS OF CONCERN (COC)™

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Figure 5-10

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TOTAL METALS AND TOTAL SUSPENDED

SOLIDS IN GROUNDWATER

WELL 59593

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Figure 5-11

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None of the radionuclides identified as COCs are eliminated through this process. Metals should not be considered COCs in groundwater at OU5. In summary, the following are the COCs for groundwater at OU5.

**RFETS OU5
Contaminants of Concern
Groundwater**

- Americium-241
- Plutonium-239/240
- Radium-226
- Strontium-89/90
- Uranium-233/234
- Uranium-235
- Uranium-238

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6.0 CONTAMINANTS OF CONCERN IN SURFACE WATER

This section describes the concentration/toxicity screen and the risk-based evaluation of infrequently detected contaminants for surface water. Data evaluation, background comparison, and detection frequency methodology and results are presented in Appendix A. PCOCs with greater than five-percent FOD are presented in Table A-12 of Appendix A and are used as inputs to the concentration/toxicity screen.

6.1 CONCENTRATION/TOXICITY SCREENS

Concentration/toxicity screens for surface water are presented in Table 6-1 (noncarcinogens), Table 6-2 (carcinogens) and Table 6-3 (radionuclides). All analytes that contribute at least one percent of the total risk factor are retained as OU-wide COCs. OU-wide COCs for surface water are listed below.

**RFETS OU5
Contaminants of Concern
following Con/Tox Screen
Surface water**

- Arsenic
- Barium
- Lithium
- Selenium
- Strontium
- Pentachlorophenol
- Americium-241
- Plutonium-239/240
- Uranium-233/234
- Uranium-238

Table 6-1
 RFETS OUS
 Concentration/Toxicity Screen
 Surface Water Noncarcinogens

PCOC	Maximum Concentration (mg/l)	RI/D (mg/kg-day) (a)	Type of RI/D (b)	Chemical-specific Risk Factor (RI)	Ratio of RI/Rj	Percentage of Total Risk Factor	Consider a COC?
Non-Carcinogen							
Arsenic	0.0057	3.00E-04	o	1.90E+01	7.82E-01	78.24%	YES
Barium	0.187	7.00E-02	o	2.67E+00	1.10E-01	11.00%	YES
Benzoic Acid	0.028	4.00E+00	o	7.00E-03	2.88E-04	0.03%	NO
Lithium	0.0138	2.00E-02	o	6.90E-01	2.84E-02	2.84%	YES
Methylene Chloride	0.01	6.00E-02	o	2.00E-01	8.24E-03	0.82%	NO
Pentachlorophenol	0.005	3.00E-02	o	1.67E-01	6.86E-03	0.69%	NO
Selenium	0.0032	5.00E-03	o	6.40E-01	2.64E-02	2.64%	YES
Strontium	0.546	6.00E-01	o	9.10E-01	3.75E-02	3.75%	YES
		Total Risk Factor (R _T)	=	2.43E+01	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

n/a Applicable toxicological criteria not available.

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Table 6-2
 RFETS OUS
 Concentration/Toxicity Screen
 Surface Water Carcinogens

PCOC	Maximum Concentration (mg/l)	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							
Arsenic	0.01	1.75E+00	o	1.75E-02	9.62E-01	96.21%	YES
Methylene Chloride	0.01	7.50E-03	o	9.00E-05	4.95E-03	0.49%	NO
Pentachlorophenol	0.005	1.20E-01	o	6.00E-04	3.30E-02	3.30%	YES
		Total Risk Factor (Rj)		1.82E-02	Total %	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

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Table 6-3
 RFETS OUS
 Concentration/Toxicity Screen
 Surface Water Radionuclides

PCOC	Maximum Concentration (pCi/l)	Slope Factor (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, Total	0.38	2.40E-10	o	9.12E-11	3.20E-01	32.02%	YES
Plutonium - 239/240, Total	0.03	2.30E-10	o	6.90E-12	2.42E-02	2.42%	YES
Uranium - 233/234, Total	4.67	1.60E-11	o	7.47E-11	2.62E-01	26.23%	YES
Uranium -238	7	1.60E-11	o	1.12E-10	3.93E-01	39.32%	YES
		Total Risk Factor (Rj)	=	2.85E-10	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

6.2 RISK-BASED EVALUATION OF INFREQUENTLY DETECTED CONTAMINANTS

There are no contaminants in surface water detected at less than five-percent frequency. Therefore the risk-based evaluation of infrequently detected compounds is not performed.

6.3 APPLICATION OF PROFESSIONAL JUDGEMENT

The spatial/temporal distribution and geochemical characteristics of certain inorganics evaluated with professional judgement are presented as the following.

The concentrations (total or dissolved) of arsenic in surface-water samples did not exceed the UTL_{99/99}, as reported in the BGCR (DOE, 1993). All concentrations (total or dissolved) were below a detection limit of 10 µg/L. All total concentrations of arsenic were below the maximum background of 11.5 µg/L. All detected (not qualified with a "U") dissolved concentrations of arsenic were below the maximum background of 5 µg/L. Concentrations immediately downslope (downgradient) from either IHSS 133 or 115 (in the South Interceptor Ditch (SID)) do not appear to be significantly higher than elsewhere along Woman Creek. Considering the above facts, arsenic is not considered a COC in surface water at OU5.

The concentrations (total or dissolved) of barium in surface-water samples did not exceed the UTL_{99/99} in any case. All concentrations (total or dissolved) of barium were below the maximum background. Concentrations immediately downslope (downgradient) from either IHSS 133 or 115 (in the SID) do not appear to be significantly higher than elsewhere along Woman Creek. The highest concentration was detected in the sample from location SW55193, which is a small depression that occasionally retains water and is located near IHSS 209. Barium is not a COC for surface soils. Considering the above facts, barium is not considered a COC in surface water at OU5.

Only one sample with detected total concentrations of lithium exceeded the mean concentration of the background (two samples have detection limits of 100 µg/L). No sample with detected dissolved concentrations of lithium exceeded the mean concentration of the background (three samples have

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detection limits of 100 $\mu\text{g/L}$). All samples had concentrations (total or dissolved) below the $\text{UTL}_{99/99}$. The few samples with high detection limits have artificially skewed the statistics. Therefore, considering this and the above facts, lithium is not considered a COC in surface water.

The concentrations (total or dissolved) of selenium in surface-water samples did not exceed the $\text{UTL}_{99/99}$ in any case. All concentrations (total or dissolved) were below a detection limit of 5 $\mu\text{g/L}$. Concentrations immediately downslope (downgradient) from either IHSS 133 or 115 (in the SID) do not appear to be significantly higher than elsewhere along Woman Creek. Considering the above facts, selenium is not considered a COC in surface water at OU5.

None of the radionuclides identified as COCs are eliminated through this process. Arsenic, barium, lithium, and selenium are not considered COCs in surface water due to spatial/temporal distribution and geochemical characteristics. In summary, the following are the COCs for surface water at OU5.

**RFETS OU5
Contaminants of Concern
Surface water**

- Pentachlorophenol
- Strontium
- Americium-241
- Plutonium-239/240
- Uranium-233/234
- Uranium-238

7.0 CONTAMINANTS OF CONCERN IN SEEP WATER

This section describes the concentration/toxicity screen and the risk-based evaluation of infrequently detected contaminants for seep water. Data evaluation, background comparison, and detection frequency methodology and results are presented in Appendix A. PCOCs with greater than five percent FOD are presented in Table A-13 of Appendix A and are used as inputs to the concentration/toxicity screen.

7.1 CONCENTRATION/TOXICITY SCREENS

Concentration/toxicity screens for seep water are presented in Table 7-1 (noncarcinogens) and Table 7-2 (carcinogens). There were no radionuclides detected in the seep-water samples. All analytes that contribute at least one percent of the total risk factor are retained as OU-wide COCs. OU-wide COCs for seep water are listed below.

**RFETS OU5
Contaminants of Concern
following Con/Tox Screen
Seep Water**

- 1,1-Dichloroethene
- Acetone^a
- Tetrachloroethene
- Trichloroethene

^a Possible laboratory contaminant.

The only PCOC in seep water that does not have EPA-established toxicity criteria is 1,1,1-trichloroethane. This contaminant cannot be evaluated in a toxicity- or risk-based screen to select COCs. However, its potential contribution to overall risk will be evaluated qualitatively in the risk assessment for OU5.

Table 7-2
 RFETS OUS
 Concentration/Toxicity Screen
 Seep Water Carcinogens

PCOC	Maximum Concentration (mg/l)	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							
1,1-Dichloroethene	0.004	1.20E+00	i	3.33E-03	2.83E-03	0.28%	NO
1,2-Dichloroethene	0.004	n/a		-	-	-	NO
Tetrachloroethene	0.028	5.20E-02	o	5.38E-01	4.57E-01	45.70%	YES
Trichloroethene	0.007	1.10E-02	o	6.36E-01	5.40E-01	54.01%	YES
		Total Risk Factor (Ri)	=	1.18E+00	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

(n/a) Applicable toxicological criteria is not available.

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7.2 RISK-BASED EVALUATION OF INFREQUENTLY DETECTED CONTAMINANTS

There are no contaminants in seep water detected at less than five-percent frequency. Therefore the risk-based evaluation of infrequently detected compounds is not performed.

7.3 APPLICATION OF PROFESSIONAL JUDGEMENT

There were no metals identified as COCs in seep water. No further evaluation of the distribution of metals in seep water was conducted for OU5.

8.0 CONTAMINANTS OF CONCERN IN POND SEDIMENTS

This section describes the concentration/toxicity screen and the risk-based evaluation of infrequently detected contaminants for the pond sediment. Data evaluation, background comparison, and detection frequency methodology and results are presented in Appendix A. PCOCs with greater than five-percent FOD are presented in Table A-14 of Appendix A and are used as inputs to the concentration/toxicity screen.

Data for pond sediment in OU5 were compared to background data for both seep and stream sediments due to the lack of background pond data. As a conservative screen, these separate PCOC lists were combined for the pond sediment comparison. Background data for samples collected from seep sediment sampling locations were used for comparison to OU5 pond sediment data because of the similarity of the flow conditions for ponds and seeps (both have relatively long resident time). Similarly, background data from stream sediment sampling locations were used for comparison to OU5 pond data because of the similarity of the source areas.

8.1 CONCENTRATION/TOXICITY SCREENS

Concentration/toxicity screens for pond sediments are presented in Table 8-1 (noncarcinogens), Table 8-2 (carcinogens) and Table 8-3 (radionuclides).

The PCOC in pond sediments that does not have EPA-established toxicity criteria is lead. While there are no toxicity criteria established for lead, EPA recommends screening levels for lead in soil for residential land use of 400 ppm (EPA, 1994c). This value cannot be used in this concentration/toxicity screen. Therefore, lead cannot be evaluated in a toxicity- or risk-based screen to select COCs. However, its potential contribution to overall risk will be evaluated qualitatively in the risk assessment for OU5.

Table 8-1
 RFETS OUS
 Concentration/Toxicity Screen
 Pond Sediments Noncarcinogens

PCOC	Maximum Concentration (mg/kg)	RfD (mg/kg-day) (a)	Type of RfD (b)	Chemical-specific Risk Factor (Rf)	Ratio of Rf/Rj	Percentage of Total Risk Factor	Consider a COC?
Non-Carcinogen							
Aluminum	15500	2.90E+00		5.34E+03	1.21E-04	0.01%	NO
Arsenic	9.8	3.00E-04	o	3.27E+04	7.42E-04	0.07%	NO
Barium	262	1.43E-04	i	1.83E+06	4.16E-02	4.16%	YES
Benzoic Acid	0.41	4.00E+00	o	1.03E-01	2.33E-09	0.00%	NO
Beryllium	1	5.00E-03	o	2.00E+02	4.55E-06	0.00%	NO
Chromium	19.6	5.00E-03	o	3.92E+03	8.91E-05	0.01%	NO
Cobalt	12.3	6.00E-02	-	2.05E+02	4.66E-06	0.00%	NO
Copper	35.9	4.00E-02	o	8.98E+02	2.04E-05	0.00%	NO
Di-N-Butylphthalate	0.11	1.00E-01	o	1.10E+00	2.50E-08	0.00%	NO
Fluoranthene	0.14	4.00E-02	o	3.50E+00	7.95E-08	0.00%	NO
Lead	34.6	n/a		-	-	-	NO
Lithium	15.7	2.00E-02		7.85E+02	1.78E-05	0.00%	NO
Manganese	602	1.43E-05	i	4.21E+07	9.57E-01	95.68%	YES
Mercury	1.6	8.57E-05	i	1.87E+04	4.24E-04	0.04%	NO
Nickel	19.1	2.00E-02	o	9.55E+02	2.17E-05	0.00%	NO
Phenol	0.15	6.00E-01	o	2.50E-01	5.68E-09	0.00%	NO
Selenium	1.5	5.00E-03	o	3.00E+02	6.82E-06	0.00%	NO
Strontium	167	6.00E-01	o	2.78E+02	6.33E-06	0.00%	NO
Vanadium	40.9	7.00E-03	o	5.84E+03	1.33E-04	0.01%	NO
Toluene	0.562	1.14E-01	i	4.93E+00	1.12E-07	0.00%	NO
Zinc	201	3.00E-01	o	6.70E+02	1.52E-05	0.00%	NO
		Total Risk Factor (Rf)	=	4.40E+07	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

(n/a) Applicable toxicological criteria is not available.

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Table 8-2
 RFETS OUS
 Concentration/Toxicity Screen
 Pond Sediments Carcinogens

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							
Arsenic	9.8	1.51E+01	i	1.48E+02	1.54E-01	15.41%	YES
Chromium	19.6	4.10E+01	i	8.04E+02	8.37E-01	83.71%	YES
Beryllium	1	8.40E+00	i	8.40E+00	8.75E-03	0.88%	NO
		Total Risk Factor (R _i)	=	9.60E+02	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

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Table 8-3
 RFETS OUS
 Concentration/Toxicity Screen
 Pond Sediments Radionuclides

PCOC	Maximum Concentration (pCi/g)	Slope Factor (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	0.42	3.20E-08	i	1.34E-08	4.89E-02	4.89%	YES
Plutonium - 239/240, Total	2.4	3.80E-08	i	9.12E-08	3.32E-01	33.21%	YES
Uranium 233/234	3.5	2.70E-08	i	9.45E-08	3.44E-01	34.41%	YES
Uranium-235	0.14	2.50E-08	i	3.50E-09	1.27E-02	1.27%	YES
Uranium-238	3	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) o = oral, i = inhalation

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All analytes that contribute at least 1 percent of the total risk factor are retained as OU-wide COCs. OU-wide COCs for pond sediments are listed as follows.

