

# **NOTICE**

**All drawings located at the end of the document.**

**DRAFT**

**PROPOSED SUBSURFACE  
INTERIM MEASURES/  
INTERIM REMEDIAL ACTION PLAN/  
ENVIRONMENTAL ASSESSMENT  
AND DECISION DOCUMENT**

**OPERABLE UNIT NO. 2**

**U.S. DEPARTMENT OF ENERGY**

**Rocky Flats Plant  
Golden, Colorado**

**ENVIRONMENTAL RESTORATION PROGRAM**

**02 March 1992**

**Volume I - Text**

**ADMIN RECORD**

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By F. J. CUNYAN *(Signature)*  
Date 2-27-92

**PROPOSED SUBSURFACE INTERIM MEASURES/INTERIM REMEDIAL ACTION  
PLAN/ENVIRONMENTAL ASSESSMENT AND DECISION DOCUMENT**

**OPERABLE UNIT NO. 2**

**VOLUME I**

U.S. Department of Energy  
Rocky Flats Plant  
Golden, Colorado

02 MARCH 1992

**DRAFT**

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## EXECUTIVE SUMMARY

The subject Interim Measures/Interim Remedial Action Plan/ Environmental Assessment (IM/IRAP/EA) addresses residual free-phase volatile organic compound (VOC) contamination suspected in the subsurface within an area identified as Operable Unit No. 2 (OU2). This IM/IRAP/EA also addresses radionuclide contamination beneath the 903 Pad at OU2. Although subsurface VOC and radionuclide contamination represent a source of OU2 ground-water contamination, they pose no immediate threat to public health or the environment. This is because the extent of the contaminated ground-water plume is contained well within the plant boundary, and its rate of migration is not expected to result in off-site contamination before final remediation of OU2 is implemented.

IM/IRAs are typically used as a vehicle for contaminant migration abatement and/or risk reduction. However, using the IM/IRA to gain site-specific remedial information to support final action is also justifiable. For example, the U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response (OSWER) Directive guidance for ground-water remedial actions states (EPA, 1989a): "Response measures may be implemented to prevent further migration of contaminants if they will prevent the situation from getting worse, initiate risk reduction, and/or the operation of such a system would provide information useful to the design of the final remedy."

This IM/IRAP/EA identifies and evaluates interim remedial actions for removal of residual free-phase VOC contamination from three different subsurface environments at OU2 and presents an assessment of the No Action Alternative. This IM/IRAP/EA also considers an interim remedial action for the removal of radionuclides from beneath the 903 Pad. The decision to pursue such an action will be based on the results of treatability studies examining radionuclide removal technologies, currently being conducted by the U.S. Department of Energy (DOE). Each of the proposed VOC-removal actions involve *in situ* vacuum-enhanced vapor extraction technology. The remedial actions are proposed not for reasons of mitigating an immediate threat, but rather, for the collection of information that will aid in the selection and design of final remedial actions that address subsurface, residual free-phase VOC contamination at OU2. Also, the IM/IRA takes advantage of the benefit

afforded by a small-scale, early remedial action at a site where the uncertainties associated with subsurface remediation are great. The purpose is in agreement with a recent recommendation by the EPA OSWER with respect to subsurface remediation (EPA, 1989a): "The major recommendation is to orient our thinking so that we initiate early action on a small scale, while gathering more detailed data prior to committing to full-scale restoration." This guidance also advocates that a proposed action provide system flexibility so that it may be modified to better achieve clean-up goals based on information gained during its operation. To achieve this operational flexibility, the proposed vacuum-enhanced vapor extraction systems are initially subjected to *in situ* pilot testing. Based on information collected during the pilot study phase of the IM/IRA, a determination as to the benefit of continued operation of the vapor extraction and treatment systems (modified as necessary) at OU2 will be made. The Plan discusses general criteria that will be used to conclude pilot testing and to assess the benefit of post-pilot operation.

As noted above, the primary purpose of the proposed early, small-scale *in situ* vapor extraction actions is to collect information that will aid in the selection and design of final remedies for OU2. Project success will, therefore, be gauged by the usefulness of the data collected with respect to final remedial design, not by the degree of cleanup achieved. However, the anticipated removal of subsurface free-phase VOCs during pilot and post-pilot operation of the vapor extraction systems provides an additional benefit of the proposed Subsurface IM/IRA. No matter how small the scale, removal of free-phase VOCs from the OU2 subsurface represents a positive environmental impact.

The Subsurface IM/IRA/EA has been prepared in accordance with EPA OSWER guidance advocating the use of Observational/Streamlined Approach methodology for managing uncertainties associated with subsurface restoration. In developing the proposed actions, reasonably conceivable deviations in site conditions at OU2 have been identified, and contingency plans have been developed to manage any associated impacts.

The IM/IRA/EA first provides project and Observational/Streamlined Approach background information. This information is followed by a description of the general extent of contamination within OU2 and the specific environmental issues associated with

subsurface VOC contamination. The IM/IRAP subsequently presents *in situ* vacuum-enhanced vapor extraction actions to be pilot tested in each of the three primary OU2 Areas: 903 Pad, Mound, and East Trenches. Each of the proposed actions are critiqued with respect to their expected effectiveness, implementability, and environmental impact.

The subsurface actions proposed at the 903 Pad and East Trenches areas are expected to involve dewatering to allow induced vapor flows to contact any free-phase VOC contamination in soils currently beneath the water table. Dewatering may also be required at the Mound Area. The IM/IRAP includes the use of the South Walnut Creek Basin Surface Water Treatment Facility to treat contaminated ground water recovered during the pilot testing phase. The IM/IRAP also provides brief descriptions of other existing or planned Rocky Flats Plant (RFP) water treatment facilities that may potentially be used during post-pilot IM/IRA operation in the event that the South Walnut Creek Basin facility becomes capacity limited.

After presentation and evaluation of the proposed actions, the IM/IRAP provides a detailed assessment of the No Action Alternative followed by an analysis of the cumulative environmental impacts resulting from all previously approved RFP IM/IRAs and the proposed Subsurface IM/IRA at OU2.

The IM/IRAP/EA concludes with a discussion of the plan for implementing the proposed subsurface actions. Implementation includes the preparation of a Pilot Test Plan for each of the proposed actions. The Test Plans will include all of the detailed design, installation, operation, and test procedures necessary to execute the pilot tests. A Pilot Test Report will also be prepared at the conclusion of all three pilot tests. The report will present an evaluation of test data and offer recommendations concerning post-pilot operation of an *in situ* vacuum-enhanced vapor extraction system at each of the three OU2 IM/IRA sites.

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### GLOSSARY OF ACRONYMS

Am	Americium
ARA	Applicable or Relevant and Appropriate Requirement
AS	Analytical Sampling Location
AT	Analytical Transmitter
BH	Borehole
CAA	Clean Air Act
CCl <sub>4</sub>	Carbon Tetrachloride
CDH	Colorado Department of Health
CEARP	Comprehensive Environmental Assessment and Response Program
CEDE	Committed Effective Dose Equivalent
CEQ	Council of Environmental Quality
CERCLA	Comprehensive Environmental Resource, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
CMS	Corrective Measures Study
COE	U.S. Army Corps of Engineers
CWA	Clean Water Act
d/m/g	disintegrations per minute per gram
DNAPL	Dense Non-Aqueous Phase Liquid
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DOO	Data Quality Objective
DRCOG	Denver Regional Council of Governments
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration (Program)
ERHSPP	Environmental Restoration Health and Safety Program Plan
ESA	Endangered Species Act
FFACO	Federal Facility Agreement and Consent Order
FI	Flow Indicator
FR	Federal Register
FS	Feasibility Study
ft/ft	feet per foot
GAC	Granular Activated Carbon
HA	High Alarm
HEPA	High Efficiency Air Particulate
HI	Hazard Index
HS	Health and Safety (Department)
LAG	Inter-Agency Agreement
IHSS	Individual Hazardous Substance Site
IM/IRAP	Interim Measures/Interim Remedial Action Plan

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### GLOSSARY OF ACRONYMS (continued)

LI	Level Indicator
mg/ℓ	milligrams per liter
mrem	milli radiation equivalent man
NCP	National Contingency Plan
NEPA	National Environmental Policy Act of 1969
NPDES	National Pollutant Discharge Elimination System
1,1,1-TCA	1,1,1-Trichloroethane
OSA	Operational Safety Analysis
OSWER	Office of Solid Waste and Emergency Response
OU2	Operable Unit No. 2
PA	Protected Area
PCE	Tetrachloroethene
pCi/g	picocurie per gram
pCi/ℓ	picocurie per liter
PI	Pressure Indicator
PPCD	Plan for Prevention of Contaminant Dispersion
PSHSP	Project Specific Health and Safety Plan
Pu	Plutonium
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act of 1986
rem	radiation equivalent man
RFI	RCRA Facility Investigation
RFP	Rocky Flats Plant
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act of 1986
SID	South Interceptor Ditch
SOP	Standard Operating Procedure
TCE	Tricholoroethene
TCLP	Toxicity Characteristic Leaching Procedure
TI	Temperature Indicator
U	Uranium
USC	United States Code
USFWS	U.S. Fish and Wildlife Coordination Act
UV	Ultra-violet
VOC	Volatile Organic Compound
μg/ℓ	micrograms per liter

## SECTION 1 INTRODUCTION

The subject Interim Measures/Interim Remedial Action Plan/ Environmental Assessment (IM/IRAP/EA) addresses residual free-phase volatile organic compound (VOC) contamination suspected in the subsurface within an area identified as Operable Unit No. 2 (OU2). This IM/IRAP/EA also addresses radionuclide contamination beneath the 903 Pad at OU2. Although subsurface VOC and radionuclide contamination represent a source of OU2 ground-water contamination, they pose no immediate threat to public health or the environment because the extent of the contaminated ground-water plume is contained well within the plant boundary, and its rate of migration is not expected to result in off-site contamination before final remediation of OU2 is implemented (EG&G, 1990c).

IM/IRAs are typically used as a vehicle for contaminant migration abatement and/or risk reduction. However, use of the IM/IRA to gain site-specific remedial information to support final action is also justifiable. For example, the U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response (OSWER) Directive guidance for ground-water remedial actions states (EPA, 1989a): "Response measures may be implemented to prevent further migration of contaminants if they will prevent the situation from getting worse, initiate risk reduction, and/or the operation of such a system would provide information useful to the design of the final remedy."

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As noted above, the primary purpose of the proposed early, small-scale *in situ* vapor extraction actions is to collect information that will aid in the selection and design of final remedies for OU2. Project success will, therefore, be gauged by the usefulness of the data collected with respect to final remedial design, not by the degree of cleanup achieved. However, the anticipated removal of subsurface free-phase VOCs during pilot and post-pilot operation of the vapor extraction systems provides an additional benefit of the proposed Subsurface IM/IRA. No matter how small the scale, removal of free-phase VOCs from the OU2 subsurface represents a positive environmental impact.

OU2 is defined in the final Federal Facility Agreement and Consent Order (FFACO) (DOE, 1991a), commonly known as the Inter-Agency Agreement (IAG), and is comprised of 20 Individual Hazardous Substance Sites (IHSS) that are known in aggregate as the 903 Pad, Mound, and East Trenches Areas.

This IM/IRAP/EA is an integrated Comprehensive Environmental Response, Compensation and Liability Act/Resource Conservation and Recovery Act/National Environmental Policy Act (CERCLA/RCRA/NEPA) document. Documentation prepared pursuant to CERCLA

is integrated with NEPA in accordance with DOE Order 5400.4. The document has been prepared to conform with the National Contingency Plan (NCP) (FR Vol. 55, No. 46, 8813; 40 CFR 300.415[b][4]) and to the NEPA of 1969, as implemented by regulations promulgated by the President's Council on Environmental Quality (CEQ) (40 CFR 1500-1508), and DOE Guidelines (52 FR 47622-47670, December 15, 1987). This IM/IRAP/EA is also based on EPA OSWER Directive No. 9355.3-03, which emphasizes the benefits of early, small-scale remedial actions to collect critical site information that would otherwise not be available to remedial action planners and designers. The Subsurface IM/IRAP/EA is also prepared in accordance with EPA OSWER Directive 9355.3-06, which advocates the use of Observational/Streamlined Approach methodology for managing uncertainties associated with subsurface restoration.

### 1.1 PROJECT BACKGROUND

In March 1987, a Phase I Remedial Investigation (RI) under the Environmental Restoration (ER) Program (formerly known as the Comprehensive Environmental Assessment and Response Program [CEARP]) began at OU2. The investigation consisted of: the preparation of detailed topographic maps, radiometric and organic vapor screening surveys, surface geophysical surveys, a soil gas survey, a boring and well completion program, soil sampling, and surface and ground-water sampling. Phase I field activities were completed at OU2 during 1987, and a draft RI report was submitted to the EPA and the Colorado Department of Health (CDH) on December 31, 1987 (Rockwell International, 1987a). Phase I data did not allow adequate definition of the nature and extent of contamination for the purpose of conducting a baseline risk assessment and a feasibility study of remedial alternatives pertaining to contaminated media.

A draft Phase II RI Work Plan that presents the details and rationale for further field work to achieve these objectives was submitted to the regulatory agencies in June 1988 (Rockwell International, 1988c). This draft Work Plan was subsequently revised and submitted as a final Phase II RCRA Facility Investigation/Remedial Investigation Feasibility Study (RFI/RIFS) Work Plan in April 1990 (EG&G, 1990c). The plan was approved by EPA in May 1990. The Work Plan specifies for boreholes to be drilled into waste sources to

characterize any waste materials remaining in place, and to assess the maximum contaminant concentrations in soils directly beneath the sites. In addition, ground-water monitor wells will be installed adjacent to some of the boreholes to characterize ground-water quality directly beneath the sites. Additional alluvial monitoring wells will be installed to further characterize and monitor ground-water flow and quality in alluvial materials at OU2. Field work for installation of the alluvial monitoring wells began in October 1991 and is expected to be completed in the Spring of 1992. Bedrock monitoring wells will be completed in subcropping Arapahoe sandstone where it is encountered.

A draft IM/IRAP for contaminated ground water at OU2 was submitted in December 1989 (Rockwell International, 1989b). The plan was prepared based on limited knowledge of the nature and extent of ground-water contamination. Regulatory agency review of the document determined that, although an IM/IRA for ground water is required by the 1989 Agreement in Principle between DOE and CDH, insufficient information existed on the nature and extent of ground-water contamination to pursue effective ground-water remediation at that time. In order to facilitate early evaluation of the need for an IM/IRA for ground water at OU2, the final Phase II RFI/RIFS Work Plan incorporates a phased investigation approach. The phased approach is to investigate alluvial and hydraulically connected bedrock migration pathways first, and then to subsequently investigate ground-water contaminant sources. This will allow planning, design, and implementation of a ground-water IM/IRA, if necessary, before completion of the RFI/RI and Corrective Measures Study/Feasibility Study (CMS/FS) for OU2.

In February and March 1990, representatives from DOE, EPA, and CDH met to discuss surface water IM/IRAs at the Rocky Flats Plant (RFP) site. The result of these meetings was a series of agreements, with the concurrence of all parties, to implement an IM/IRA for the cleanup of contaminated surface water in OU2. On 26 September 1990, the DOE released for public comment a proposed Surface Water IM/IRA Plan and Decision Document for OU2. In this Plan, specific point source locations in the South Walnut Creek and Woman Creek drainage basins were proposed for collection of surface water. According to the Plan, surface water collected in each basin was to be transferred to a treatment facility discharging to the South Walnut Creek drainage. Effluent would

ultimately flow to Pond B-5, where water is monitored, treated as necessary, and discharged in accordance with the RFP's National Pollutant Discharge Elimination System (NPDES). Comments on the IM/IRAP received during the public comment period, however, revealed strong opposition to the transfer of contaminated seep water from the Woman Creek drainage to the South Walnut Creek drainage. Opposition was based on the absence of a proven performance record for the proposed IM/IRA treatment facility with respect to radionuclide removal and the potential for treatment process upsets. Opposition to the Plan was also based on the use of Indiana Street (located outside of the RFP boundary) to transport Woman Creek Basin seep water to the treatment facility by truck. In addition, the public voiced strong concern over potential worker and public health risks resulting from construction activities in the Woman Creek Basin (i.e., atmospheric resuspension of radionuclide-contaminated dust). In light of these concerns, the DOE and regulatory agencies agreed to address collection and treatment of South Walnut Creek and Woman Creek Basin contaminated surface water in two separate IM/IRAPs.

A final South Walnut Creek Basin Surface Water IM/IRAP was submitted in March 1991 (EG&G, 1991f), and was approved by the regulatory agencies shortly thereafter. The Plan included removal of radionuclides and metals from surface water by chemical precipitation and microfiltration, followed by removal of VOCs by granular activated carbon (GAC) adsorption. Installation and startup of the GAC adsorption units occurred in May 1991. Installation and startup of the chemical precipitation/microfiltration units are currently scheduled for the Spring of 1992.

Prior to preparation of a Woman Creek Basin Surface Water IM/IRAP, EPA mandated that bench-scale treatability studies of various treatment technologies be conducted in the Spring of 1991 to provide performance data for radionuclide removal. However, seep flows were insufficient for collection of an adequate volume with sufficient levels of radionuclides for conduct of these studies, and it was agreed that the Woman Creek Basin IM/IRAP/EA would be prepared in the absence of such studies to avoid project delays.

A draft Woman Creek Basin Surface Water IM/IRAP/EA was submitted on 02 October 1991 (EG&G, 1991g). This IM/IRAP/EA presents a detailed evaluation of the human

health risks and environmental impacts associated with the contaminated Woman Creek Basin surface seeps. Results of the evaluation indicated that the contaminated seeps present no immediate threat to public health or the environment. The IM/IRAP/EA thus presented the No Action Alternative as the preferred alternative. Meetings between DOE, EPA, and CDH were held subsequent to submission of the IM/IRAP/EA to discuss alternative IM/IRAs that could be conducted at OU2 in lieu of the originally conceived Woman Creek Basin surface water action. The result of these discussions was an agreement that a better use of resources was to pursue an IM/IRA that addresses suspected free-phase VOC contamination in the subsurface at one or more OU2 areas. It was further agreed that since subsurface VOC contamination at OU2 does not pose an immediate threat to public health and the environment, the IM/IRA should primarily be used to gain information that will aid in selection and design of final remedial actions at OU2.

## 1.2 OBSERVATIONAL/STREAMLINED APPROACH

OSWER Directive No. 9355.3-06 (EPA, 1989b) provides guidance for streamlining RI/FS activities to reduce the cost and time required for planning and implementing site cleanups. Streamlining is based on the Observational Method, which has been used for decades in the geotechnical engineering field when dealing with uncertainties associated with subsurface work. The "Observational/Streamlined Approach" has been used to plan the Subsurface IM/IRA at OU2. The fundamentals of the Observational/Streamlined Approach are discussed in this section along with the benefits of applying this approach to the restoration of hazardous waste sites.

The Observational/Streamlined Approach is based on the fundamental tenet that it is not always possible to fully characterize the subsurface. In recent years, incomplete characterization of hazardous waste sites has delayed design and implementation of remedial actions, and has thus resulted in higher than expected costs. Observational methods aid in the streamlining of clean-up activities by emphasizing "data sufficiency" rather than "data completeness." Planners and designers should ask the question, "Is the site sufficiently characterized to develop a cost-effective and technically defensible remedial action?" By

using the four-step process discussed below when developing a remedial action, this questions is answered.

The first step is to explicitly state the expected or probable conditions at the site based on all available data. Expected conditions pertain to subsurface geology, nature of contamination, water table behavior, etc. The expected site conditions, together with the remedial action objectives, are used to formulate the proposed remedial action.

Steps 2 and 3 require identification of reasonable deviations or uncertainties in the expected conditions and development of mechanisms for their resolution, respectively. Uncertainties in subsurface hydraulic communication, for example, may be resolved by conducting a tracer study prior to placement of ground-water recovery wells.

The final step in the Observational/Streamlined Approach planning involves development of contingency plans that address the potential deviations. Contingency planning may involve relocation of contaminant recovery systems, modification of treatment system configuration, use of alternative disposal methods for treatment system residuals, criteria to continue or cease system operation, etc. Modification of the proposed action based on Observational/Streamlined Approach contingency planning results in a technically superior and more cost effective remedial action than would otherwise be achieved.

Although the Subsurface IM/IRA is investigatory in nature, implementation of the pilot-scale systems discussed herein is based on limited site characterization data, and an Observational/Streamlined Approach to conduct this study is necessary. Utilizing this approach will maximize the quality and quantity of information that is gathered for subsequent remedial design of full-scale systems for final remediation. This IM/IRA may also indicate that the technologies tested are either ineffective or not cost-effective for final remediation. This information is equally valuable by allowing these technologies to be dropped from further consideration in the FS process, and thus foregoing possible costly implementation of ineffective full-scale systems.

### 1.3 IM/IRAP ORGANIZATION

Section 2 of this IM/IRAP provides RFP site characterization information, focusing on site characterization information for the 903 Pad, Mound, and East Trenches Areas at OU2. The discussion also describes the potentially affected environment associated with the IM/IRA and the results of previous investigations at OU2. The information included in Section 2 has been derived from the draft RI report and final Phase II RFI/RIFS Work Plan.

Section 3 identifies the objectives of the Subsurface IM/IRA at OU2. Applicable or Relevant and Appropriate Requirements (ARAR) and applicable environmental regulations pertinent to remediation of subsurface VOC contamination are also presented in this section.

Section 4 presents the proposed remedial actions to be implemented at each of the OU2 Areas: 903 Pad, Mound, and East Trenches. The proposed actions address removal of expected free-phase VOC contamination from the subsurface and are conceptually designed to provide information that will aid in the selection and design of final remedial actions at OU2. The proposed actions are critically evaluated based on CERCLA effectiveness and implementability and NEPA environmental impact criteria. Section 4 also presents an environmental assessment of the No Action Alternative.

Section 5 presents the plan for implementing the Subsurface IM/IRA at OU2. Implementation includes the preparation of a Pilot Test Plan for each of the proposed actions, and a Pilot Test Report at the conclusion of pilot testing. The purpose and content of the Test Plans and Test Report is discussed.

Section 6 provides a list of sources referenced in this IM/IRAP/EA.

Volume II of this IM/IRAP/EA contains ground-water, soils, and surface water quality data. Volume II also includes a tabulation of ARARs pertinent to the proposed Subsurface IM/IRA, and includes details of the transportation analysis performed for this Plan.

## SECTION 2

### SITE CHARACTERIZATION

This section describes the RFP and surrounding environs, and provides details on site hydrology, geohydrology, and contamination at OU2.

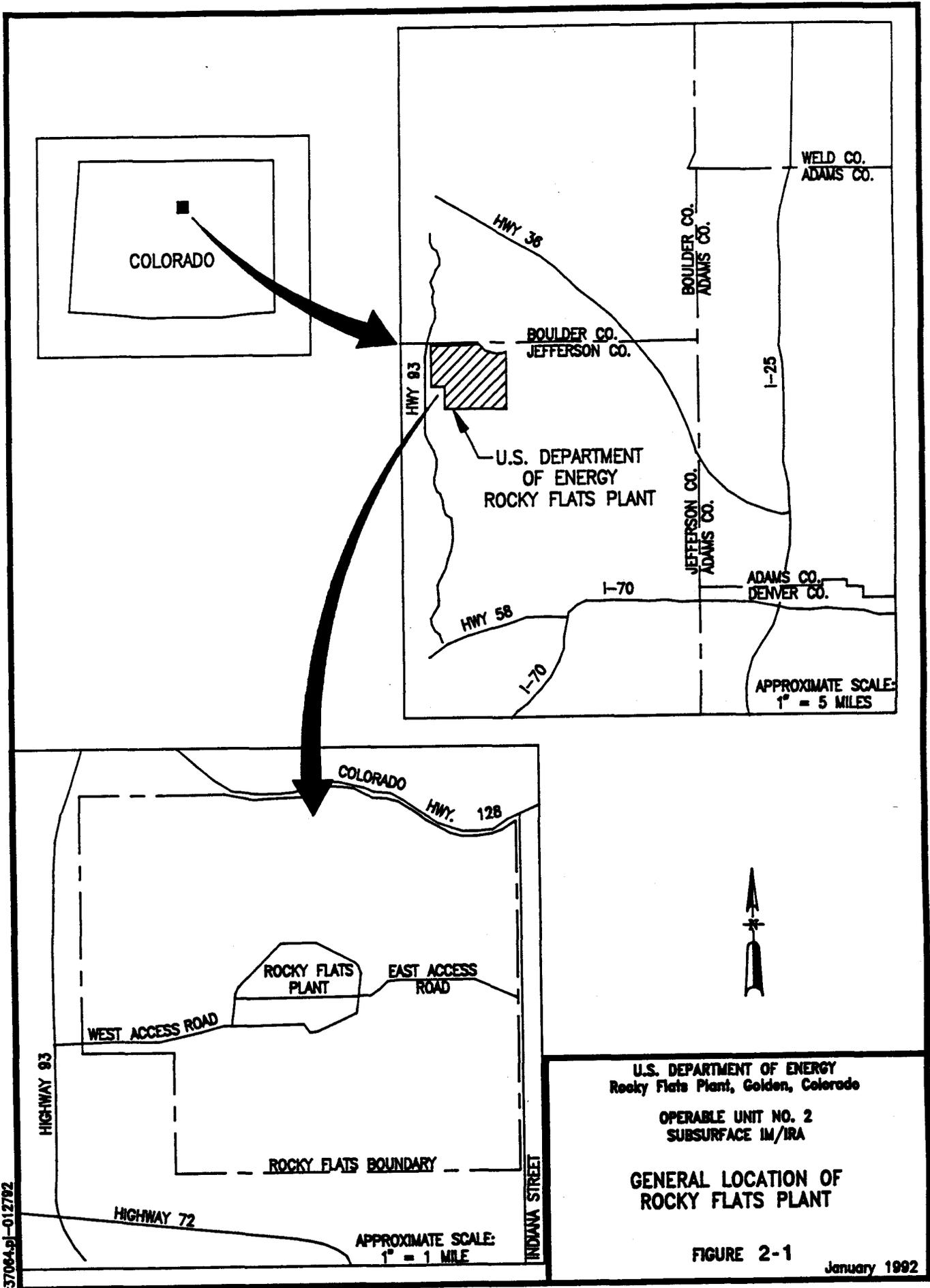
#### 2.1 SITE DESCRIPTION AND BACKGROUND

##### 2.1.1 Location and Facility Type

The RFP is located in northern Jefferson County, Colorado, approximately 16 miles northwest of downtown Denver (Figure 2-1). The plant site consists of approximately 6,550 acres of federally owned land in Sections 1 through 4, and 9 through 15, of Township 2 South, Range 70 West, 6th principal meridian. Plant buildings are located within an area of approximately 400 acres, known as the RFP security area. The security area is surrounded by a buffer zone of approximately 6,150 acres.

The RFP is a government-owned, contractor-operated facility. It is part of a nationwide nuclear weapons research, development, production, and plutonium reprocessing complex, and is administered by the Rocky Flats Office of the DOE. The operating contractor for the RFP is EG&G Rocky Flats, Inc. The facility has been in operation since 1951 and manufactures components for nuclear weapons and conducts plutonium reprocessing. The RFP fabricates components from plutonium, uranium, beryllium, and stainless steel. Historically, production activities have included metal fabrication, machining, and assembly. Both radioactive and nonradioactive wastes are generated in the process. Current waste handling practices involve on-site and off-site recycling of hazardous materials and off-site disposal of solid radioactive and mixed wastes at another DOE facility.

The RFP is currently a RCRA hazardous waste treatment/storage facility. In the past, both storage and disposal of hazardous and radioactive wastes occurred at on-site locations. Preliminary assessments conducted under Phase I of the ER Program identified some of the



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past on-site storage and disposal locations as potential sources of environmental contamination.

### 2.1.2 Operable Unit No. 2 Description

OU2 is comprised of the 903 Pad, Mound, and East Trenches Areas, which are located east-southeast of the RFP as shown in Figure 2-2. (Also see Figure 2-4.) The Areas of OU2 lie within either the Woman Creek or South Walnut Creek drainage basins. Because this IM/IRAP/EA exclusively addresses subsurface contamination within the Woman Creek and South Walnut Creek drainage basins, it is useful to examine the historical uses of the OU2 Areas. Twenty sites, designated as IHSSs) lie within OU2: 5 in the 903 Pad Area, 4 in the Mound Area, and 11 in the East Trenches Areas. The historical activities at the OU2 IHSSs is discussed below.

#### 2.1.2.1 903 Pad Area

Five sites are located within the 903 Pad Area (Figure 2-2). These sites are:

- 903 Drum Storage Site (IHSS No. 112).
- 903 Lip Site (IHSS No. 155).
- Trench T-2 Site (IHSS No. 109).
- Reactive Metal Destruction Site (IHSS No. 140).
- Gas Detoxification Site (IHSS No. 183).

Brief descriptions of each of these sites are presented below.

1. 903 Drum Storage Site (IHSS No. 112) — The site was used from 1958 to 1967 to store drums containing radioactively contaminated, used machine cutting oil. The drums, some of which corroded and leaked, contained oils and solvents contaminated with plutonium or uranium. Most of the drums contained lathe coolant consisting of mineral oil (i.e., petroleum distillate oil) and carbon tetrachloride (CCl<sub>4</sub>) in varying proportions. However, an

unknown number of drums contained hydraulic oils, vacuum pump oils, trichloroethene (TCE), tetrachloroethene (PCE), silicone oils, and acetone (Rockwell International, 1987a). Ethanolamine was also added to new drums after 1959 to reduce the drum corrosion rate. All drums were removed by 1968.

After the drums were removed, efforts were made to scrape and move the plutonium-contaminated soil into a relatively small area, cover it with fill material, and top it with an asphalt containment cover. This remedial action was completed in November 1969. An estimated 5,000 gallons of liquid leaked into the soil during use of the drum storage site. The liquid was estimated to contain 86 grams of plutonium (Rockwell International, 1987a).

2. 903 Lip Site (IHSS No. 155) — During drum removal and clean-up activities associated with the 903 Drum Storage Site, winds distributed plutonium to the south and east of what is now the 903 Pad. Although most plutonium-contaminated soils were removed, radioactive contamination is still present at the 903 Lip Site in the surficial soils.
3. Trench T-2 Site (IHSS No. 109) — This trench was used prior to 1968 for the disposal of sanitary sewage sludge and flattened drums contaminated with uranium and plutonium.
4. Reactive Metal Destruction Site (IHSS No. 140) — This site was used during the 1950s and 1960s primarily for the destruction of lithium metal (DOE, 1986). Small quantities of other reactive metals (sodium, calcium, and magnesium) and some solvents were also destroyed at this location (Illsley, 1983).
5. Gas Detoxification Site (IHSS No. 183) — Building 952, located south of the 903 Drum Storage Site, was used to detoxify various bottled gases between June 1982 and August 1983. The gases consisted of: nitrogen oxides, chlorine, hydrogen sulfide, sulphur tetrafluoride, methane, hydrogen fluoride, and ammonia. Gas detoxification was accomplished by using various commercial neutralization processes available at the time. The neutralized gases released to the environment during detoxification would no longer be detectable (Rockwell International, 1987b).

A Phase I RI has been completed for these five sites. Phase II was initiated in the fall of 1991.

### 2.1.2.2 Mound Area

The Mound Area is composed of four sites (Figure 2-2). These are:

- Mound Site (IHSS No. 113).
- Trench T-1 Site (IHSS No. 108).
- Oil Burn Pit No. 2 Site (IHSS No. 153).
- Pallet Burn Site (IHSS No. 154).

These sites are individually described below.

1. Mound Site (IHSS No. 113) — The Mound Site contained approximately 1,405 drums containing primarily depleted uranium- and plutonium-contaminated lathe coolant (i.e., petroleum distillate oil). Some drums also contained "Perclene" (Smith, 1975); perclene was a brand name of tetrachloroethene (Sax and Lewis, 1987). Some of the drummed wastes placed in the Mound Site were in solid form (Rockwell International, 1987b). Initial remediation of the Mound Site was accomplished in 1970, and the materials that were removed were packaged and shipped to an off-site DOE facility as radioactive waste. Subsequent surficial soils sampling in the vicinity of the excavated Mound Site indicated 0.8 to 112.5 disintegrations per minute per gram (d/m/g) alpha activity. This radioactive contamination is thought to have come from the 903 Drum Storage Site via wind dispersion rather than from the Mound Site (Rockwell International, 1987a).
2. Trench T-1 Site (IHSS No. 108) — The trench was used from 1954 until 1962 and contains approximately 125 drums filled with depleted uranium chips (Dow Chemical, 1971) and plutonium chips coated with lathe coolant. The drums are still present in this trench.
3. Oil Burn Pit No. 2 Site (IHSS No. 153) — Oil Burn Pit No. 2 is actually two parallel trenches that were used in 1957 and from 1961 to 1965 to burn 1,082 drums of oil containing uranium (Rockwell International, 1987a). The residues from the burning operations and some flattened drums were covered with backfill. Initial remedial activities were performed in the 1970s (Rockwell International, 1987a).

4. Pallet Burn Site (IHSS No. 154) — An area southwest of Oil Burn Pit No. 2 was reportedly used to destroy wooden pallets in 1965. The types of hazardous substances or radionuclides that may have been spilled on these pallets is unknown. Initial remedial activities were performed in the 1970s (DOE, 1986).

### 2.1.2.3 East Trenches Area

The East Trenches Area consists of nine burial trenches and two spray irrigation areas (Figure 2-2). The trench numbers and their respective IHSS designations are:

- Trench T-3 — IHSS No. 110.
- Trench T-4 — IHSS No. 111.1.
- Trench T-5 — IHSS No. 111.2.
- Trench T-6 — IHSS No. 111.3.
- Trench T-7 — IHSS No. 111.4.
- Trench T-8 — IHSS No. 111.5.
- Trench T-9 — IHSS No. 111.6.
- Trench T-10 — IHSS No. 111.7.
- Trench T-11 — IHSS No. 111.8.

Trenches T-3, T-4, T-10, and T-11 are located north of the east access road, and trenches T-5 through T-9 are located south of the east access road. The trenches were used from 1954 to 1968 for disposal of depleted uranium; flattened, depleted uranium- and plutonium-contaminated drums; and sanitary sewage sludge. The wastes have not been disturbed since their burial.

IHSS numbers 216.2 and 216.3 are part of the East Trenches Area and are designated as IHSSs because they were used for spray irrigation of sewage treatment plant effluent. The historical discharge of Pond B-3 was to this spray irrigation area. However, this practice has been terminated, and the current Pond B-3 discharge is sent to Pond B-4.

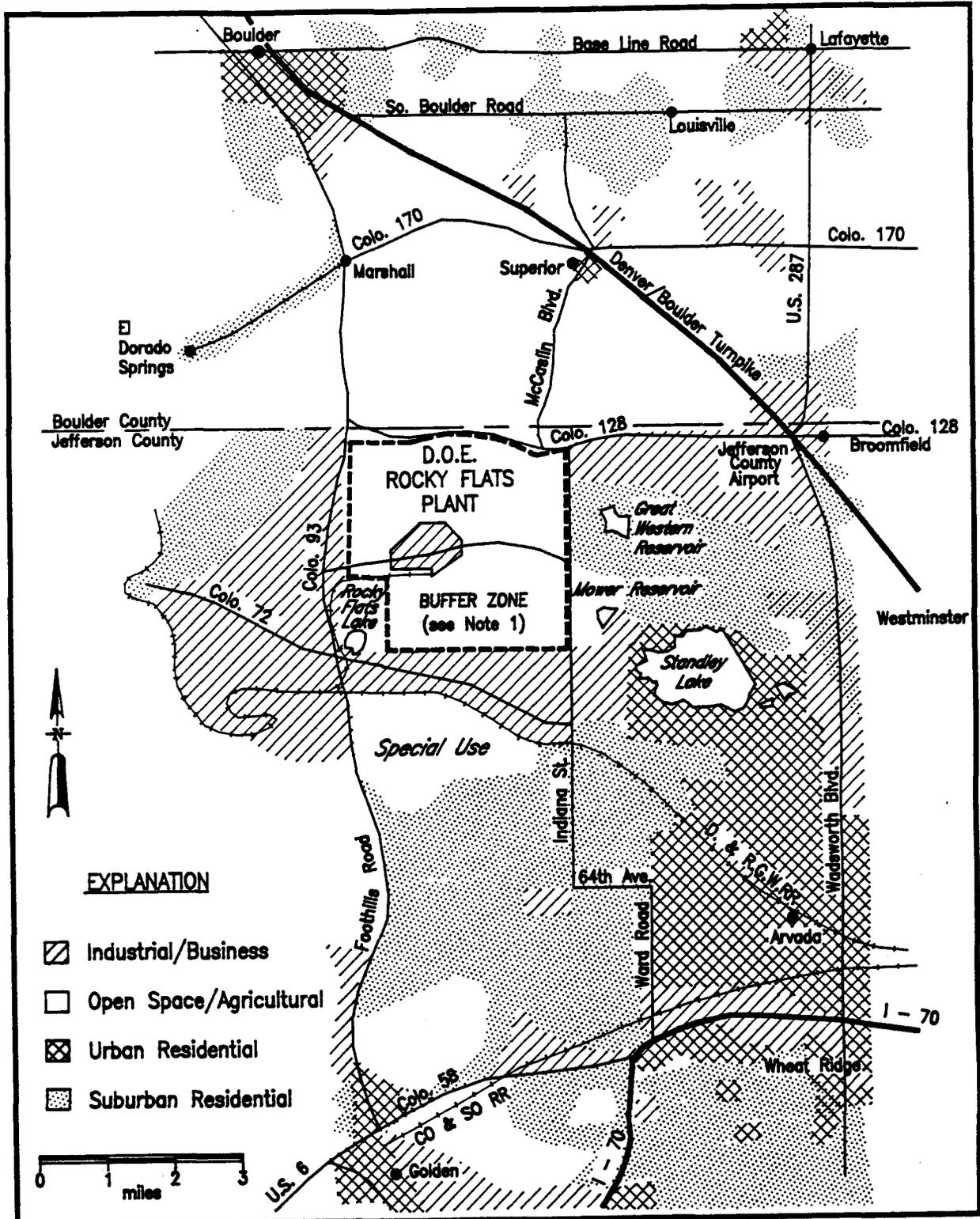
### **2.1.3 Surrounding Land Use and Population Density**

The RFP property is located in a rural area. Approximately 50 percent of the area within 10 miles of the RFP is in Jefferson County. The remainder is located in Boulder County (40 percent) and Adams County (10 percent). According to the 1973 Colorado Land Use Map, 75 percent of this land was unused or was used for agriculture. Since that time, portions of this land have been converted to housing, with several new housing subdivisions being started within a few miles of the Buffer Zone, southeast of the plant site. Land zoning is depicted in Figure 2-3.

A demographic study, using 1990 census data, shows that approximately 1.9 million people lived within the eight-county Denver metropolitan region. This region covers approximately 5,076 square miles and includes the following counties: Adams, Arapahoe, Boulder, Clear Creek, Denver, Douglas, Gilpin, and Jefferson. The most populated sector is to the southeast, toward the center of Denver. This sector had a 1989 population of approximately 600,000 people living between 10 and 50 miles from Rocky Flats. Recent population estimates registered by the Denver Regional Council of Governments (DRCOG) for the eight-county Denver metro region have shown distinct patterns of growth between the first and second halves of the decade.

Between 1980 and 1985, the population of the 8-county region increased by 197,890, a 2.4 percent annual growth rate (DRCOG, 1989). Between 1985 and 1990 a population gain of 80,875 was recorded, representing a 0.9 percent annual increase. The 1990 population showed an increase of 9,300 (or 0.5 percent) from the same date in 1989 (DRCOG, 1990).

The RFP property is approximately 3 miles (north-south) by 4 miles (east-west). Figure 2-3 illustrates that this property consists of plant facilities surrounded by an area of undeveloped land known as the Buffer Zone (approximately 4,600 acres). The current and intended future use of the Buffer Zone is as an undeveloped open area (i.e., "greenbelt") (AEC, 1972). Use of the Buffer Zone as a greenbelt serves to preserve the natural ecological state of the land and prevents development immediately adjacent to the plant area.



(after: Jefferson County Planning and Zoning Department, April, 1990)

NOTE 1: Current and intended future use of the Buffer Zone is as an undeveloped open area (i.e., "greenbelt"). (A.E.C., 1972)

January 1992

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

**LAND ZONING IN THE VICINITY**  
**OF ROCKY FLATS PLANT**

**FIGURE**  
**2-3**

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There are eight public schools within 6 miles of the RFP. The nearest educational facility is Witt Elementary School, which is approximately 2.7 miles east of the Plant Buffer Zone. The closest hospital is Centennial Peaks Hospital, located approximately 7 miles northeast. The closest park and recreational area is the Standley Lake area, approximately 5 miles southeast of the Plant. Boating, picnicking, and limited overnight camping are permitted in the Standley Lake Recreational Area. Several other small parks are located in communities within 10 miles of the RFP. The closest major park is Golden Gate Canyon State Park, located approximately 15 miles to the southwest, providing 8,400 acres of general camping and outdoor recreation. Other national and state parks are located in the mountains west of the RFP, but all are more than 15 miles away.

Some of the land adjacent to the RFP is zoned for industrial development. Industrial facilities within 5 miles include the former TOSCO (The Oil Shale Company) laboratory (40-acre site located 2 miles south and now occupied by Analytica, Inc.), the Great Western Inorganics Plant (2 miles south), the Frontier Forest Products yard (2 miles south), the Idealite Lightweight Aggregate Plant (2.4 miles northwest), and the Jefferson County Airport and Industrial Park (990-acre site located 4.8 miles northeast).

Several ranches are located within 10 miles of the RFP, primarily in Jefferson and Boulder Counties. They are operated to produce crops, raise beef cattle, supply milk, and breed and train horses. According to the 1987 Colorado Agricultural Statistics, 20,758 acres of crops were planted in Jefferson County (total land area of approximately 475,000 acres), and 68,760 acres of crops were planted in Boulder County (total land area of 405,760 acres). Crops consisted of: winter wheat, corn, barley, dry beans, sugar beets, hay, and oats. Livestock consisted of: 5,314 head of cattle, 113 hogs, and 346 sheep in Jefferson County; and 19,578 head of cattle, 2,216 hogs, and 12,133 sheep in Boulder County (Post, 1989).

## 2.2 AFFECTED ENVIRONMENT

### 2.2.1 Physical Environment

The natural environment of the RFP and vicinity is primarily influenced by its proximity to the Front Range of the Rocky Mountains. The RFP is located directly east of the north-south trending Rocky Mountains at an elevation of approximately 6,000 feet above mean sea level. The RFP is located on a broad, eastward-sloping plain of overlapping alluvial fans. These fans extend approximately 5 miles east of the Front Range and terminate where gentle slopes break to low rolling hills. The Continental Divide is approximately 16 miles west of the RFP. The operational area at the RFP is located near the eastern edge of the fans on a terrace between the stream-cut valleys of North Walnut Creek and Woman Creek. The Rocky Flats Alluvium (the deposit of coalescing alluvial fans) is exposed at the surface and consists of a topsoil layer underlain by as much as 100 feet of silt, clay, sand, and gravel.

Mineral resources found in the vicinity of the RFP include: sand, gravel, crushed rock, clay, coal, and uranium. There are no known clay, coal or uranium deposits within the RFP Buffer Zone; however, these commodities are mined within 20 miles of the plant. The Schwartzwalder Uranium Mine is located approximately 4 miles southwest of the RFP. This mine has been the largest producer of vein type uranium ore in Colorado and ranks among the six largest of this type in the United States (DOE, 1980). Active sand and gravel mines lie within the Buffer Zone boundaries. In addition, there is an aggregate processing facility adjacent to the northwest corner of the Buffer Zone that reopened in 1989. Oil and natural gas production is also active in nearby northwest Adams County and east central Boulder County.

Oil and natural gas activities near the RFP site includes oil field developments, pipeline, and production operations. The closest major oil and gas fields are in northwest Adams County (Jackpot and Spindle Fields), and in east central Boulder County (Boulder Field). A natural gas pipeline, which originates in Wyoming and proceeds across eastern Colorado into Oklahoma, is located approximately 10 miles north of the RFP in southern Boulder County.

Local natural gas pipelines cross the south side of the RFP. The nearest refinery operation is the Conoco Refinery located in Commerce City about 20 miles east of the RFP. A north-south oriented oil pipeline feeds into the refinery from fields in northeastern Colorado and southeastern Wyoming (Donaldson and MacMillan, 1980).

There are four main drainages within the RFP property as shown in Figure 2-4. North Walnut, South Walnut, Rock, and Woman Creeks all have intermittent streams. These drainages enter downstream reservoirs that provide drinking and irrigation water. There are a number of ditches crossing the area that convey water collected off site to other areas of the RFP, Walnut Creek, or Woman Creek. Until late 1974, Plant wastewater had been discharged into Walnut Creek, and until 1975, filter backwash from the raw water treatment plant went into Woman Creek. All process wastewater is now either recycled or disposed through evaporation. Evaporation residues are solidified by the addition of Portland cement, characterized, and subsequently managed according to RFP waste management operating procedures. Sanitary wastewater is discharged in accordance with the RFP's NPDES permit effluent requirements.

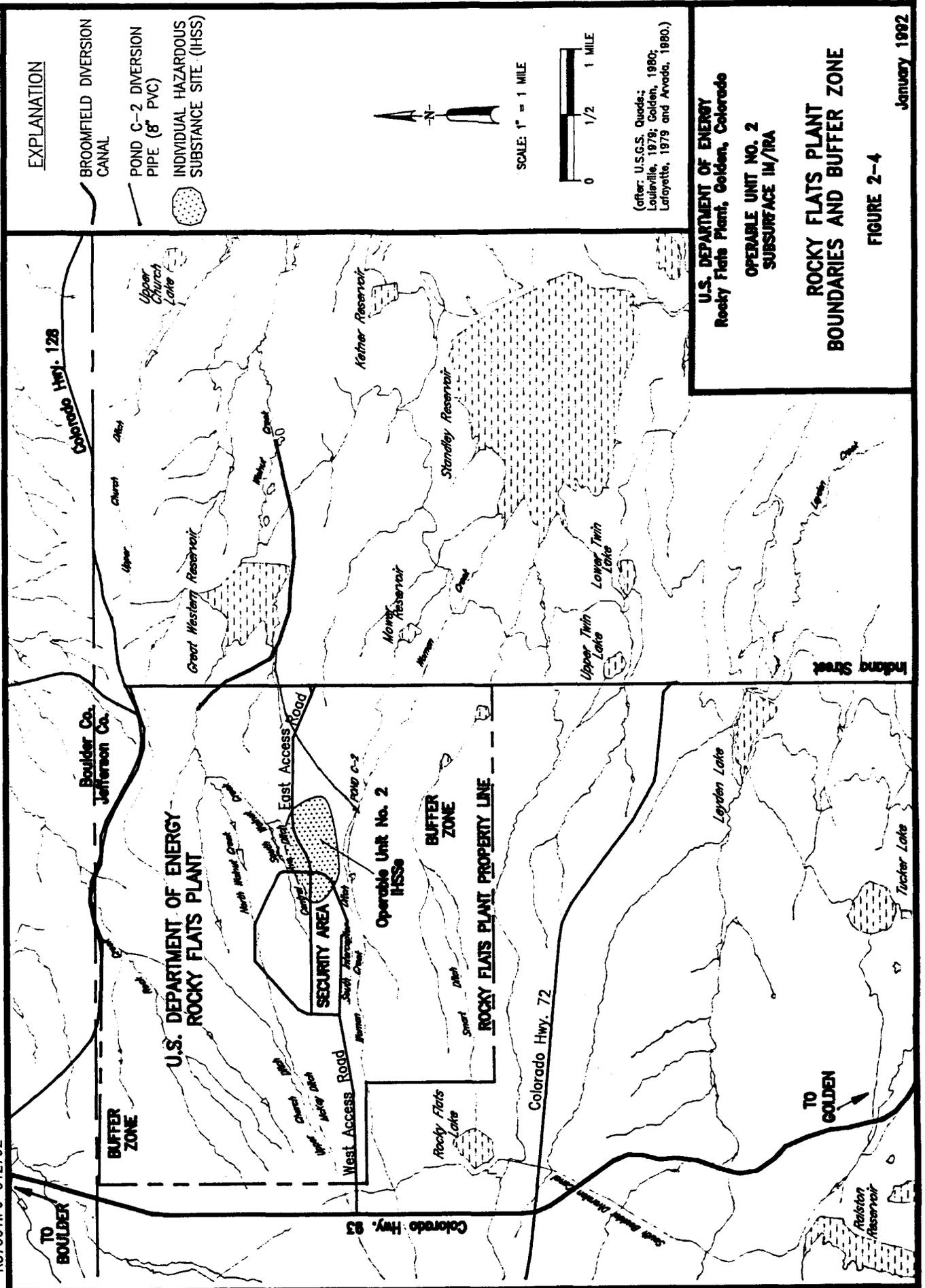
## **2.2.2 Regional and Local Hydrogeology**

The stratigraphic section that pertains to the RFP includes, in descending order, unconsolidated surficial units (Rocky Flats Alluvium, various terrace alluviums, valley fill alluvium, and colluvium) (Figure 2-5), Arapahoe Formation, Laramie Formation, and Fox Hills Sandstone (Figure 2-6). Ground water occurs under unconfined conditions in both the surficial and shallow bedrock units. In addition, confined ground-water flow occurs in deeper bedrock sandstones.

### **2.2.2.1 Alluvial Materials**

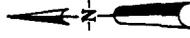
The Rocky Flats Alluvium underlies a large portion of the RFP. The alluvium is a broad planar deposit consisting of a topsoil layer underlain by up to 100 feet of poorly stratified silt, clay, sand, gravel, and cobbles.

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**EXPLANATION**

- BROOMFIELD DIVERSION CANAL
- POND C-2 DIVERSION PIPE (8" PVC)
- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS)



SCALE: 1" = 1 MILE



(after: U.S.G.S. Quads:  
Louisville, 1979; Golden, 1980;  
Lafayette, 1979 and Arvada, 1980.)

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

**OPERABLE UNIT NO. 2**  
SUBSURFACE IM/IRA

**ROCKY FLATS PLANT**  
**BOUNDARIES AND BUFFER ZONE**

**FIGURE 2-4**

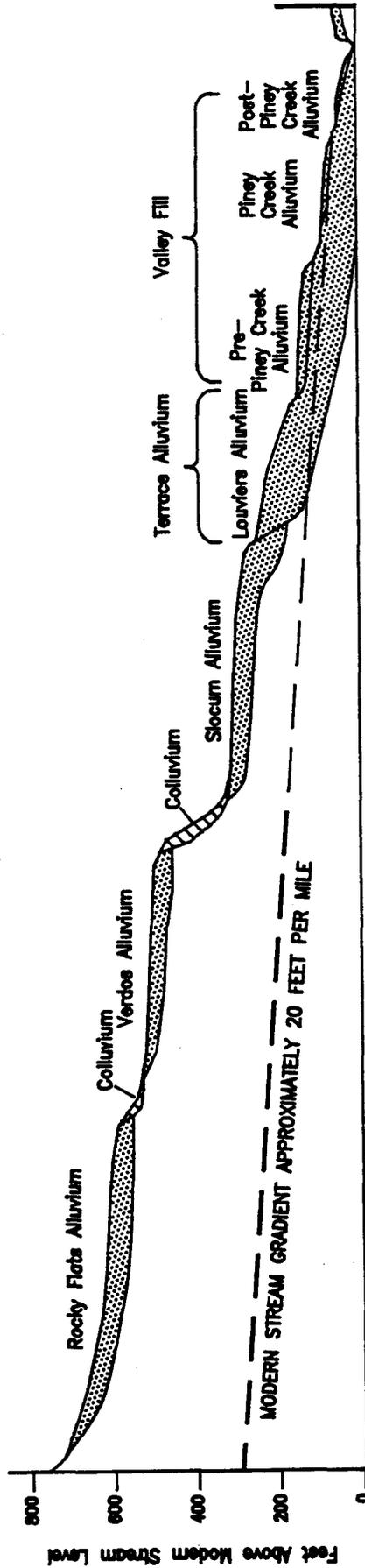
January 1992

R37063.PJ-012792

EAST

WEST

ROCKY FLATS PLANT SITE



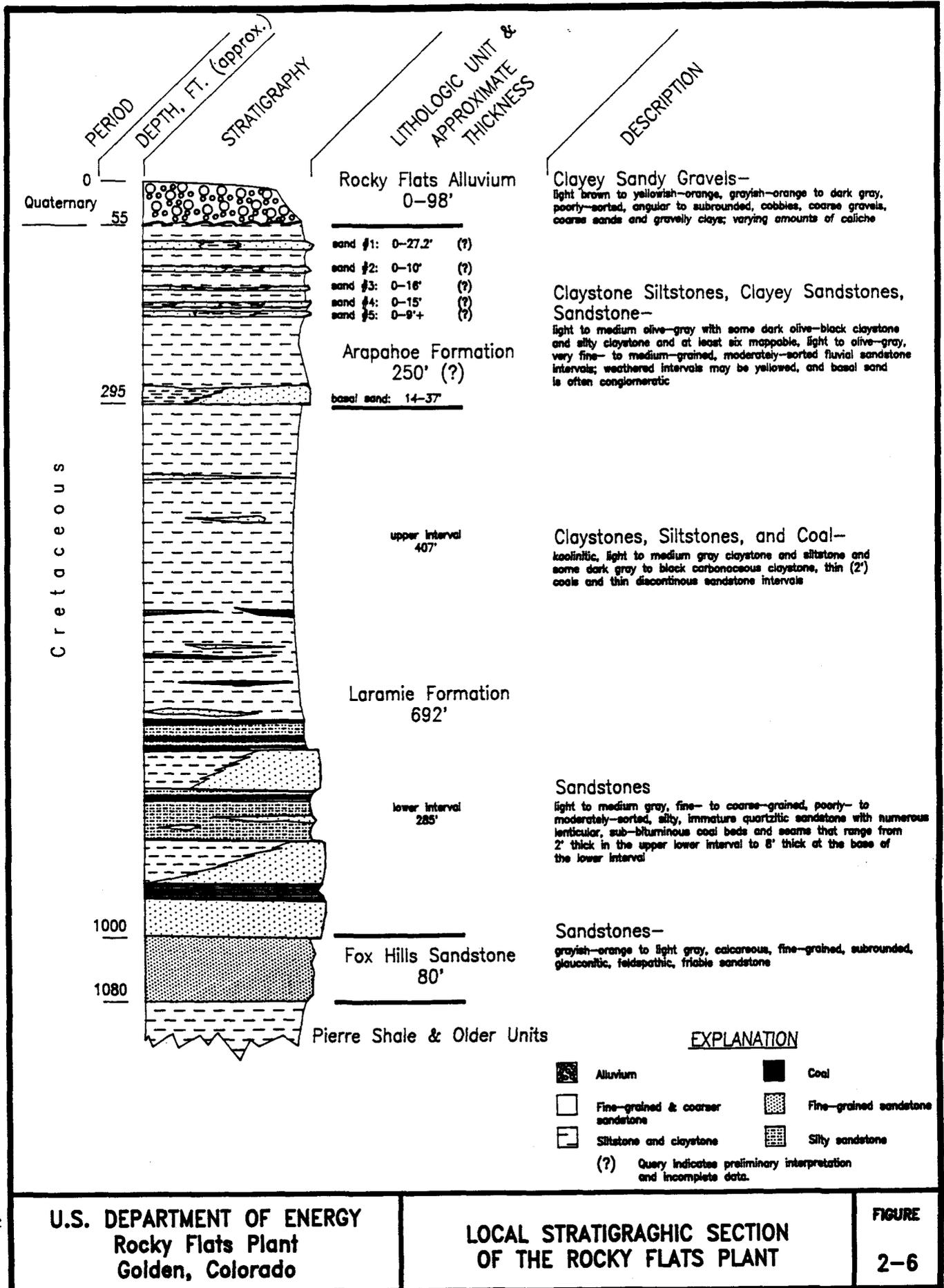
NOT TO SCALE  
(after: Scott, 1960)

January 1992

FIGURE  
2-5

EROSIONAL SURFACES AND ALLUVIAL DEPOSITS  
EAST OF THE FRONT RANGE  
COLORADO

U.S. DEPARTMENT OF ENERGY  
Rocky Flat Plant  
Golden, Colorado



r37062.pj-012782

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

LOCAL STRATIGRAPHIC SECTION  
OF THE ROCKY FLATS PLANT

FIGURE  
2-6

Unconfined ground-water flow occurs in the Rocky Flats Alluvium, which is relatively permeable. Recharge to the alluvium occurs from precipitation, snowmelt, and water losses from ditches, streams, and ponds that are cut into the alluvium. General water movement in the Rocky Flats Alluvium is from west to east and toward the drainages. (Ground-water flow is also controlled by paleochannels in the top of the bedrock.) The water table in the Rocky Flats Alluvium rises in response to recharge during the spring and declines during the remainder of the year. Discharge from the alluvium occurs at minor seeps in the colluvium that covers the contact between the alluvium and bedrock along the edges of the valleys. OU2 is situated on a terrace of Rocky Flats Alluvium that thins to the east of the RFP, and does not directly supply water to wells located downgradient of the RFP.