**RFETS OU5
Contaminants of Concern
following Con/Tox Screen
Pond Sediments**

- Arsenic
- Barium
- Chromium
- Manganese
- Americium-241
- Plutonium-239/240
- Uranium-233/234
- Uranium-235
- Uranium-238

8.2 RISK-BASED EVALUATION OF INFREQUENTLY DETECTED CONTAMINANTS

There are no contaminants in pond sediments detected at less than five-percent frequency. Therefore the risk-based evaluation of infrequently detected compounds is not performed.

8.3 APPLICATION OF PROFESSIONAL JUDGEMENT

The spatial/temporal distribution and geochemical characteristics of certain inorganics evaluated with professional judgement are presented as follows.

Concentrations of arsenic in the six pond-sediment samples were all below the maximum concentrations detected for both background stream sediments and seep sediments. In fact the highest concentration detected in the pond samples was 9.8 mg/kg versus the highest background seep-sediment concentration of 49.2 mg/kg. Given these facts, arsenic is not considered a COC for pond sediments.

Concentrations of barium in the pond-sediment samples were below the UTL_{99/99} in seep sediments. The highest concentration in pond sediments was 262 mg/kg compared to a maximum background seep-sediment concentration of 706 mg/kg and a mean background seep-sediment concentration of 204.61 mg/kg. Considering these facts, barium is not considered a COC in pond sediments.

Concentrations of chromium in the six pond-sediment samples were all below the UTL_{99/99} for both stream sediments and seep sediments. Concentrations of chromium in the six pond-sediment samples were all below the maximum concentrations detected for both background stream sediments and seep sediments. Considering these facts, chromium is not considered a COC for pond sediments.

Concentrations of manganese in the six pond-sediment samples were all below the UTL_{99/99} for both stream sediments and seep sediments. Concentrations of manganese in the six pond-sediment samples were all below the maximum concentrations detected for both background stream sediments and seep sediments. In fact the highest concentration detected in the pond samples was 602 mg/kg versus the highest background stream-sediment concentration of 1,280 mg/kg. Given these facts, manganese is not considered a COC for pond sediments.

None of the radionuclides identified as COCs are eliminated through this process. Arsenic, barium, chromium, and manganese are not considered COCs for pond sediment following spatial/temporal distribution and geochemical characteristics evaluation. The following is a list of pond sediment COCs for OU5.

**RFETS OU5
Contaminants of Concern
Pond Sediments**

- Americium-241
- Plutonium-239/240
- Uranium-233/234
- Uranium-235
- Uranium-238

9.0 CONTAMINANTS OF CONCERN IN SEEP SEDIMENTS

This section describes the concentration/toxicity screen and the risk-based evaluation of infrequently detected contaminants for seep sediments. Data evaluation, background comparison, and detection frequency methodology and results are presented in Appendix A. PCOCs with greater than five-percent FOD are presented in Table A-15 of Appendix A and are used as inputs to the concentration/toxicity screen.

9.1 CONCENTRATION/TOXICITY SCREENS

Concentration/toxicity screens for seep sediments are presented in Table 9-1 (noncarcinogens), Table 9-2 (carcinogens) and Table 9-3 (radionuclides). All analytes that contribute at least one percent of the total risk factor are retained as OU-wide COCs. OU-wide COCs for seep sediments are listed below.

**RFETS OU5
Contaminants of Concern
following Con/Tox Screen
Seep Sediments**

- Antimony
- Beryllium
- Zinc
- Uranium-233/234
- Uranium-235
- Uranium-238

PCOCs in seep sediments that do not have EPA-established toxicity criteria are phenanthrene and thallium. These contaminants cannot be evaluated in a toxicity- or risk-based screen to select COCs. However, their potential contribution to overall risk will be evaluated qualitatively in the risk assessment for OU5.

Table 9-1
 RFETS OUS
 Concentration/Toxicity Screen
 Seep Sediments Noncarcinogens

PCOC	Maximum Concentration (mg/kg)	RfD (mg/kg-day) (a)	Type of RfD (b)	Chemical-specific Risk Factor (Rf)	Ratio of Rf/Rj	Percentage of Total Risk Factor	Consider a COC?
Non-Carcinogen							
Acetone	0.017	1.00E-01	o	1.70E-01	1.27E-06	0.00%	NO
Antimony	51.3	4.00E-04	o	1.28E+05	9.57E-01	95.68%	YES
Beryllium	1.7	5.00E-03	o	3.40E+02	2.54E-03	0.25%	NO
Flouranthene	0.097	4.00E-02	o	2.43E+00	1.81E-05	0.00%	NO
Mercury	0.06	8.57E-05	i	7.00E+02	5.22E-03	0.52%	NO
Nickel	25	2.00E-02	o	1.25E+03	9.33E-03	0.93%	NO
Phenanthrene	0.082	n/a		-	-	-	NO
Pyrene	0.097	3.00E-02	o	3.23E+00	2.41E-05	0.00%	NO
Thallium	0.28	n/a		-	-	-	NO
Zinc	1050	3.00E-01	o	3.50E+03	2.61E-02	2.61%	YES
		Total Risk Factor (Rj)	=	1.34E+05	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

(n/a) Applicable toxicological criteria is not available.

Table 9-2
 RFETS OUS
 Concentration/Toxicity Screen
 Seep Sediments Carcinogens

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							
Benzo(a)anthracene	0.038	7.30E-01	o	2.77E-02	1.94E-03	0.19%	NO
Beryllium	1.7	8.40E+00	i	1.43E+01	9.98E-01	99.80%	YES
Bis(2-Ethylhexyl)phthalate	0.08	1.40E-02	o	1.12E-03	7.83E-05	0.01%	NO
Chrysene	0.041	7.30E-03	o	2.99E-04	2.09E-05	0.00%	NO
Methylene Chloride	0.005	7.50E-03	o	3.75E-05	2.62E-06	0.00%	NO
Tetrachloroethene	0.001	5.20E-02	o	5.20E-05	3.63E-06	0.00%	NO
		Total Risk Factor (R _i)	=	1.43E+01	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

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Table 9-3
 RFETS OUS
 Concentration/Toxicity Screen
 Seep Sediments Radionuclides

PCOC	Maximum Concentration (pCi/g)	Slope Factor (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, Total	2.00	2.70E-08	i	5.40E-08	3.65E-01	36.47%	YES
Uranium -235	0.21	2.50E-08	i	5.25E-09	3.55E-02	3.55%	YES
Uranium - 238	3.7	2.40E-08	i	8.88E-08	6.00E-01	59.98%	YES
		Total Risk Factor (Rj)	=	1.48E-07	Total % =	100%	

Notes:

(a) The most restrictive of the oral or inhalation slope factor is used.

(b) o = oral, i = inhalation

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9.2 RISK-BASED EVALUATION OF INFREQUENTLY DETECTED CONTAMINANTS

There are no contaminants in seep sediments detected at less than five-percent frequency. Therefore the risk-based evaluation of infrequently detected compounds is not performed.

9.3 APPLICATION OF PROFESSIONAL JUDGEMENT

The spatial/temporal distribution and geochemical characteristics of certain inorganics evaluated with professional judgement are presented as follows.

The concentrations of antimony in seep sediments ranged from 35.20 to 51.30 mg/kg, and concentrations of beryllium ranged from 1.30 to 1.70 mg/kg . These relatively narrow ranges of concentrations indicate that the concentrations are indicative of naturally occurring antimony and beryllium in seep sediments in this vicinity. The contaminants that may possibly be detected in seep sediments at the locations near IHSS 115 are expected to be different than those expected near IHSS 133. If the levels of these two metals at these locations are attributable to environmental contamination associated with these IHSSs, it would be expected that the concentrations detected would vary greatly. This is illustrated by the fact that the zinc concentrations in the two seep-sediment samples collected near IHSS 133 were 294 and 1,050 mg/l, while the concentrations of zinc in the samples collected near IHSS 115 were 53.8 and 69.9 mg/l. The zinc concentrations detected in the samples from the IHSS 115 area are consistent with background concentration. This information indicates that, with the exception of zinc, metals should not be considered site contaminants for seep sediments.

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The following list presents the seep sediment COCs for OU5.

**RFETS OU5
Contaminants of Concern
Seep Sediments**

- Zinc
- Uranium-233/234
- Uranium-235
- Uranium-238

10.0 CONTAMINANTS OF CONCERN IN STREAM SEDIMENTS

This section describes the concentration/toxicity screen and the risk-based evaluation of infrequently detected contaminants for stream sediments. Data evaluation, background comparison, and detection frequency methodology and results are presented in Appendix A. PCOCs with greater than five-percent FOD are presented in Table A-16 of Appendix A and are used as inputs to the concentration/toxicity screen.

10.1 CONCENTRATION/TOXICITY SCREENS

Concentration/toxicity screens for stream sediments are presented in Table 10-1 (noncarcinogens), Table 10-2 (carcinogens) and Table 10-3 (radionuclides). All analytes that contribute at least one percent of the total risk factor are retained as OU-wide COCs. OU-wide COCs for stream sediments are listed below.

**RFETS OU5
Contaminants of Concern
following Con/Tox Screen
Stream Sediments**

- Arsenic
- Cadmium
- Copper
- Mercury
- Molybdenum
- Silver
- Zinc
- Americium-241
- Plutonium-239/240

Table 10-1
 RFETS OU5
 Concentration/Toxicity Screen
 Stream Sediments Noncarcinogens

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?
Non-Carcinogen							
Benzoic Acid	0.41	4.00E+00	o	1.03E-01	2.01E-06	0.00%	NO
Copper	135.5	4.00E-02	o	3.39E+03	6.63E-02	6.63%	YES
Di-N-Butylphthalate	0.11	1.00E-01	o	1.10E+00	2.15E-05	0.00%	NO
Fluoranthene	0.14	4.00E-02	o	3.50E+00	6.85E-05	0.01%	NO
Mercury	3.05	8.57E-05	i	3.56E+04	6.96E-01	69.63%	YES
Molybdenum	40	5.00E-03	o	8.00E+03	1.57E-01	15.65%	YES
Phenol	0.15	6.00E-01	o	2.50E-01	4.89E-06	0.00%	NO
Selenium	1.1	5.00E-03	o	2.20E+02	4.30E-03	0.43%	NO
Silver	7.7	5.00E-03	o	1.54E+03	3.01E-02	3.01%	YES
Toluene	0.562	1.14E-01	i	4.93E+00	9.65E-05	0.01%	NO
Zinc	709	3.00E-01	o	2.36E+03	4.62E-02	4.62%	YES
		Total Risk Factor (Rj)	=	5.11E+04	Total % =	100%	

Notes:

(a) - The most restrictive of the oral or inhalation RfDs is used.
 (b) - o = oral, i = inhalation

Table 10-2
 RFETS OUS
 Concentration/Toxicity Screen
 Stream Sediments Carcinogens

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							
Arsenic	5.5	1.51E+01	i	8.31E+01	8.25E-01	82.48%	YES
Cadmium	2.8	6.30E+00	i	1.76E+01	1.75E-01	17.52%	YES
		Total Risk Factor (Rj)	=	1.01E+02	Total % =	100%	

Notes:

(a) - The most restrictive of the oral or inhalation slope factors is used.

(b) - o = oral, i = inhalation

Table 10-3
 RFETS OUS
 Concentration/Toxicity Screen
 Stream Sediments Radionuclides

PCOC	Maximum Concentration (pCi/g)	Slope Factor (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	2.90	3.20E-08	i	9.28E-08	6.03E-01	60.30%	YES
Plutonium - 239/240, Total	1.6	3.80E-08	i	6.08E-08	3.95E-01	39.51%	YES
Tritium	3900	7.80E-14	i	3.04E-10	1.98E-03	0.20%	NO
		Total Risk Factor (Ri)	=	1.54E-07	Total % =	100%	

Notes:

(a) - The most restrictive of the oral or inhalation slope factors is used.

(b) - o = oral, i = inhalation

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10.2 RISK-BASED EVALUATION OF INFREQUENTLY DETECTED CONTAMINANTS

There are no contaminants in stream sediments detected at less than five-percent frequency. Therefore the risk-based evaluation of infrequently detected compounds is not performed.

10.3 APPLICATION OF PROFESSIONAL JUDGEMENT

The spatial/temporal distribution and geochemical characteristics of certain inorganics evaluated with professional judgement are presented as follows.

Concentrations of arsenic and silver do not exceed the UTL_{99/99} in any of the eight samples. In fact, the sample from the SID (SED507) directly downstream from IHSS 115 had the lowest concentration of arsenic. Molybdenum was found to be statistically significant, however, it was not detected in any of the eight stream sediment samples. Therefore, arsenic, silver, and molybdenum are not considered COCs.

With the exception of location SED507, the concentrations of copper, mercury, and zinc do not exceed the UTL_{99/99}. In fact with the exception of location SED507, mercury was below the reported detection limit. Even though the only sample with concentrations above the respective UTL_{99/99} is located in the SID directly downgradient from IHSS 115, copper, mercury, and zinc are considered COCs for stream sediments. However, if SID sediments can be separated from stream sediments then these three constituents should only be considered COCs for SID sediments and not for stream sediments.

With the exception of copper, mercury, and zinc, metals are not considered site contaminants for stream sediments. The following list presents the stream sediment COCs for OU5.

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**RFETS OU5
Contaminants of Concern
Stream Sediments**

- Copper
- Mercury
- Zinc
- Americium-241
- Plutonium-239/240

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APPENDIX A
ANALYTICAL DATA EVALUATION FOR DEVELOPMENT OF
POTENTIAL CONTAMINANTS OF CONCERN

The process of developing a list of potential contaminants of concern (PCOCs) is intended to identify the constituents in each medium that have detected concentrations statistically greater than background concentrations.

Analytical results from each medium sampled were pooled, and the background comparison was performed on an OU-wide basis. The background data used for comparison were reported in the Background Geochemical Characterization Report (BGCR) (EG&G, 1993), with the exception of the surface-soil data, which were not available in the 1993 report. The background surface-soil samples (aka "Rock Creek 18") were collected in the Rock Creek area during the 1991 OU1 Phase III investigation and the 1993 OU2 Phase II investigation.

The four procedures used in the PCOC selection process are listed below and described in the following sections:

- Data review and cleanup;
- Data separation (by media);
- Background comparisons; and
- Professional judgment.

A.1 DATA REVIEW AND CLEANUP

The following is a brief summary of the sampling and analytical programs separated by media (surface soil, subsurface soil, groundwater, surface water, seep water, pond sediment, seep sediment, and stream sediment).

- Surface Soil – The field procedures used to collect surface-soil samples were in accordance with the *RFETS, Section 5.0 of SOP GT.08 "Surface Soil Sampling"* (EG&G, 1991). The following list identifies the types of surface soil samples taken at each IHSS.

- IHSS 115 (Original Landfill) AND IHSS 196 (Filter Backwash Ponds) - Surface-soil samples were collected at 66 locations in IHSSs 115/196. Fifty-four of the samples were analyzed for target analyte list (TAL) metals, radionuclides, pesticides, polychlorinated biphenyls (PCEs), and target compound list (TCL) semivolatile organic compounds (SVOCs). The remaining 12 samples were collected at areas of relatively high radioactivity as identified by High-purity Germanium (HPGe) and/or Field Instrument for Detection of Low Energy Radiation (FIDLER) surveys and were analyzed only for radionuclides.
- IHSS 133 (Ash Pits, Incinerator, and Concrete Wash Pad) - A total of 20 surface-soil samples were collected in IHSS 133. Eighteen of the samples were analyzed for TOC, TAL metals, polyaromatic hydrocarbons, and radionuclides. Two profile samples were collected at HPGe survey stations and were analyzed only for radionuclides.
- IHSS 142.10 and IHSS 142.11 (Detention Ponds C-1 and C-2) - No surface soil samples were collected.
- IHSS 209 and Other Surface Disturbances - Surface-soil samples were collected at 19 locations and analyzed for TAL metals, radionuclides, pesticides, PCEs, TCL SVOCs, specific conductivity, pH, and TOC.
- Subsurface Soil - Subsurface-soil samples were collected with the use of hollow-stem auger drilling techniques and hydraulic-advancement drilling techniques. Soil samples were collected with split-barrel type samplers. Boreholes were typically cored continuously, with analytical samples being composited over six-foot intervals to a depth of five feet into claystone bedrock. Analytical parameters and depth intervals varied among the IHSSs as described below.
 - IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Ponds) - Eight boreholes were advanced for subsurface characterization (six in the disturbed area east of the Original Landfill and two in the former Filter Backwash Ponds). Additionally, six boreholes were advanced into soil-gas anomalies (two were completed as mini-wells) at IHSS 115. Eight more boreholes were advanced for installation of monitoring wells (only five were completed as monitoring wells and one was completed as a small-diameter well). Discrete samples from all the boreholes were collected on two-foot intervals and were analyzed for TCL VOCs. In addition, six-foot composite samples from all the boreholes were analyzed for TCL SVOCs, TAL metals, and radionuclides.
 - IHSS 133 (Ash Pits, Incinerator, and Concrete Wash Pads) - Two boreholes were advanced in a hot spot detected during HPGe surface radiological surveys. Three boreholes (Kansas Sampler) were drilled in an anomaly identified by geophysical surveys on the west side of the IHSS 133 area. Nine boreholes were monitoring-well boreholes (due to the absence of groundwater, only three monitoring wells were installed). Seventeen boreholes were "offset" boreholes as described in TM15 (DOE, 1994a) (no soil samples were analyzed). Twenty-eight boreholes were drilled in the locations specified in TM15. Six-foot composite samples from all the boreholes were analyzed for TAL metals, and radionuclides.

- IHSS 142.10 and IHSS 142.11 (Detention Ponds C-1 and C-2) - Two monitoring-well boreholes were advanced below each of the two ponds. Discrete samples from all the boreholes were collected on two-foot intervals and were analyzed for TCL VOCs. In addition, six-foot composite samples from all the boreholes were analyzed for TCL SVOCs, TAL metals, and radionuclides.
- IHSS 209 and Other Surface Disturbances - One borehole was advanced in the Surface Disturbance west of IHSS 209 and three were advanced in the Surface Disturbance south of the Ash Pits. Discrete samples from all the boreholes were collected on two-foot intervals and were analyzed for TCL VOCs. In addition, six-foot composite samples from all the boreholes were analyzed for TCL SVOCs, TAL metals, and radionuclides.
- Groundwater — Groundwater samples were collected as Hydropunch® samples during drilling activities; from well points and small-diameter wells as one-time samples; and from monitoring wells on a quarterly basis under a site-wide groundwater sampling program. Many groundwater sampling points were found to be dry and therefore could not be sampled. The specifics of sampling varied among the IHSSs as described below.
 - IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Ponds) - One groundwater sample was collected with the use of a Hydropunch® and was analyzed for TCL VOCs, SVOCs, TAL metals, and radionuclides. Two monitoring wells were sampled for three quarters (June, 1993 to November, 1993) and analyzed for TCL VOCs, SVOCs, TAL metals, and radionuclides. Six well points were sampled once (July, 1993) for TCL VOCs, three were sampled once (July, 1993) for radionuclides, and two were sampled once (July, 1993) for TAL metals.
 - IHSS 133 (Ash Pits, Incinerator, and Concrete Wash Pads) - Four Hydropunch® samples were analyzed for TAL metals and radionuclides. One well was sampled for three quarters (June, 1993 to November, 1993) and analyzed for TAL metals and radionuclides.
 - IHSS 142.10 and IHSS 142.11 (Detention Ponds C-1 and C-2) - One well was sampled for four quarters (March, 1993 to November, 1993) and analyzed for TCL VOCs, SVOCs, TAL metals, and radionuclides. One well was sampled for four quarters (March, 1993 to November, 1993) and analyzed for TCL VOCs. This well was also sampled for radionuclides three times (March, 1993, April, 1993, and November, 1993). Additionally, this well was sampled once for TAL metals (April, 1994).
 - IHSS 209 and Other Surface Disturbances - No monitoring wells were installed because groundwater was not encountered during drilling.
- Surface Water - Surface-water samples were collected as indicated in the following list.
 - IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Ponds) - Surface-water samples were collected from various locations in the Woman Creek Drainage during two baseflow

sampling events (March, 1993 and November, 1993) and two high-flow sampling events (March, 1993 and May, 1993). These samples were analyzed for TCL VOCs, SVOCs, pesticides, PCEs, TAL metals, and radionuclides.

- IHSS 209 and Other Surface Disturbances - Two surface-water samples were collected in depressions at IHSS 209. Samples were analyzed for TCL VOCs, SVOCs, TAL metals, and radionuclides.
- IHSS 142 (Detention Ponds C-1 and C-2) - Surface water samples were collected during a one-time sampling event at three locations in both Detention Ponds C-1 and C-2 with an Eckman dredge. These locations were located five feet from the inlet, at the mid-point, and at the deepest point in each pond. Samples were analyzed for TCL VOCs, TAL metals, and radionuclides.
- Seep Water - Seep-water samples were collected as indicated in the following list.
 - IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Ponds) - Water samples were collected from two seeps in IHSS 115. Only enough water could be collected for analysis of TCL VOCs and some radionuclides.
 - IHSS 133 (Ash Pits, Incinerator, and Concrete Wash Pads) - Water samples were collected from two seeps in IHSS 133. Only enough water could be collected from one seep for analysis of TCL VOCs. The other was sampled for TCL VOCs and some radionuclides.
- Pond Sediment - Pond sediments were collected only in IHSS 142. Pond sediments were collected during a one-time sampling event at three locations in both Detention Ponds C-1 and C-2 with an Eckman dredge. These locations were located five feet from the inlet, at the mid-point, and at the deepest point in each pond. Samples were analyzed for TCL VOCs, TAL metals, and radionuclides.
- Seep Sediment - Seep-sediment samples were collected in both IHSSs 115 and 133. These samples were collected as grab samples.
 - IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Ponds) - Two sediment samples were collected from seeps near IHSS 115 and analyzed for TAL metals, radionuclides, TCL VOCs, TCL SVOCs, pesticides, and PCEs.
 - IHSS 133 (Ash Pits, Incinerator, and Concrete Wash Pads) - Two sediment samples were collected from seeps near IHSS 133 and analyzed for TAL metals, radionuclides, TCL VOCs, TCL SVOCs, pesticides, and PCEs.
- Seep Sediment - Stream sediments were collected at nine monitoring sites along Woman Creek. One-time sediment sampling sites was conducted on November 5, 1992. These samples were analyzed for TAL metals, radionuclides, nitrate/nitrite, and TOC.

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The OU5 Phase 1 field program began in August 1992 and is on-going. A total of 641 samples have been analyzed. More than 42,000 analytical results (not including QA/QC samples) were reported for OU5 as of February 1994. Approximately 94 percent of these results have been validated by the validation contractor. Data review and cleanup were primarily conducted in accordance with "Practical Suggestions for Users of RFEDS Data" prepared by EG&G, dated April 5, 1994 (EG&G, 1994b). This Section describes the procedures used to review and edit the OU5 data.

Results for QA/QC samples, such as equipment rinsates, field and trip blanks, spikes, surrogates, and laboratory-generated samples were removed from the data set. Data were then checked for multiple reported records for the same sample. When multiple records were identified, RFEDS personnel were consulted to assist in selecting which records to retain. Records with blanks in the result field or those rejected by the validation contractor ("R" in the validation field) were also removed. Results of field duplicates were averaged with the associated real samples. The averaged result was used in the comparison with background.

Following DOE guidance given in DOE Order 5400.1, all results for radionuclides were considered detects, even if the reported result was qualified as being below the reported detection limit. Records for radionuclide analyses were used as reported, therefore, there were no non-detect results. Records for inorganic and organic analyses were modified based on the result qualifiers that were assigned by the analytical laboratory or the validation contractor. The following is a summary of the qualifiers and how the data were modified prior to application of any statistical test.

- The B-qualifier for results of inorganic analyses indicates that the reported concentration is greater than the instrument detection limit but less than the contract required detection limit. These data were used as reported.
- The B-qualifier for results of organic analyses indicates the analyte was detected in both the method blank and the real sample. These data were used as reported if they were not qualified as non-detected on the basis of laboratory contamination (U-qualified) by the validation contractor.
- The E-qualifier indicates that the result exceeded the calibration range of the instrument. These data were replaced with the associated D-qualified data (diluted to within calibration range), if a D-qualified record was received. When only an E-qualified record was reported, it was used.

- The U-qualifier indicates that the constituent was not detected at the concentration reported in the "DETECTION LIMIT" field. When qualified as non-detected, the result was used when the result was greater than reported detection limit. The result was replaced with the detection limit when the result was lower than the detection limit and qualified as a non-detect.

A.2 DATA SEPARATION

The contaminant data were separated by medium into seven categories:

- Surface soil
- Subsurface soil
- Groundwater
- Surface water
- Seep water
- Pond sediment
- Seep sediment

A.3 BACKGROUND COMPARISONS

Organic compounds were assumed to not exist in background, therefore, any organic compound detected was considered a PCOC. Background comparisons for radionuclides and inorganic analytes were performed according to the procedures given in the "Guidance Document, Statistical Comparisons of Site-To-Background Data in Support of RFI/RI Investigations" (EG&G, 1994a), which was primarily based on the methodology proposed by Gilbert (Gilbert, 1993). The formal statistical tests include the Gehan test, Slippage test, Quantile test, and t-test. Analytical results were also compared to the UTL_{99/99} of background. The conditions for applying each of the tests are briefly discussed in the following sections.

Each analyte was compared to the same analyte in the corresponding background medium. However, data for pond sediment in OU5 were compared to background data for both seep and stream sediments due to the lack of background pond data. As a conservative screen, these separate PCOC lists were combined for the pond sediment comparison. Background data for samples collected from seep sediment sampling locations were used for comparison to OU5 pond sediment data because of the similarity of the

flow conditions for ponds and seeps (both have relatively long resident time). Similarly, background data from stream sediment sampling locations were used for comparison to OU5 pond data because of the similarity of the source areas.

A.3.1. Upper Tolerance Limit Comparison

For each analyte in each medium evaluated in the BGCR (DOE, 1993), an upper tolerance limit with 99% confidence and 99% coverage ($UTL_{99/99}$) was calculated. This was done once assuming the background data were normally distributed and once assuming the background data were lognormally distributed (EG&G, 1994c). Because all the radionuclide results were treated as detects, calculation of the lognormal $UTL_{99/99}$ required that all values be shifted (i.e., add positive number to all values) such that they were all positive results. After calculation of the lognormal $UTL_{99/99}$, the shift was reversed (i.e., subtracted) (EG&G, 1994c).

The distribution of results for each analyte was evaluated by examining probability plots of the data. Each OU5 measurement was compared to the corresponding $UTL_{99/99}$ (normal or lognormal). If one or more OU5 measurements exceed the background $UTL_{99/99}$, the analyte was considered as a PCOC for further evaluation, even if the analyte did not exceed background levels according to the formal statistical evaluation.

A.3.2 Formal Statistical Tests

Four formal statistical tests were performed to evaluate if there is a difference between background and site populations. If any of the four statistical tests was significant, the analyte was considered to be a PCOC. Significance was defined as a p-value less than or equal to 0.05, the Type I (false positive) error rate. Non-detects of metals were treated as described below for each test. All the radionuclide results were treated as detects.

1. Gehan Test

The Gehan test (Gehan, 1965, explained in Gilbert, 1993) is a nonparametric ranking test. It was performed for all the analytes in all media. For non-detects, the reporting limits were used for ranking purposes.

2. Slippage Test

The slippage test (Rosenbaum, 1954), a nonparametric test, was performed by comparing the OU5 measurements to the maximum background measurement (detect or non-detect). The p-value for the probability of the number of site measurements greater than the maximum background measurement was calculated. Reporting limits were used for non-detects.

3. Quantile Test

The Quantile test (Gilbert and Simpson, 1992), a nonparametric test, was performed by first ranking the combined background and OU5 measurements from largest to smallest. If there were no non-detects among the top 20% of the combined background and OU5 measurements, the probability of the number of site measurements within the top 20% of the data set was calculated. If there were any non-detects among the top 20% of the measurements, no Quantile test was performed.

4. t-Test

The t-test, a parametric statistical test, was performed under these conditions: that (1) the non-detects in each of the data sets represent less than 20% of the measurements; and (2) each of the data sets contains at least 20 data points and both the data sets are normally distributed.

For simplicity, the t-test was only performed when condition (1) and the first option of condition (2) were met. Non-detect results for metals were replaced by one-half the reporting limits.

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Results of these statistical tests have been compiled on Tables A-1 to A-7.

A.4 PROFESSIONAL JUDGEMENT

Professional judgement was applied in the form of examination of a variety of graphics (probability plots, relative-frequency-stacked histograms, and box-and-whisker plots) and ordered listings of site and background data combined. Initially, probability plots for each analyte in each medium in OU5 were constructed and examined to evaluate whether the data more closely matched a normal distribution or a lognormal distribution. Relative-frequency-stacked histograms (non-detects and detects both indicated) were examined for each analyte in each medium for both site and background data. Similarly, box-and-whisker plots were examined for each analyte in each medium for both site and background data. In these plots, the central box covers the middle 50 percent of the values, between the lower and upper quartiles, the "whiskers" extend out to the minimum and maximum values, and the central line indicates the median. Summaries of these evaluations are contained on tables A-1 to A-7.

A.5 DEVELOPMENT SUMMARY OF POTENTIAL CONTAMINANTS OF CONCERN

Tables A-1 to A-7 are summaries of the background comparisons for radionuclides and inorganic analytes. Tables A-8 to A-14 are summaries of the compounds that were detected in the site data. Also contained on these tables are the maximum concentrations for each constituent identified as a PCOC.