Various other alluvial deposits occur topographically below the Rocky Flats Alluvium in the Plant drainages. Colluvium (slope wash) mantles the valley side slopes between the Rocky Flats Alluvium and the valley bottoms. In addition, remnants of younger terrace deposits, including the Verdos, Slocum, and Louviers Alluvia, occasionally occur along the valley side slopes. Recent valley fill alluvium occurs in the active stream channels.

Unconfined ground-water flow occurs in these surficial units. Recharge is from precipitation, percolation from streams and ditches during periods of surface water runoff, and by seeps discharging from the Rocky Flats Alluvium. Discharge is by seepage into other geologic formations and streams, and by evaporation where the water table approaches the ground surface. The direction of ground-water flow is generally downslope through colluvial materials and then along the course of the stream in valley fill materials. During periods of high surface water flow, water is lost to bank storage in the valley fill alluvium and returns to the stream after the runoff subsides.

#### **2.2.2.2 Bedrock Materials**

The Cretaceous Arapahoe Formation underlies surficial materials beneath the Plant. This formation is a fluvial deposit composed of overbank and channel deposits. It primarily consists of claystone with some sandstone and is nearly flat lying beneath the Plant (less than a 2-degree dip) based on the draft seismic profiling report (Rockwell International,

1989a). The sand bodies within the claystone are composed of fine-grained sands and silts, and their hydraulic conductivity is relatively low compared to the overlying Rocky Flats Alluvium. Total formation thickness varies up to 270 feet (Robson, Romero, and Zawistowski, 1981).

The Arapahoe Formation is recharged by ground-water movements from overlying surficial deposits and by leakage from streams. The main recharge areas are under the Rocky Flats Alluvium, although some recharge from the colluvium and valley fill alluvium is likely to occur along the stream valleys. Recharge is greatest during the spring and early summer when rainfall and stream flow are at a maximum and water levels in the Rocky Flats Alluvium are high. Ground-water movement in the Arapahoe Formation is generally toward the east, although flow within individual sandstones is not fully characterized at this time. Regionally, ground-water flow in the Arapahoe Formation is toward the South Platte River in the center of the Denver Basin (Robson, Romero, and Zawistowski, 1981).

The Laramie Formation underlies the Arapahoe Formation and is composed of two units, a thick upper claystone and a lower sandstone. The claystone is greater than 700 feet thick and is of very low hydraulic conductivity; therefore, the U.S. Geologic Survey (Hurr, 1976) concludes that RFP operations will not impact any units below the upper claystone unit of the Laramie Formation.

The lower sandstone unit of the Laramie Formation and the underlying Fox Hills Sandstone comprise a regionally important aquifer in the Denver Basin known as the Laramie-Fox Hills Aquifer. Aquifer thickness ranges from 200 to 300 feet near the center of the basin. These units subcrop west of the Plant and can be seen in clay pits excavated through the Rocky Flats Alluvium. The steeply dipping beds of these units west of the Plant (approximately a 50-degree dip) quickly flatten to the east (less than 2-degree dip) based on preliminary results of the high resolution seismic reflection study (Rockwell International, 1989a). Recharge to the aquifer occurs along the rather limited outcrop area exposed to surface water flow and leakage along the Front Range (Robson, Wacinski, Zawistowski, and Romero, 1981). In the vicinity of the RFP, this would occur west of the Plant where the units subcrop.

Sixteen wells were completed in various zones within bedrock during the 1987 drilling program at OU2. Although claystone was the most frequently encountered lithology immediately below the alluvium/bedrock contact, interbedded sandy, silty, and lignitic units with both gradational and sharp contacts were present as well. All of the bedrock encountered directly beneath surficial materials was weathered, and some saturated sandstones were encountered.

### **2.2.3 Site Hydrology**

The following discussion of the site hydrology of OU2 includes ground water that occurs in surficial and bedrock materials, and surface water drainage patterns of the Woman Creek and South Walnut Creek drainages.

#### **2.2.3.1 Ground Water**

Ground water occurs in surficial materials (Rocky Flats Alluvium, colluvium, and valley fill alluvium) and in Arapahoe sandstones and claystones at OU2. These two flow systems, which are hydraulically connected at shallower portions of the Arapahoe Formation, are discussed separately below.

#### **Ground Water in Surficial Materials**

Ground water is present in the Rocky Flats Alluvium, colluvium, and valley fill alluvium under unconfined conditions. Recharge to the water table occurs as infiltration of incident precipitation and seepage from ditches and creeks. In addition, detention ponds along Woman Creek and South Walnut Creek recharge the valley fill alluvium. Figure 2-7 shows the potentiometric surface of the uppermost ground water measured between April 4 and April 8, 1988, and the locations of alluvial and bedrock wells in the vicinity of OU2. The potentiometric surface during April 1988 is typical of the spring time water table at OU2.

The shallow ground-water flow system is quite dynamic with large water level changes occurring in response to precipitation events that influence stream and ditch flow. For

example, between mid-April and September 1986 water levels in wells 1-86 and 4-86 (completed in valley fill alluvium) dropped more than 4 and 8 feet, respectively. Alluvial water levels are highest during the months of May and June then decline during late summer and fall with some wells going completely dry. Ground-water flow in the Rocky Flats Alluvium is generally from west to east, following the surface of the claystone bedrock.

Alluvial ground water discharges to seeps, springs, surface water drainages, and subcropping Arapahoe Sandstone at OU2. Seeps and springs occur along the edge of the Rocky Flats Alluvium terrace (at the alluvium/bedrock contact) and on the side slopes of the terrace. Seeps and springs on the terrace side slopes may be due to thinning of colluvial materials. Ground water in colluvial materials south of the 903 Pad and East Trenches Areas discharges to the South Interceptor Ditch (SID), and ground water in valley fill materials discharges to Woman or South Walnut Creeks.

Hydraulic conductivity values for surficial materials were estimated from drawdown-recovery tests performed on 1986 wells during the initial site characterization, and from slug tests performed on selected 1986 and 1987 wells during the Phase I RI (Rockwell International, 1987a). Mean hydraulic conductivities are  $4 \times 10^{-4}$ ,  $7 \times 10^{-4}$ , and  $9.5 \times 10^{-5}$  centimeters per second (cm/s) for Rocky Flats, Woman Creek Valley Fill, and South Walnut Creek Valley Fill Alluvium, respectively.

### Bedrock Ground Water

Due to their relatively high permeability, the meandering lenticular sandstones contained within the claystones (i.e., the basal formation) provide the greatest potential for ground-water flow in the Arapahoe Formation. Flow within individual sandstones is assumed to be from west to east, but the geometry of the bedrock ground-water flow path is not fully understood at this time due to its dependence upon the continuity of the sandstones and their hydraulic interconnection (Robson, Romero, and Zawistowski, 1981). Evaluation of the lateral extent and degree of interconnection of the sandstone units is a primary goal of the Phase II Bedrock RI for OU2. Ground water recharged to sandstones occurs as infiltration from alluvial ground water where sandstones subcrop beneath the alluvium and

by leakage from claystones overlying the sandstones. Ground water from the basal formation of the Arapahoe aquifer is used for irrigation, livestock, watering, and domestic purposes. Wells are located east of the RFP within the Denver Basin.

There is a strong downward gradient between ground water in surficial materials and bedrock. Vertical gradients range from 0.31 feet per foot (ft/ft) between wells 35-86 and 34-86 to 1.05 ft/ft between wells 41-86 and 40-86. These gradients imply a relatively high hydraulic conductivity contrast between the surficial materials and bedrock, which is supported by hydraulic conductivity test results.

### **2.2.3.2 Surface Water**

Surface water drainage patterns at the RFP are shown on Figures 2-2 and 2-4. A discussion of the major OU2 surface water features, including the Woman Creek and South Walnut Creek drainages, is presented below. Collection and treatment of the South Walnut Creek Basin surface water and seepage is being addressed in the IM/IRA (EG&G, 1991f) discussed in Section 1.

#### **Woman Creek**

Woman Creek is located south of the Plant, with headwaters in largely undisturbed Rocky Flats Alluvium. Runoff from the southern part of the Plant is collected in the SID located north of the creek and delivered downstream to Pond C-2 (see Figure 2-2). Pond C-1 (upstream of C-2) receives stream flow from Woman Creek. Flow in Woman Creek is also influenced by diversion of water from Rocky Flats Lake into the creek by local landowners. The discharge from Pond C-1 is diverted around Pond C-2 into the Woman Creek channel downstream. Water in Pond C-2 is treated and monitored prior to discharge. Discharge from Pond C-2 is in accordance with the Plant's NPDES permit (discharge point 007). Historically, discharge from Pond C-2 has been to Woman Creek; however, since October of 1989, treated water is being pumped to the South Walnut Creek drainage and flows off site via the Broomfield Diversion Canal.

Flow in Woman Creek and the SID is intermittent. This has been observed by field investigation crews since 1986.

### South Walnut Creek

The headwaters area of South Walnut Creek has been filled during construction of RFP facilities. As a result, flow originates from a buried culvert located in the east-central portion of OU2, west of Building 991. Flow in the upper reach of South Walnut Creek is directed to the south of Building 991 and under the Protected Area (PA) fence by a buried, corrugated metal culvert. The culvert outlet is located in the South Walnut Creek drainage approximately 500 feet downgradient of the PA fence near the discharge of the sewage treatment plant. A concrete culvert and a second corrugated metal culvert also discharge into the South Walnut Creek drainage just downgradient of the PA fence and north of the Mound Area. The flow from the concrete culvert originates as seepage from the hillside south of Building 991 and flows into a ditch along the slope. The corrugated metal culvert drains Plant runoff that collects in a drainage south of the PA. The combined flow then enters the South Walnut Creek detention pond system. Below the detention ponds, South Walnut Creek, North Walnut Creek, and an unnamed tributary join within the Buffer Zone to form Walnut Creek. Flow is routed around Great Western Reservoir by the Broomfield Diversion Canal. Great Western Reservoir is located approximately 1 mile east of this confluence and is a primary drinking water source for the residents of Broomfield.

The South Walnut Creek detention pond system consists of five ponds (B-1, B-2, B-3, B-4, and B-5) that retain surface water runoff and RFP discharges for flood control, monitoring, and treatment prior to downstream release. All flow in the pond system is eventually detained in Pond B-5, where it is treated and monitored prior to discharge. Water is discharged from Pond B-5 in accordance with the Plant NPDES permit (discharge point 006). Ponds B-1 and B-2 are reserved for spill control, surface water runoff, or treated sanitary waste of questionable quality. Pond B-3 is used as a holding pond for sanitary sewage treatment plant effluent. The historical discharge of Pond B-3 was a spray irrigation system located in the vicinity of the East Trenches; however, this practice has been terminated and current Pond B-3 discharge is routed to Pond B-4. In addition to Pond B-3

discharge, Ponds B-4 and B-5 receive surface water runoff from the central portion of the RFP. The surface water runoff received by Pond B-4 is collected by the Central Avenue Ditch and the South Walnut Creek Drainage.

#### 2.2.4 Meteorology and Climatology

The area surrounding the RFP has a semiarid climate characteristic of much of the central Rocky Mountain region. Approximately 40 percent of the 15-inch annual precipitation falls during the spring season, much of it as snow. Thunderstorms (June to August) account for an additional 30 percent of the annual precipitation. Autumn and winter are drier seasons, accounting for 19 and 11 percent of the annual precipitation, respectively. Snowfall averages 85 inches per year, falling from October through May (DOE, 1980). Temperatures are moderate; extremely warm and cold weather is usually of short duration. On the average, daily summer temperatures range from 55°F to 85°F, and winter temperatures range from 20°F to 45°F. The low average relative humidity (46 percent) is due to the blocking effect of the Rocky Mountains.

Wind, temperature, and precipitation data are collected on Plant site and summarized annually. Table 2-1 presents the 1990 annual summary of the percent frequency of wind directions (16 compass points) divided into 6 speed categories. These frequency values are represented graphically in Figure 2-8. Winds at the RFP are predominantly northwesterly. Winds greater than 4.18 meters per second (m/s) (9.2 miles per hour [mph]) with easterly components occur with a low frequency. The Pasquill Stability Class D represents the prevailing meteorological conditions for the RFP (EG&G, 1991a), and average downwind directional frequencies.

Special attention has been focused on dispersion meteorology surrounding the Plant due to the remote possibility that significant atmospheric releases might affect the Denver metropolitan area, which is located in the predominant downwind (southeast) direction. Studies of air flow and dispersion characteristics (e.g., Hodgin, 1983 and 1984) indicate that drainage flows (winds coming down from the mountains to the west) turn and move toward

Table 2-1

**Rocky Flats Meteorological Monitoring Station  
60 Meter Tower  
January 1, 1990 to December 31, 1990  
Wind Frequency Distribution by Percent - Stability Class D  
10 Meter Level**

Wind Speed Classes (Knots)

Wind Direction	<3.0	3.0 - <6.0	6.0 - <10.0	10.0 - <16.0	16.0 - <21.0	≥21.0	Class <sup>a</sup>	Total <sup>b</sup>
N	0.8	2.9	3.4	1.6	0.2	0.2	9.29	9.25
NNE	1.1	3.5	2.9	1.0	0.0	0.0	8.52	8.49
NE	1.1	3.3	1.6	0.3	0.0	0.0	6.31	6.29
ENE	1.0	2.3	.8	0.1	0.0	0.0	4.20	4.19
E	1.4	3.0	.7	0.0	0.0	0.0	5.06	5.04
ESE	0.9	2.7	1.9	0.1	0.0	0.0	5.60	5.58
SE	0.9	3.5	3.6	0.6	0.0	0.0	8.57	8.54
SSE	0.8	2.5	2.6	0.6	0.1	0.0	6.66	6.64
S	0.7	2.0	1.5	0.5	0.1	0.0	4.79	4.78
SSW	0.5	1.2	1.0	0.3	0.1	0.0	3.09	3.08
SW	0.3	1.2	1.2	0.4	0.1	0.0	3.29	3.28
WSW	0.4	1.1	1.2	1.0	0.4	0.3	4.25	4.24
W	0.5	1.1	1.1	1.6	1.1	1.5	6.89	6.87
WNW	0.5	1.3	1.5	3.0	1.8	1.6	9.59	9.56
NW	0.7	1.6	2.1	2.3	0.7	0.2	7.54	7.51
NNW	0.6	1.9	2.6	1.1	0.1	0.0	6.34	6.32
All	12.1	35.0	29.7	14.6	4.7	3.9	100.00	99.64

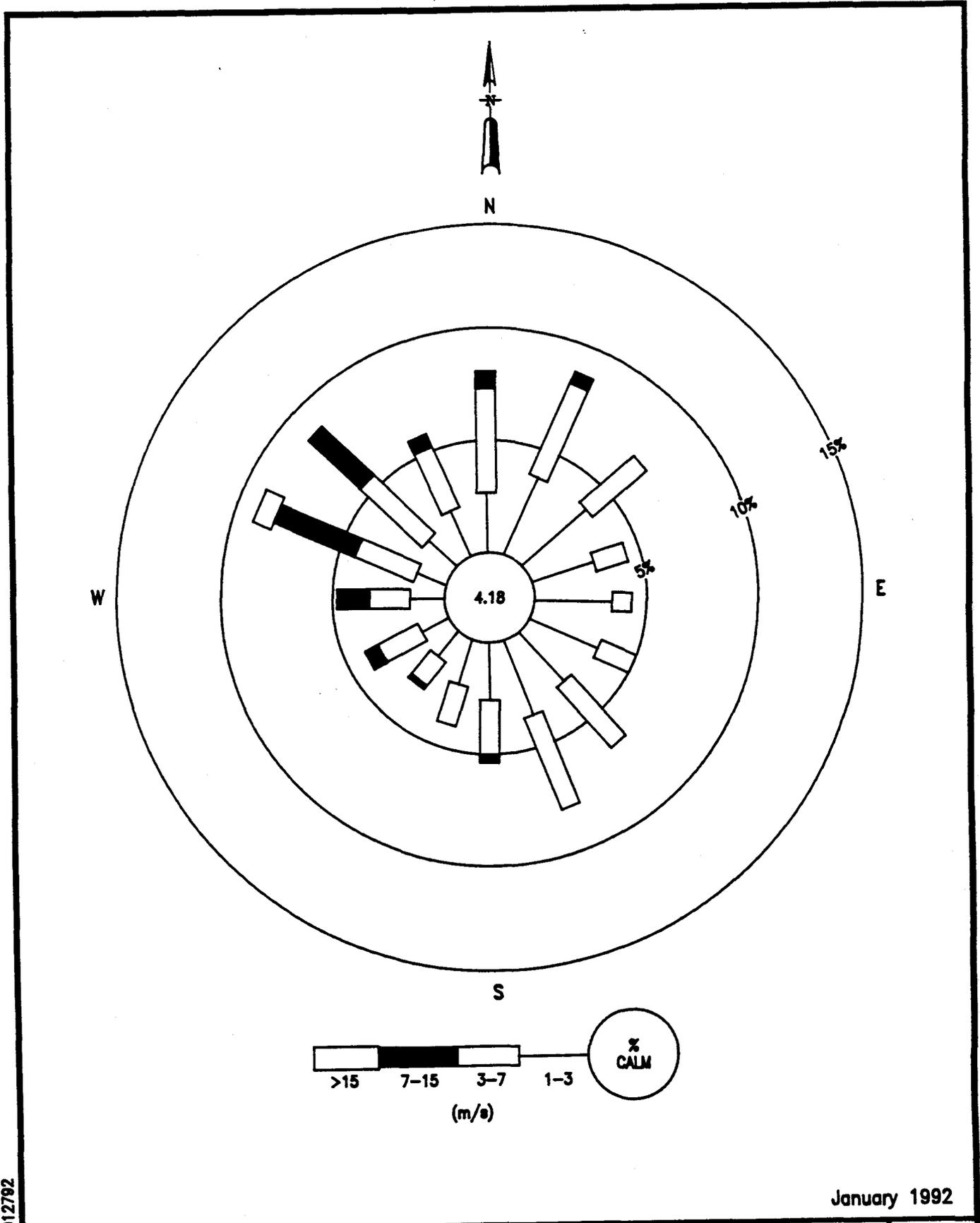
<sup>a</sup> Total Percent for this stability class

<sup>b</sup> Total percent relative to all stability classes (A through F)

Total Number of invalid observations in this stability class = 18

Total Number of valid observations in this stability class = 18,240

Joint Data Recovery Rate = 99.9%



January 1992

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

1990 ANNUAL WIND ROSE  
 FOR THE ROCKY FLATS PLANT

FIGURE  
 2-8

R37066.MBp]-012792

the north and northeast along the South Platte River valley and pass to the west and north of Brighton, Colorado (DOE, 1980), which is just north of Denver.

### 2.2.5 Ecology

The RFP site includes species of flora representative of tall grass prairie, short grass plains, lower montane, and foothills ravine regions. It is evident that the vegetative cover along the Front Range of the Rocky Mountains has been altered by human activities such as burning, timber cutting, road building, and overgrazing for many years. Since the acquisition of the RFP property, vegetative recovery has occurred as evidenced by the presence of grasses such as big bluestem and sideoats grama (two disturbance-sensitive species). No vegetative stresses attributable to hazardous waste contamination have been identified (DOE, 1980).

The animal life inhabiting the RFP and its buffer zone consists of species associated with western prairie regions. The most common large mammal is the mule deer with an estimated population between 100 to 125 permanent residents. There are a number of small carnivores, such as the coyote, red fox, striped skunk, and long-tailed weasel. A profusion of small herbivore species can be found throughout the RFP and Buffer Zone such as the pocket gopher, white-tailed jackrabbit, and the meadow vole (DOE, 1980).

Woman Creek supports an aquatic biota typical of high-prairie streams. Due to the low nutrient content in Woman Creek, the stream supports only small algal populations. Cattails and bullrush are also present. The rocky bottom of Woman Creek supports a relatively diverse biota composed of may flies, caddis flies, and other forms typical of clean water streams. Redside dace minnows are abundant in the streams and ponds; a few bluegill are also present (DOE, 1990a).

Bull snakes and rattlesnakes are the most frequently observed reptiles. Eastern yellow-bellied racers have also been seen. The eastern short-horned lizard has been reported on Plant site, but these and other lizards are not commonly observed. The western painted turtle and the western plains garter snake are found in and around many of the ponds (DOE, 1980).

Commonly observed birds include western meadowlarks, horned larks, morning doves, and vesper sparrow. A variety of ducks, killdeer, and red-winged blackbirds are seen in areas adjacent to ponds. Mallards and other ducks frequently nest and raise young on several of the ponds. Common birds of prey in the area include marsh hawks, red-tailed hawks, ferruginous hawks, rough-legged hawks, Swainson's Hawks, Great Horned Owls, and Burrowing Owls (DOE, 1980).

### 2.2.6 Threatened and Endangered Species

Relevant laws and regulations that protect threatened and endangered species include: NEPA of 1969, the Endangered Species Act (ESA) of 1973 (Public Law 93-0205), the Clean Water Act (CWA) as amended (33 U.S.C. 1251), and the Migratory Bird Treaty Act (16 U.S.C. 1701-711). Federal agencies must ensure that actions authorized, funded, or carried out by them will not jeopardize the continued existence of any endangered or threatened species (EG&G, 1991g).

Studies were conducted at the RFP to identify potential habitat for threatened and endangered species and other species of special concern (EG&G, 1991g). A literature search was conducted to obtain information on sensitive species that may be present at the RFP and data on habitats present on the site. Information on endangered species was obtained from the U.S. Fish and Wildlife Service (USFWS). The U.S. Army Corps of Engineers (COE) was contacted for information on wetland plant species. The Colorado Natural Areas Program and Colorado Division of Wildlife were contacted for information on state plant and animal species of special concern (EG&G, 1991g).

Habitat potentially suitable for four sensitive plant species: the Colorado butterfly plant (*Gaura neomexicana* var. *coloradensis*), the diluvium lady's tresses orchid (*Spiranthes diluvialis*) the forktip threeawn (*Aristida basiramea*) and the toothcup (*Rotala ramosior*), is also present on the RFP site. However, no individuals of these species were observed during the reconnaissance surveys.

The bald eagle (*Haliaeetus leucocephalus*) was identified to occasionally use habitat between 0.3 and 1.1 miles from the RFP site during the winter months. Habitat use by bald eagles on the site is expected to be casual, if it occurs at all. No bald eagle nests occur on the RFP site (DOE, 1990a).

Results of RFP studies also indicate that habitats potentially suitable for the endangered peregrine falcon (*Falco peregrinus*) is present at the RFP site (EG&G, 1991g). Although the peregrine falcon was not observed during the reconnaissance level surveys, two historic eyries are present within 10 miles of the RFP site. The Peregrine Falcon Recovery Plan (USFWS, 1984) discourages land-use practices that would adversely alter the character of their hunting habitat or prey base within a 10-mile radius of a nesting cliff (including historical sites).

Potentially suitable habitat is also present for six sensitive wildlife species, including: white-faced ibis (*Plegadis chichi*), ferruginous hawk (*Buteo regalis*), mountain plover (*Charadrius montanus*), long-billed curlew (*Numenius americanus*), Preble's meadow jumping mouse (*Zapus hudsonius preblei*), and swift fox (*Vulpes velox*). Insufficient information is available to determine if habitat for the sensitive species Texas horned lizard (*Phrynosoma cornutum*) is present on the RFP site. Prior to undertaking actions that may affect potentially suitable habitat, focused surveys will be conducted to determine if sensitive wildlife species are present.

The results of the aforementioned studies that pertain to fauna indicate that habitat potentially suitable for the endangered black-footed ferret (*Mustela nigripes*) is present on the RFP site. Black-footed ferrets require prairie dog colonies or complexes of smaller prairie dog colonies as habitat. In the northeast area of the plant site, approximately 15 acres were identified as a prairie dog colony location. These 15 acres are part of a larger colony comprised of an estimated 47 acres that is dissected by Highway 128. This acreage is part of a 753-acre complex that primarily occurs east of Indiana Street. Although the 47-acre colony by itself is insufficient to support black-footed ferrets, the larger complex is potentially suitable habitat for ferrets. This 753-acre complex is fragmented by several major roads and highways. No confirmed sightings have been reported for this area, but

several unconfirmed sightings have been reported for the Denver area. Surveys of the 753-acre complex may be required to determine if the 15 acres present on the RFP site is habitat for the black-footed ferret. Surveys will be required only if potential development directly impacts this colony. Based upon the information gathered for this survey, the USFWS is not considering the area of the RFP site as a re-introduction site for black-footed ferrets.

### 2.2.7 Sensitive Environments - Wetlands and Floodplains

The relevant laws and acts which protect wetlands and floodplains include: NEPA, Executive Order (E.O.) 11990—Protection of Wetlands; Sections 401 and 402 of the CWA; the Fish and Wildlife Act plus associated coordination acts; and regulations promulgated under 10 CFR Part 1022 - DOE Compliance with Floodplain Wetlands Environmental Review Requirements. The rules promulgated under NEPA 42 U.S.C. 4321, et seq., in 40 CFR parts 1500 through 1508 state that all federal agencies are required to consider the environmental effects to wetlands and floodplains for any proposed action (EG&G, 1990d).

Aerial photography for the 903 Pad, Mound, and East Trenches Areas was examined for wetlands identification, followed by limited site inspection (EG&G, 1990a). Wetlands have also been identified along both the Woman Creek and SID drainage areas (EG&G, 1990a). The SID receives surface water runoff from the southern part of the RFP facility with additional contributions from OU2. However, drainage contribution to the SID from OU2 is minimal. Evenly spaced drop structures along the SID have lowered flow velocities, increased sediment accumulation, and created fairly dense linear stands of wetlands. From a point due south of the 903 Pad and extending to Pond C-2, approximately 0.15 acres of wetlands are contained within this portion of the SID. Two isolated stands of wetlands have also been identified southeast of IHSS 140, where ground water emerges as seeps or springs. These two areas are each less than 500 square feet in size. Wetland species observed were primarily common cattails (*Typha latifolia*) (greater than 95 percent predominance), spike rush (*Eleocharis macrostachya*) and bullrush (*Scirpus americanus*). The wetlands primarily function as flow attenuation features with additional minor contributions to wildlife habitat and water quality enhancement. Drainage contribution to the SID from OU2 is minimal.

A detailed floodplain analysis has delineated a narrow, 100-year floodplain along the linear channel configuration of Woman Creek estimated to be 100-feet wide (DOE, 1991a). Woman Creek is an intermittent stream flowing primarily in response to precipitation events and interaction between surface water and shallow ground water. Initial site characterization studies completed in 1986 record measurable flow occurrences only at 4 of the 11 gauging stations along the drainage. Flow data for each of the four gauging stations was less than 10 gallons per minute (DOE, 1990a).

Each of the proposed actions for the Subsurface IM/IRA, along with their anticipated impacts to floodplains and wetlands, are described in Section 4. However, since the proposed actions are not located in the above described wetlands, but are at least 400 to 500 feet away, it should be noted that 10 CFR 1022, DOE Compliance with Floodplain Wetlands Environmental Review Requirements, does not apply.

#### **2.2.8 Cultural Resources**

NEPA (1969), the National Historic Preservation Act of 1966 (Public Law 89-665), and subsequent law amendments (Public Laws 91-243, 93-54, 94-422, 94-458) provide that all federal agencies implement programs for the protection of cultural resources.

A Cultural Resources Survey of the RFP was conducted between 31 May and 23 June 1991 that identified 45 cultural resources, none of which were recommended as eligible for listing on the National Register of Historic Places (EG&G, 1991a). In addition to the 45 sites located during the 1991 survey, there are six previously identified historic sites that were previously determined not to be eligible for listing on the National Register for Historic Places. However, these sites were not re-evaluated during this site-wide archeological survey. The State Office of Archeology and Historic Preservation has determined that any action in the vicinity of OU2 will not impact cultural resources (Burney, 1989).