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TABLE A-3: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN -- GROUND WATER SAMPLES
(Rocky Flats OJ5 RF/RJ)

# of Samples Site	Distribution (norm or log)	UTL Comparison # > UTL / # > UTL	% Detects, Background	Detects, Site	Gilbert Methodology Statistics				P < 0.05 Significant?	P T	P < 0.05 Significant?	# Tests	Number Signif. Tests	PROFESSIONAL JUDGMENT		
					P	P SLIP	P QUANT	P QUANT						Significant?	Box Plot Listing	CONCLUSION AND MAXIMUM CONCENTRATION
Radionuclides, Total																
Americium-241	183 lognormal	5 YES	100	100	0.00036	YES	0.076	NO	0.00049	YES	0.043	YES	5	4	YES	PCOC, 0.2 pCi/L
Plutonium-238	15 normal	NO	100	100	0.03647	YES	1	NO	0.04412	YES	0.089	NO	5	2	NO	PCOC, 0.01 pCi/L
Plutonium-239/24	15 194 lognormal	4 YES	100	100	0.00001	YES	0.072	NO	0	YES	0.097	NO	5	3	YES	PCOC, 1.04 pCi/L
Uranium-233/234	14 35 lognormal	NO	100	100	0.04116	YES	1	NO	0.59675	NO	0.79	NO	5	1	YES	PCOC, 49 pCi/L
Uranium-235	14 35 lognormal	NO	100	100	0.03138	YES	1	NO	0.59675	NO	0.488	NO	5	1	YES	PCOC, 4 pCi/L
Uranium-238	14 22 lognormal	NO	100	100	0.01256	YES	1	NO	0.1274	NO	0.634	NO	5	1	NO	PCOC, 44 pCi/L
Alpha	14 23 lognormal	NO	100	100	0.00036	YES	0.378	NO	0.11364	NO	9E-05	YES	5	2	YES	PCOC, 1.600 pCi/L
Beta	14 23 lognormal	NO	100	100	0.00023	YES	0.378	NO	0.11364	NO	5E-05	YES	5	2	YES	PCOC, 1.300 pCi/L
Cesium-137	1 156 normal	NO	100	100	0.19981	NO	1	NO	0.20382	NO	n/a	n/a	4	0	NO	NO
Radium-226	14 6 lognormal	NO	100	100	0.00048	YES	7E-04	YES	0.12913	NO	1E-05	YES	5	3	YES	PCOC, 4.4 pCi/L
Strontium-89/90	8 32 normal	2 YES	100	100	0.01174	YES	0.036	YES	0.03653	YES	0.078	NO	5	4	YES	PCOC, 1.5 pCi/L
Tritium	5 84 lognormal	NO	100	100	0.96872	NO	1	NO	0.68633	NO	0.9	NO	5	0	NO	NO
Radionuclides, Dissolved																
Americium-241	9 2 lognormal	NO	100	100	0.82932	NO	1	NO	0.94545	NO	0.7249	NO	5	0	NO	NO
Plutonium-239/24	9 1 normal	7 YES	100	100	0.94756	NO	1	NO	n/a	n/a	n/a	n/a	3	1	NO	NO
Uranium-233/234	19 207 lognormal	NO	100	100	0.09972	NO	1	NO	0.3379	NO	0.9865	NO	5	0	NO	NO
Uranium-235	19 207 lognormal	NO	100	100	0.01765	YES	1	NO	0.06451	NO	0.7157	NO	5	1	NO	PCOC, 0.53 pCi/L
Uranium-238	19 177 lognormal	NO	100	100	0.0316	YES	1	NO	0.16419	NO	0.9719	NO	5	1	NO	PCOC, 8.8 pCi/L
Alpha	19 213 lognormal	NO	100	100	0.02239	YES	1	NO	0.33391	NO	0.8884	NO	5	1	YES	PCOC, 27 pCi/L
Beta	19 196 lognormal	1 YES	100	100	0.00014	YES	0.884	NO	0.00448	YES	0.1477	NO	5	3	YES	PCOC, 230 pCi/L
Cesium-137	2 38 normal	NO	100	100	0.93181	NO	1	NO	1	NO	0.9997	NO	5	0	NO	NO
Radium-226	7 36 normal	1 YES	100	100	0.00746	YES	0.0003	YES	0.02568	YES	0.0136	YES	5	5	YES	PCOC, 1.03 pCi/L
Strontium-89/90	12 180 normal	1 YES	100	100	0.00418	YES	0.0625	NO	0.0004	YES	0.047	YES	5	4	YES	PCOC, 1.83 pCi/L

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TABLE A-3: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN - GROUND WATER SAMPLES
(Rocky Flats OUS RE/IR)

# of Samples Site	Distribution (norm or log)	UTL Comparison # > UTL	% Detects/Background	Detects Site	P GEHANI	P < 0.05 Significant?	P SLIP	Gilbert Methodology Statistics		P < 0.05 Significant?	P T	P < 0.05 Significant?	# Tests	Number Signif. Tests	GRAPHICS		PROFESSIONAL JUDGMENT
								P < 0.05 Significant?	P QUANT						Significant?	Box Plot Listing	
Metals, Total																	
Aluminum	17 149 lognormal	3 YES	91.28	88.24	0	YES	1E-05	YES	0	YES	3E-05	YES	5	5	YES	YES	PCOC, 357,000 ug/L
Antimony	16 141 lognormal	NO	16.31	12.5	0.02795	YES	1	NO		n/a		n/a	3	1	YES	NO	PCOC, 39.2 ug/L
Arsenic	17 138 normal	4 YES	11.59	64.71	0	YES	0.11	NO		n/a		n/a	3	2	YES	YES	PCOC, 13.3 ug/L
Barium	17 149 normal	13 YES	81.21	100	0	YES	0	YES		n/a	3E-05	YES	4	4	YES	YES	PCOC, 3,040 ug/L
Beryllium	17 148 lognormal	4 YES	7.43	64.71	0	YES	1E-05	YES		n/a		n/a	3	3	YES	YES	PCOC, 29.4 ug/L
Cadmium	17 148 lognormal	2 YES	11.49	17.65	0.01762	YES	1	NO		n/a		n/a	3	2	YES	NO	PCOC, 8.2 ug/L
Calcium	17 149 lognormal	1 YES	100	100	0	YES	0.102	NO	0.00003	YES	5E-06	YES	5	4	YES	YES	PCOC, 413,000 ug/L
Cesium	17 142 lognormal	NO	10.56	17.65	0.61941	NO	1	NO		n/a		n/a	3	0	NO	NO	
Chromium	17 145 lognormal	8 YES	41.38	70.59	0	YES	1	NO		n/a		n/a	3	2	YES	YES	PCOC, 442 ug/L
Cobalt	17 148 lognormal	2 YES	13.51	70.59	0	YES	8E-05	YES		n/a		n/a	3	3	YES	YES	PCOC, 161 ug/L
Copper	17 148 lognormal	7 YES	54.05	82.35	0	YES	1E-05	YES		n/a		n/a	3	3	YES	YES	PCOC, 420 ug/L
Iron	17 149 lognormal	4 YES	93.29	88.24	0	YES	8E-05	YES	0	YES	2E-05	YES	5	5	YES	YES	PCOC, 418,000 ug/L
Lead	17 141 lognormal	10 YES	63.12	88.24	0	YES	0	YES	0	YES		n/a	4	4	YES	YES	PCOC, 240 ug/L
Lithium	17 149 lognormal	NO	77.18	82.35	0.00017	YES	0.01	YES		n/a		n/a	3	2	YES	YES	PCOC, 306 ug/L
Magnesium	17 149 lognormal	3 YES	97.99	100	0	YES	9E-04	YES	0	YES	6E-08	YES	5	5	YES	YES	PCOC, 113,000 ug/L
Manganese	17 148 lognormal	9 YES	90.6	100	0	YES	0	YES	0	YES	2E-07	YES	5	5	YES	YES	PCOC, 13,700 ug/L
Mercury	17 148 lognormal	5 YES	2.03	29.41	0	YES	8E-05	YES		n/a		n/a	3	3	NO	NO	PCOC, 3 ug/L
Molybdenum	17 150 lognormal	NO	28	17.65	0.02993	YES	1	NO		n/a		n/a	3	1	YES	YES	PCOC, 18 ug/L
Nickel	17 146 lognormal	5 YES	28.08	82.35	0	YES	1	NO		n/a		n/a	3	2	YES	YES	PCOC, 313 ug/L
Potassium	17 150 lognormal	6 YES	76.67	82.35	0	YES	0	YES		n/a		n/a	3	3	YES	YES	PCOC, 49,700 ug/L
Selenium	16 145 lognormal	1 YES	23.45	25	0.15208	NO	1	NO		n/a		n/a	3	1	NO	NO	PCOC, 126 ug/L
Silicon	17 84 lognormal	NO	100	100	0.00003	YES	0.027	YES	0.00001	YES	1E-04	YES	5	4	YES	YES	PCOC, 354,000 ug/L
Silver	17 147 lognormal	2 YES	6.8	23.53	0.00003	YES	0.01	YES		n/a		n/a	3	3	YES	YES	PCOC, 35.2 ug/L
Sodium	17 149 lognormal	NO	98.66	100	0.00009	YES	1	NO	0.10395	NO	1E-04	YES	5	2	NO	NO	PCOC, 120,000 ug/L
Strontium	17 146 lognormal	1 YES	89.73	100	0	YES	0.104	NO	0.00023	YES	2E-08	YES	5	4	YES	YES	PCOC, 2,575 ug/L
Thallium	17 146 lognormal	1 NO	8.22	5.88	0.17048	NO	1	NO		n/a		n/a	3	0	NO	NO	
Tin	17 149 lognormal	NO	8.05	35.29	0	YES	0.102	NO		n/a		n/a	3	1	YES	YES	PCOC, 300 ug/L
Vanadium	17 149 lognormal	5 YES	71.14	76.47	0	YES	8E-05	YES		n/a		n/a	3	3	YES	YES	PCOC, 674 ug/L
Zinc	17 149 lognormal	6 YES	77.18	82.35	0	YES	9E-04	YES	0	YES		n/a	4	4	YES	YES	PCOC, 982 ug/L

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TABLE A-3: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN - GROUND WATER SAMPLES
(Rocky Flats OU5 Rf/Rf)

Metal, Dissolved	# of Samples Site	Distribution (norm or log)	UTL Comparison # > UTL > UTL?	% Detects, Background	Detects, Site	P GBHAN Significant?	P <= 0.05 Significant?	P SLIP Significant?	P <= 0.05 Significant?	P T Significant?	P <= 0.05 Significant?	# Tests	Number Signif. Tests	PROFESSIONAL JUDGMENT	
														istogra	Box Plot/Listing
Aluminum	14	248 lognormal	NO	68.15	21.43	0.9868	NO	1	NO	n/a	n/a	3	0	NO	NO
Antimony	14	248 lognormal	NO	28.23	7.14	0.26546	NO	1	NO	n/a	n/a	3	0	NO	NO
Arsenic	14	220 normal	NO	5	42.86	0	YES	1	NO	n/a	n/a	3	1	YES	NO
Barium	14	256 lognormal	6 YES	84.38	100	0	YES	0	YES	9E-06	YES	4	4	YES	YES
Beryllium	14	212 lognormal	NO	2.36	0	0.66718	NO	1	NO	n/a	n/a	3	0	NO	NO
Cadmium	14	240 lognormal	5 YES	13.33	0	0.7681	NO	1	NO	n/a	n/a	3	1	NO	NO
Calcium	14	257 normal	1 YES	100	100	0.00224	YES	1	NO	0.0009	YES	5	4	NO	NO
Cesium	14	212 lognormal	NO	8.96	7.14	0.79963	NO	1	NO	n/a	n/a	3	0	NO	NO
Chromium	14	250 lognormal	NO	24	0	0.95904	NO	1	NO	n/a	n/a	3	0	NO	NO
Cobalt	14	231 lognormal	NO	9.52	14.29	0.01449	YES	1	NO	n/a	n/a	3	1	NO	NO
Copper	14	250 lognormal	NO	28.4	0	0.95851	NO	1	NO	n/a	n/a	3	0	NO	NO
Iron	14	256 lognormal	8 YES	62.5	78.57	0	YES	0	YES	n/a	n/a	3	3	YES	YES
Lead	14	251 lognormal	NO	14.74	0	0.81773	NO	1	NO	n/a	n/a	3	0	NO	NO
Lithium	14	250 lognormal	NO	70.4	35.71	0.76711	NO	1	NO	n/a	n/a	3	0	NO	NO
Magnesium	14	254 normal	NO	96.06	100	0.00017	YES	1	NO	0.01005	YES	5	3	YES	NO
Manganese	14	256 lognormal	12 YES	60.16	92.86	0	YES	0	YES	n/a	n/a	4	4	YES	YES
Mercury	14	207 lognormal	NO	2.42	0	0.7217	NO	1	NO	n/a	n/a	3	0	NO	NO
Molybdenum	14	241 lognormal	NO	28.63	0	0.63224	NO	1	NO	n/a	n/a	3	0	NO	NO
Nickel	14	236 lognormal	NO	22.03	0	0.59992	NO	1	NO	n/a	n/a	3	0	NO	NO
Potassium	14	253 lognormal	NO	77.87	92.86	0.00001	YES	1	NO	n/a	n/a	3	1	YES	NO
Selenium	14	220 lognormal	NO	28.64	14.29	0.8459	NO	1	NO	n/a	n/a	3	0	NO	NO
Silver	14	236 lognormal	NO	19.92	0	0.83869	NO	1	NO	n/a	n/a	5	0	NO	NO
Sodium	14	255 normal	NO	98.82	100	0.01967	YES	1	NO	0.5591	YES	5	2	NO	NO
Strontium	14	253 normal	NO	92.89	100	0.00059	YES	1	NO	2E-06	YES	5	2	NO	NO
Thallium	14	214 lognormal	NO	5.14	0	0.59972	NO	1	NO	n/a	n/a	5	0	NO	NO
Tin	13	236 lognormal	NO	28.81	7.69	0.475	NO	1	NO	n/a	n/a	5	0	NO	NO
Vanadium	14	249 lognormal	NO	53.82	7.14	0.84831	NO	1	NO	n/a	n/a	5	0	NO	NO
Zinc	14	256 lognormal	NO	67.19	42.86	0.9902	NO	1	NO	n/a	n/a	5	0	NO	NO
Water Quality Parameters															
Nitrite	6	52 normal	NO	65.38	100	0.93113	NO	1	NO	n/a	n/a	3	0		
TOC	8	1 normal	NO	100	100	0.72101	NO	0.7778	NO	0.77778	NO	4	0		

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TABLE A-4: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN - SURFACE WATER SAMPLES

Radionuclides, Total	# of Samples	Site	Distribution (norm or log)	UTL Comparison (# > UTL)	% Detects	Background	Detects Site	P < 0.05				P < 0.05				P < 0.05 Significant	P T Significant	P < 0.05 Significant	# Tests	Number Signif. Tests	GRAPHICS		CONCLUSION AND MAXIMUM CONCENTRATION
								P GEHANI	P SLIP	P QUANT	P T	P SLIP	P QUANT	P T	istogra						Box Plot	Listing	
Americium-241	23	112	lognormal	3	YES	100	100	0.0044	YES	0.50718	NO	0.1	NO	0.1	NO	0.1	NO	5	3	YES	YES	PCOC, 0.38 pCi/L	
Plutonium-239/24	23	111	normal	1	YES	100	100	0.75172	NO	0.51511	NO	0.7	NO	0.7	NO	0.7	NO	5	1	NO	NO	PCOC, 0.03 pCi/L	
Uranium-233/234	26	84	lognormal	2	YES	100	100	0.00061	YES	0.46577	NO	0.2	NO	0.2	NO	0.2	NO	5	4	YES	YES	PCOC, 4.67 pCi/L	
Uranium-235	26	80	lognormal	NO	NO	100	100	0.00045	YES	0.00207	YES	0	YES	0	YES	0	YES	5	0	NO	NO	PCOC, 7 pCi/L	
Uranium-238	26	61	lognormal	2	YES	100	100	0.00054	YES	0.04456	YES	0.8	NO	0.8	NO	0.8	NO	5	2	NO	NO	PCOC, 7.6 pCi/L	
Alpha	26	91	lognormal	NO	NO	100	100	0.03009	YES	0.67644	NO	1	NO	1	NO	1	NO	5	0	NO	NO		
Beta	26	90	lognormal	NO	NO	100	100	0.8389	NO	0.5	NO	0.5	NO	0.5	NO	0.5	NO	4	0	NO	NO		
Radium-226	1	4	normal	NO	NO	100	100	0.51086	NO	1	NO	1	NO	1	NO	1	NO	5	0	NO	NO		
Strontium-89/90	18	81	normal	NO	NO	100	100	0.92136	NO	1	NO	1	NO	1	NO	1	NO	5	0	NO	NO		
Tritium	2	73	normal	NO	NO	100	100											5	0	NO	NO		
Radionuclides, Dissolved																							
Americium-241	24	28	lognormal	NO	NO	100	100	1	NO	1	NO	1	NO	1	NO	1	NO	5	0	NO	NO		
Plutonium-239/24	25	30	lognormal	NO	NO	100	100	1	NO	1	NO	1	NO	1	NO	1	NO	5	0	NO	NO		
Uranium-233/234	25	51	lognormal	NO	NO	100	100	0.00004	YES	0.00013	YES	0.5	NO	0.5	NO	0.5	NO	5	2	NO	NO	PCOC, 4.2 pCi/L	
Uranium-235	25	51	lognormal	NO	NO	100	100	0.99813	NO	0.99861	NO	1	NO	1	NO	1	NO	5	0	NO	NO		
Uranium-238	25	50	lognormal	1	YES	100	100	0.00073	YES	0.00005	YES	0.3	NO	0.3	NO	0.3	NO	5	3	NO	NO	PCOC, 7.5 pCi/L	
Alpha	25	55	lognormal	NO	NO	100	100	0.01667	YES	0.10028	NO	0.6	NO	0.6	NO	0.6	NO	5	1	NO	NO	PCOC, 8.3 pCi/L	
Beta	25	55	lognormal	NO	NO	100	100	0.41979	NO	0.93941	NO	0.8	NO	0.8	NO	0.8	NO	5	0	NO	NO		
Cesium-137	8	5	normal	NO	NO	100	100	0.97624	NO	1	NO	1	NO	1	NO	1	NO	5	0	NO	NO		
Radium-226	2	3	normal	NO	NO	100	100	0.5	NO	1	NO	0.5	NO	0.5	NO	0.5	NO	5	0	NO	NO		
Strontium-89/90	25	77	lognormal	NO	NO	100	100	0.96832	NO	0.99914	NO	0.9	NO	0.9	NO	0.9	NO	5	0	NO	NO		
Metals, Total																							
Aluminum	26	139	lognormal	NO	NO	76.26	96.15	0.99922	NO									3	0	NO	NO		
Antimony	27	119	normal	NO	NO	10.92	0	0.50973	NO									3	0	NO	NO		
Arsenic	27	110	lognormal	NO	NO	13.64	18.52	0.04248	YES									3	1	NO	NO	PCOC, 5.7 ug/L	
Barium	27	131	normal	NO	NO	85.5	100	0	YES									4	2	NO	YES	PCOC, 187 ug/L	
Beryllium	27	115	normal	NO	NO	7.83	0	0.53184	NO									3	0	NO	NO		
Cadmium	27	108	normal	NO	NO	2.78	0	0.51724	NO									3	0	NO	NO		
Calcium	27	153	normal	11	YES	100	100	0	YES	0.0031	YES	0	YES	0	YES	0	YES	5	5	YES	YES	PCOC, 80,700 ug/L	
Cesium	21	120	normal	NO	NO	8.33	23.81	0.80322	NO									3	0	NO	NO		
Chromium	27	120	normal	NO	NO	15.83	0	0.84458	NO									3	0	NO	NO		
Cobalt	27	116	normal	NO	NO	6.9	3.7	0.18268	NO									3	0	NO	NO		
Copper	27	121	lognormal	NO	NO	38.84	44.44	0.33311	NO									3	0	NO	NO		
Iron	27	157	lognormal	NO	NO	93.63	88.89	0.99922	NO									5	0	NO	NO		
Lead	27	131	lognormal	NO	NO	39.69	18.52	0.89233	NO									3	0	NO	NO		
Lithium	27	126	lognormal	NO	NO	46.83	92.59	0	YES									3	1	NO	NO	PCOC, 13.8 ug/L	
Magnesium	27	146	lognormal	NO	NO	91.78	100	0	YES	0.0035	YES	0	YES	0	YES	0	YES	5	4	YES	YES	PCOC, 23,000 ug/L	
Manganese	27	151	lognormal	NO	NO	91.39	100	0.97225	NO									5	0	NO	NO		
Mercury	27	122	normal	NO	NO	7.38	0	0.92772	NO									3	0	NO	NO		
Molybdenum	27	125	normal	NO	NO	9.6	0	0.52005	NO									3	0	NO	NO		
Nickel	27	120	normal	NO	NO	12.5	3.7	0.11658	NO									3	0	NO	NO		
Potassium	27	128	lognormal	NO	NO	72.66	100	0.44326	NO									3	0	NO	NO		
Selenium	27	120	normal	NO	NO	5.83	14.81	0.0025	YES									3	1	NO	NO	PCOC, 3.2 ug/L	
Silicon	27	67	normal	NO	NO	100	100	0.5333	NO									5	0	NO	NO		
Silver	27	116	normal	NO	NO	12.07	0	0.5149	NO									3	0	NO	NO		
Sodium	27	155	normal	1	YES	99.35	100	0.00454	YES									5	4	NO	NO	PCOC, 41,250 ug/L	
Strontium	27	135	normal	NO	NO	86.67	100	0	YES	0.02307	YES	0	YES	0	YES	0	YES	4	2	YES	YES	PCOC, 546 ug/L	
Thallium	27	124	normal	NO	NO	2.42	0	0.51831	NO									3	0	NO	NO		
Tin	27	118	normal	NO	NO	15.25	3.7	0.26729	NO									3	0	NO	NO		
Vanadium	27	120	normal	NO	NO	27.5	7.41	0.36268	NO									3	0	NO	NO		
Zinc	24	151	normal	NO	NO	68.87	54.17	0.89811	NO									3	0	NO	NO		

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TABLE A-4: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN – SURFACE WATER SAMPLES
(Rocky Flats OUS R5/R3)

Metal, Dissolved	# of Samples Site	Distribution (norm or log)	UTL Comparison # > UTL	% Detects, Background	Detects, Site	P <= 0.05		P <= 0.05		P <= 0.05		# Tests	Number Signif. Tests	PROFESSIONAL JUDGMENT	
						P	GHIAN Significant	P	SLIP Significant	P	T Significant			Significant?	CONCLUSION AND MAXIMUM CONCENTRATION
Aluminum	27	134 lognormal	NO	41.79	11.11	NO	0.94772	NO	1	NO	n/a	3	0	NO	NO
Antimony	27	97 normal	NO	20.62	0	NO	0.50587	NO	1	NO	n/a	3	0	NO	NO
Arsenic	27	94 normal	NO	4.26	11.11	YES	0.00343	YES	1	NO	n/a	3	1	NO	YES NO PCOC, 3.6 ug/L
Barium	27	146 normal	NO	71.23	100	YES	0	YES	1	NO	n/a	3	1	NO	YES NO PCOC, 160 ug/L
Beryllium	27	90 normal	NO	8.89	0	NO	0.66393	NO	1	NO	n/a	3	0	NO	NO
Cadmium	27	78 normal	NO	6.41	0	NO	0.54116	NO	1	NO	n/a	3	0	NO	NO
Calcium	27	154 normal	10	100	100	YES	0	YES	0	YES	0	5	4	YES	YES YES PCOC, 79,700 ug/L
Cesium	16	98 normal	NO	9.18	6.25	NO	0.35105	NO	1	NO	n/a	3	0	NO	YES NO PCOC, 80 ug/L
Chromium	27	90 normal	NO	10	0	NO	0.80944	NO	1	NO	n/a	3	0	NO	NO
Cobalt	27	87 normal	NO	3.45	0	NO	0.5	NO	1	NO	n/a	3	0	NO	NO
Copper	27	125 normal	NO	38.4	3.7	NO	0.52431	NO	1	NO	n/a	3	0	NO	NO
Iron	27	134 lognormal	1	70.13	37.04	NO	0.93213	NO	0.1492	NO	n/a	3	1	YES	NO YES PCOC, 3,180 ug/L
Lithium	27	119 lognormal	NO	22.12	3.7	NO	0.57409	NO	1	NO	n/a	3	1	NO	NO YES PCOC, 13.7 ug/L
Magnesium	27	151 lognormal	NO	43.7	100	YES	0	YES	0.0032	YES	0	5	4	YES	YES YES PCOC, 22,900 ug/L
Manganese	27	150 lognormal	NO	78	96.3	NO	0.58121	NO	1	NO	0.48362	4	0	NO	NO
Mercury	27	83 normal	NO	9.64	0	NO	0.95216	NO	1	NO	n/a	3	0	NO	NO
Molybdenum	27	93 normal	NO	15.05	0	NO	0.52413	NO	1	NO	n/a	3	0	NO	NO
Nickel	27	86 normal	NO	4.65	0	NO	0.50943	NO	1	NO	n/a	3	0	NO	NO
Potassium	27	126 lognormal	NO	69.05	100	NO	0.24163	NO	1	NO	n/a	3	0	NO	NO
Selenium	27	85 normal	NO	8.24	29.63	NO	0.00394	YES	1	NO	n/a	3	1	NO	NO YES PCOC, 2.8 ug/L
Silver	27	99 normal	1	99.35	100	YES	0.5108	NO	1	NO	0.02027	5	4	NO	NO YES PCOC, 43,200 ug/L
Sodium	27	153 normal	NO	81.29	100	YES	0	YES	1	NO	n/a	4	2	YES	YES YES PCOC, 537 ug/L
Strontium	27	139 normal	NO	2.04	0	NO	0.5	NO	1	NO	n/a	3	0	NO	NO
Thallium	27	98 normal	NO	16.35	0	NO	0.52284	NO	1	NO	n/a	3	0	NO	NO
Tin	27	104 normal	NO	13.08	0	NO	0.52079	NO	1	NO	n/a	3	0	NO	NO
Vanadium	27	107 normal	NO	61.43	33.33	NO	0.8074	NO	1	NO	n/a	3	0	NO	NO
Zinc	27	140 normal	NO	14.38	25.93	NO	0.0005	YES	0.15	NO	n/a	3	1	NO	YES YES PCOC, 44,000 ug/L
Water Quality Parameters	27	153 lognormal	2	94.04	100	YES	0.00001	YES	1	NO	0.00006	5	4	NO	YES YES PCOC, 63,000 ug/L
Carbonate Chloride	1	128 normal	NO	3.13	0	NO	0.57295	NO	1	NO	n/a	3	0	NO	NO
Cyanide	22	35 lognormal	1	100	100	YES	0.4241	NO	0.0526	NO	0.78546	5	1	YES	YES YES PCOC, 33,000 ug/L
DOC	27	100 normal	1	94	96.3	YES	0.00002	YES	1	NO	n/a	4	3	NO	YES YES PCOC, 700 ug/L
Fluoride	1	85 normal	NO	3.53	0	NO	0.52707	NO	1	NO	n/a	3	0	NO	NO
Nitrate/nitrite	1	152 normal	NO	57.24	0	NO	0.8481	NO	1	NO	n/a	3	0	NO	NO
Oil and Grease	1	105 normal	NO	25.71	0	NO	0.60828	NO	1	NO	n/a	3	0	NO	NO
Orthophosphate	1	95 normal	NO	16.84	100	YES	0.00022	YES	1	NO	n/a	3	1	NO	YES NO PCOC, 160 ug/L
Sulfate	27	151 normal	2	98.01	96.3	YES	0.00427	YES	1	NO	0.00163	5	4	YES	YES YES PCOC, 48,000 ug/L
Sulfide	1	78 normal	NO	7.69	0	NO	0.62097	NO	1	NO	n/a	3	0	NO	NO
TDS	27	152 normal	3	100	100	YES	0.00109	YES	1	NO	0.00032	5	4	NO	YES YES PCOC, 380,000 ug/L
TOC	26	49 lognormal	1	100	100	YES	0.98734	NO	0.3467	NO	0.84896	5	1	YES	YES YES PCOC, 41,000 ug/L
TSS	27	159 lognormal	NO	58.49	29.63	NO	0.99892	NO	1	NO	0.95541	4	0	NO	NO

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TABLE A-5: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN -- SEEP WATER SAMPLES
(Rocky Flats OUS REF/RED)