### 2.3 CONTAMINANTS — DESCRIPTION AND SOURCES

The following discussion of contaminant types and distribution are based on data and interpretations presented in the Phase II RI/FS Work Plan (EG&G, 1990c), Draft Remedial Investigation Report (Rockwell, 1987a), and Draft Remedial Investigation Plan (Rockwell, 1988c). Soil, ground water, and surface water were sampled and analyzed for radionuclides and for the Hazardous Substance List (HSL) organics and inorganics. In general, soils in the vicinity of the IHSSs were found to contain low concentrations of VOCs, and occasionally elevated concentrations of plutonium (Pu) and americium (Am). Most soil samples contained phthalates, but this may be a result of field or laboratory contamination of the samples. Carbon tetrachloride (CCl<sub>4</sub>), tetrachloroethene (PCE), and trichloroethene (TCE) are the primary VOCs found in the upper hydrostratigraphic unit (this includes the alluvium and hydraulically interconnected bedrock sandstone [uppermost sandstone]) ground-water flow system at OU2. Trace elements occurring above natural background levels in ground water include: strontium, barium, copper, and nickel, and to a lesser extent chromium, manganese, selenium, lead, zinc, and molybdenum. Also, major cations and anions and total dissolved solids are somewhat elevated above background throughout and downgradient of the 903 Pad, Mound, and East Trenches Areas. Uranium-238 is the predominant radionuclide occurring above background in the upper hydrostratigraphic unit ground-water flow system. An evaporative concentration conceptual model has been advanced that may explain concentrations of high total dissolved solids, metals, and uranium in ground water at OU2.

Organic contamination is observed in seeps downgradient of the 903 Pad and in the upper reaches of South Walnut Creek at the Mound Area. Also, there are somewhat elevated concentrations of total dissolved solids, major ions, strontium, zinc, and uranium at many of the surface water stations. Seeps downgradient of the 903 Pad have also been found to contain Pu and Am. This is postulated to be due to the presence of contaminated suspended solids (i.e., soil) in the seep water, and is based on the chemistry of Pu and Am in natural water systems and studies performed by EG&G. The literature indicates that Pu is practically insoluble under oxidizing and near-neutral conditions (Cleveland, 1979) and Am strongly complexes with colloidal material and should exist in the particulate fraction

(Orlandini et al., 1990). That Pu and Am in surface seep water is particulate in nature is also supported by preliminary studies performed by EG&G (EG&G, 1991). The studies involved successive filtration of OU2 seep water with filter media possessing various pore sizes (i.e., 0.45 micrometers ( $\mu\text{m}$ ), 0.2  $\mu\text{m}$ , and 0.1  $\mu\text{m}$ ). The filtrates were then analyzed for Pu and Am. The analyses indicate that Pu and Am in surface water at OU2 are associated with the particulate phase. A more, comprehensive successive filtration study to examine the distribution of Pu and Am (i.e., dissolved versus particulate) in OU2 surface water is being planned by EG&G at this time.

Pu and Am occur above background in surface soils. Other radionuclides and trace metals occur at low concentrations and are infrequently above background, but may also be soil contaminants at the 903 Pad, Mound, and East Trenches Areas. Data suggest Pu and Am were released to soils in the area via wind dispersion during initial remedial efforts at the 903 Drum Storage Site. These radionuclides occur in surface soils throughout the 903 Pad, Mound, and East Trenches Areas and other downwind areas to the southeast.

The following discussion provides additional details of contamination in OU2 ground water, soils, sediments, and surface water. Comprehensive ground-water monitoring at the RFP has occurred since 1986. Wells have been installed throughout the property and are sampled quarterly. Appendix B-1 presents a summary of VOCs, radionuclides, metals, and inorganic contaminant concentrations above detection limits in the unconfined ground-water system at OU2. The extent of soil contamination at the 903 Pad, Mound, and East Trenches Areas was determined from soil samples collected in 1987 during the Phase I RI (Appendix A). Samples were collected from boreholes drilled in and adjacent to known IHSS locations (Figure 2-9). Two-foot intervals were composited for VOCs, and 2- to 10-foot intervals were composited for all other analytes. Boreholes were not drilled into sites still containing wastes (the Trenches and 903 Pad) due to potential health hazards to field workers and potential for release of waste constituents to the environment. Data for surface water and sediments has not been tabulated in this IM/IRAP because these media are not directly relevant to the IM/IRA. Nevertheless, a discussion of existing contamination in these media is provided in order to present a comprehensive description of the nature and extent of contamination at OU2.

### **2.3.1 Background Characterization**

In order to facilitate the interpretation of chemical results in non-background areas, a background characterization program has been implemented to define the spatial and temporal variability of naturally occurring constituents. Field work was conducted in 1989, and a draft Background Geochemical Characterization Report was prepared and submitted to the regulatory agencies on 15 December 1989 (Rockwell International, 1989a). The draft report was updated in December 1990 to include additional rounds of ground-water and surface water samples. The document summarizes the background data for ground water, surface water, sediments, and geologic materials, and identifies preliminary statistical boundaries (tolerance intervals) of background variability. Spatial variations in the chemistry of geologic materials and water were addressed by placing sample locations throughout background areas at the Plant. Evaluation of temporal variations in water chemistry is ongoing.

### **2.3.2 Soil Contamination**

The following discussions include a summary of VOCs, radionuclides, and metals concentrations that are above detection limits in soils at OU2. This discussion is considered preliminary because soil samples have not been collected in the actual waste burial areas (IHSS). This type of sampling will be conducted during the Phase II RI.

#### **2.3.2.1 Volatile Organic Contamination**

VOCs (including: PCE, TCE, toluene, 2-butanone, CCl<sub>4</sub>, acetone, and methylene chloride) were reported in samples from the 903 Pad and East Trenches Areas. Occurrences of total xylenes, ethylbenzene, and toluene were also reported for the 903 Pad Area, whereas 1,2-dichloroethane (1,2-DCA), 1,1,1-TCA, and 1,1,2-Trichloroethane (1,1,2-TCA) were reported in an East Trenches borehole. The Mound Area soils, like other portions of OU2, contained acetone (hundreds of micrograms per kilogram) and methylene chloride (typically tens of micrograms per kilogram) at concentrations too low to unambiguously demonstrate

contamination with these compounds. Other organic constituents in the Mound Area (PCE, CHCl<sub>3</sub>, 1,2-DCA) were less numerous and at lower levels than at other areas within OU2.

### **2.3.2.2 Inorganic Contamination**

#### **Radionuclide Contamination**

Based on the Phase I RI borehole data, Pu and Am are the principal radionuclide contaminants exhibiting elevated concentrations in soils. Highest concentrations occurred in samples that included the surface soils in the area, and were typically on the order of 100 picoCuries per gram (pCi/g). Because many of the surface soil samples were mixed into large composites, the Phase I RI data do not eliminate the presence of radionuclides other than Pu and Am. Cesium-137, tritium, and uranium were detected, albeit at near-background concentrations and in fewer than 10 samples. Surface contamination of soils with Pu and Am was further demonstrated by recent aerial and *in situ* radiological surveys (EG&G, 1990a; EG&G, 1991b) (Figures 2-10 and 2-11). The radioactivity detected in that survey was associated with known radioactive material storage and handling areas (i.e., the 903 Pad), and was attributed to Pu, Am, and a uranium decay product. Soil sampling indicated elevated concentrations of americium in soils east of the 903 Pad Lip Site as high as 97 pCi/g, and by inference from their expected activity ratio, plutonium as high as 500 pCi/g. Subsequent analysis of samples from the area with high americium concentrations indicated plutonium concentrations as high as 457 pCi/g. The cesium-137 activity at RFP is at a level consistent with global fallout.

#### **Metals Contamination**

Several metals occurred above background in soil samples (aluminum, arsenic, barium, cadmium, calcium, iron, mercury, manganese, lead, antimony, vanadium, and zinc), although most exceeded background by less than a factor of two and/or in only one or two samples. Appendix A presents maximum metal concentrations in soils.

### 2.3.3 Ground-Water Contamination

#### 2.3.3.1 Volatile Organic Contamination

The primary VOCs in ground water ( $\text{CCl}_4$ , PCE, and TCE) are portrayed by isopleths for alluvial ground water in Figures 2-12 through 2-14 and bedrock ground water in Figures 2-15 through 2-17. This data provides a representative "snapshot" of ground-water contamination at OU2, i.e., previous and subsequent water quality data show similar patterns of ground-water VOC contamination. The ground-water data in Appendix B-2 confirm the relative dominance of  $\text{CCl}_4$ , PCE, and TCE in alluvial and shallow bedrock ground water at OU2 compared to other VOCs, and documents occurrences of 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), 1,2-dichloroethene (1,2-DCE), and vinyl chloride (all are possible degradation products of the principal contaminants), and 1,1,1-trichloroethane (1,1,1-TCA), total-1,2-DCE, 2-hexanone, chloroform ( $\text{CHCl}_3$ ), methylene chloride, acetone, and carbon disulfide. The latter four analytes were reported at levels below detection limit and therefore represent only estimated values.

A review of Figures 2-12 through 2-17 suggest that the 903 Pad is the main source of  $\text{CCl}_4$ , with possible contributions from the northern East Trenches. Also, the Mound Area appears to be the main source of PCE, and TCE occurs throughout OU2 implying multiple sources.

#### 2.3.3.2 Inorganic Contamination

##### Radionuclides

Appendix B-2 shows that dissolved concentrations of the uranium isotopes (U-234, U-235, and U-238) have been above background at OU2. The maximum concentration for uranium 238 was  $28 \pm 2$  picoCuries per liter ( $\text{pCi}/\ell$ ) in well 12-87 in the 903 Pad Area. Numerous occurrences of uranium at lower concentrations and in wells completed in diverse lithologies demonstrate that the distribution of uranium is not thoroughly delineated at OU2. Review of unvalidated Pu data (total and dissolved) for ground-water wells east-southeast of the 903

Pad indicates Pu in ground water is generally at non-detectable levels (error term is greater than the reported value). The highest concentrations of Pu reported were in well 2-71 (total plutonium =  $1.9 \pm 1$  pCi/ $\ell$  on 3/11/87 and  $32 \pm 3$  pCi/ $\ell$  in 1988). However, there are three other sampling events showing total Pu was non-detectable, and the reported value for 1988 is suspect because an exact date for the sample cannot be determined from the documentation. Furthermore, there are seven other analyses for dissolved plutonium for this well where the radionuclide was non-detectable. Because Pu and Am are infrequently detected in ground water at this well and elsewhere, it is uncertain whether these radionuclides are actual ground-water contaminants.

### Metals

Metals that exceeded background in one or more wells in the second quarter of 1989 include: aluminum, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, strontium, vanadium, and zinc. A summary of multiple sampling events (Appendix B-1) shows that only a subset of these analytes repeatedly exceed background and/or exceed background by a wide margin. The sporadic exceedances of background, and the absence of apparent gradients in metal concentrations with respect to IHSSs, hinders drawing definite conclusions as to whether these constituents are derived from IHSSs.

### Major Ions

Major ions and total dissolved solids (TDS) are somewhat elevated above background throughout and downgradient of the 903 Pad, Mound and East Trenches Areas (Appendix B-2). Total dissolved solids typically ranged between 400 and 1,000 milligrams per liter (mg/ $\ell$ ); chloride was generally 30 to 100 mg/ $\ell$ , nitrate was 2 to 10 mg/ $\ell$ , and most sulfate concentrations were between 10 and 100 mg/ $\ell$  in the second quarter of 1989. In general, major cations were accordingly elevated. The highest concentrations of major ions are in well 29-87 southeast of the 903 Pad, although TDS in ground water at the northernmost wells (34-87 and 35-87) was also quite high in ( $\sim 1,000$  mg/ $\ell$ ).

#### **2.3.4 Surface Water Contamination**

Surface water and surface seep stations in the vicinity of the 903 Pad, Mound, and East Trenches Areas were sampled during field activities from 1986 through 1991. The following discussion is based on all available data because many seeps or stream stations were dry during some samplings. Surface water monitoring locations are shown in Figure 2-18. The surface water seeps are immediately downslope and southeast of the 903 Pad Area, and downslope and north of the Mound Area and East Trenches Areas.

Because surface water at seeps and in streams represents ground-water discharge (intermittent discharge with respect to streams), the surface water compositions are similar to those of local ground water. The data for both media show that PCE, TCE, CCl<sub>4</sub>, and their degradation products are the principal VOCs and show very similar major ion contents as well. However, there is enough variability within stations so that it is not possible to demonstrate surface/ground-water connections on a well-by-well, seep-by-seep basis.

Seeps in the vicinity of the 903 Pad Lip Site have had significant concentrations of Pu and/or Am. However, the samples contained suspended solids, and surface soils in the vicinity of the seeps are contaminated with radionuclides. Furthermore, total radiochemistry data do indicate notably higher Pu and Am concentrations than in filtered samples (0.45  $\mu$ m nominal pore size), demonstrating that most of the radionuclides are in a particulate form. Therefore, the local soils represent the most direct potential source for seep contamination. There is no immediate threat to public health and the environment posed by surface water contamination because the affected surface water is contained within the Plant boundary by existing detection ponds, and is treated and monitored prior to discharge for removal of volatile organic contaminants and suspended particulates to which radionuclides, if present, are likely to adsorb.

#### **2.3.5 Air Contamination**

The 903 Pad Area is recognized as the principal source of airborne Pu contamination at the RFP. An extensive air monitoring network known as the Radioactive Ambient Air

Monitoring Program (RAAMP) is maintained at the Plant in order to monitor particulate emissions from the 903 Pad Area and other Plant facilities. Historically, the particulate samplers located immediately east, southeast, and northeast of the 903 Pad, Mound, and East Trenches Areas have shown the highest Pu concentrations. This finding is corroborated by the results of soil surveys that indicate elevated Pu concentrations to the east, particularly southeast of the area. However, RAAMP has found ambient air samples for Pu to be well within the DOE guidelines of  $20.0 \times 10^{-6}$  pCi/l established for the protection of human health (Rockwell International, 1987b).

### 2.3.6 Summary of Contamination

The Phase I RI investigations of environmental media lead to the general conclusions that volatile organic and inorganic contamination in soils, ground water, and surface water and radionuclide contamination in soils exist around several OU2 IHSS. The RI also determined that the distribution and magnitude of the contamination can be better delineated via sampling and analysis planned for the Phase II investigation.

TCE, PCE, and  $\text{CCl}_4$  are the principal organic contaminants in soils, surface, and ground waters, with lesser amounts of their degradation products and other compounds at numerous sampling sites throughout OU2. Apparent Pu and Am in surface water samples are other apparent indicators of RFP-derived contamination.

Several metals and other inorganic constituents (including uranium) are also above background in the environmental media, but the data do not permit unambiguous conclusions with regard to contamination. The uncertainty results in part from the absence of clear concentration gradients and from the limited knowledge of the inorganic composition of waste sources in OU2. Natural processes (e.g., evaporative concentration) may govern the source and distribution of such inorganic constituents. This will be further investigated in the context of long-term remediation at OU2.

## 2.4 ANALYTICAL DATA

Appendix A of Volume II presents a compilation of volatile organic, inorganic, and radiochemistry data for all ground-water monitoring stations at OU2 that are available at this time. Some of the data have been validated; they are identified in the appendices by a qualifier adjacent to each datum. The qualifiers "V" (valid), "A" (acceptable with qualifications), and "R" (rejected) are assigned in accordance with the ER Program Quality Assurance/Quality Control (QA/QC) Plan (Rockwell International, 1989c). Rejected data either did not conform to the QA/QC procedures, or insufficient documentation exists to demonstrate conformance with these procedures. These data, at best, can only be considered qualitative measures of the analyte concentrations. The schedule for the IM/IRA does not permit waiting for all data to be validated. However, the validated data and their similarity to invalidated data are considered sufficient for this IM/IRAP/EA.

## 2.5 SITE CONDITIONS THAT JUSTIFY AN IM/IRA

The IM/IRA will provide information for selection, design, and implementation of the final remedial action that addresses subsurface VOC contamination.

As discussed in Section 1, there is no immediate threat to public health and the environment posed by subsurface VOC contamination at OU2. Cleanup of subsurface VOC contamination at OU2 will, therefore, be addressed in designing and implementing final remedial actions. However, uncertainties with respect to the OU2 subsurface geology and its effect on site-specific remedial technology performance presents many challenges for selection and design of final actions. Thus, the IM/IRA is an investigative tool to resolve such uncertainties and streamline the RI/FS/remedial action (RA) process which is, the primary justification for the proposed Subsurface IM/IRA at OU2.

## SECTION 3

### IDENTIFICATION OF SUBSURFACE IM/IRA OBJECTIVES

#### 3.1 OBJECTIVES OF INTERIM MEASURES/INTERIM REMEDIAL ACTION

The primary objective of the Subsurface IM/IRA is to provide information that will aid in the selection and design of final remedial actions at OU2 that will address removal of suspected free-phase VOC contamination. In general, the information to be collected includes subsurface characterization and site-specific technology performance data, which can be used in FS alternative evaluation and final remedial system design. The IM/IRA will be comprehensive in that subsurface geological data will be collected for a minimum of three different OU2 locations. Based on the meetings between DOE, EPA, and CDH during the Fall of 1991 (Section 1), DOE is proposing this Subsurface IM/IRAP/EA that specifies treatability testing at the 903 Pad, Mound, and East Trenches Areas for the implementation and evaluation of VOC source removal technologies.

#### 3.2 COMPLIANCE WITH ARARS AND PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The NCP [40 CFR 300.430 (e)] requires that, in development of remediation goals, the following be considered:

- ARARs.
- For systemic contaminants, concentration levels that will not cause adverse effects to the human population and sensitive subgroups over a lifetime of exposure.
- For carcinogens, exposure levels represent an upper bound lifetime cancer risk between  $10^{-4}$  and  $10^{-6}$ . The  $10^{-6}$  risk level is to be used as a point of departure when ARARs are not available or are not sufficiently protective because of multiple contaminants or multiple exposure pathways.
- Factors related to detection limits.
- For current or potential sources of drinking water, attainment of Maximum Contaminant Level Goals (MCLGs) or Maximum Contaminant Levels (MCLs), if MCLGs are zero.

- Attainment of CWA ambient water quality criteria (AWQC), where relevant and appropriate.

The IAG, in paragraph 150, states "Interim Remedial Actions/Interim Measures shall, to the greatest extent practicable, attain ARARs." Also for interim actions, the NCP [40 CFR 300.430(f)] specifically notes that an ARAR can be waived if the action is to become part of the final remedy that will attain ARARs.

This section identifies and analyzes ARARs relevant to the proposed Operable Unit No. 2 Subsurface IM/IRA. Because a remedial action would be considered an on-site IM/IRA to be administered under CERCLA, only substantive and not administrative requirements of regulations (such as RCRA) apply. Permits, for example, are not required (per paragraph 121 of the IAG).

### **3.2.1 Applicable or Relevant and Appropriate Requirements**

"Applicable requirements," as defined in 40 CFR 300.5, mean "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable." "Relevant and appropriate requirements," also defined in 40 CFR 300.5, mean "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws, that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate." According to CERCLA §121(d)(2), in order to be considered an ARAR, a state requirement must have

been "promulgated." As defined in 40 CFR 300.400(g)(4) of the NCP, the term "promulgated" means that the requirement is of general applicability and is legally enforceable.

### 3.2.2 Items to be Considered

In addition to ARARs, advisories, criteria, or guidance may be identified as to be considered (TBC) for a particular release. As defined in 40 CFR 300.400(g)(3), the TBC category consists of advisories, criteria, or guidance developed by EPA, other federal agencies, or states that may be useful in developing remedies. Unlike ARARs, use of TBCs is discretionary.

### 3.2.3 ARAR Categories

In general, there are three categories of ARARs. These categories are:

- Ambient or chemical-specific requirements.
- Location-specific requirements.
- Performance, design, or other action-specific requirements.

Each category is discussed in more detail below.

## 3.3 AMBIENT OR CHEMICAL-SPECIFIC REQUIREMENTS

Ambient or chemical-specific requirements set health- or risk-based concentration limits in various environmental media for specific hazardous substances or pollutants. These requirements set protective clean-up levels for the chemicals of concern in the designated media, or may act as action-related requirements in indicating a safe level of air emission or wastewater discharge. The chemical-specific ARARs identified herein are used in defining the remediation goals for discharge of treated ground water to surface water.

ARARs are derived primarily from federal and state health and environmental statutes and regulations. Where background concentrations for constituents are above the ARAR for that constituent, a waiver from the ARAR may be appropriate. A summary of ARARs for the

contaminants found to exceed background in OU2 ground water are presented in Appendix C, Table C-1 and includes ARARs for volatile organics, metals, conventional pollutants, and radionuclides. These ARARs will be applied as effluent standards for the water treatment facility. TBCs generally have been identified in Table C-1 where ARARs could not be found, and will be used as goals for ground-water treatment.

As discussed in 55 FR 8741 (Preamble to the NCP), when more than one ARAR exists for a contaminant, the most stringent standard has been identified as the ARAR. This IM/IRA will attain the most stringent ARAR to the greatest extent practicable. Where no ARAR standard can be found, a TBC standard has been identified as a goal for the IM/IRA. Federal and state ARAR spreadsheets used in the ARAR analysis for volatile organics, metals, conventional pollutants, and radionuclides are presented in tables C-2.1 and C-2.2, Appendix C. The standards identified as chemical-specific ARARs in Table C-1, Appendix C, are based on the most stringent standards found in the Safe Drinking Water Act (SDWA) MCLs and the Colorado Water Quality Control Commission (WQCC) statewide and basin-wide water standards. As described in Sections 3.3.1 through 3.3.3, the standards mentioned above were found to be applicable or relevant and appropriate to discharge to South Walnut Creek Basin surface waters.

The standards and criteria identified as TBC in Table C-1 are based on the most stringent standards found in WQCC Site-Specific Surface Water Standards found in section 3.8.0 (5 CCR 1002-8) and the criteria in Tables I, II, and III of 3.1.16 in the Basic Standards for Surface Water. Additionally, CWA Ambient Water Quality Criteria (AWQC) were applied as TBC whenever more appropriate ARARs or TBCs were not identified.

Of the elements/compounds detected in ground water at OU2, there are no ARARs or TBCs applicable to treated effluent discharges to South Walnut Creek for: acetone, carbon disulfide, 1,1-dichloroethane, 4-methyl-2-pentanone, 2-hexanone, calcium, lithium, magnesium, molybdenum, potassium, sodium, strontium, vanadium, bicarbonate and cesium<sup>137</sup>. As discussed in Section 2.3.3., cesium<sup>137</sup> is not an RFP contaminant. Where appropriate, background concentrations are used as goals for the IM/IRA.

### 3.3.1 Safe Drinking Water Act MCLs

SDWA MCLs represent the maximum permissible level of contaminants in water that is delivered to the free-flowing outlet of the ultimate user of a public water system [40 CFR 141.2(c)]. Because water in the South Walnut Creek Basin is a potential source of drinking water, MCLs are relevant and appropriate. Furthermore, the NCP [40 CFR 300.430(e)] requires that, in the development of remediation goals for evaluating final remediation alternatives for current or potential sources of drinking water, MCLGs (or MCLs, if MCLGs are zero), should be attained, where relevant and appropriate. As surface water at OU2 is a potential source of drinking water, the MCLGs (or MCLs) are relevant and appropriate and should be attained. It is important to note that with the exception of copper, the MCLGs are currently zero or equal to the MCLs. It should be further noted that on 30 January 1991 (56 FR 3526) EPA published final rules amending MCLs and MCLGs for a number of the constituents identified in Table C-1. These standards are effective and become requirements on 30 July 1992 and, accordingly, will be regarded as relevant and appropriate at that time. Because they will likely be effective before this IM/IRAP is implemented, the new MCLs have been identified as ARAR in Table C-1.

### 3.3.2 Colorado WQCC Standards for Surface Water

The Colorado WQCC has established both statewide and stream segment-specific standards for the protection of state surface waters. Statewide standards exist for certain radioactive isotopes and organic compounds, and have been adopted for all state sources of drinking water and areas requiring protection of aquatic life (see Section 3.1.11, 5 CCR 1002-8). These standards are consequently of general applicability. The statewide standards are enforceable through the state's NPDES permitting process. Having met the NCP state ARAR requirements of enforceability and general applicability [40 CFR 300.400(g)(4)], the statewide surface water standards have been applied as ARAR in Table C-1.

Site-specific surface water standards exist for certain organics, metals, inorganics, and radioactive constituents in the form of goals for Segment 5. Unlike the WQCC statewide standards discussed above, these site-specific standards do not appear to satisfy the NCP

requirements for state ARARs. As goals, these standards are not enforceable through the NPDES permitting process and furthermore, they have been adopted only for surface waters at the RFP and so are not of general applicability. In addition, the site-specific standards for radioactive constituents are significantly more stringent than any standards applied to other Colorado surface waters. Consequently, the site-specific organic and inorganic chemical, metal, and radionuclide surface water standards are not ARAR. These standards have been applied as TBC in Table C-1 because they reflect the degree of protectiveness determined to be necessary for the RFP surface waters by the Colorado WQCC.

### **3.3.3 CWA Ambient Water Quality Criteria**

The CWA AWQC are non-enforceable guidance developed under CWA Section 304, and are used by states in conjunction with designated stream segment usages to establish water quality standards for the protection of aquatic life and for the protection of human health. Standards exist for drinking water and fish consumption, fish consumption only, as well as standards for the protection of aquatic life. CERCLA Section 121(d) requires that CWA AWQC be considered in the development of remediation goals in the FS process, where relevant and appropriate. Use of "relevant and appropriate" relative to AWQC does not refer to ARARs. Rather, 40CFR 300.430(a) of the NCP requires that attainment of AWQC be considered in addition to ARARs. Pursuant to the preamble of the NCP and EPA guidance (55 FR 8754; EPA, 1990) AWQC will generally not be considered relevant and appropriate whenever other standards exist that are specific to the constituents and the use of the affected water. Consequently, since the WQCC has designated RFP surface waters as drinking water usage and aquatic life protection stream reaches with associated standards, the AWQC were used as TBC in Table C-1 only when more appropriate federal or Colorado standards were unavailable.

## **3.4 LOCATION-SPECIFIC REQUIREMENTS**

Location-specific ARARs are limits placed on the concentration of hazardous substances or the conduct of activities solely because they occur in certain locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of a site. Examples

of location-specific ARARs that pertain to the IM/IRA are federal and state siting laws for hazardous waste facilities (40 CFR 264.18, fault zone, and floodplain restrictions), and federal regulations requiring that actions minimize or avoid adverse effects to wetlands (40 CFR Part 6 Appendix A and 40 CFR Parts 230-231).

More specifically, in addition to the requirements described above, pertinent location-specific ARARs include: Colorado requirements for siting of hazardous waste facilities and wastewater treatment facilities (Colorado Revised Statute 25-15-101, 203, 208, 302 and 25-8-292, 702, respectively); National Historic Preservation Act requirements for preservation of significant articles and historic properties (36 CFR Parts 65 and 800, respectively); federal critical habitat protection requirements (50 CFR Parts 200, 402 and 33 CFR Parts 320-330); and federal requirements for the protection of fish and wildlife resources (40 CFR 6.302).

A summary of location-specific ARARs, which this IM/IRA will attain to the greatest extent practicable, is presented in Table C-5.

### **3.5 PERFORMANCE, DESIGN, OR OTHER ACTION-SPECIFIC REQUIREMENTS**

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are not triggered by the specific chemicals present at a site, but rather by the particular IM/IRA actions that are part of this plan. Action-specific ARARs are technology-based performance standards, such as the Best Available Technology (BAT) standard of the Federal Water Pollution Control Act. Other examples include RCRA treatment, storage, and disposal standards, and CWA pretreatment standards for discharges to publicly owned treatment works (POTW).

RCRA land disposal restrictions (LDR) for certain contaminants (40 CFR Part 268.40) are also action-specific ARARs for the disposal of secondary wastes generated during water treatment. Any wastes, hazardous or not, are subject to CERCLA section 121(d)(3), also known as the "off-site policy." The "off-site policy" requires that CERCLA wastes be shipped off site only to facilities in compliance with applicable federal and state laws. Action-specific

ARARs that will be attained by the IM/IRA to the greatest extent practicable are included in Table C-4. Table C-3 presents RCRA LDRs that are potentially ARAR for placement or land disposal involving non-effluent wastes (e.g., treatment sludges, excavated soils, used treatment materials) if they may be determined to contain hazardous wastes. LDR requirements may be relevant and appropriate for wastes that are not hazardous wastes, as defined in 40 CFR Part 261, but do contain hazardous substances. Any wastes generated by the IM/IRA will be evaluated to determine if they are identifiable as hazardous wastes. At present, no determination has been made whether the anticipated contaminants of wastes from the IM/IRA are listed hazardous wastes. However, IM/IRA wastes, such as spent carbon may be found to be characteristically hazardous (40 CFR part 261 Subpart C).

Action-specific ARARs also exist for air emissions from this IM/IRA. The Colorado Air Quality Control Commission (AQCC) has established emission control regulations for the protection of state air quality. Relative to this IM/IRA, AQCC regulations provide pertinent requirements that must be considered. Action-specific ARARs, which the IM/IRA will attain to the greatest extent practicable, are included in Table C-4.

AQCC Regulation 7 (5 CCR 1001-7) provides requirements for sources of VOCs that are associated with the formation of ozone. Regulated sources of VOCs must implement Reasonably Achievable Control Technology (RACT) and describe any control measures in an emission permit application to the Air Quality Control Division (AQCD). According to AQCC Regulation 3, Section III.D, the threshold for the permit requirement is emission of 1 ton or more of VOCs per year. As defined in Section G of the AQCC Common Provisions Regulations, RACT means a technology that will achieve the maximum degree of emission control that a particular source is capable of meeting, and which is reasonably available considering technological and economic feasibility. The IM/IRA will not emit VOCs in excess of 1 ton/year because a vapor treatment system will be used to remove in excess of 99 percent of the VOCs. However, the treatment system would constitute a RACT.

AQCC Regulation 8 (5 CCR 1001-8) includes requirements for the control of hazardous air pollutants. Of the potential contaminants in this IM/IRA, beryllium, benzene, mercury, lead, and vinyl chloride are considered hazardous air pollutants according to this regulation. With

the exception of lead, the requirements of Regulation 8 are neither applicable nor relevant and appropriate to this IM/IRA. In general, the controls of Regulation 8 apply to emission sources that use or manufacture material containing the hazardous air pollutant. Since this IM/IRA will neither use nor manufacture any of the hazardous air pollutants, the emission limit provisions of Regulation 8 are not ARAR, however, they do provide useful guidance to be considered. With respect to lead, the emission limit of 1.5 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) applies to any stationary source. Therefore, the standard may be applicable to the IM/IRA, and accordingly, has been applied as ARAR.

Under EPA regulations at 40 CFR Part 61 Subpart H, hazardous air pollutant restrictions also exist for radionuclide emissions at DOE facilities. These regulations require monitoring to ensure that any radionuclides emitted do not result in any member of the public receiving an effective dose equivalent of 10 milliradiation equivalent man per year (mrem/yr). Because this standard applies to RFP as a whole, plant emissions are regularly assessed. The plant emissions have been found to fall orders of magnitude below the standard. Emissions from the IM/IRA will be monitored and the results incorporated with the plant data.

A table summarizing restrictions on IM/IRA air emissions is presented in Table C-6.

As explained in the NCP (see 55 FR 8666), OSHA requirements for worker protection in hazardous waste operations and emergency response (29 CFR 1910.120) are applicable to workers involved in hazardous substance-related activities, as well as other OSHA requirements related to specific circumstances or activities. Even though these requirements are not environmental in nature, and therefore, are not considered ARARs, they must be satisfied.

## SECTION 4 PROPOSED ACTIONS

This IM/IRA involves application of *in situ* vacuum-enhanced vapor extraction at three different subsurface environments at OU2 for removal of suspected, free-phase VOCs from the vadose and saturated zones. The three subsurface sites selected for implementation of the IM/IRA differ in their expected geology and nature of contamination. Each of the three selected sites are located within one of the three primary OU2 areas: 903 Pad, Mound, and East Trenches. As discussed in this section, each of the sites offer unique challenges for *in situ* remediation of the subsurface.

Implementation of the proposed *in situ* vacuum-enhanced vapor extraction actions may be complicated by uncertainties resulting from incomplete site characterization of OU2. A phased implementation of the proposed actions is therefore proposed to ensure project success. The planned phases of implementation include:

- Location of test sites.
- Pilot testing.
- Post-pilot operation (if deemed beneficial).

The first phase is the location of suitable test sites at the 903 Pad, Mound, and East Trenches Areas. Data from the Phase II RI will be used to pinpoint locations for the vapor extraction and injection wells. In the event that these data do not provide enough information to select well locations, a soil vapor survey will be conducted.

The second phase involves *in situ* pilot testing of the proposed vapor extraction systems at each of the test sites. Information collected during the pilot studies will aid in the selection, design, and implementation of final subsurface VOC removal actions at OU2. Information from the pilot study phase will also be used to assess the benefit of pursuing th of the IM/IRA, post-pilot study operation of the systems with system mo appropriate.

The final phase of IM/IRA implementation is post-pilot operation (if deemed beneficial) of the vapor extraction systems at the three OU2 test sites. EPA OSWER Observational/Streamlined Approach methodology has been used to formulate the proposed actions to minimize difficulties in the execution of this IM/IRA. The Observation/Streamlined Approach involves development of a remedial action based on probable site conditions that are identified using existing information, and that are modified as necessary as additional information is gained during implementation.

Prior to presentation of the proposed actions, it is useful to consider the rationale behind selection of *in situ* vacuum-enhanced vapor extraction for this IM/IRA. This background information is presented in Section 4.1. Section 4.2 describes the process that is used to critically evaluate the effectiveness, implementability, and environmental impact of the proposed actions. Sections 4.3 through 4.5 present and evaluate each of the proposed actions at the 903 Pad, Mound, and East Trenches Areas, respectively. Section 4.6 presents a detailed description of existing or planned RFP water treatment facilities that could potentially be used to treat contaminated ground water generated during Subsurface IM/IRA dewatering operations. Section 4.7 presents an environmental assessment of the No Action Alternative with respect to OU2 subsurface VOC contamination, and Section 4.8 provides a summary comparison of environmental impacts from the proposed remedial actions and the No Action Alternative.

#### 4.1 RATIONALE FOR IM/IRA TECHNOLOGY SELECTION

NCP guidance states that "few alternatives, and in some cases, perhaps only one, should be developed for interim actions." Based on a review of technologies available for *in situ* removal/destruction of VOCs, only one remedial alternative, *in situ* vacuum-enhanced vapor extraction, was selected for immediate implementation in the Subsurface IM/IRA. A second technology, *in situ* steam stripping, is also being considered for investigation as part of this IM/IRA because it has the potential to recover both VOCs and radionuclides, and the technology is currently being tested by DOE.

The technology review process involved identification of potentially feasible VOC-removal/destruction technologies followed by evaluation with respect to the following criteria:

- Achieve IM/IRA objective.
- Address the source of the dissolved-phase ground-water plume.
- Minimize the risk of spreading contamination.

As discussed in Section 3, the primary objective of the IM/IRA is to collect information that will aid in selection and design of final OU2 remedial actions that address subsurface free-phase VOC contamination.

Source removal played an important role in the technology review process. The organic contaminants at OU2 are primarily chlorinated solvents (PCE, TCE, and carbon tetrachloride). All of the chlorinated solvent contaminants at OU2 have specific gravities greater than 1.0 (i.e., heavier than water). Liquids with this property are referred to as Dense Non-Aqueous Phase Liquids or DNAPLs. These substances have very low solubilities in water, on the order of 100 to 1,100 mg/ℓ (parts per million). For this reason, classical remedial actions like ground-water extraction and aboveground treatment will not remediate the site in a timely manner. Pump and treat technologies require that the source material first dissolve into the ground water. For example, removal of a 55-gallon solvent spill in this manner would require pumping approximately 45,000,000 gallons of ground water with an average concentration of 2 mg/ℓ. Furthermore, the water bearing formations at OU2 are not expected to yield large volumes of water due to their low permeabilities. Therefore, technologies that have the potential to directly remove the source material were considered desirable.

Finally, the review process involved examining technologies with respect to their risk of spreading VOC and radionuclide contamination. This is particularly important at OU2 due to the potential mobilization of radionuclides that may be present at the test sites, specifically uranium, plutonium, and americium. Radionuclide mobility in the aquifer is sensitive to fluctuations in temperature and pH. Candidate remedial technologies were

eliminated from further consideration if they posed any unknown risk of uncontrolled mobilization of radionuclides or VOCs.

Candidate *in situ* remedial technologies considered for the Subsurface IM/IRA included:

- Dehalogenation.
- Chemical oxidation.
- Steam stripping.
- Bioremediation.
- Vacuum-enhanced vapor extraction.

*In situ* dehalogenation involves introducing an aqueous dehalogenating solution such as sodium borohydrite solution or zinc and acetic acid into the affected portion of the aquifer. Dehalogenating solutions are reductants that liberate nascent (atomic) hydrogen, which replaces chlorine atoms on the solvent molecules, significantly reducing their toxicity. However, there are process uncertainties with respect to uncontrolled mobilization of radionuclides that may be present in the subsurface. The dehalogenation solutions may, for example, lower the pH of the ground water or degrade subsurface humic materials, potentially increasing radionuclide mobility. Bench-scale treatability studies will be performed to resolve this uncertainty prior to consideration of the technology for field implementation.

*In situ* chemical oxidation involves introducing an aqueous oxidizing solution such as a combination of metallic iron and hydrogen peroxide (i.e., Fenton's reagent) into the affected portion of the aquifer. The oxidizing agent (hydroxyl radical in the case of Fenton's reagent) reacts with the VOCs to mineralize them to carbon dioxide and water. Preliminary results of bench-scale testing of chemical oxidation for the 881 Hillside ultra-violet (UV) peroxide/oxidation treatment system have indicated successful destruction of VOCs containing carbon-carbon double bonds (i.e., TCE, PCE, etc.). The results have suggested poor destruction efficiencies for VOCs not containing the reactive carbon-carbon double bonds (i.e., carbon tetrachloride, 1,1,1-TCA, etc.). Also, as discussed above for *in situ* dehalogenation, there are uncertainties associated with chemical oxidation with respect to

uncontrolled mobilization of radionuclides. Therefore, treatability studies examining chemical oxidation will be conducted in the laboratory prior to consideration of the technology for field implementation.

*In situ* bioremediation utilizes naturally occurring or cultured microorganisms to degrade VOCs. Nutrients and co-metabolites are injected into the subsurface to augment and sustain the microbe populations. Bioremediation has successfully treated many non-halogenated hydrocarbons, but has been less successful with halogenated compounds. Nonetheless, recent progress in bioremediation research indicates that this technology holds promise for the degradation of halogenated organic compounds. At this time, however, inclusion of bioremediation investigations in the Subsurface IM/IRA at OU2 is premature. If future research progress indicates that bioremediation is a practical alternative for degradation of free-phase chlorinated solvents, this technology will be tested to examine its applicability for OU2.

*In situ* steam stripping includes injection of pressurized steam to displace ground water and vaporize free-phase VOCs trapped in the aquifer and vadose zone soils. Subsurface temperature increases associated with the injected steam, along with a reduction in subsurface pH, may be effective in solubilizing radionuclides adsorbed to the subsurface matrix. Recovery wells are used to collect dissolved, free-phase and/or vapor-phase VOCs and dissolved radionuclides. Condensation of steam and VOCs occurs at the steam front, which expands vertically and laterally over time. The orientation of the steam front is critical to prevent the downward migration of condensed free-phase VOCs. However, uncertainties associated with maintaining the steam front at the proper angle and the effectiveness of radionuclide desorption and solubilization require that *in situ* steam stripping be first examined on a bench scale prior to field testing. Treatability studies examining this technology are currently being conducted by Lawrence Livermore National Laboratory (LLNL) in Livermore, California. Because *in situ* steam stripping has the potential to recover both VOCs and radionuclides, and this technology is currently being

investigated by DOE, it is being considered for further investigation as part of this Subsurface IM/IRA. An additional project phase may, therefore, be added to the Subsurface IM/IRA to conduct an *in situ* steam stripping pilot test after the results of LLNL study are assessed.

*In situ* vacuum-enhanced vapor extraction involves the installation of one or more vapor extraction wells within or adjacent to an area containing residual free-phase hydrocarbons. The wells are manifolded into a vacuum pump and the vacuum induced in the subsurface creates a sweep of air through the formation. The induced air flow volatilizes and removes the residual free-phase solvents. Separate wells may also be used to inject ambient or heated air into the formation to increase airflow through the contaminated area. In order to address residual contamination held in the aquifer material, the water table must be lowered by pumping to expose the residual DNAPL to the air flow induced in the formation.

*In situ* vacuum-enhanced vapor extraction coupled with water table depression satisfies the three criteria listed above and has been selected for the Subsurface IM/IRA at OU2. It will provide data that will be useful in the selection and design of a final action as it is potentially applicable at all OU2 solvent spill or burial sites. It addresses the source of the dissolved-phase ground-water plume and reduces the likelihood of additional contaminants migrating from the vadose to the saturated zone. This technology does not involve subsurface injection of liquid reagents, so there is little probability of spreading the VOC contamination. In addition, mobilization of radionuclides that may be present is not expected because no change in ground-water pH is expected.

Actions involving *in situ* vacuum-enhanced vapor extraction are proposed at three locations within OU2: IHSS No. 112, a former drum storage site at the 903 Pad Area; IHSS No. 113, a former drum storage site at the Mound Area; and IHSS No. 111.1, a burial trench at the East Trenches Area. The locations of these IHSSs are shown on Figure 2-2. Vapor extraction technology can be universally applied at all proposed test locations given adequate formation permeability to air and a known residual DNAPL location. However, application of this technology will be customized to the site-specific hydrogeologic and contaminant distribution conditions. Water table depression efforts will be applied only at

sites where a significant saturated thickness exists (>3 feet). Additional differences in vapor extraction technology application at the three test sites will include site-specific extraction and air injection well placement and design. Site-specific considerations are discussed in Sections 4.3 through 4.5.

## 4.2 EVALUATION OF PROPOSED ACTIONS

This section discusses the elements of an integrated CERCLA/NEPA evaluation process that will be used to critically examine the proposed actions at the 903 Pad, Mound, and East Trenches Areas. This integrated process is based on both CERCLA and NEPA evaluation criteria as set forth in the March 1990 NCP and the draft DOE NEPA Compliance Guidance Manual (DOE, 1988a as revised), respectively.

An integrated CERCLA/NEPA evaluation process is used in DOE remedial action planning to critically evaluate alternative remedies so that a preferred alternative may be selected. In this case, however, only one action alternative, *in situ* vacuum-enhanced vapor extraction, has been proposed for implementation at this time (see Section 4.1). Nonetheless, analysis of the proposed *in situ* vapor extraction actions with respect to CERCLA and NEPA evaluation criteria provides a more thorough understanding of the actions. CERCLA evaluation criteria considered in the analysis include effectiveness and implementability. Analysis of relative cost is used in the CERCLA evaluation process to choose between one or more similarly effective and implementable remedial alternatives. Cost analysis, therefore, need not be included in the evaluation process for the Subsurface IM/IRA. NEPA evaluation criteria considered in the analysis include impacts of the proposed remedial actions to human health and the environment. In order to integrate the requirements of NEPA into the evaluation process, two elements are included:

- CERCLA and NEPA criteria are given equal weighing in the evaluation process.
- Assessment of the environmental impacts of the No Action Alternative is included in the evaluation process.

#### 4.2.1 Effectiveness

The criteria for effectiveness evaluation of the proposed subsurface IRAs include the use of alternatives to land disposal, thus promoting treatment or recycling; risk of potential exposure to residuals remaining on site; continued reliability over the life of the IM/IRA; and compliance with ARARs criteria, advisories, and guidance. In addition, the proposed actions will be evaluated with respect to reduction of toxicity, mobility, and volume of wastes per the March 1990 NCP.

Effectiveness evaluation of the proposed subsurface IRAs does not include several of the CERCLA effectiveness criteria due to the nature of the IM/IRA. These criteria include threat reduction and length of time until protection is achieved. These criteria are not applicable to the Subsurface IM/IRA since subsurface VOC contamination at OU2 does not pose a threat to public health or the environment nor is the proposed action in its current form expected to substantially alter the existing dissolved-phase ground-water plume during the duration of the test. The Subsurface IM/IRA is designed to remove contaminants from small areas at three of the suspected source areas at OU2 and to evaluate a remedial technology that may ultimately be applied on a large scale as part of the final action. Therefore, statements regarding mitigation of identified threats or length of time until protection is achieved are not applicable.

CERCLA effectiveness and NEPA environmental impact criteria both address worker and community protection. In order to avoid repetition in this document, worker and community protection issues associated with the proposed actions will be presented only once in the environmental impact analysis sections.

#### 4.2.2 Implementability

The criteria for implementability evaluation of proposed actions include technical feasibility, availability, and administrative feasibility. Technical feasibility includes the ability to: construct the technology; maintain its operation; meet process efficiencies or performance goals; demonstrate performance; and comply with the Superfund Amendments and

Reauthorization Act (SARA) requirement that IM/IRAs should contribute to the efficient performance of a long-term remedial action to the extent practicable. Availability includes the availability of necessary equipment, materials and personnel; availability of adequate off-site treatment, storage, and disposal capacity, if appropriate; and description of post-remedial site controls that will be required at the completion of the action. Administrative feasibility includes the likelihood of public acceptance of the proposed action, including site and local concern; coordination of activities with other agencies; and ability to obtain any necessary approvals or permits.

#### 4.2.3 Environmental Impacts

The criteria for environmental evaluation of the IM/IRA actions include DOE NEPA compliance guidelines for: terrestrial and aquatic impacts, threatened and endangered species, historical and archeological sites, wetlands and floodplains, and cumulative impacts; and air quality, water quality, short- and long-term land productivity, personnel exposures, commitment of resources, and transportation impacts.

The procedural guidance for compliance with NEPA and various related environmental statutes for the proposed action in this Subsurface IM/IRAP/EA is found in the Draft DOE NEPA Compliance Guide (DOE, 1988a as revised). Coordination of NEPA compliance procedures with review requirements of other environmental statutes that bear on the NEPA process enhances the probability of complete compliance and achievement of timely implementation of programs and projects.

The Compliance Guide is intended to assist DOE and contractors by providing the following information on the NEPA process: the processes of related environmental statutes that bear on the NEPA process; the timing relationships between EPA review and review requirements of other environmental statutes; and the NEPA process compliance and development for programs and projects. Regulatory guidance procedures for environmental restoration projects as they relate to air quality, water quality, terrestrial and aquatic impacts, threatened and endangered species, and historic and archaeological sites are discussed in Sections 4.2.3.1 through 4.2.3.5. Short- and long-term land productivity,

personnel exposures, commitment of resources, transportation impacts, wetland and floodplain impact assessment, and cumulative impacts are discussed in Sections 4.2.3.6 through 4.2.3.11.

#### 4.2.3.1 Air Quality

Air quality impacts are addressed by estimating changes in ambient air quality due to the No Action Alternative and the Subsurface IM/IRAs. Changes in air quality could result from possible emissions of VOCs (Subsurface IM/IRAs) and generation of fugitive dust (Subsurface IM/IRAs). VOC air emissions from the No Action Alternative are not expected to be significant relative to other VOC air emissions from the RFP that are regulated by CDH since, under the No Action Alternative, VOCs will primarily remain in the subsurface and continue to leach into ground water.

Air quality impacts from VOCs released during vapor extraction system installation activities (e.g., drilling, well installation, and vapor extraction system component setup) would be minimal when compared to the normal operational activity at the RFP even though VOC concentrations in soils in the vicinity of 903 Pad, Mound, and East Trenches are significant. This is because the limited amount of drilling planned for each of the three IM/IRA sites is expected to minimize the generation of VOC-containing drill cuttings. Thus, there will be an insignificant release of VOCs to the air from drill cuttings that amount to less than 2 cubic yards per site. However, in the event that releases are greater than expected, they will be controlled by adherence to the Project-Specific Health and Safety Plan (PSHSP) and the Plan for Prevention of Contaminant Dispersion. (See "Personal Exposures" section below.)

The vapor extraction system includes an offgas treatment unit for removal of contaminants from the vapor stream prior to discharge to the atmosphere. The system includes GAC adsorption units to remove VOCs and in-line high efficiency air particulate (HEPA) filters to capture any radionuclides that may be released from the subsurface. HEPA filters will be followed by a radiation sensor that will shut the system down before the release of significant amounts of radionuclides to the GAC units can occur. Although not intended

to capture radionuclides, the GAC units provide redundant filtration capacity to ensure that radionuclides are not discharged to the atmosphere.

Dermal exposure, inhalation, and inadvertent ingestion of airborne radioactivity and VOCs on fugitive dusts are analyzed in later sections of this report entitled "Personnel Exposure-Routine Operation." Pollution from engine emissions, fugitive dust generation by vehicles and particulates from tire wear will be analyzed separately in "Transportation Impacts."

With respect to dewatering activities any subsurface water collected would be processed through existing RFP treatment systems. If free-phase VOCs are recovered during dewatering, a closed phase separator system (described in Section 4.3.2) will be added to the vapor extraction system. Therefore, no change in the levels of VOCs in the ambient air off site is expected. The mixing of chemicals for water treatment and use of strong acids or bases in cleaning operations may contribute to odors within the confines of existing water treatment facilities and will be controlled by adequate ventilation. These odors would not be noticeable from outside the treatment facilities, nor would they be a hazard to workers in the facility under normal circumstances. Spills of chemicals that might be involved in accident conditions will be administratively controlled by actions specified in the Operational Safety Analysis (OSA). Considering the above factors, air quality impacts are not further discussed except under personnel exposures and transportation impacts.

#### **4.2.3.2 Water Quality**

As discussed in Section 2.3.5, the water quality data for the 26 surface water and surface seep stations in OU2 suggest that VOC contamination at these stations is a result, at least in part, from soil and subsurface contamination at the 903 Pad, Mound, and East Trenches. The proposed vapor extraction system will remove VOCs from the subsurface and may, over an extended period of time, eliminate enough source material to reduce VOC contaminants in the OU2 seeps, ponds, and creeks.

With respect to the Subsurface IM/IRA, potential impacts to water quality may also arise from surface water runoff from disturbed ground surfaces resulting in sediment transport to

the surface waters in both South Walnut Creek and Woman Creek drainage basins. However, erosion control measures, as defined in the construction specifications, would prevent any contaminated runoff from entering surface waters. Techniques may include, but not be limited to: fiber compost nets; grouted riprock; hydromulching and seeding; erosion bales to prevent runoff; and benches, berms, and silt fences to control runoff. The area impacted by the construction would be restored immediately upon completion of the project.

Soils within OU2 are contaminated with plutonium, uranium, and americium (Rockwell International, 1989a). During drilling and vapor extraction system installation, surveys would be performed to detect any radioactive contamination. Significant radioactive contamination would be handled in accordance with the PSHSP procedures.

With respect to water treatment, spills of subsurface water, chemicals, or treatment media associated with operation and maintenance of the vapor extraction system will be mitigated by use of secondary containment, which would likely capture all of the spilled material. Spills of liquids resulting from accidents will be controlled by actions specified in the OSA. Transport of secondary wastes will be in accordance with standard Plant and project-specific operating procedures and presents a negligible hazard to on-site or off-site water quality. Considering the above factors, water quality impacts are not further discussed.

#### **4.2.3.3 Terrestrial and Aquatic Impacts**

Regulations which require federal agencies to assess project impacts on terrestrial and aquatic biota include: NEPA of 1969, the Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661-666c), the ESA of 1973 (Public Law 93-0205), the CWA as amended, and the Migratory Bird Treaty Act (16U.S.C. 1701-1711) and DOE Order 5400.5. Related guidance includes: DOE, 1988, Environmental Guidance Program Reference Book; ESA and the FWCA, U.S. DOE, Washington, D.C.

Terrestrial populations that may be negatively impacted by drilling and excavation within OU2 for subsurface remediation include: vegetation, ground-dwelling rodents, reptiles, and invertebrates. However, none of these terrestrial populations are threatened or endangered,

and they can be expected to quickly re-establish their populations in the disturbed area. Furthermore, areas of impact will be minimal (less than 50 feet by 50 feet) and any loss of vegetation could be offset somewhat by reseeding disturbed areas with native grass and shrub species. Therefore, impacts to terrestrial ecosystems from subsurface remediation will not be further discussed in subsequent sections.

The nearest point of aquatic life that may be affected by the collection, treatment, and discharge of subsurface contaminated ground water is South Walnut Creek. The quality of effluent discharges and the effects on aquatic biota are evaluated and discussed in the Surface Water IM/IRAP for South Walnut Creek (EG&G, 1991e).

#### **4.2.3.4 Threatened and Endangered Species**

Representative laws and regulations which protect threatened and endangered species include: the NEPA of 1969, the ESA of 1973, the CWA as amended, and the Migratory Bird Treaty Act. Federal agencies must ensure that actions authorized, funded, or carried out by them will not jeopardize the continued existence of any endangered or threatened species (EG&G, 1991g). Section 7(a)(2) of the ESA requires federal agencies "in consultation with and with the assistance of the Secretaries of the Interior and Commerce, to ensure that their actions are not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species...." The statutory authority is listed as follows: Section 7 of the ESA of 1973 (16 U.S.C. 1536), P.L. 93-205, December 28, 1973; as amended by P.L. 95-632, P.L. 96-159, and P.L. 97-304. Authority to conduct consultations has been delegated by the Secretary of the Interior to the Director of the USFWS who has authority over endangered or threatened species and their critical habitats as listed in 50 CFR 17.

Related guidance implementation includes the following:

- 50 CFR Part 17 — Endangered and Threatened Wildlife and Plants (includes critical habitats).

- 50 CFR Part 225 — Federal/State Cooperation in the Conservation of Endangered and Threatened Species.
- 50 CFR Part 402 — Interagency Cooperation.
- Environmental Guidance Program Reference Book. U.S. Department of Energy, 1988.
- Endangered Species Act, and the Fish and Wildlife Coordination Act, U.S. DOE, Washington, D.C.

The drilling and excavation for subsurface IRA in OU2 will not affect potential habitat suited for threatened and endangered species. Although there are three endangered species of interest in the RFP area, there is no critical habitat present for these species in the OU2 area. The three endangered species of interest in the RFP area are the black-footed ferret (*Mustela nigripes*) (USFWS, 1988), the peregrine falcon (*Falco peregrinus*), and the bald eagle (*Haliaeetus leucociphalus*) (EG&G, 1991g).

Prairie dog colonies in the northeast area of the plant site provide the potential food source and habitat for the black-footed ferrets. However, no prairie dog towns exist in or near the OU2 area so black-footed ferrets are likely not to exist in this area (DOE, 1990a).

Peregrine falcons were not observed during the reconnaissance-level surveys for the threatened and endangered species evaluation (EG&G, 1991g), although two historic nest sites are located within 10 miles of the RFP site. The Peregrine Falcon Recovery Plan (USFWS, 1984) discourages land-use practices that would adversely alter the character of their hunting habitat or prey base within a 10-mile radius of a nest cliff (including historical sites). Because peregrine falcons prey exclusively on waterfowl and other birds, drilling extraction and or injection wells in OU2 and installation of wells in OU2 will not affect the hunting habitat or the prey base for the peregrine falcon.

Although bald eagles (*Haliaeetus leucocephalus*) are identified as occasionally using habitat between 0.3 and 1.1 miles from the RFP site during the winter months, sightings are rare and little suitable habitat occurs. No bald eagle nests occur on plant site (DOE, 1990a).

Based on the above discussion, further consideration of impacts to threatened and endangered species for OU2 IM/IRA is not warranted and is not included in subsequent sections.

#### 4.2.3.5 Cultural Resource

NEPA (1969) and the National Historic Preservation of 1966 (Public Law 89-665), together with subsequent law amendments (Public Laws 91-243, 93-54, 94-422, 94-458), provide that all federal agencies implement programs for the protection of historical and archeological resources. Section 106 of the National Historic Preservation Act requires federal agencies to consider the effects of the proposed actions on properties eligible for or listed on the National Register of Historic Places. Section 110(f) of the National Historic Preservation Act requires specifications in federal agency's actions to minimize harm and adverse effects to National Historic Landmarks. Regulatory guidance procedures include the following:

- 36 CFR 800 — Protection of Historic and Cultural Properties (51 FR 31118-31125, September 2, 1986).
- Environmental Guidance Program Reference Book. Historic Preservation Requirements. U.S. Department of Energy, 1987. U.S. DOE, Washington, D.C.
- Guidelines for Federal Agency Responsibilities under Section 110 of the National Historic Preservation Act (53 FR 4727-4746, February 17, 1988). National Park Service.
- National Register of Historic Places (published by the National Park Service at various times in the Federal Register) (reference to these listings is in DOE. 1987).
- Advisory Council on Historic Preservation, 1986. Section 1206, Step-by-step.
- National Register Bulletins issues periodically by the National Park Service.

Compliance with Section 106 requires federal agencies to identify and evaluate historic properties. The RSO (DOE Order 5440.1c) and the State Historic Preservation Officer locate and evaluate the eligibility of possible historic properties for the National Register

of Historic Places. A cultural resource study of the RFP was conducted between 31 May and 28 June 1991 that identified 45 cultural resources, none of which were recommended as eligible for listing on the National Register of Historic Places (EG&G, 1991a). In addition to the 45 sites located during the 1991 survey, six previously identified historic sites were also previously determined to not be eligible for listing on the National Register for Historic Places. They were not re-evaluated during this site-wide archeological survey. The State Office of Archeology and Historic Preservation has determined that any action in the vicinity of OU2 will not impact cultural resources (Burney, 1989). Therefore, further discussion of historic and archeological sites is not included in subsequent sections.