	# of Samples	Distribution (norm or log)	UTL Comparison # > UTL	% Detects/Background	Detects Site	P <= 0.05 Significant	Gilbert Methodology Statistics			P <= 0.05 Significant	P <= 0.05 Significant	P <= 0.05 Significant	# Tests	PROFESSIONAL JUDGMENT	
							P SLIP	P QUANT	P T					Significant?	CONCLUSION AND MAXIMUM CONCENTRATION
Radionuclides, Total															
Americium-241	1	37 normal	NO	100	100	NO	1	NO	1	NO	n/a	4	NO		
Plutonium-239/24	1	33 normal	NO	100	100	NO	1	NO	1	NO	n/a	4	NO		
Radionuclides, Dissolved															
Uranium-233/234	3	13 normal	NO	100	100	NO	0.3187	NO	0.60714	NO	0	YES	5	YES	POOC, 12 pCi/L
Uranium-235	3	12 normal	NO	100	100	NO	0.5577	NO	0.63736	NO	0	YES	5	YES	POOC, 0.34 pCi/L
Uranium-238	3	13 normal	NO	100	100	NO	0.4732	NO	0.60714	NO	0	YES	5	YES	POOC, 8.3 pCi/L
Alpha	3	13 normal	NO	100	100	NO	0.2295	NO	0.70536	NO	0	YES	5	YES	POOC, 25 pCi/L
Beta	3	14 normal	NO	100	100	NO	0.6473	NO	0.57941	NO	0	YES	5	NO	POOC, 11 pCi/L
Radium-226	1	2 normal	NO	100	100	NO	0.5	NO	1	NO	n/a	4	NO		
Strontium-89/90	1	19 normal	NO	100	100	NO	0.1686	NO	1	NO	n/a	4	NO		
Metals, Total															
Aluminum	1	48 normal	NO	89.58	0	NO	0.9113	NO	1	NO	n/a	4	NO		
Antimony	1	34 normal	NO	17.65	0	NO	0.6155	NO	1	NO	n/a	3	NO		
Arsenic	1	44 normal	NO	52.27	0	NO	0.7508	NO	1	NO	n/a	4	NO		
Barium	1	44 normal	NO	81.82	100	NO	0.6886	NO	1	NO	n/a	4	NO		
Beryllium	1	38 normal	NO	21.05	0	NO	0.6204	NO	1	NO	n/a	3	NO		
Cadmium	1	33 normal	NO	21.21	0	NO	0.6751	NO	1	NO	n/a	3	NO		
Calcium	1	53 normal	NO	100	100	NO	0.9256	NO	1	NO	n/a	4	NO		
Cesium	1	33 normal	NO	15.15	0	NO	0.5636	NO	1	NO	n/a	3	NO		
Chromium	1	40 normal	NO	32.5	0	NO	0.7496	NO	1	NO	n/a	3	NO		
Cobalt	1	35 normal	NO	22.86	0	NO	0.6475	NO	1	NO	n/a	3	NO		
Copper	1	44 normal	NO	47.73	100	NO	0.5	NO	1	NO	n/a	4	NO		
Iron	1	51 normal	NO	96.08	100	NO	0.9031	NO	1	NO	n/a	4	NO		
Lead	1	45 normal	NO	66.67	0	NO	0.8098	NO	1	NO	n/a	4	NO		
Lithium	1	35 normal	NO	57.14	0	NO	0.535	NO	1	NO	n/a	3	NO		
Magnesium	1	50 normal	NO	86.27	100	NO	0.6586	NO	1	NO	n/a	4	NO		
Manganese	1	51 normal	NO	86.27	100	NO	0.4598	NO	1	NO	n/a	4	NO		
Mercury	1	33 normal	NO	9.09	0	NO	0.6232	NO	1	NO	n/a	3	NO		
Molybdenum	1	33 normal	NO	24.24	0	NO	0.5442	NO	1	NO	n/a	3	NO		
Nickel	1	35 normal	NO	25.71	0	NO	0.6561	NO	1	NO	n/a	3	NO		
Potassium	1	41 normal	NO	56.1	0	NO	0.7014	NO	1	NO	n/a	3	NO		
Selenium	1	36 normal	NO	16.67	0	NO	0.56	NO	1	NO	n/a	3	NO		
Silicon	1	11 normal	NO	100	100	NO	0.9038	NO	1	NO	n/a	4	NO		
Silver	1	32 normal	NO	18.75	0	NO	0.6411	NO	1	NO	n/a	3	NO		
Sodium	1	53 normal	NO	100	100	NO	0.2711	NO	1	NO	n/a	4	NO		
Strontium	1	42 normal	NO	73.81	100	NO	0.7699	NO	1	NO	n/a	3	NO		
Thallium	1	39 normal	NO	2.56	0	NO	0.5	NO	1	NO	n/a	3	NO		
Tin	1	35 normal	NO	28.57	0	NO	0.6089	NO	1	NO	n/a	3	NO		
Vanadium	1	41 normal	NO	48.78	0	NO	0.7428	NO	1	NO	n/a	3	NO		
Zinc	1	50 normal	NO	80	0	NO	0.8541	NO	1	NO	n/a	4	NO		

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TABLE A-5: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN -- SEEP WATER SAMPLES
(Rocky Flats OJ5 RF/RJ)

Water Quality Parameters	# of Samples Site	Distribution (norm or log)	UTL Comparison # > UTL	% Detects Background	Detects Site	Gilbert Methodology Statistics				P <= 0.05 Significant	Number Signif. Tests	PROFESSIONAL JUDGMENT				
						GEHA	P SLIP	P QUANT	P T						Significant?	CONCLUSION AND MAXIMUM CONCENTRATION
Carbonate	1	55 normal	NO	18.18	0	0.5991	NO	1	NO	n/a	n/a	n/a	3	0	NO	
Chloride	1	53 normal	NO	96.23	100	0.0577	NO	1	NO	0.25926	NO	NO	4	0	NO	
Fluoride	1	18 normal	NO	88.89	100	0.9355	NO	1	NO	1	NO	NO	4	0	NO	
Nitrate/nitrite	1	53 normal	NO	60.38	100	0.17	NO	1	NO	n/a	n/a	n/a	3	0	NO	
Orthophosphate	1	18 normal	NO	16.67	100	0.0026	YES	1	NO	n/a	n/a	n/a	3	1	NO	PCOC, 70 ug/L
Sulfate	1	53 normal	NO	90.57	100	0.5268	NO	1	NO	n/a	n/a	n/a	3	0	NO	
TDS	1	53 normal	NO	98.11	100	0.8163	NO	1	NO	1	NO	NO	4	0	NO	
TOC	1	7 normal	NO	100	0	0.9367	NO	1	NO	1	NO	NO	4	0	NO	
TSS	1	54 normal	NO	83.33	100	0.5	NO	1	NO	1	NO	n/a	4	0	NO	

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TABLE A-6: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN - POND SEDIMENTS VERSUS BACKGROUND SEEP SEDIMENTS SAMPLES
(Rocky Flats OUS RFR/R)

Radionuclides, Total	# of Samples Site	Distribution (norm or lo ckgmd)	UTL Comparison # > UTL	% Detects, Background	Detects, Site	GBHA	P <= 0.05 Significant?	Gilbert Methodology Statistics			P <= 0.05 Significant?	P T	P <= 0.05 Significant?	# Tests	Number Signif. Tests	PROFESSIONAL JUDGEMENT	
								P SLIP	QUAN	Signific						Signific?	Box Plot
Americium-241	9	14 normal	NO	100	100	0.004	YES	1	NO	0.283	NO	0.256	NO	5	1	NO	PCOC, 0.42 PCJ/G
Plutonium-239/24	9	16 normal	NO	93.75	100	0.002	YES	1	NO	0.002	NO	0.155	NO	5	1	NO	PCOC, 2.4 PCJ/G
Uranium-233/234	6	16 normal	2 YES	100	100	3E-04	YES	2E-04	YES	2E-04	YES	3E-04	YES	5	5	YES	PCOC, 3.5 PCJ/G
Uranium-235	6	17 normal	NO	100	100	0.006	YES	1	NO	0.089	NO	0.017	YES	5	2	NO	PCOC, 0.14 PCJ/G
Uranium-238	6	14 normal	1 YES	100	100	0.001	YES	0.018	YES	0.061	NO	0.001	YES	5	4	YES	PCOC, 3 PCJ/G
Alpha	9	15 normal	NO	100	100	5E-04	YES	0.13	NO	0.004	YES	9E-05	YES	5	3	YES	PCOC, 59 PCJ/G
Beta	9	14 normal	1 YES	100	100	5E-04	YES	0.014	YES	0.056	NO	8E-05	YES	5	4	YES	PCOC, 46 PCJ/G
Tritium	9	13 normal	NO	100	100	0.332	NO	1	NO	0.707	NO	0.47	NO	5	0	NO	
Metals, Total																	
Aluminum	6	20 normal	NO	100	100	0.404	NO	1	NO	0.832	NO	0.442	NO	5	0	NO	
Antimony	4	18 normal	NO	5.56	0	0.5	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	
Arsenic	6	20 normal	NO	95	100	0.561	NO	1	NO	1	NO	0.816	NO	5	0	NO	
Barium	6	20 normal	NO	100	100	0.404	NO	1	NO	0.832	NO	0.525	NO	5	0	NO	
Beryllium	5	16 normal	NO	43.75	80	0.057	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	
Cadmium	4	16 normal	NO	18.75	0	0.593	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	
Calcium	6	20 normal	NO	100	100	0.428	NO	1	NO	0.428	NO	0.453	NO	5	0	NO	
Chromium	6	18 normal	NO	94.44	100	0.076	NO	1	NO	n/a	n/a	0.099	NO	4	0	NO	
Cobalt	6	19 normal	NO	68.42	100	0.076	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	
Copper	6	19 normal	NO	73.68	100	0.124	NO	1	NO	0.781	NO	0.475	NO	4	0	NO	
Iron	6	19 normal	NO	100	100	0.223	NO	1	NO	1	NO	0.475	NO	5	0	NO	
Lead	6	19 normal	NO	100	100	0.822	NO	1	NO	1	NO	0.897	NO	5	0	NO	
Lithium	6	18 normal	NO	61.11	100	0.227	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	
Magnesium	6	20 normal	NO	90	100	0.084	NO	1	NO	0.112	NO	0.116	NO	5	0	NO	
Manganese	6	20 normal	NO	100	100	0.064	NO	1	NO	0.428	NO	0.04	YES	5	1	NO	PCOC, 602 MG/KG
Mercury	6	15 normal	3 YES	0	100	1E-05	YES	0.071	NO	n/a	n/a	n/a	n/a	3	2	YES	PCOC, 1.6 MG/KG
Molybdenum	4	19 normal	NO	42.11	0	0.5	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	
Nickel	6	17 normal	NO	64.71	100	0.072	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	
Potassium	6	18 normal	NO	61.11	100	0.004	YES	0.25	NO	n/a	n/a	n/a	n/a	3	1	YES	PCOC, 2,850 MG/KG
Selenium	4	19 normal	NO	57.89	50	0.48	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	
Silver	4	15 normal	NO	20	0	0.687	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	
Sodium	6	20 normal	NO	55	100	0.943	NO	1	NO	n/a	n/a	0.775	NO	3	0	NO	
Strontium	6	20 normal	NO	80	100	0.544	NO	1	NO	n/a	n/a	n/a	n/a	4	0	NO	
Thallium	4	13 normal	NO	7.69	0	n/a	n/a	1	NO	n/a	n/a	n/a	n/a	2	0	NO	
Tin	6	19 normal	NO	42.11	0	0.5	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	
Tungsten	6	19 normal	NO	89.47	100	0.201	NO	1	NO	0.781	NO	0.302	NO	5	0	NO	
Vanadium	6	20 normal	2 YES	90	100	0.009	YES	0.046	YES	0.013	YES	0.023	YES	5	5	YES	PCOC, 201 MG/KG
Zinc	6	20 normal															
Water Quality Parameters																	
Nitrate/nitrite	6	18 normal	NO	50	100	0.976	NO	1	NO	n/a	n/a	n/a	n/a	3	0	NO	

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TABLE A-4: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN - POND SEDIMENTS VERSUS BACKGROUND STREAM SEDIMENTS SAMPLES
(Rocky Flats OUS RTR/R)

Contaminant	# of Samples Site	Distribution (norm or lo)	Comparison # > UTL > UTL?	% Detects, Background	Detects, Site	GEHA	P < 0.05 Significant?	Gilbert Methodology Statistics		P < 0.05 Significance	P < 0.05 Significance	P < 0.05 Significance	Number Signif Tests	GRAPHICS Significant? Box Plot Listing	PROFESSIONAL JUDGEMENT CONCLUSION AND MAXIMUM CONCENTRATION
								P SLIP	QUAN						
Radionuclides, Total															
Americium-241	9	37 normal	NO	100	100	0.001	YES	1	NO	0.087	NO	0.43	5	NO	PCOC, 0.42 PCI/G
Plutonium-239/24	9	45 normal	NO	97.78	100	2E-04	YES	1	NO	0.012	YES	0.051	5	NO	PCOC, 2.4 PCI/G
Uranium-233/234	6	47 normal	NO	100	100	0.106	NO	1	NO	0.364	NO	0.022	5	NO	PCOC, 3.5 PCI/G
Uranium-235	6	49 normal	NO	100	100	0.054	NO	1	NO	0.087	NO	0.075	5	NO	PCOC, 3 PCI/G
Uranium-238	6	36 normal	NO	100	100	0.082	NO	1	NO	0.382	NO	0.023	5	NO	PCOC, 59 PCI/G
Alpha	9	45 normal	NO	100	100	0.001	YES	1	NO	0.261	NO	0	5	NO	
Beta	9	43 normal	NO	100	100	0.39	NO	1	NO	0.905	NO	0.433	5	NO	
Tritium	9	42 normal	NO	92.86	100	0.153	NO	1	NO	0.087	NO	0.411	5	NO	
Metals, Total															
Aluminum	6	59 normal	NO	100	100	0.008	YES	1	NO	0.069	NO	0.001	5	NO	PCOC, 15,500 MG/KG
Antimony	4	52 normal	NO	11.54	0	0.602	NO	1	NO	n/a	n/a	n/a	3	NO	
Arsenic	6	59 normal	NO	89.83	100	7E-04	YES	1	NO	0.012	YES	0.001	5	NO	PCOC, 9.8 MG/KG
Barium	6	57 normal	1	100	100	0.001	YES	0.095	NO	0.014	YES	4E-04	5	YES	PCOC, 262 MG/KG
Beryllium	5	57 normal	NO	47.37	80	0.019	YES	1	NO	n/a	n/a	n/a	3	NO	PCOC, 1 MG/KG
Cadmium	4	51 normal	NO	11.76	0	0.55	NO	1	NO	n/a	n/a	n/a	3	NO	
Calcium	6	59 normal	2	98.31	100	3E-04	YES	0.007	YES	8E-04	YES	6E-04	5	YES	PCOC, 47,700 MG/KG
Chromium	6	59 normal	NO	79.66	100	0.011	YES	1	NO	n/a	n/a	n/a	3	NO	PCOC, 19.6 MG/KG
Cobalt	6	59 normal	1	72.88	100	0.002	YES	1	NO	n/a	n/a	n/a	3	NO	PCOC, 12.3 MG/KG
Copper	6	59 normal	NO	72.88	100	7E-04	YES	1	NO	n/a	n/a	n/a	3	NO	PCOC, 35.9 MG/KG
Iron	6	59 normal	NO	100	100	0.003	YES	1	NO	0.012	YES	7E-04	5	NO	PCOC, 23,500 MG/KG
Lead	6	59 normal	NO	100	100	0.024	YES	1	NO	0.344	NO	0.003	5	NO	PCOC, 34.6 MG/KG
Lithium	6	57 normal	NO	71.93	100	0.007	YES	1	NO	0.012	YES	0.002	5	NO	PCOC, 4.490 MG/KG
Magnesium	6	59 normal	NO	91.53	100	0.003	YES	1	NO	0.012	YES	0.001	5	NO	PCOC, 602 MG/KG
Manganese	6	59 normal	NO	98.31	100	0.011	YES	1	NO	0.089	NO	0.01	5	NO	PCOC, 1.6 MG/KG
Mercury	6	49 normal	6	4.08	100	0	YES	0	YES	n/a	n/a	n/a	3	YES	All non-detects
Molybdenum	4	58 normal	4	27.59	0	0.5	NO	1	NO	n/a	n/a	n/a	3	NO	
Nickel	6	57 normal	NO	68.42	100	0.001	YES	1	NO	n/a	n/a	n/a	3	NO	PCOC, 19.1 MG/KG
Potassium	6	58 normal	NO	74.14	100	1E-04	YES	1	NO	n/a	n/a	n/a	3	NO	PCOC, 2,850 MG/KG
Selenium	4	58 normal	NO	22.41	50	0.018	YES	1	NO	n/a	n/a	n/a	3	NO	PCOC, 1.5 MG/KG
Silver	4	54 normal	NO	3.7	0	0.821	NO	1	NO	n/a	n/a	n/a	3	NO	
Sodium	6	59 normal	NO	79.66	100	0.955	NO	1	NO	n/a	n/a	n/a	3	NO	
Strontium	6	58 normal	NO	82.76	100	3E-04	YES	1	NO	n/a	n/a	0.002	4	NO	PCOC, 167 MG/KG
Thallium	4	50 normal	NO	4	0	0.5	NO	1	NO	n/a	n/a	n/a	3	NO	
Tin	6	55 normal	NO	29.09	0	0.5	NO	1	NO	n/a	n/a	n/a	3	NO	
Vanadium	6	57 normal	NO	92.98	100	0.01	YES	1	NO	0.014	YES	0.005	5	NO	PCOC, 40.9 MG/KG
Zinc	6	59 normal	NO	94.92	100	0.002	YES	1	NO	0.012	YES	0.004	5	NO	PCOC, 201 MG/KG
Water Quality Parameters															
Nitrate/nitrite	6	52 normal	NO	65.38	100	0.938	NO	1	NO	n/a	n/a	n/a	3	NO	
TOC	6	1 normal	NO	100	100	0.609	NO	0.857	NO	n/a	n/a	n/a	3	NO	