#### **4.2.3.6 Short- and Long-Term Land Productivity**

Land within OU2 is currently undeveloped and will remain so for the foreseeable future as part of the Rocky Flats Plant. OU2 lies within the Rocky Flats security boundaries and is not accessible to the general public. Short- and long-term land productivity will not be altered by the project and, therefore, is not discussed.

#### **4.2.3.7 Personnel Exposures**

DOE NEPA documentation includes analysis of potentially significant occupational impacts to workers and the public. This analysis includes radiological and nonradiological impacts under routine and accident conditions. Analysis of accidents includes potential impacts to workers as a result of an accident, and potential impacts associated with clean-up activities.

When analyzing occupational impacts, credit was taken for worker protection provided by the Environmental Restoration Health and Safety Program Plan (ERHSPP). The ERHSPP addresses the minimum health and safety requirements for outside contractors as dictated by the EM Department and the Health and Safety (HS) Department. The ERHSPP outlines the requirements for a PSHSP that identifies construction tasks, potential hazards and the steps to control hazards. The PSHSP would be prepared in accordance with

guidelines set forth in the ERHSPP, and the Plan for Prevention of Contaminant Dispersion (PPCD) (EG&G, 1991d), and would be completed after the IM/IRA design is finalized. The PSHSP must be approved by the EM and HS Departments, and will be reviewed by EPA and CDH. Worker protection is also addressed by the OSA which is completed during preparation of the PSHSP. The OSA addresses health and safety concerns originating from routine site operations.

### Drilling Activities

Potential personnel exposures during drilling/vapor extraction system installation activities would result from several pathways:

- Dermal and airborne exposure to VOCs or radioactive materials from subsurface water and drilling fluids.
- Airborne exposure to radionuclides and VOCs while drilling the wells.

There would be limited potential for dermal contact with contaminated soil and fluids considering the small amount of soil cuttings generated (~2 yd<sup>3</sup>). Also, the PSHSP would specify the appropriate levels of personnel protection (e.g., respirators, gloves, goggles, protective clothing) to protect against inhalation and direct contact with contaminants. Considering the personnel protection and limited potential for dermal exposure, and that dermal contact is a minor exposure route for the identified contaminants, potential impact to workers would be negligible. Airborne exposure of workers and the public to radionuclides and VOCs will be prevented through the PPCD and the PSHSP. Access controls to the plant site and drilling areas would preclude dermal contact as a credible exposure route for other site personnel and the public.

### Routine Operations

Potential exposure routes for remediation workers, other on-site personnel, and members of the general public during routine operations include:

- Airborne exposure to VOC vapors from the subsurface water collection system sumps, the tank truck, the process influent tank, and from the water treatment process equipment.
- Dermal contact with contaminants while performing operations and maintenance activities.
- Fugitive dust generated in the wake of vehicles traveling to the water collection stations for maintenance and surveillance activities.

Subsurface IM/IRA operations and maintenance activities would be performed in accordance with OSA procedures, which specify appropriate levels of monitoring and personnel worker exposure protection. Considering the unconfined nature of the work areas and administrative controls, potential worker exposures to airborne VOCs would be very low. Airborne VOC concentrations and resulting exposures to other on-site personnel and the general public would be significantly less because of their greater distance from the source. The potential for chronic exposure of workers to VOCs resulting from operational tasks associated with the GAC adsorption system would be small, considering replacement of GAC units does not involve contact with spent carbon, and OSA procedures will be in place to protect workers from potential hazards.

Personnel protective measures may be necessary during some routine operational activities where there is a potential for worker contact with contaminated water. Appropriate measures would be followed as specified in the OSA for those activities. Access controls would preclude dermal exposure as a credible pathway for other on-site personnel and the general public.

Occasional travel to the subsurface water collection stations will be required for maintenance and surveillance purposes. While some fugitive dust may be generated in the wake of vehicles, it is not expected to be a significant exposure pathway for the vehicle operator, other on-site personnel, or the general public because of the short travel distance on unpaved roads and the anticipated low frequency of travel to the collection stations.

Any accidents that may occur during the installation phase of the proposed action would be typical of drilling activities. The PSHSP will identify appropriate precautions and responsibilities for each job. The PSHSP will also specify appropriate air monitoring and response procedures in the event of an unusual VOC or radionuclide release. Workers will be familiar with the PSHSP and a copy of it will be available at the work site.

During operations, accidents that could impact either workers or members of the public would include fires or major spills of contaminated material. Potential releases of untreated water along the truck route or proposed pipeline or within the existing treatment facilities would create the potential for short duration airborne VOCs. Intake of contaminants by workers involved in the cleanup would be controlled by following safety precautions specified in the OSA.

This section on personnel exposures applies to all three proposed actions. Therefore, further discussion of personnel exposure is not included in subsequent sections.

#### **4.2.3.8 Commitment of Resources**

Commitment of Resources is evaluated by examining the economic and ecological value of materials (and labor) required for the IM/IRA preferred actions. The resources (including both material and labor) required for construction and operation of this Subsurface IM/IRA are relatively minor. No significant commitment of economically or ecologically valuable resources is involved. With the exception of the land area, all the materials for construction and operation of the surface water treatment system will be irrevocably and irretrievably committed to the implementation of remedial action. The facilities proposed for treatment of the Subsurface IM/IRA-generated water utilize pre-existing process equipment and do not require additional purchase and installation of treatment facilities for the IM/IRA.

#### **4.2.3.9 Transportation Impacts**

Human health impacts due to transportation include latent effects associated with vehicle pollution, in addition to traumatic injuries and fatalities resulting from accidents. Normal

transportation is associated with incremental pollution from engine emissions, fugitive dust generation in the vehicle's wake, and particulates from tire wear. The table below presents estimates of risks (Rao et al., 1982) resulting from truck and rail transportation. Uncertainties are associated with pollution emission rates and atmospheric dispersion behavior. To compensate for these uncertainties, the analysis utilized conservative estimates for determining pollution health effects. The tabulated accident impacts are average values over population zones (urban, suburban, rural) and are derived from Department of Transportation (DOT) nationwide statistics.

Estimates of Risks Resulting from Truck and Rail Transportation				
Source	Transportation Mode	Health Effects per Kilometer		
		LCFs*	Injuries	Fatalities
Pollutants	Truck	1.0 E-7 (urban only)		
	Rail	1.3 E-7 (urban only)		
Accidents	Truck		5.1 E-7	3.0 E-8
	Rail		4.6 E-7	3.4 E-8

\* LCFs represent latent cancer fatalities resulting from incremental vehicle pollution, and would occur after a latency period following initial exposure.

Drilling fluids and cuttings are to be treated as hazardous material and transported in accordance with appropriate DOT regulations and DOE orders. Transport and handling of other hazardous materials will also be in accordance with appropriate regulations and orders and the On-Site Transportation Manual (DOE, 1991c). Emergency response procedures for accidental spills or container failures are described in Section 17 of the On-Site Transportation Manual. Estimation of transportation impacts for the 903 Pad, Mound, and East Trenches Subsurface IM/IRAs is detailed in Appendix E.

#### 4.2.3.10 Wetlands and Floodplains Impact Assessment

The relevant laws and acts that protect wetlands and floodplains include: NEPA of 1969; Section 401 and 402 of the CWA; the Fish and Wildlife Act of 1956 plus associated coordination acts; and regulations promulgated under 10 CFR Part 1022 — DOE Compliance with Floodplain Wetlands Environmental Review Requirements. The rules promulgated under NEPA 42 U.S.C. 4321, et seq., in 40 CFR parts 1500 through 1508 state that all federal agencies are required to consider the environmental effects of any proposed action (EG&G, 1990d). Since the proposed actions are at least 400 feet away from any wetlands, 10 CFR Part 1022 does not apply.

Executive Orders (E.O.) that require federal agencies to consider the effects of proposed action on wetlands and floodplains are as follows:

- E.O. 11990 Protection of Wetlands (May 24, 1977).
- E.O. 11988 Floodplain Management (May 24, 1977).

These orders require federal agencies to avoid, to the extent possible, destruction and modifications of wetlands, and adverse impacts associated with the occupancy and modification of floodplains. Federal agencies are required to determine if wetlands and floodplains that may be affected by the action are present, assess the impacts on these environments, and consider alternatives to the action. DOE regulations establishing policy and procedures for the RFP site in compliance with E.O. 11990 and 11988 are found in Federal Register 44(46): 12594-12599. Wednesday, May 7, 1979.

Documentation of a wetlands and/or floodplain review involves: (1) public notification of intent to perform a wetlands/floodplain review; (2) wetlands/floodplain assessment; and (3) a statement of findings for actions involving floodplains.

When an action in a wetlands and/or floodplain requires an EA, the wetlands and/or floodplain assessment will be prepared concurrent with, and is included in, the EA. Wetlands and/or floodplain assessments that are part of the EA are subject to approval by

the Assistant Secretary for the Environment, Safety and Health. Actions in wetlands may, but do not necessarily, require an EA (DOE, 1988).

#### **4.2.3.11 Cumulative Impacts**

A "cumulative impact" is defined in 40 CFR 1508.7 as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." Cumulative impacts will incorporate similar, previous IM/IRA actions in the same geographic location and consider impacts on aquatic and terrestrial biota, and impacts from construction and operations of the proposed action to on-site personnel and the general public (DOE, 1988d). It is noted that air quality and water quality impacts are not cumulative because emissions, discharges, or releases are not expected to occur during routine operations. Impacts resulting from installation activities or operational accidents would be short lived and are, thus, also not cumulative.

### **4.3 VACUUM-ENHANCED VAPOR EXTRACTION AT 903 PAD (IHSS NO. 112)**

This section presents a detailed description of the proposed action at the 903 Pad. This discussion focuses on the rationale and criteria for selecting the test site at the 903 Pad, expected test site conditions, proposed treatment systems, and Observational/Streamlined Approach considerations with respect to deviations in expected test site conditions. The criteria presented below for 903 Pad test site selection were also used to select sites at the Mound and East Trenches Areas (Sections 4.4 and 4.5, respectively).

### 4.3.1 Test Site Description

#### 4.3.1.1 Test Site Selection Rationale

The criteria listed below were used to guide test site selection. The test area should possess:

- A relatively high probability of containing residual free-phase DNAPL in the vadose and/or saturated zone.
- A low probability of containing buried drums.
- A low probability of containing metallic Pu or U.

The first criterion is related to the proposed remedial technology, *in situ* vacuum-enhanced vapor extraction. As discussed in Section 4.1, *in situ* vacuum-enhanced vapor extraction is a VOC source removal technology, requiring the presence of residual free-phase chlorinated solvents in order to demonstrate successful performance. In addition, the test site should not contain buried containers because the proposed actions involve drilling boreholes. Penetration of a buried drum containing waste will likely result in a release of contamination to the subsurface. Lastly, the test site should not contain buried metallic Pu or U as these materials are potentially autopyrophoric and should not be disturbed during drilling or vapor extraction activities.

IHSS No. 112 (see Figure 2-2), a former drum storage location at the 903 Pad, satisfies all three test site selection criteria. With respect to the first criterion, drums stored at IHSS No. 112 between 1958 and 1967 reportedly leaked an estimated 5,000 gallons of fluid onto the ground (Freiberg, 1970). Calkins (1970) reports that fluids stored at the 903 Pad included: lathe coolant consisting of hydrocarbon oils, and carbon tetrachloride in varying proportions; hydraulic oils; vacuum pump oils; TCE; and PCE. Carbon tetrachloride was detected at a 6,400  $\mu\text{g}/\ell$  in a water sample collected in September 1990 from alluvial monitoring well 1587 which is located downgradient of the 903 Pad (see Figure 2-11). This well is located approximately 300 feet from the suspected spill location, suggesting much higher concentrations at the spill site. IHSS 112 satisfies the second criterion based on

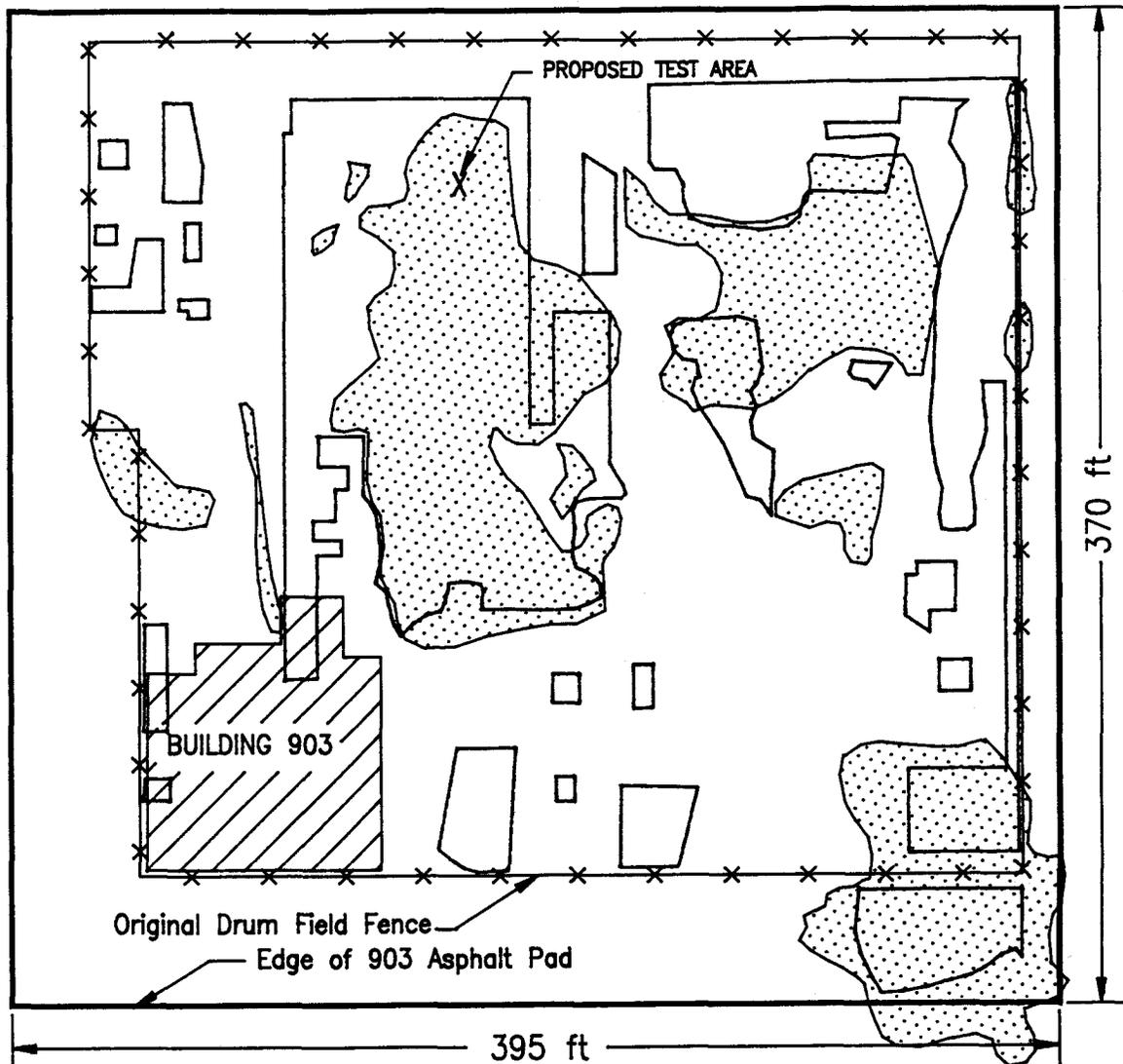
reports indicating that drums were not buried at this location. All drums were stored on the ground and subsequently removed. Reportedly, the only metallic nuclear material released at the 903 Pad is an estimated 86 grams of finely divided plutonium (Freiberg, 1970) of which a significant portion was removed during subsequent remedial efforts. A study conducted by Clark (1991) concluded that plutonium in the 903 Pad soil is inert with respect to pyrophoricity (Clark, 1991).

The specific location of the fluids released at 903 Pad was determined by review of aerial photographs which reveal the former location of storage drums and areas of stained soils (Figure 4-1). The proposed action will be conducted in an area of stained soils in the north-central portion of IHSS No. 112.

#### 4.3.1.2 Expected Conditions

Site-specific geologic, hydrologic, and contaminant type and distribution information local to the proposed 903 Pad test site is not currently available. Therefore, an idealized conceptual hydrogeologic and contaminant distribution model has been developed based on information derived from geologic logs, water level data, and ground-water chemistry from investigative activities conducted near the proposed test site. The site-specific conceptual model was further refined using the geologic log of borehole BH1687 located approximately 800 feet southwest of the 903 Pad (Figure 2-9). This log is representative of the 903 Pad Area and is presented in Appendix D. The idealized conceptual model of the 903 Pad pilot test site is illustrated in Figure 4-2. The diagram illustrates the hydrogeology and contaminant distribution expected to exist within 50 feet of the ground surface.

Sand and gravel alluvium extends to approximately 18 feet below ground surface. It is expected that the alluvium contains unconfined ground water perched on bedrock with a saturated thickness of approximately 4 feet. Furthermore, the saturated thickness will likely vary seasonally. The alluvium overlies claystone bedrock which may contain isolated or interconnected fractures. The claystone bedrock is not expected to contain recoverable ground water.



**EXPLANATION**

-  AREA OF SOIL STAINING BASED ON AERIAL PHOTOGRAPHS FROM:  
4/29/67, 4/10/68, 5/24/69.
  -  BARREL STORAGE LOCATIONS BASED ON AERIAL PHOTOGRAPHS FROM:  
5/5/63, 4/29/65, 4/29/67, 9/10/68.
- NOTE: BUILDING 903 LOCATION BASED ON AERIAL PHOTOGRAPHS FROM 4/10/68.

January 1992

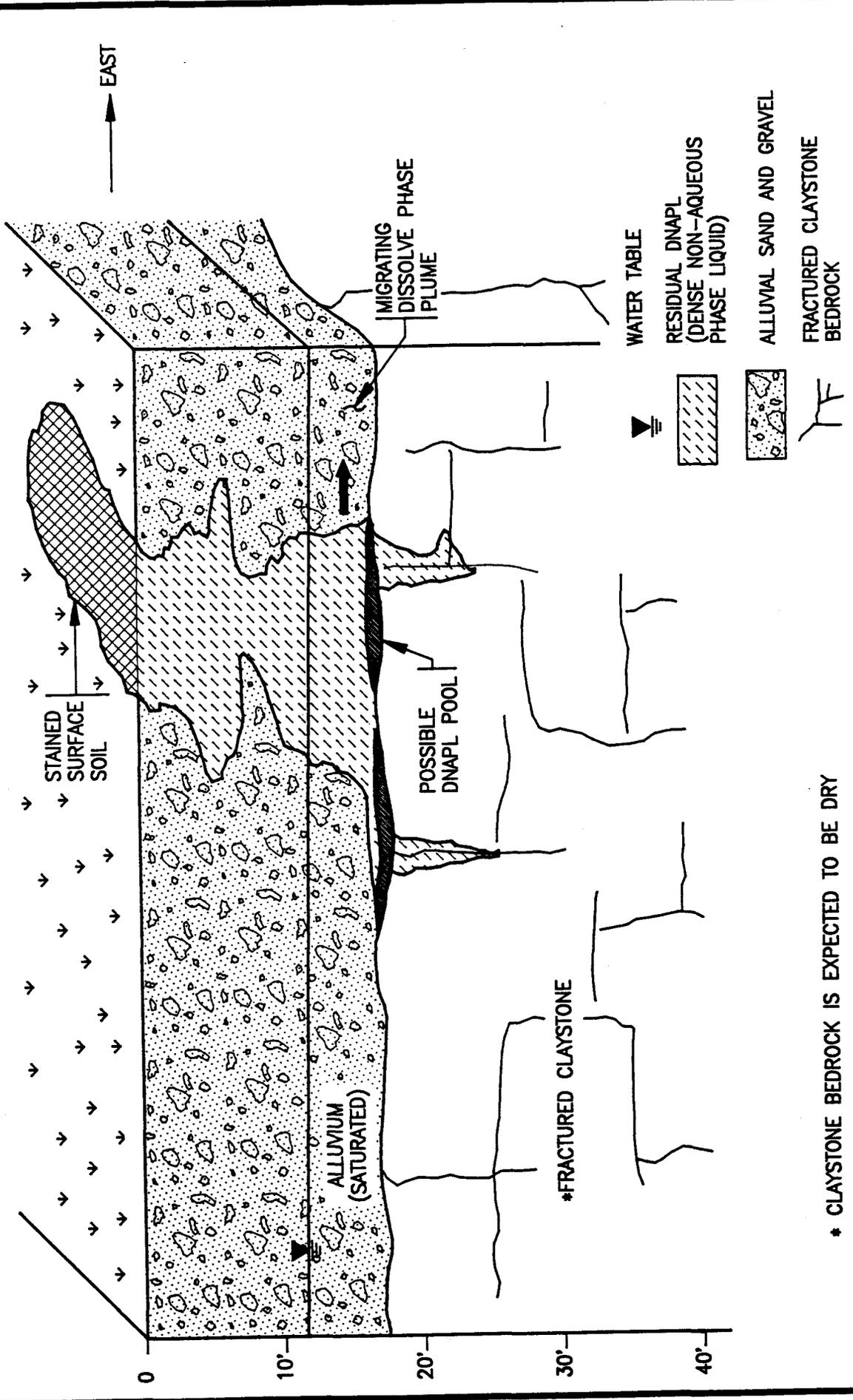
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APPROXIMATE LOCATIONS OF  
DRUM STORAGE  
903 PAD DRUM STORAGE SITE

FIGURE  
4-1

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R37052.MB012392



\* CLAYSTONE BEDROCK IS EXPECTED TO BE DRY

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IDEALIZED CROSS-SECTION  
903 PAD AREA (IHSS 112)

FIGURE  
4-2

It is expected that carbon tetrachloride comprises the majority of the released hazardous contaminants with lesser amounts of TCE and PCE. As discussed in Section 4.1, these contaminants have limited solubility in water and have a specific gravity greater than 1.0 (i.e., DNAPL). The conceptual model thus indicates the vertical migration of these DNAPLs through the vadose zone and the saturated alluvium coming to rest in structural depressions on the claystone bedrock surface. Infiltration of DNAPL along bedrock fractures is also shown. A review of existing monitoring well design and ground-water chemistry (Rockwell, 1987a) with respect to the presence of dissolved versus residual free-phase chlorinated solvents in the claystone bedrock near the 903 Pad was inconclusive. It is important to note that the presence of pools of DNAPL perched on the bedrock is also uncertain and may never be conclusively determined. However, the presence of a dissolved carbon tetrachloride plume coupled with the presence of stained surface soils and an estimated release of 5,000 gallons of fluids suggests the presence of free-phase residual chlorinated solvents in the vadose and saturated zones which would constitute a continuing source for the dissolved-phase contaminant plume.

#### **4.3.2 Remedial Approach**

##### **4.3.2.1 Proposed Action Based on Expected Conditions**

This section provides a detailed description of the interim remedial action proposed for implementation at the 903 Pad test site. The proposed action is based on the idealized conceptual hydrogeologic and contaminant distribution model described in Section 4.3.1.2, and involves:

- *In situ* vacuum-enhanced vapor extraction coupled with ground-water depression for the alluvial material.
- *In situ* vacuum-enhanced vapor extraction for the upper portion of the claystone bedrock.

A second site may also be selected at the 903 Pad to conduct tests of *in situ* steam stripping for removal of both VOC and radionuclide contamination. Further consideration of this

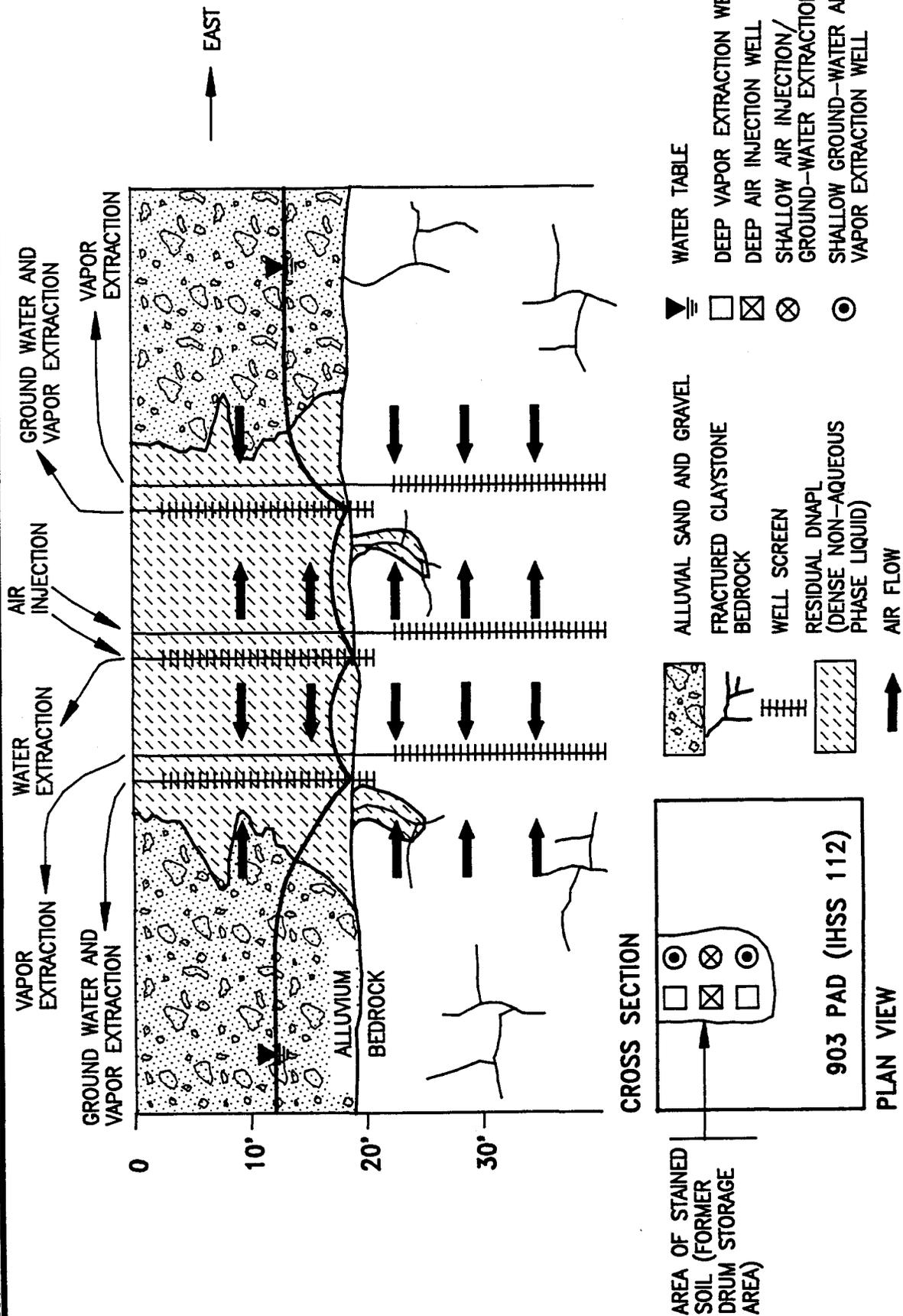
technology is deferred pending completion of treatability studies being conducted by LLNL. The reader is referred to Section 4.1 for additional explanation of *in situ* steam stripping.

This section first discusses the elements of the vapor and ground-water extraction system followed by a description of the proposed vapor and ground-water treatment systems.

### Vapor and Ground-Water Extraction

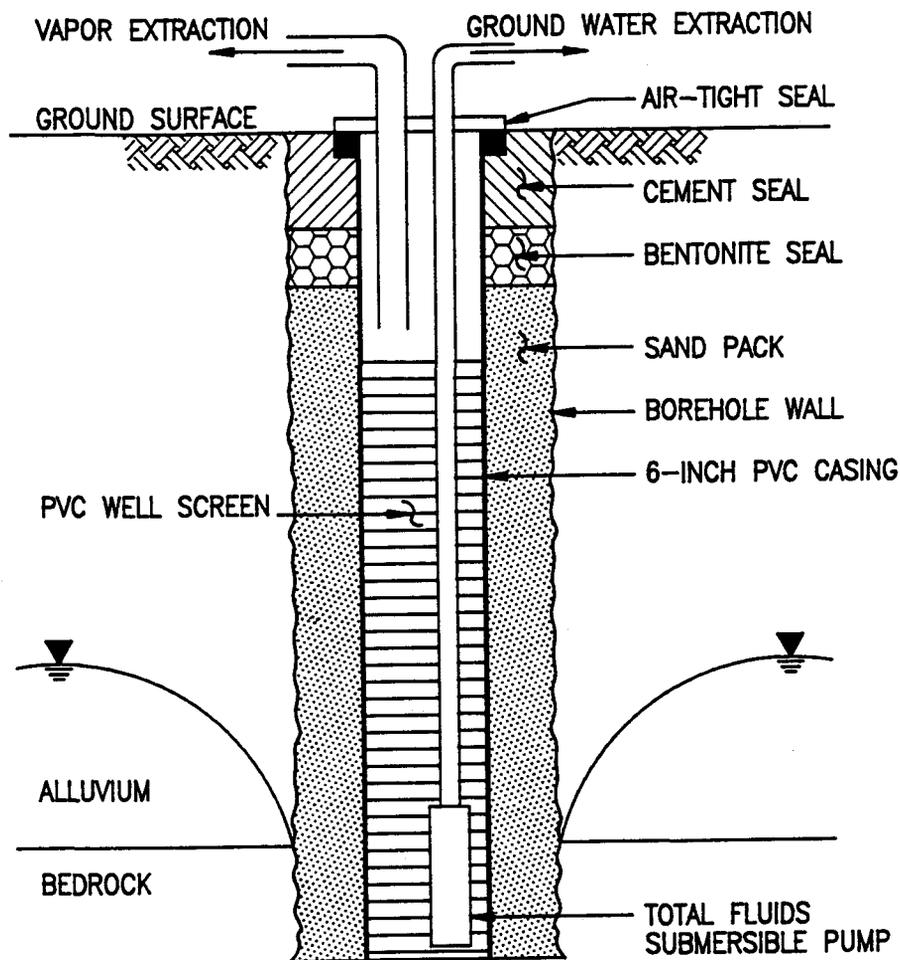
Figure 4-3 illustrates the location and configuration of the vapor and ground-water recovery wells to be installed at the 903 Pad. Two alluvial vapor extraction wells will be installed in an area of stained soils in the north central portion of IHSS No. 112 (Figure 4-1). The existing asphalt cap on 903 Pad is expected to prevent short circuiting of air flow from the atmosphere to the extraction wells. Ground water will be extracted from the alluvium using pumps installed in the vapor extraction wells. An air-tight seal will be installed at the top of the well casing to allow the extraction of both vapor and ground water. A schematic diagram showing pump placement and casing cap is presented in Figure 4-4. Between these two wells, one air injection well will be installed in the alluvium. This well will be used to depress the water table and increase the volume of soils contacted by injecting ambient air. This will be accomplished by connecting an air injection manifold to the well and also installing a submersible pump. The pump riser pipe and air injection manifold will exit the well casing via an airtight seal. Ambient and heated air will also be injected during the test to determine if the additional air flow and heat increases the rate of volatilization of residual DNAPL. Ambient and heated air will be injected at a rate equal to one-half of the combined extraction rate. This is to ensure that injected air does not further disperse vapor phase contaminants in the vadose zone. Under ideal conditions of isotropy and homogeneity of the alluvial soils or bedrock, air flow lines can be expected to form a closed loop between the injection and extraction wells given reasonably close well spacing (<25 feet). Radial pressure distribution equations (Johnson et. al, 1989) will be used during Test Plan development to insure that negative pressures are maintained at the boundary of the test area.

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SCHEMATIC  
GROUND-WATER AND VAPOR RECOVERY SYSTEM  
903 PAD DRUM STORAGE SITE (IHSS 112)



VAPOR AND GROUND-WATER  
EXTRACTION WELL

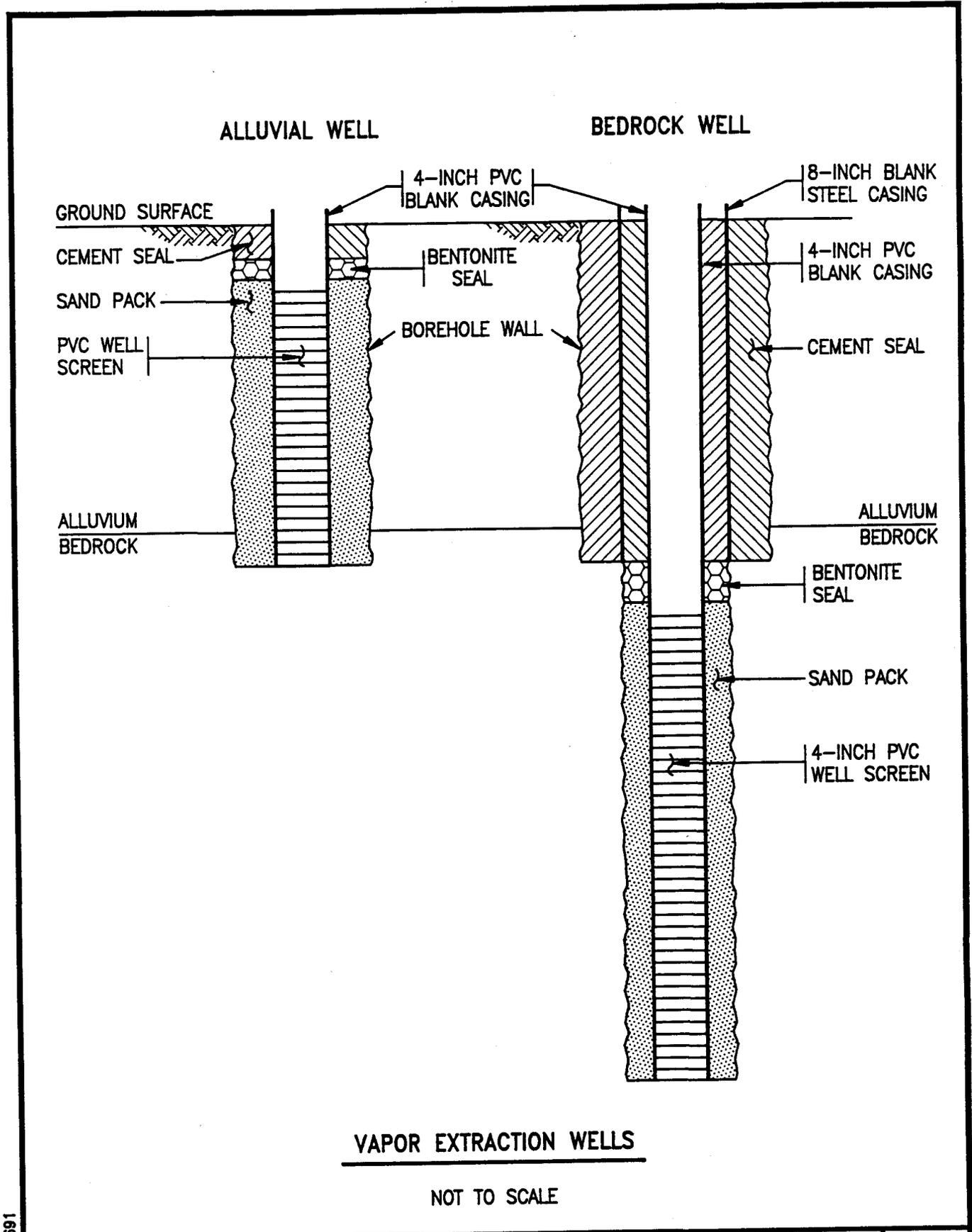
NOT TO SCALE

R37056.MB121391

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GROUND-WATER AND  
VAPOR EXTRACTION WELL  
SCHEMATIC

FIGURE  
4-4



**VAPOR EXTRACTION WELLS**

NOT TO SCALE

R37049.MB121691

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VAPOR EXTRACTION WELLS  
 SCHEMATIC

FIGURE  
 4-5

Remedial efforts in the alluvium and bedrock will be isolated from each other in order to prevent cross-contamination. Preventative measures include installing separate wells in the alluvium and bedrock. Bedrock wells will be isolated from the alluvium by the installation of a steel surface casing. Well construction schematics are presented in Figure 4-5. Note that alluvial ground-water extraction wells will have screened sections that penetrate several feet into the bedrock. This is to allow for the collection and recovery of free-phase DNAPL should it be encountered at the alluvial/bedrock interface.

The results of the *in situ* pilot tests will be evaluated to assess the benefit of post-pilot operation of the vapor extraction system at each of the IM/IRA test sites. The objective of post-pilot system operation is to recover significant amounts of VOCs from the test areas. Pilot test data will be evaluated with respect to the following criteria:

- Mass of VOCs recovered per unit cost.
- Mass of VOCs recovered per unit time.
- Areal influence of vapor extraction system.
- Ability to successfully control the mobility of contaminants.
- Ability to successfully dewater aquifer material (if present).

These criteria will be used to evaluate the pilot test data within the context of the limitations imposed by test site geology and contaminant distribution, logistical considerations, and costs relative to alternative free-phase VOC-removal technologies (e.g., excavation). As discussed in Section 5, the pilot test data, data analysis, and recommendations for continued system operation at the three test sites will be presented in a Pilot Test Report.

The conceptual hydrogeologic model illustrated in Figure 4-2 shows some limited penetration of DNAPLs into bedrock fractures. To evaluate the potential to recover residual DNAPL (if any), two vapor extraction wells will be installed in the upper portion of the claystone bedrock. One air injection well will be installed between the two extraction wells. All bedrock extraction/injection wells will be installed to a minimum depth of 30 feet into the bedrock. No recoverable ground water is expected in the upper portion of the bedrock.

Dynamic system performance will be evaluated by monitoring vapor recovery rates, contaminant concentrations in recovered vapor and by measuring vacuum induced in the subsurface. Vapor recovery rates will be measured using a dedicated Pitot tube installed in the vapor collection manifold. Contaminant concentrations will be measured by sampling recovered vapor with subsequent chemical analyses. Formation pressures will be measured in recovery wells and the injection well prior to injecting air. Dedicated valves between the vapor collection manifold and each vapor extraction well will allow one well to be operated independently while formation pressures are measured in the adjacent well. In addition, two or more temporary vacuum monitoring probes will be placed within the test area to determine the area of influence of the vapor extraction system.

System effectiveness will be evaluated by establishing initial conditions through collection of soil samples during the advancement of boreholes for well installation and subjecting them to laboratory analyses. Upon completion of the IRA, additional soil samples will be collected in the proximity of the original samples. Comparison of contaminant concentrations before and after the test will provide a quantitative evaluation of system effectiveness.

The proposed test site selection was based on qualitative data from the proposed test site and conditions extrapolated from quantitative data collected near the proposed test site. Should the proposed test site prove inadequate, an alternative test site will be selected. The most likely reason for poor site conditions is the absence of residual free-phase DNAPL. A preliminary threshold for determining success will be concentrations of hydrocarbon compounds in the recovered soil vapor equal to 1 part per million (ppm) as measured with a portable photoionization detector calibrated for the major contaminant expected at each test site (i.e.,  $\text{CCl}_4$  at 903 Pad). This value was selected because it is the lowest concentration which can be reliably detected with basic field instrumentation. The hydrocarbon concentrations will be confirmed by subsequent laboratory analyses. The test will be conducted for a minimum of 7 days before abandonment and new site selection. If the recovered vapor contains hydrocarbon concentrations equal or greater than 1 ppm, the test duration will be determined while the test is in progress. In any case, the test duration should not exceed 3 months.

Therefore, implementation of this technology may be appropriate under the criteria, outlined in the introductory paragraphs of this section, once treatability studies have been successfully completed.

A preliminary review of potential test sites revealed 903 Pad as the most suitable test site. Releases of VOCs are suspected to have occurred at the 903 Pad and finely disseminated radionuclide contamination is known to be present in the soil. However, further evaluation of this technology is deferred pending completion of the treatability studies.

### Vapor and Ground-Water Treatment

Vapors extracted from the subsurface at the 903 Pad will be treated for removal of particulates and VOCs prior to discharge to the atmosphere as illustrated in Figure 4-6. Extracted vapors are first passed through a mist eliminator to remove entrained condensate that may be present. The mist eliminator is packed with stainless steel mesh that provides a large surface area that allows small entrained liquid droplets to coalesce into larger droplets that separate by gravity from the vapor stream. Accumulated liquids are gravity drained from the mist eliminator while the vacuum pump is off. Condensate generated by the treatment system will be placed in the ground-water holding tank for subsequent treatment (discussed below).

The vapor leaving the mist eliminator passes through a vacuum pump provides the driving force for subsurface vapor extraction. The vacuum pump will be specified to provide a range of operational service to accommodate the different subsurface conditions at each of the OU2 pilot test sites. Lower permeability clay soils at the Mound, for example, will likely require higher vacuum pressure to be applied to the subsurface to induce adequate vapor flow than would be required for the higher permeability soils at the East Trenches Area. Detailed specification of the vacuum pump as well as all other treatment system components will be provided in the Pilot Test Plan which will be prepared after regulatory agency approval of the Subsurface IM/IRAP/EA (Section 5.1).

The vapor exiting the vacuum pump is filtered by a HEPA filtration unit. HEPA filters contain fabric filtration media that is capable of removing particulates as small as 0.3 microns with 99.7 percent efficiency (Federal Standard 209b). In this vapor treatment application, HEPA filtration prevents fouling of downstream process equipment (i.e., vacuum pump and GAC units) and ensures operation within particulate emissions standards (Section 3.2.3). The latter is particularly important if the extracted vapors contain particulates contaminated with radionuclides. Figure 4-6 shows that the vapor treatment process includes two HEPA filters configured in parallel. One of the units is operated in a standby mode, and thus provides redundancy in the event that the on-line filter plugs or otherwise fails. Filter plugging is monitored with the pressure indicators installed on the inlet and outlet of the HEPA filters.

The vacuum pump mentioned above imparts heat to the vapor stream as a result of the work performed on the fluid. The magnitude of increase in vapor temperature depends on many factors including vapor flow rate and pump duty. The vapor stream may have to be cooled to ensure efficient adsorption of VOCs by the GAC units. Optimal adsorption efficiencies are achieved at temperatures less than 80°F. If required, a heat exchanger will be included in the pilot system design to cool the vapor stream. Figure 4-6 illustrates a water-cooled heat exchanger where warm water exiting the exchanger is sprayed cooled (i.e., evaporative cooling) in a recirculation tank.

The cooled vapor stream is then processed through two GAC adsorption units for removal of VOCs prior to discharge to the atmosphere. Adsorption of VOCs is a result of a physico-chemical attraction between the VOC molecules and the GAC, which provides a very large surface area for adsorption to occur. The concept design includes two GAC units configured in series (i.e., lead and polishing positions). Once the GAC unit in the lead position is fully loaded with VOCs (i.e., spent), it is taken out of service. The polishing GAC unit is moved to the lead position and a new GAC unit is placed in the polishing position. Physical movement of the polishing GAC unit is not necessary to place it in the lead position. This is accomplished by changing the open/closed configuration of the process valves. Spent GAC generated during the pilot study phase of the IM/IRA will be analyzed for the presence of radionuclides to determine whether it may be regenerated or

must be managed as a mixed waste. Due to the nature of this remedial action along with the presence of HEPA filtration upstream of the GAC units, it is expected that the GAC will not be contaminated with radionuclides and will be able to be regenerated. Regeneration is typically performed by the manufacturer and involves the passage of hot air through the bed to desorb the VOCs. The desorbed VOCs are then destroyed by high-temperature incineration.

The instrumentation and analytical sampling locations shown on Figure 4-6 conceptually illustrates the process information necessary to properly operate and evaluate the proposed vacuum-enhanced vapor extraction and treatment system. Detailed specification and placement of process instrumentation will be provided in the Pilot Test Plan. However, the following discussion of process measurements that are common to a variety of vapor extraction system configurations will aid in the understanding of process operation.

Level measurement on the mist eliminator indicates the amount of condensate that has accumulated and notifies the operator of the need to drain the unit. As mentioned above, pressure measurement before and after the HEPA filters provides an indication of filter plugging. Based on this differential pressure measurement, the standby filter containing virgin filter media is brought on line. The spent filter is taken off line and its filter media replaced. Similarly, differential pressure measurement across the GAC units provides an indication of unit loading and/or plugging.

Real-time monitoring is often employed for critical parameter measurement, alarm, and control. For the proposed vapor treatment system, on-line radiation monitoring immediately downstream of the HEPA filters detects failure of the filters to remove radionuclide-contaminated particulates if present in the extracted vapors. Likewise, real-time VOC leak detection is used to monitor the integrity of system piping and connections to ensure emission-free operation. Leaks in process piping located downstream of the vacuum pump (i.e., positive pressure side) and upstream of the GAC units may result in VOC emissions. Leaks on the negative pressure side of the process do not result in undesired emissions. Rather, atmospheric air is pulled into the system. RCRA leak detection is often implemented by monitoring the secondary containment cavity of the process piping.

Specifically, a hydrocarbon sensor is placed into the secondary containment cavities of the process piping and connected to an alarm. In addition to these alarms, the signals from the real-time radiation and VOC sensors may be used to provide automatic shutdown of the system. Details of control signal wiring will be presented in the Pilot Test Plans.

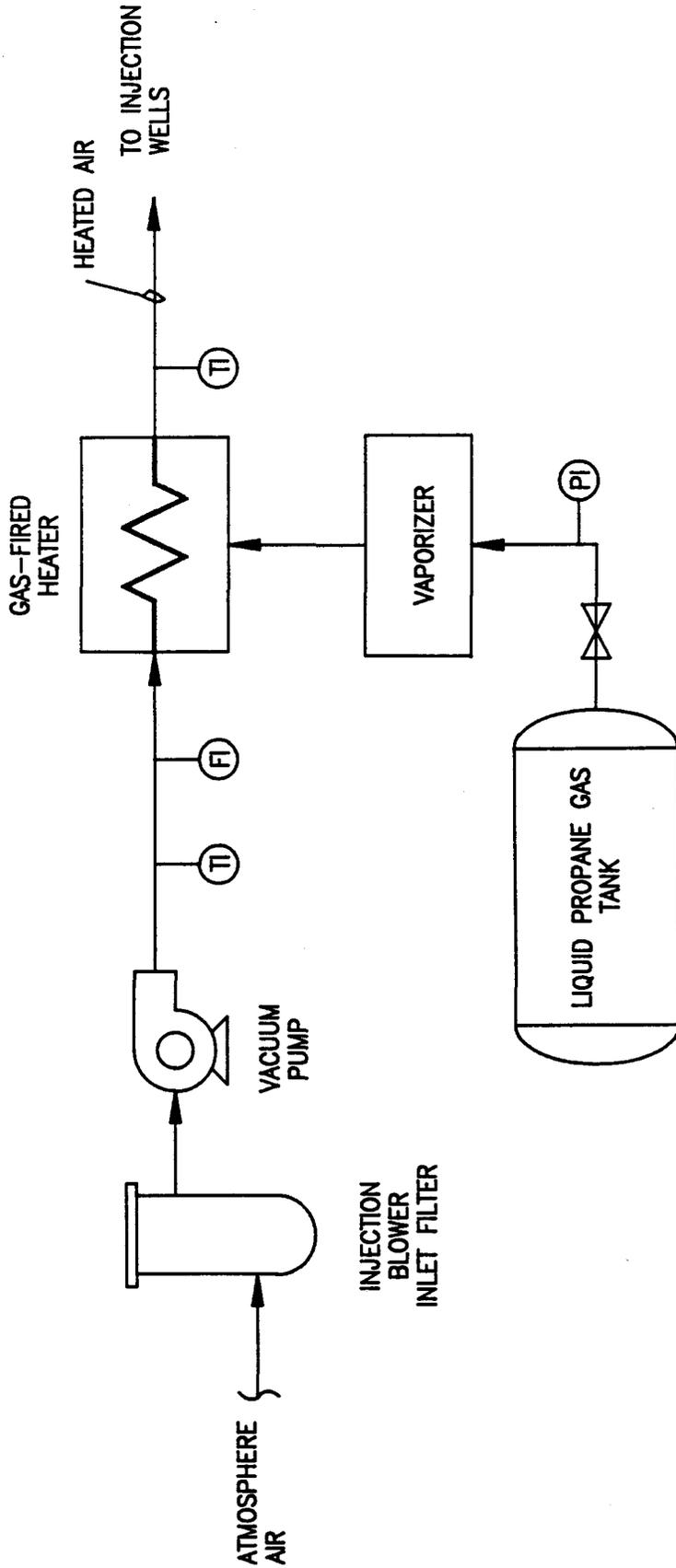
Vapor flow measurement and analysis of vapor samples will allow calculation of contaminant mass recovery rates, and thus, evaluation of system performance. Comparison of upstream and downstream vapor flow measurements provides additional information for assessment of system vapor leaks. Measurement of the temperature of the vapor leaving the heat exchanger is crucial in maintaining the operating efficiency of the GAC units.

As mentioned above, pilot testing of the *in situ* vacuum-enhanced vapor extraction system involves injection of ambient and heated air into the test area formation to study the effect on VOC mass recovery. Figure 4-7 illustrates the equipment that will be used for air injection: a blower and liquid propane gas-fired heater. This equipment will be sized during the detailed design phase of the IM/IRA (i.e., Test Plan) to provide a range of operational service that accommodates the different subsurface conditions at each of the OU2 test areas. Process instruments and controls will be used on the air injection system to ensure proper control of air flows and temperatures.

As noted on Figures 4-6 and 4-7, the vapor injection, extraction, and treatment system components are mounted on a flat-bed trailer. This allows the equipment to be easily moved to different vapor extraction test sites. Electric power necessary to operate these systems at the 903 Pad test site will be obtained from existing power lines in the vicinity of 903 Pad. Electric power-driven equipment includes vapor and ground-water extraction pumps, air injection blower, instrumentation and controls, cooling water circulation pump, and heat tracing.

The South Walnut Creek Basin Surface Water Treatment Facility (Section 4.6.1) is proposed for use in treating contaminated ground water and condensate generated by Subsurface IM/IRA pilot test activities at the 903 Pad. This facility has been selected because of the uncertainty associated with the chemistry of the ground water that may be recovered directly

R37048.MB120891



**LEGEND**

- (FI) FLOW INDICATOR
- (PI) PRESSURE INDICATOR
- (TI) TEMPERATURE INDICATOR
- ∇ VALVE

**NOTE:**  
 VAPOR INJECTION EQUIPMENT  
 IS MOUNTED ON A FLATBED  
 TRAILER FOR EASE OF TRANSPORT  
 TO EACH PILOT TEST SITE.

January 1992

**PILOT TEST UNIT  
 VAPOR INJECTION SYSTEM**

**FIGURE  
 4-7**

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beneath the 903 Pad. The South Walnut Creek Basin Surface Water Treatment Facility is the only existing or planned RFP treatment system that has been designed to address all of the potential contaminants of concern. At OU2 these contaminants include VOCs, radionuclides (i.e., Pu, Am, and U), and metals. The 881 Hillside Ground-Water Treatment System, for example, has been designed to remove VOCs, metals, and U, but not Pu or Am. Proposed use of the South Walnut Creek Basin facility to treat contaminated Woman Creek Basin Surface seeps and discharge the treated water to the South Walnut Creek drainage (EG&G, 1990e) encountered strong public opposition with respect to interbasin transfer of this seep water. It should be noted, however, that ground water at the 903 Pad test site flows in two directions: northeast toward the South Walnut Creek Basin, and southeast toward the Woman Creek basin. This bidirectional flow is a result of the 903 Pad area being located on a potentiometric crest. Therefore, use of the South Walnut Creek Basin facility to treat any ground water that may be recovered at the 903 Pad IM/IRA test site does not raise the issue of interbasin transfer of contaminated water. The South Walnut Creek Basin Treatment System is centrally located with respect to all of the proposed pilot test locations and has spare processing capacity. It is also proposed that ground water and condensate generated from pilot testing at the 903 Pad be transported to the South Walnut Creek Basin Treatment System by tank truck. Truck transport has been selected over pipeline transport because of the relatively short duration of the pilot study and the uncertainties associated with production of ground water, if any. Ground-water production and chemistry data collected during the pilot study phase of the IM/IRA will allow consideration of the use of other RFP treatment systems for post-pilot study operation. These data will also be used to determine the means of contaminated water transport (tank truck versus pipeline) to the designated treatment facility during post-pilot study operation. Candidate RFP water treatment systems that may potentially support the Subsurface IM/IRA are discussed in Section 4.6.

It is estimated that approximately 1 gallon per minute (gpm) of ground water will be produced in dewatering the 903 Pad test area alluvium. The volume of condensate produced will be minimal. Ground water and condensate recovered during pilot testing will be allowed to accumulate in an insulated and heated holding tank located at the test site. The contents of the tank will be transported by tank truck to the South Walnut Creek Basin

Treatment Facility for removal of contaminants. Assuming the use of a 5,000-gallon holding tank and a 5,000-gallon tank truck, one trip will be required every 3 days to accommodate a 1 gpm recovery rate. The one-way transportation distance from the 903 Pad test site to the South Walnut Creek Basin treatment facility is less than one-half mile via Central Avenue and the treatment facility access road.

As discussed above, several incidental wastes would be generated during installation and operation of the proposed subsurface action at the 903 Pad. These wastes include: personnel protective equipment, drill cuttings (i.e., contaminated soil from well installation), vapor extraction treatment residuals including spent HEPA filtration media and GAC; ground-water treatment residuals including sludge and GAC; and recovered free-phase solvents (Section 4.3.3.2). All incidental wastes from installation and operation are expected to be similar to those already generated at RFP and will constitute a small fraction of the wastes already processed for storage or disposal by the site. These solid wastes will be characterized and handled according to RFP waste management operating procedures (EG&G, 1991h).

#### **4.3.2.2 Observational/Streamlined Approach Considerations**

In accordance with EPA Observational/Streamlined Approach guidance, this section identifies potential deviations from the expected conditions at the 903 Pad test site, mechanisms to identify the deviations, and contingency plans that respond to the deviations. Deviations from expected conditions are a result of incorrect assumptions with respect to site-specific hydrogeology and nature of contamination based on limited site characterization data. As mentioned in Section 4.3.1.2, the expected conditions at the 903 Pad are based on qualitative data regarding the site history and quantitative data derived from investigative activities performed near the proposed test site, but not actually within the test area. In light of the uncertainties associated with extrapolation of site conditions from these data, the development of contingencies to respond to unexpected conditions within the test site is a critical component of the IM/IRA.

**Table 4-1**  
**Observational/Streamlined Approach**  
***In Situ* Vacuum-Enhanced Vapor Extraction at 903 Pad (IHSS 112)**

Expected Conditions	Potential Deviations	Mechanisms to Identify Deviations	Contingency
RI data provides sufficient information to place vapor extraction and injection wells.	RI data does not provide sufficient information to place vapor extraction and injection wells.	Analysis and interpretation of RI data.	Plan and conduct soil vapor survey to provide additional information.
Limited VOC contamination in bedrock.	VOC contamination extends deep into bedrock.	Direct observation (i.e., staining and odor) and measurement (i.e. OVA) of soil boreholes samples	Advance boring to maximum depth of contamination (limited to 100 feet).
No recoverable ground water in bedrock.	Recoverable ground water in bedrock.	Direct measurement.	Retrofit existing vapor extraction and injection wells with ground-water pump.
No free-phase solvents in recovered ground water.	Free-phase solvents are present in recovered ground water.	Direct observation.	Install phase separation unit.
Radionuclide-contaminated particulates not present in vapor stream.	Radionuclide-contaminated particulates present in vapor stream.	Analysis of spent HEPA filter media.	Retain HEPA filters.
GAC adsorption is cost effective vapor treatment technology (based on VOC concentration).	GAC adsorption is not a cost effective vapor treatment technology due to high VOC concentrations.	Sampling and analysis of vapor stream.	a. Install clean air intake upstream of vacuum pump to reduce VOC concentrations. b. Evaluate feasibility of vapor treatment by thermal oxidation or condensation.
All OU2 contaminants of concern present in recovered ground-water and condensate (VOCs; radionuclides, including Pu, Am, and U; and metals).	All OU2 contaminants of concern not present in recovered ground water and condensate.	Sampling and analysis of recovered ground water and condensate.	Use most appropriate RFP treatment system to process recovered ground water and condensate.
Ground-water recovery rates $\leq 1$ gpm.	Ground-water recovery rates $>> 1$ gpm.	Direct observation.	Use most appropriate RFP treatment system(s) to process recovered ground water, and assess pipeline vs. tank truck transport.
VOC concentration in extracted vapors $\geq 1$ ppm (field measurement)	VOC concentration in extracted vapors $< 1$ ppm (field measurements)	Direct measurement.	a. Abandon proposed test site. b. Assess feasibility of considering an alternative test site.
Post-pilot operation of <i>in situ</i> vacuum-enhanced vapor extraction system is deemed to be beneficial.	Post-pilot operation of <i>in situ</i> vacuum-enhanced vapor extraction system is not deemed to be beneficial.	Analysis of pilot test data with respect to evaluation criteria (Section 4.3.2).	Post-pilot operation not conducted at test site.