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TABLE A-6: POTENTIAL CONTAMINANTS OF CONCERN -- POND SEDIMENTS (Rocky Flats OUS RFR/R)	
	MAXIMUM CONCENTRATION
Radionuclides, Total	
Americium-241	PCOC, 0.42 PCU/G, STREAM & SHEEPS
Plutonium-239/240	PCOC, 2.4 PCU/G, STREAM & SHEEPS
Uranium-233/234	PCOC, 3.5 PCU/G, STREAM & SHEEPS
Uranium-235	PCOC, 0.14 PCU/G, SHEEPS
Uranium-238	PCOC, 3 PCU/G, STREAM & SHEEPS
Alpha	PCOC, 59 PCU/G, STREAM & SHEEPS
Beta	PCOC, 46 PCU/G, SHEEPS
Metals, Total	
Aluminum	PCOC, 15,500 MG/KG, STREAM
Arsenic	PCOC, 9.8 MG/KG, STREAM
Barium	PCOC, 262 MG/KG, STREAM
Beryllium	PCOC, 1 MG/KG, STREAM
Calcium	PCOC, 47,700 MG/KG, STREAM
Chromium	PCOC, 19.6 MG/KG, STREAM
Cobalt	PCOC, 12.3 MG/KG, STREAM
Copper	PCOC, 35.9 MG/KG, STREAM
Iron	PCOC, 23,500 MG/KG, STREAM
Lead	PCOC, 34.6 MG/KG, STREAM
Lithium	PCOC, 15.7 MG/KG, STREAM
Magnesium	PCOC, 4,490 MG/KG, STREAM
Manganese	PCOC, 602 MG/KG, STREAM & SHEEPS
Mercury	PCOC, 1.6 MG/KG, STREAM & SHEEPS
Molybdenum	All non-detects
Nickel	PCOC, 19.1 MG/KG, STREAM
Potassium	PCOC, 2,850 MG/KG, STREAM & SHEEPS
Selenium	PCOC, 1.5 MG/KG, STREAM
Strontium	PCOC, 167 MG/KG, STREAM
Vanadium	PCOC, 40.9 MG/KG, STREAM
Zinc	PCOC, 201 MG/KG, STREAM & SHEEPS

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TABLE A-7: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN - SEEP SEDIMENT SAMPLES
(Rocky Flats OUS RE/RL)

# of Samples Site	Distribution (norm or log)	UTL Comparison # > UTL / # > UTL?	% Detects Background	Detects Site	GEHA				P SLP				P QUANT				P T				P <= 0.05 Significant				Number Signif. Tests		GRAPHICS Significant? Box Plot Listing		PROFESSIONAL JUDGMENT CONCLUSION AND MAXIMUM CONCENTRATION				
					P <= 0.05 Significant	P <= 0.05 Significant	P <= 0.05 Significant	P <= 0.05 Significant	P <= 0.05 Significant	P <= 0.05 Significant																							
Radionuclides, Total																																	
4	14 normal	NO	NO	4	14	0.1695	NO	1	NO	0.67288	NO	0.9027	NO	5	0	NO	NO	NO	NO	NO													
4	16 normal	NO	NO	4	16	0.1846	NO	1	NO	0.9001	NO	0.9001	NO	5	0	NO	NO	NO	NO	NO	NO												
4	16 normal	NO	NO	4	16	0.0445	YES	0.0316	YES	0.01342	YES	0.0278	YES	5	4	YES	YES	YES	YES	YES	PCOC, 2 pCi/g												
4	17 lognormal	NO	NO	4	17	0.0365	YES	1	NO	0.02757	YES	0.0707	NO	5	2	YES	YES	YES	YES	YES	PCOC, 0.21 pCi/g												
4	14 normal	1	YES	4	14	0.0111	YES	0.0392	YES	0.01863	YES	0.0165	YES	5	5	YES	YES	YES	YES	YES	PCOC, 3.7 pCi/g												
4	15 lognormal	NO	NO	4	15	0.2419	NO	1	NO	0.29902	NO	0.0647	NO	5	0	NO	NO	NO	NO	NO	NO												
4	14 normal	NO	NO	4	14	0.0554	NO	1	NO	0.02	YES	0.02	YES	5	1	NO	NO	NO	NO	NO	NO	PCOC, 30 pCi/g											
4	13 lognormal	NO	NO	4	13	0.8938	NO	1	NO	0.9147	NO	0.9147	NO	5	0	NO	NO	NO	NO	NO	NO	NO											

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TABLE A-7: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN - SEEP SEDIMENT SAMPLES
(Rocky Flats OUS REF/R)

Metals, Total	# of Samples	Site	edgmd	Distribution	UTL Comparison	% Detects, Background	Detects, Site	P <= 0.05		P <= 0.05		P T	# Tests	Signif. Tests	PROFESSIONAL JUDGMENT		
								GEHA Significant	P SLP	Significant	QUANT/Significant				Significant?	Box Plot/Listing	CONCLUSION AND MAXIMUM CONCENTRATION
Aluminum	4		20	normal	NO	100	100	NO	0.5919	NO	0.627	5	0	NO	NO		
Antimony	4		18	normal	4 YES	5.56	100	0	YES	0.0001	0.0001	3	3	YES	YES	PCOC, 51.3 mg/kg	
Arsenic	4		20	normal	NO	95	100	0.5	NO	NO	0.7489	5	0	NO	NO		
Barium	4		20	normal	NO	100	100	0.9186	NO	NO	0.9686	5	0	NO	NO		
Beryllium	4		16	normal	NO	43.75	100	0.0002	YES	NO		3	1	NO	NO	PCOC, 1.7 mg/kg	
Cadmium	4		16	lognormal	NO	18.75	75	0.2373	NO	NO		3	0	NO	NO		
Calcium	4		20	normal	NO	100	100	0.8924	NO	NO	0.952	5	0	NO	NO		
Cesium	4		17	normal	NO	5.88	0	0.5	NO	NO		3	0	NO	NO		
Chromium	4		18	normal	NO	94.44	100	0.0747	NO	NO	0.0929	4	0	NO	NO		
Cobalt	4		19	normal	NO	68.42	100	0.2168	NO	NO		3	0	NO	NO		
Copper	4		19	normal	NO	73.68	100	0.3936	NO	NO		4	0	NO	NO		
Iron	4		19	normal	NO	100	100	0.1652	NO	NO	0.3878	5	0	NO	NO		
Lead	4		19	normal	NO	100	100	0.5	NO	NO	0.4516	5	0	NO	NO		
Lithium	4		18	normal	NO	61.11	100	0.3907	NO	NO		3	0	NO	NO		
Magnesium	4		20	lognormal	NO	90	100	0.3443	NO	NO	0.2176	5	0	NO	NO	Not normal distribution.	
Manganese	4		20	lognormal	NO	100	100	0.094	NO	NO	0.0486	5	1	NO	NO	PCOC, 0.06 mg/kg	
Mercury	4		15	lognormal	NO	0	25	0.0457	YES	NO		3	1	NO	NO	PCOC, 25 mg/kg	
Molybdenum	4		19	normal	NO	42.11	0	0.5	NO	NO		3	0	NO	NO	PCOC, 3.110 mg/kg	
Nickel	4		17	lognormal	NO	64.71	100	0.0076	YES	NO		3	1	NO	NO		
Potassium	4		18	lognormal	NO	61.11	100	0.0028	YES	0.1818		3	1	NO	NO		
Selenium	2		19	normal	NO	57.89	0	0.8041	NO	NO		3	0	NO	NO		
Silver	4		15	normal	NO	20	50	0.0986	NO	NO		3	0	NO	NO		
Sodium	4		20	normal	NO	55	100	0.572	NO	NO		3	0	NO	NO		
Strontium	4		20	normal	NO	80	100	0.8211	NO	NO	0.9714	4	0	NO	NO		
Thallium	4		13	normal	NO	7.69	100	0.0358	YES	NO		3	1	NO	NO	PCOC, 0.28 mg/kg	
Tin	4		19	normal	NO	42.11	50	0.6779	NO	NO		3	0	NO	NO		
Vanadium	4		19	normal	NO	89.47	100	0.0951	NO	NO	0.108	5	0	NO	NO		
Zinc	4		20	lognormal	1 YES	90	100	0.0214	YES	0.0217	0.0811	NO	5	3	YES	YES	PCOC, 1.050 mg/kg

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TABLE A-7: SELECTION OF POTENTIAL CONTAMINANTS OF CONCERN - SEEP SEDIMENT SAMPLES
(Rocky Flats OUS RI/RI)

# of Samples Site	Distribution (norm or log)	UTL Comparison # > UTL	% Detects Background	Detects Site	GEHA Significant	P SLIP Significant	P SLIP Significant	Gilbert Methodology Statistics		P <= 0.05 Significant	P <= 0.05 Significant	# Tests	P T Significant	# Tests	Number Signif. Tests	PROFESSIONAL JUDGMENT	
								P <= 0.05 Significant	P <= 0.05 Significant							GRAPHICS Significant?	CONCLUSION AND MAXIMUM CONCENTRATION
Water Quality Parameters Nitrate/nitrite	18 lognormal	NO	50	100	0.9468	NO	1	NO	n/a	n/a	3	0	NO	NO	NO	NO	

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TABLE A-9: Potential Contaminants of Concern -- Surface Soil Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Radionuclides, Total			
Americium-241	106	100	0.8 pCi/g
Plutonium-239/240	108	100	5.01 pCi/g
Uranium-233/234	112	100	2,800 pCi/g
Uranium-235	110	100	670 pCi/g
Uranium-238	112	100	38,000 pCi/g
Alpha	81	100	113.49 pCi/g
Beta	81	100	304.55 pCi/g
Metals, Total			
Antimony	83	2.41	49.8 mg/kg
Cadmium	84	27.38	4.1 mg/kg
Calcium	91	100	21,300 mg/kg
Cobalt	91	82.42	13.7 mg/kg
Copper	91	98.9	184 mg/kg
Lead	91	100	129 mg/kg
Mercury	91	42.86	0.66 mg/kg
Silver	80	6.25	94.3 mg/kg
Zinc	91	100	199 mg/kg
Water Quality Parameters			
Specific Cond.	72	100	355 ug/kg
TOC	90	100	35,000 ug/kg
Semi-Volatile Organic Compounds			
2-Methylnaphthalene	34	17.6	12,000 (ug/kg)
4,4'-DDT	74	1.4	21 (ug/kg)
Acenaphthene	60	33.3	44,000 (ug/kg)
Acenaphthylene	46	2.2	600 (ug/kg)
Aldrin	74	1.4	17 (ug/kg)
Anthracene	67	32.8	47,000 (ug/kg)
Aroclor-1254	74	12.2	3,900 (ug/kg)
Benzo(a)anthracene	53	52.8	45,000 (ug/kg)
Benzo(a)pyrene	57	38.6	41,000 (ug/kg)
Benzo(b)fluoranthene	58	41.4	49,000 (ug/kg)
Benzo(ghi)perylene	50	28	6,900 (ug/kg)
Benzo(k)fluoranthene	47	38.3	25,000 (ug/kg)
Benzoic Acid	29	55.2	770 (ug/kg)
Bis(2-ethylhexyl)phthalate	48	33.3	200 (ug/kg)

TABLE A-9: Potential Contaminants of Concern -- Surface Soil Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Semi-Volatile Organic Compounds (continued)			
Butyl Benzyl Phthalate		32	3.1 220 (ug/kg)
Chrysene	68	42.6	46,000 (ug/kg)
Di-n-butyl Phthalate	41	22	424.5 (ug/kg)
Di-n-octyl Phthalate	33	3	83 (ug/kg)
Dibenzo(a,h)anthracene	43	16.3	7,000 (ug/kg)
Dibenzofuran	40	27.5	20,000 (ug/kg)
Dieldrin	74	1.4	34 (ug/kg)
Endosulfan Sulfate	74	1.4	24 (ug/kg)
Endrin Ketone	74	1.4	36 (ug/kg)
Fluoranthene	69	56.5	140,000 (ug/kg)
Fluorene	63	28.6	39,000 (ug/kg)
Heptachlor Epoxide	74	1.4	10 (ug/kg)
Indeno(1,2,3-cd)pyrene	54	37	32,000 (ug/kg)
Isophorone	33	3	96 (ug/kg)
Methoxychlor	74	1.4	450 (ug/kg)
Naphthalene	57	17.5	41,000 (ug/kg)
Phenanthrene	77	46.8	170,000 (ug/kg)
Pyrene	73	52.1	120,000 (ug/kg)

TABLE A-10: Potential Contaminants of Concern -- Subsurface Soil Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Radionuclides, Total			
Americium-241	249	100	0.61 pCi/g
Plutonium-239/240	231	100	3.2 pCi/g
Uranium-233/234	244	100	126 pCi/g
Uranium-235	245	100	37.6 pCi/g
Uranium-238	245	100	1,160 pCi/g
Alpha	221	100	742 pCi/g
Beta	222	100	1,580 pCi/g
Metals, Total			
Antimony	223	12.11	149 mg/kg
Arsenic	239	99.58	18.9 mg/kg
Barium	239	100	683 mg/kg
Beryllium	239	69.46	131 mg/kg
Cadmium	239	11.3	56.9 mg/kg
Calcium	239	99.58	35,000 mg/kg
Chromium	239	99.58	8,310 mg/kg
Cobalt	239	96.65	67.6 mg/kg
Copper	239	98.74	6,920 mg/kg
Iron	239	100	107,000 mg/kg
Lead	239	100	935 mg/kg
Manganese	239	100	1,540 mg/kg
Molybdenum	238	8.4	190 mg/kg
Nickel	239	95.4	4,750 mg/kg
Potassium	239	88.7	7,040 mg/kg
Silver	203	14.29	311 mg/kg
Sodium	239	94.14	3,220 mg/kg
Strontium	239	100	148 mg/kg
Thallium	238	29.41	0.55 mg/kg
Zinc	239	100	2,390 mg/kg
Semi-Volatile Organic Compounds			
2-Methylnaphthalene	82	14.6	15,000 (ug/kg)
Acenaphthene	80	23.8	31,000 (ug/kg)
Acenaphthylene	82	2.4	84 (ug/kg)
Anthracene	82	23.2	46,000 (ug/kg)
Aroclor-1254	76	11.8	960 (ug/kg)
Aroclor-1260	77	3.9	1,300 (ug/kg)
Alpha-BHC	77	1.3	15 (ug/kg)

TABLE A-10: Potential Contaminants of Concern -- Subsurface Soil Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Semi-Volatile Organic Compounds (continued)			
Benzo(a)anthracene	82	26.8	48,000 (ug/kg)
Benzo(a)pyrene	82	25.6	43,000 (ug/kg)
Benzo(b)fluoranthene	82	26.8	48,000 (ug/kg)
Benzo(ghi)perylene	82	23.2	19,000 (ug/kg)
Benzo(k)fluoranthene	82	24.4	19,000 (ug/kg)
Benzoic Acid	80	21.3	974 (ug/kg)
Bis(2-Ethylhexyl)phthalate	82	15.9	290 (ug/kg)
Butyl Benzyl Phthalate	82	2.4	360 (ug/kg)
Chrysene	82	26.8	53,000 (ug/kg)
Di-n-butyl Phthalate	82	2.4	300 (ug/kg)
Dibenzo(a,h)anthracene	82	14.6	700 (ug/kg)
Dibenzofuran	82	17.1	20,000 (ug/kg)
Fluoranthene	82	30.5	160,000 (ug/kg)
Fluorene	82	23.2	35,000 (ug/kg)
Heptachlor Epoxide	77	1.3	11 (ug/kg)
Indeno(1,2,3-cd)pyrene	81	21	22,000 (ug/kg)
Isophorone	82	1.2	82 (ug/kg)
Naphthalene	82	15.9	61,000 (ug/kg)
Pentachlorophenol	82	1.2	160 (ug/kg)
Phenanthrene	82	31.7	220,000 (ug/kg)
Phenol	82	4.9	140 (ug/kg)
Pyrene	82	31.7	150,000 (ug/kg)
Volatile Organic Compounds			
1,1,1-Trichloroethane	193	0.5	2 (ug/kg)
2-Butanone	157	5.1	69 (ug/kg)
4-Methyl-2-Pentanone	194	0.5	2 (ug/kg)
Acetone	181	9.9	280 (ug/kg)
Ethylbenzene	195	0.5	66 (ug/kg)
Methylene Chloride	195	14.4	66 (ug/kg)
Tetrachloroethene	195	13.3	920 (ug/kg)
Toluene	194	45.4	310 (ug/kg)
Total Xylenes	195	0.5	150 (ug/kg)
Trichloroethene	195	11.3	440 (ug/kg)

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TABLE A-11: Potential Contaminants of Concern -- Groundwater Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Radionuclides, Total			
Americium-241	15	100	0.2 pCi/L
Plutonium-238	2	100	0.01 pCi/L
Plutonium-239/240	15	100	1.04 pCi/L
Uranium-233/234	14	100	49 pCi/L
Uranium-235	14	100	4 pCi/L
Uranium-238	14	100	44 pCi/L
Alpha	14	100	1,600 pCi/L
Beta	14	100	1,300 pCi/L
Radium-226	14	100	4.4 pCi/L
Strontium-89/90	8	100	1.5 pCi/L
Radionuclides, Dissolved			
Uranium-235	19	100	0.53 pCi/L
Uranium-238	19	100	8.8 pCi/L
Alpha	19	100	27 pCi/L
Beta	19	100	230 pCi/L
Cesium-137	2	100	0.08 pCi/L
Radium-226	7	100	1.03 pCi/L
Strontium-89/90	12	100	1.83 pCi/L
Metals, Total			
Aluminum	17	88.24	357,000 ug/L
Antimony	16	12.5	40.8 ug/L
Arsenic	17	64.71	13.3 ug/L
Barium	17	100	3,040 ug/L
Beryllium	17	64.71	29.4 ug/L
Cadmium	17	17.65	8.2 ug/L
Calcium	17	100	413,000 ug/L
Chromium	17	70.59	442 ug/L
Cobalt	17	70.59	161 ug/L
Copper	17	82.35	420 ug/L
Iron	17	88.24	418,000 ug/L
Lead	17	88.24	240 ug/L
Lithium	17	82.35	306 ug/L
Magnesium	17	100	113,000 ug/L
Manganese	17	100	13,700 ug/L
Mercury	17	29.41	3 ug/L
Molybdenum	17	17.65	18 ug/L

TABLE A-11: Potential Contaminants of Concern -- Groundwater Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Metals, Total (continued)			
Nickel	17	82.35	313 ug/L
Potassium	17	82.35	49,700 ug/L
Selenium	16	25	126 ug/L
Silicon	17	100	354,000 ug/L
Silver	17	23.53	53.2 ug/L
Sodium	17	100	120,000 ug/L
Strontium	17	100	2,575 ug/L
Tin	17	35.29	300 ug/L
Vanadium	17	76.47	674 ug/L
Zinc	17	82.35	982 ug/L
Metals, Dissolved			
Arsenic	14	42.86	8.05 ug/L
Barium	14	100	647 ug/L
Calcium	14	100	156,000 ug/L
Cesium	14	7.14	14 ug/L
Cobalt	14	14.29	11.1 ug/L
Iron	14	78.57	349,000 ug/L
Magnesium	14	100	22,200 ug/L
Manganese	14	92.86	10,500 ug/L
Potassium	14	92.86	6,110 ug/L
Sodium	14	100	44,000 ug/L
Strontium	14	100	754 ug/L
Semi-Volatile Organic Compounds			
Acenaphthene	15	20	5 (ug/l)
Bis(2-ethylhexyl)phthalate	15	20	3 (ug/l)
Di-n-butyl Phthalate	15	6.7	2 (ug/l)
Diethyl Phthalate	15	6.7	6 (ug/l)
Fluoranthene	15	20	4 (ug/l)
Fluorene	15	20	4 (ug/l)
Naphthalene	17	11.8	13 (ug/l)
Phenanthrene	15	20	6 (ug/l)
Pyrene	15	20	6.5 (ug/l)
Volatile Organic Compounds			
Methylene chloride	21	4.8	6 (ug/l)

TABLE A-12: Potential Contaminants of Concern -- Surface Water Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Radionuclides, Total			
Americium-241	23	100	0.38 pCi/L
Plutonium-239/240	23	100	0.03 pCi/L
Uranium-233/234	26	100	4.67 pCi/L
Uranium-238	26	100	7 pCi/L
Alpha	26	100	7.6 pCi/L
Radionuclides, Dissolved			
Uranium-233/234	25	100	4.2 pCi/L
Uranium-238	25	100	7.5 pCi/L
Alpha	25	100	8.3 pCi/L
Metals, Total			
Arsenic	27	18.52	5.7 ug/L
Barium	27	100	187 ug/L
Calcium	27	100	80,700 ug/L
Lithium	27	92.59	13.8 ug/L
Magnesium	27	100	23,000 ug/L
Selenium	27	14.81	3.2 ug/L
Sodium	27	100	41,250 ug/L
Strontium	27	100	546 ug/L
Metals, Dissolved			
Arsenic	27	11.11	3.6 ug/L
Barium	27	100	160 ug/L
Calcium	27	100	79,700 ug/L
Cesium	16	6.25	80 ug/L
Iron	27	37.04	3,180 ug/L
Lithium	27	88.89	13.7 ug/L
Magnesium	27	100	22,900 ug/L
Selenium	27	29.63	2.8 ug/L
Sodium	27	100	43,200 ug/L
Strontium	27	100	537 ug/L

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TABLE A-12: Potential Contaminants of Concern -- Surface Water Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Water Quality Parameters			
Carbonate	27	25.93	44,000 ug/L
Chloride	27	100	63,000 ug/L
DOC	22	100	33,000 ug/L
Fluoride	27	96.3	700 ug/L
Orthophosphate	1	100	160 ug/L
Sulfate	27	96.3	47,000 ug/L
TDS	27	100	380,000 ug/L
TOC	26	100	41,000 ug/L
Semi-Volatile Organic Compounds			
Benzoic Acid	27	3.7	28 (ug/l)
Pentachlorophenol	27	3.7	5 (ug/l)
Volatile Organic Compounds			
Methylene Chloride	28	3.6	3.5 (ug/l)

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TABLE A-13: Potential Contaminants of Concern -- Seep Water Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Radionuclides, Dissolved			
Uranium-233/234	3	100	12 pCi/L
Uranium-235	3	100	0.34 pCi/L
Uranium-238	3	100	8.3 pCi/L
Alpha	3	100	25 pCi/L
Beta	3	100	11 pCi/L
Water Quality Parameters			
Orthophosphate	1	100	70 ug/L
Volatile Organic Compounds			
1,1,1-Trichloroethane	4	25	2 (ug/l)
1,1-Dichloroethene	4	25	4 (ug/l)
1,2-Dichloroethene	4	25	4 (ug/l)
Acetone	1	100	65 (ug/l)
Tetrachloroethene	4	25	28 (ug/l)
Trichloroethene	4	25	7 (ug/l)

TABLE A-14: Potential Organic Contaminants of Concern -- Pond Sediment Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Radionuclides, Total			
Americium-241	9	100	0.42 PCI/G
Plutonium-239/240	9	100	2.4 PCI/G
Uranium-233/234	6	100	3.5 PCI/G
Uranium-235	6	100	0.14 PCI/G
Uranium-238	6	100	3 PCI/G
Alpha	9	100	59 PCI/G
Beta	9	100	46 PCI/G
Metals, Total			
Aluminum	6	100	15,500 MG/KG
Arsenic	6	100	9.8 MG/KG
Barium	6	100	262 MG/KG
Beryllium	5	80	1 MG/KG
Calcium	6	100	47,700 MG/KG
Chromium	6	100	19.6 MG/KG
Cobalt	6	100	12.3 MG/KG
Copper	6	100	35.9 MG/KG
Iron	6	100	23,500 MG/KG
Lead	6	100	34.6 MG/KG
Lithium	6	100	15.7 MG/KG
Magnesium	6	100	4,490 MG/KG
Manganese	6	100	602 MG/KG
Mercury	6	100	1.6 MG/KG
Nickel	6	100	19.1 MG/KG
Potassium	6	100	2,850 MG/KG
Selenium	4	50	1.5 MG/KG
Strontium	6	100	167 MG/KG
Vanadium	6	100	40.9 MG/KG
Zinc	6	100	201 MG/KG
Semi-Volatile Organic Compounds			
Benzoic Acid	5	80	410 (ug/kg)
Di-n-butyl Phthalate	4	25	110 (ug/kg)
Fluoranthene	4	25	140 (ug/kg)
Phenol	4	25	150 (ug/kg)
Volatile Organic Compounds			
Toluene	6	100	562.5 (ug/kg)

TABLE A-15: Potential Contaminants of Concern -- Seep Sediment Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Radionuclides, Total			
Uranium-233/234	4	16	2 pCi/g
Uranium-235	4	17	0.13 pCi/g
Uranium-238	4	14	3.7 pCi/g
Beta	4	14	30 pCi/g
Metals, Total			
Antimony	4	100	51.3 mg/kg
Beryllium	4	100	1.7 mg/kg
Mercury	4	25	0.06 mg/kg
Nickel	4	100	25 mg/kg
Potassium	4	100	3,110 mg/kg
Thallium	4	100	0.28 mg/kg
Zinc	4	100	1,050 mg/kg
Semi-Volatile Organic Compounds			
Benzo(a)anthracene	4	25	38 (ug/kg)
Bis(2-ethylhexyl)phthalate	4	50	80 (ug/kg)
Chrysene	4	25	41 (ug/kg)
Fluoranthene	4	50	97 (ug/kg)
Phenanthrene	4	50	82 (ug/kg)
Pyrene	4	50	97 (ug/kg)
Volatile Organic Compounds			
Acetone	7	42.9	17 (ug/kg)
Methylene Chloride	4	75	5 (ug/kg)
Tetrachloroethene	7	14.3	1 (ug/kg)

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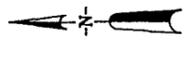
TABLE A-16: Potential Contaminants of Concern -- Stream Sediment Samples

<u>Constituent</u>	<u>Number of Samples</u>	<u>Percent Detect.</u>	<u>Maximum Concentration</u>
Radionuclides, Total			
Americium-241	7	100	0.29 pCi/g
Plutonium-239/240	8	100	1.6 pCi/g
Tritium	8	100	3,900 pCi/g
Metals, Total			
Arsenic	8	100	5.5 mg/kg
Cadmium	8	50	2.8 mg/kg
Copper	8	50	135.5 mg/kg
Mercury	8	12.5	3.05 mg/kg
Selenium	7	57.14	1.1 mg/kg
Silver	8	12.5	7.7 mg/kg
Zinc	8	100	709 mg/kg
Water Quality Parameters			
TOC	8	100	27,500 ug/kg

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MAP LEGEND

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- SURFACE WATER IMPOUNDMENTS
- BUILDINGS
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES (APPROXIMATE LOCATION)



SCALE: 1" = 1000'

Drawn	Date
Checked	Date
Approved EG&G	Date
Approved DDE	Date

WOMAN CREEK PRIORITY DRAINAGE AREA (OPERABLE UNIT No. 5)

CHEMICALS OF CONCERN (COC)™

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ROCKY FLATS, GOLDEN, COLORADO



FIGURE 1-1