Table 4-1 presents reasonable deviations that might be encountered during implementation of the proposed vapor extraction system at the 903 Pad test site. The table also indicates the mechanisms that will be used to identify the potential deviations and presents contingency plans that will be implemented in the event that a deviation actually occurs. The remainder of this Section provides a detailed explanation of Table 4-1.

Residual free-phase solvent contamination at 903 Pad is not expected to have penetrated more than 30 feet into the claystone bedrock. This expected condition is based on a review of existing RI data. The potential deviation would be the presence of free-phase contamination at depths greater than 30 feet into bedrock. The method for detecting the deviation is visual inspection of soil samples recovered during drilling of the bedrock vapor extraction well boreholes. The contingency involves continuing the boring to the lower limit of observed contamination and installing a well screen to the total depth of the boring. However, the boring will not extend beyond 100 feet total depth.

Recoverable ground water in the claystone bedrock at the 903 Pad test site is not expected. Borings advanced through the claystone near the 903 Pad during previous investigative efforts recovered only dry to moist soil samples. It is possible, however, that the vacuum induced by the vapor recovery wells will result in the accumulation of residual soil moisture in the well. This potential deviation from expected conditions will be directly measured using an electronic water level indicator. The contingency will involve retrofitting the vapor recovery wells with ground-water extraction pumps. Ground water extracted during pilot testing will be transported to the South Walnut Creek Basin Treatment System as discussed above.

DNAPLs are not expected to accumulate in the alluvial or bedrock wells. There is, however, uncertainty in this expectation, and it is conceivable that accumulation of DNAPLs in the wells may occur. The bedrock wells, for example, may receive DNAPLs from pools perched on the bedrock. The presence of free-phase liquid contaminants in ground-water extraction wells will be determined by visual inspection of the recovered ground water for an immiscible phase. The contingency to respond to this deviation will involve retrofitting

the ground-water storage system with a liquid-phase separation unit installed between the extraction wells and the storage tank.

Although not expected, during vapor extraction system startup it is conceivable that radionuclide-contaminated particulates resulting from disturbed soils along the length of the extraction wells may be entrained into the vapor stream. HEPA filters are included in the vapor treatment process for particulate removal. Filtration protects the GAC against fouling and ensures that radionuclides are not discharged from the system. Spent HEPA filter media will be sampled and analyzed for the presence of radionuclides. If after several weeks of system operation, analysis of spent filtration media establishes that radionuclide-contaminated particles are not present in the vapor stream, HEPA filtration will be removed from the process, allowing a greater vacuum to be pulled on the subsurface. If analysis indicates the presence of radionuclides, however, HEPA filtration will be retained. In either event, real-time radiation monitoring will be conducted.

It is expected that GAC adsorption will provide cost-effective recovery of vapor-phase VOCs. This is strictly a function the VOC mass recovery rate observed during the pilot study. Based on the mass recovery rate, the feasibility of stand-alone GAC adsorption will be compared to condensation and thermal oxidation. Condensation involves chilling the vapor stream to liquify VOCs. The liquid stream is recovered and sent off site for recycling. Residual VOCs in the vapor stream are removed by GAC adsorption. Thermal oxidation involves immediate destruction of VOCs extracted from the subsurface.

### **4.3.3 Evaluation of Remedial Approach**

#### **4.3.3.1 Effectiveness**

The proposed subsurface action at the 903 Pad test site provides an alternative to excavation and disposal of VOC-contaminated soils. VOCs recovered by the GAC adsorption units are subsequently thermally desorbed and destroyed at an off-site GAC regeneration facility. During the regeneration process, a small quantity of ash may be generated which requires land disposal. The action is also expected to generate sludge from treatment of

contaminated ground water and condensate at the South Walnut Creek Basin Surface Water Treatment Facility. This sludge may require land disposal and/or on-site storage as a hazardous mixed waste. Likewise, spent HEPA filtration media may also require land disposal or on-site storage as a hazardous mixed waste. However, generation of spent HEPA filtration media is expected to be minimal and only during the initial weeks of operation. Management of treatment system residuals according to RFP standard operating procedures will eliminate exposure risks.

Vapor-phase recovery is an efficient method for reducing contaminant mobility and volume. By addressing free-phase source contamination, a reduction in the amount of contaminant available to dissolve into the ground water ultimately results in reduction of the volume of contaminated ground water migrating from the test areas. A reduction in toxicity is also achieved by recovery and destruction of VOCs. Vapor-phase recovery may be implemented using relatively simple, cost effective and reliable equipment. As discussed in Section 3, there are no ARARs for remediation of subsurface soils. ARARs do exist, however, for treatment and discharge of any ground water recovered during the IRA. Proposed use of the South Walnut Creek Basin Surface Water Treatment Facility (EG&g, 1991f) is expected to achieve ARARs associated with ground-water treatment.

#### 4.3.3.2 Implementability

Vacuum-enhanced vapor extraction is a technically feasible remedial action for OU2. The simplicity of design, fabrication using commonly available materials, ease of maintenance and potential for cost-effective operation make *in situ* vacuum-enhanced vapor extraction an attractive remedial technology. Vapor extraction is a proven technology that has been successfully applied at many sites. In unconsolidated formations, vapor extraction has been successfully implemented in both coarse and fine-grained material. The alluvial material at the proposed test sites is expected to be coarse grained and consist of sand, gravel and lesser amounts of silt and clay. The bedrock material at the proposed test sites is consolidated and its permeability to air flow has not been quantified. Both sandstone and claystone bedrock is expected to have relatively low permeabilities when compared with the alluvium; however, bedrock permeability is expected to be high enough to permit a

measurable vapor flow rate. Performance of the proposed systems will be demonstrated by calculating contaminant mass recovery rates based on vapor flows and contaminant concentrations. Regeneration services for the GAC adsorption units are readily available, and special labor skills are not necessary to construct and operate the vapor extraction and treatment equipment.

Factors limiting the success of *in situ* vacuum-enhanced vapor extraction at the 903 Pad include low formation permeability and amount of residual free-phase contamination in the subsurface. A review of existing data suggest that low formation permeability will not be a limiting factor in the alluvium, however, bedrock permeability may be low. Confirmation of source area locations will be critical to the successful implementation of this technology as an interim or final action. Should additional data become available during the Phase II RI suggesting a more promising test area, interim remedial efforts may be redirected to another site.

Public acceptance is anticipated for the proposed subsurface action at the 903 Pad because this interim action could expedite final remediation, and there will be contaminant source removal and subsequent contaminant destruction during the IRA. The public should also support the use of the Observational/Streamlined Approach in planning and implementing the IRA in order to maximize data quality and quantity. Finally, use of existing RFP water treatment facilities to treat ground water and condensate should also be viewed favorably by the public because these systems have already passed public scrutiny. No permits are required for implementation of the subsurface IM/IRA.

All materials needed to construct and operate the proposed interim remedial system are commonly available. During the installation of extraction wells, approximately 6 cubic yards of drill cuttings (waste soil) will be generated. This material may be classified as hazardous mixed waste. Extracted ground water will be treated at existing RFP facilities that already have received public acceptance. Therefore, administrative feasibility of the proposed interim action appears high.

### 4.3.3.3 Environmental Impact

#### Commitment of Resources

The vapor extraction system proposed for the Subsurface IM/IRA at the 903 Pad will not require construction of additional treatment facilities, but will require commitment of resources (equipment and material) to install approximately six extraction wells with component HEPA filters, GAC units, water collection systems, and monitoring devices.

Treatment of contaminated subsurface water from OU2 will result in an incremental increase in site pickup and deliveries of spent GAC units and replacement units and chemicals for the pretreatment of water. If the pilot testing phase is successful and the vapor extraction system is expected to operate for a year or more, deliveries will be spread out over the course of the year and will be handled by one of the existing Plant chemical suppliers. The very small number of shipments involved for both the GAC units and the chemical treatment system will result in an insignificant impact to human health.

Off-site transportation impacts associated with the shipment of dewatering sludge to a mixed waste disposal site, will be very low as determined in DOE (1990b). Relatively low concentrations of contaminants, the physical form of the waste, disposal site acceptance criteria, and compliance with DOT packaging and transport requirements all contribute to very low health risks from incident-free shipment and accident events.

#### Transportation Impacts

The proposed subsurface water collection system involves transportation activities during installation and routine operations. Installation transportation activities will primarily involve the movement of equipment for drilling, well installation, material deliveries for installation, and potential off-site disposal of excavated soils resulting from drilling. Routine operations will require the transfer of collected water to the South Walnut Creek Treatment System, periodic inspection and maintenance of the pumps and collection systems, and occasional off-site shipment of dewatering sludge to a low-level mixed waste disposal site.

Potential health effects from fugitive dust during installation will have negligible impacts, as discussed earlier in this section. Given the limited extent of transportation activities associated with the collection system and the health effect estimates presented in Appendix E, transportation health effects are predicted to be very small. Additional discussion details are provided in Appendix E.

### Wetlands

Wetlands areas have been identified near the 903 Pad proposed action site. These wetlands are fed by several seeps that are located in two areas: approximately 1,000 feet to the southeast of the site, and approximately 1,200 feet to the north of the site. These seeps typically have flows that fluctuate seasonally and normally remain below 2 gpm. Many of these seeps dry up during periods of low recharge.

Dewatering activities at the 903 Pad are predicted to result in a water extraction rate of 1 gpm or less. Inasmuch as there are no technologies for effectively conducting vapor extraction when ground water is present, removal or collection of the water is a necessity. Ground-water extraction is not expected to have a significant impact on nearby wetlands because of the small expected flow and limited duration (3 years or less). However, it is known that there is significant variation in the water table elevations within OU2, near surface water-bearing units. Therefore, it is possible that dewatering rates may be different than predicted and may have a significant effect on wetlands. The total wetlands area that could be affected by the proposed 903 Pad action is estimated to be less than one-fortieth of an acre. Suitable habitat exists in the surrounding area to accommodate any temporary wildlife displacement. At the conclusion of the IM/IRA, ground-water flow will return to its previous levels, and any temporary wetlands impacts will be naturally mitigated.

Water treatment alternatives are considered in Section 4.6. If a treatment alternative is selected, its purpose would be to remove contaminants from the water that might reach a drinking water source. While it would be possible to reintroduce the treated water at the collection point or at the seeps, thus preserving the wetland areas, such a program would simply reintroduce clean water into a local ground-water system that is contaminated. This

would contribute to an increased potentiometric surface and this an increased potential for contaminant migration.

### **Cumulative Impacts**

Installation activities will result in increased vehicular traffic, engine emissions, and the number of workers. The number of personnel required for the project will be a small increase to the assumed yearly additional construction loading.

It is estimated that two workers will be involved in routine operation and maintenance of the vapor extraction system at the 903 Pad. The same workers will also be able to operate and maintain vapor extraction system systems at Mound and the East Trenches. This will have negligible impact on the number of Plant personnel. In routine operations, these workers will not be exposed to any levels of chemicals or waste stream pollutants that would restrict them from other assignments at the RFP.

#### **4.4 VACUUM-ENHANCED VAPOR RECOVERY AT MOUND (IHSS No. 113)**

This section presents a detailed description of the proposed action at the Mound Area. This discussion focuses on the expected test site conditions, proposed treatment systems, and Observational/Streamlined Approach considerations with respect to deviations in expected test site conditions.

##### **4.4.1 Test Site Description**

###### **4.4.1.1 Test Site Selection Rationale**

The rationale and criteria used for selection of the Subsurface IM/IRA test sites is discussed in Section 4.3.1.1. IHSS No. 113, a former drum storage location at the Mound Area, is the second site proposed for pilot testing *in situ* vacuum-enhanced vapor extraction. Its location within OU2 is shown in Figure 2-2. IHSS No. 113 satisfies all three test site selection criteria as discussed below.

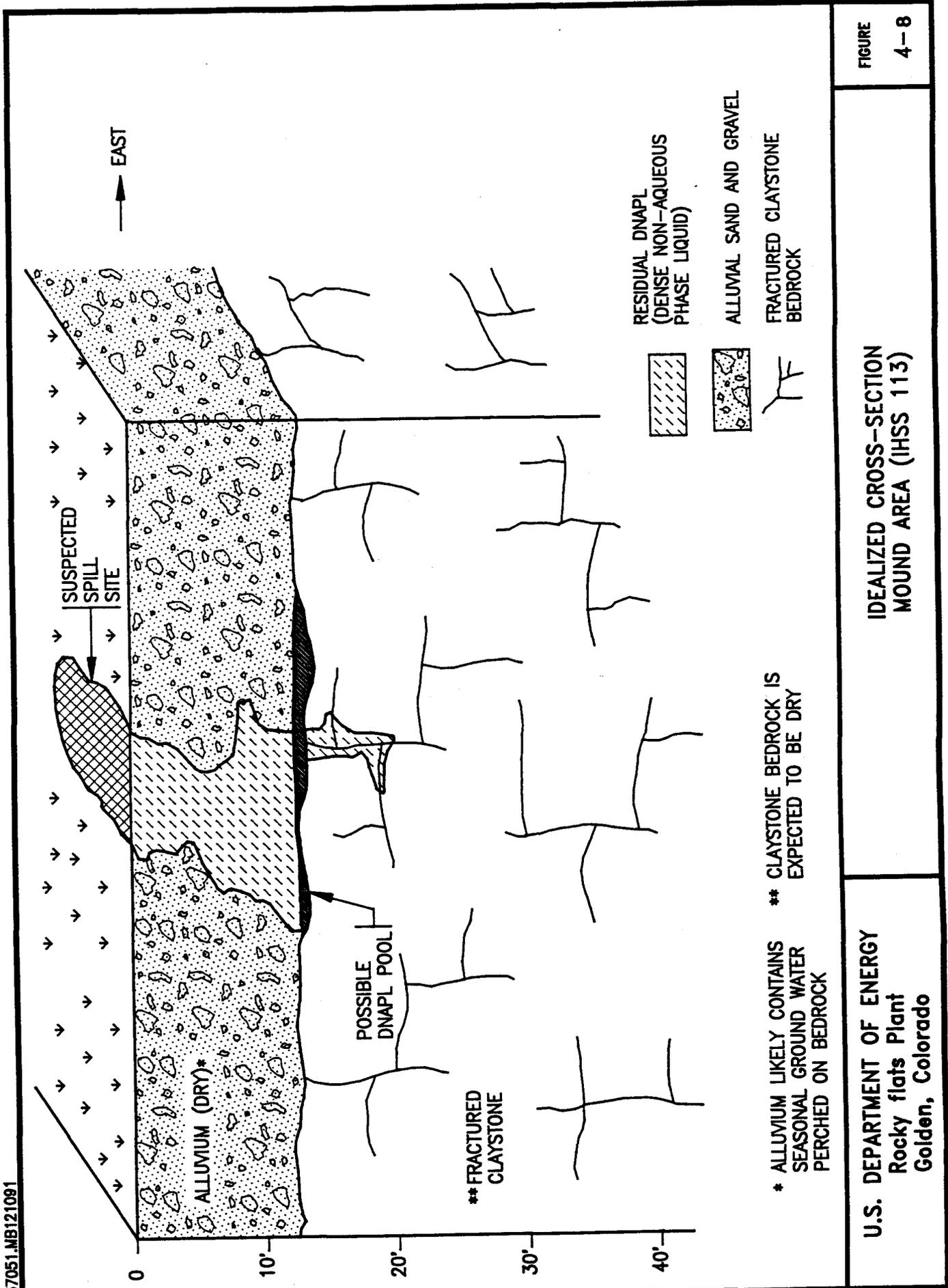
IHSS No. 113 was used to store an estimated 1,405 drums containing primarily depleted uranium- and beryllium-contaminated lathe coolant (a mixture of 70 percent hydraulic oil and 30 percent carbon tetrachloride). Records do not indicate that the drums were buried (Calkins, 1970). Some drums also contained Perclene (Smith, 1975). Perclene was a brand name of tetrachloroethylene (Sax and Lewis, 1987). Initial remediation of this site was accomplished in May 1970. It is not clear from the literature whether fluid was observed to have leaked from these drums before or during cleanup. However, a release of free-phase chlorinated hydrocarbons is inferred from the chemistry of water samples collected from a monitoring well adjacent and hydraulically downgradient of IHSS No. 113 (Well No. 0174 [Figure 2-12]). Water samples collected in May 1987 and 1989 contained 528.0 mg/ℓ and 45.0 mg/ℓ of PCE, respectively. The solubility of PCE at standard temperature and pressure is approximately 160 mg/ℓ suggesting the presence of free-phase PCE near IHSS No. 113. The potential for free-phase chlorinated solvents at this site coupled with a lack of evidence for buried drums makes this site suitable for the Subsurface IM/IRA.

Soil sampling conducted at IHSS No. 113 after the May 1970 clean-up indicated 0.8 to 112.5 disintegrations per minute per gram (dnm/g) (0.4 to 51 pCi/g) activity. This contamination is thought to have been transported by wind from the 903 Pad Drum Storage Site. Nothing has been found in the literature to suggest the presence of metallic nuclear material buried at IHSS No. 113.

#### 4.4.1.2 Expected Conditions

No site-specific hydrogeologic or chemical information is currently available for the area within IHSS No. 113 boundaries. However, several exploratory boreholes were drilled and monitoring wells constructed near the test site. These data were used to construct a conceptual model of the site hydrogeology and contaminant type and distribution. A geologic log of borehole 2087 (Figure 2-9), which is typical of the IHSS No. 113 area, is presented in Appendix D. An idealized block diagram of the IHSS No. 113 test area is presented in Figure 4-8. The diagram illustrates the hydrogeology and contaminant distribution expected to exist within 50 feet of the ground surface.

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IDEALIZED CROSS-SECTION  
MOUND AREA (IHSS 113)

FIGURE  
4-8

Sand and gravel alluvium extends to approximately 10 feet below ground surface and overlies claystone bedrock that may contain isolated or interconnected fractures. The alluvium is expected to be dry but may contain a small amount of seasonal ground water perched on the underlying claystone bedrock. The bedrock is not expected to contain recoverable ground water.

It is expected that PCE comprises the majority of the VOC contamination in the IHSS No. 113 area with lesser amounts of carbon tetrachloride. A sample of ground water collected from Monitoring Well 0174 (Figure 2-12), located adjacent to IHSS No. 113, contained PCE at a concentration that exceeded its solubility limit. The well screen crosses the alluvial/bedrock boundary suggesting that free-phase PCE released at IHSS No. 113 infiltrated the alluvium coming to rest on the claystone bedrock. It is likely that a small amount of free-phase PCE or an emulsion of PCE and seasonal ground water flowed towards and entered Well 0174. The conceptual diagram shows the residual DNAPL in the alluvium and pools of DNAPL perched on the claystone bedrock with some infiltration of DNAPL along bedrock fractures. A review of existing monitoring well as-built diagrams and ground-water chemistry (Rockwell, 1987a) with respect to the presence of dissolved or residual free-phase chlorinated solvents in the claystone bedrock near IHSS No. 113 was inconclusive. It is important to note that the presence of pools of DNAPL perched on the bedrock is also uncertain and may never be conclusively determined. However, the presence of very high concentrations of PCE in a monitoring well adjacent to IHSS No. 113, and in light of the inventory of drum numbers and contents stored at IHSS No. 113, it is reasonable to infer the presence of residual free-phase chlorinated solvents in the vadose zone. This material may be mobilized during periods of high precipitation when ground water may be perched on the claystone bedrock.

#### **4.4.2 Remedial Approach**

##### **4.4.2.1 Proposed Action Based On Expected Conditions**

This section provides a detailed description of the interim remedial action proposed for implementation at the Mound Area test site (IHSS No. 113). The proposed action is based

on the idealized conceptual hydrogeologic and contaminant distribution model described in Section 4.4.1.2, and involves:

- *In situ* vacuum-enhanced vapor extraction for the alluvial material.
- *In situ* vacuum-enhanced vapor extraction in the upper portion of the underlying claystone bedrock.

### Vapor Extraction

Figure 4-9 illustrates the configuration of the vapor recovery system. At IHSS No. 113, two vapor extraction wells will be installed in both the alluvium and the upper portion of the claystone bedrock and manifolded to one or more vacuum pump(s). The precise location of the vapor recovery wells has not been determined as there currently is no contaminant concentration data available for the area within IHSS No. 113 boundaries. A Phase II RI is currently in progress at OU2 and includes the advancement of soil borings and the construction of ground-water monitoring wells within IHSS No. 113 boundaries. Prior to implementation of this portion of the IM/IRA, a review of available RI data will be conducted with respect to identified locations of residual chlorinated hydrocarbons. In order to prevent significant short circuiting of atmospheric air to the vapor extraction wells, the upper 6 feet of the well will be constructed of blank casing. Should contamination be observed during drilling in the upper 5 feet of soils, the well screen will extend across shallow contaminated soils, but no less than 2 feet below the surface. In this case, an impermeable cover will be installed over the ground surface within 10 feet of the vapor extraction wells.

Interim remedial efforts in the alluvium and bedrock will be isolated from each other in order to prevent cross-contamination between the two distinct formations. Bedrock wells will be isolated from the alluvium by the installation of steel surface casing set into the bedrock. Alluvial and bedrock well construction schematics are provided in Figure 4-5. One air injection well will be installed in both the bedrock and alluvium and will be located between the vapor extraction wells. These wells will be used to inject ambient and heated air into the formations to evaluate any enhancement to VOC recovery due to the additional

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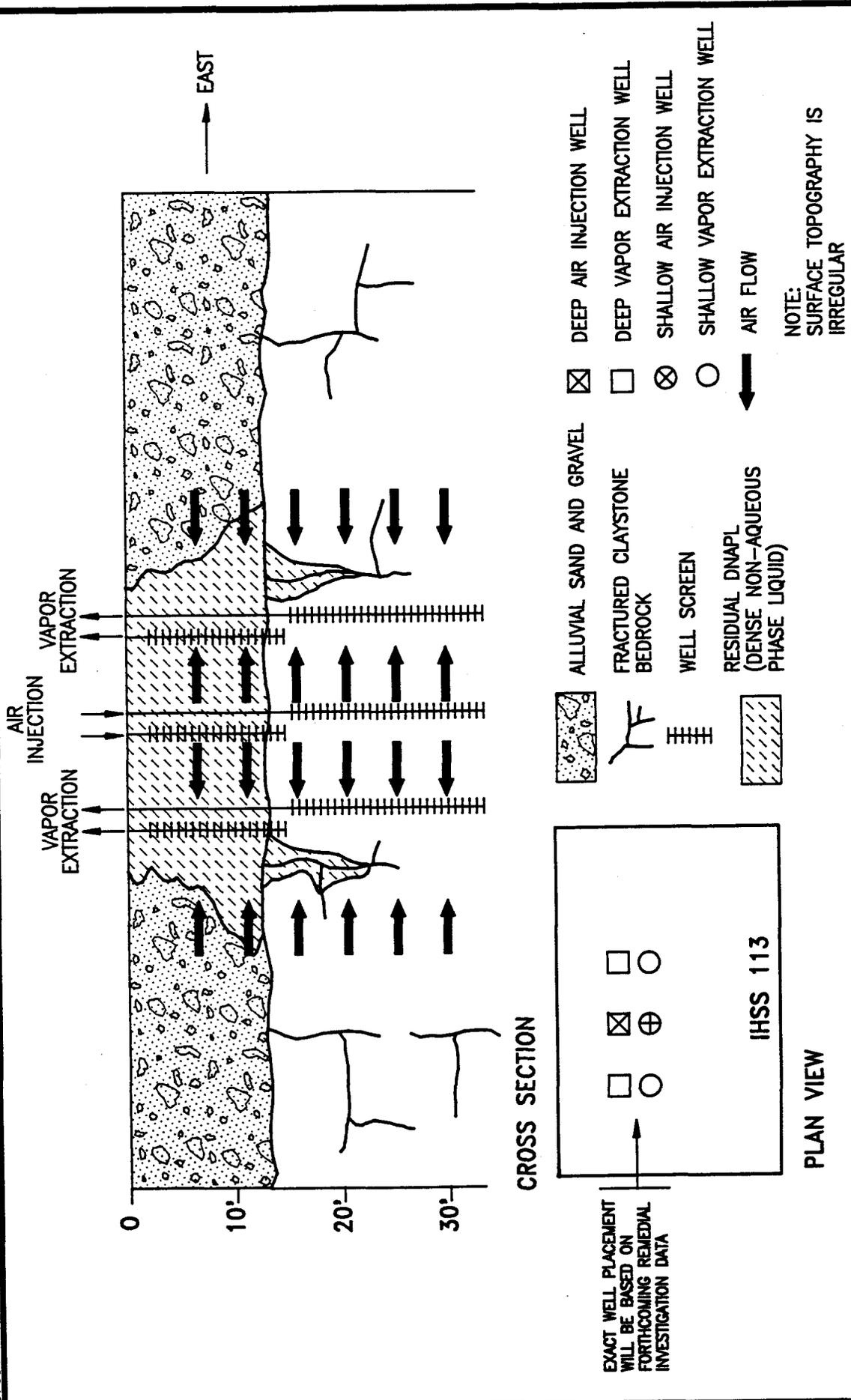


FIGURE  
4-9

SCHEMATIC  
PROPOSED VAPOR EXTRACTION SYSTEM  
MOUND AREA (IHSS 113)

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flow and heat. Ambient and warm air will be injected at a rate equal to one-half of the combined extraction rate. This is to insure that injected air does not further disperse vapor phase contaminants in the vadose zone. Under ideal conditions of isotropy and homogeneity of the alluvial soils or bedrock, air flow lines can be expected to form a closed loop between the injection and extraction wells given reasonably close well spacing (<25 feet). Radial pressure distribution equations (Johnson et. al, 1989) will be used during Test Plan development to insure that negative pressures are maintained at the boundary of the test area. Static pressure monitoring wells will be installed at various distances from the well array to verify capture and to determine the area of influence of the vapor extraction system.

The conceptual hydrogeologic model illustrated in Figure 4-8 shows some limited penetration of DNAPL into bedrock fractures. The lack of conclusive evidence of contaminant migration into bedrock suggests the need for a conservative approach to bedrock remedial efforts. For this reason, it is proposed to install vapor recovery wells to a maximum of 30 feet into bedrock.

Dynamic performance and effectiveness of the *in situ* vapor extraction system at IHSS No. 113 will be assessed as described in Section 4.3.2.1.

The proposed test site selection was based on qualitative data from the proposed test site and conditions extrapolated from quantitative data collected near the proposed test site. Should the proposed test site prove inadequate, an alternative test site will be selected. The most likely reason for poor site conditions is the absence of residual free-phase DNAPL. A preliminary threshold for determining success will be a recovery rate of 0.5 lbs/day of VOCs. The test will be conducted for a minimum of 7 days before abandonment and new site selection. If the recovery rate equals or exceeds 0.5 lbs/day, the test duration will be decided while the test is in progress. In any case, test duration will not exceed three months.

## Vapor Treatment

A discussion of the system proposed to treat vapors extracted from the subsurface at the IHSS No. 113 test site is presented in Section 4.5.2.1.

### **4.4.2.2 Observational/Streamlined Approach Considerations**

A summary of the expected conditions, potential deviations and contingencies relevant to the proposed action at Mound is presented in Table 4-2. Many of the items presented in Table 4-2 are identical for each proposed OU2 test site. Therefore, this section will address only those items that are unique to the Mound test site. The reader is referred to section 4.3.2.2 for a detailed discussion of the items common to all OU2 test sites.

The Mound test site is unique in that no recoverable ground water is expected in either the alluvium or bedrock. The potential deviation would be the presence of a saturated thickness greater than 3 feet in the alluvium and/or an accumulation of ground water in the bedrock vapor extraction wells. This potential deviation from expected conditions would be identified by direct measurement with an electronic water level indicator. In this event, the existing wells would be retrofitted with ground-water recovery pumps. Ground water recovered during pilot testing would be transported by tank truck to the South Walnut Creek Basin Surface Water Treatment Facility for treatment.

### **4.4.3 Evaluation of Remedial Approach**

#### **4.4.3.1 Effectiveness**

Evaluation of the proposed IRA at the Mound Area with respect to CERCLA effectiveness criteria is essentially the same as the effectiveness evaluation presented in Section 4.3.3.1. One difference, however, is the elimination of treatment system sludge production and associated land disposal since ground water is not expected to be recovered at the Mound Area test site.

**Table 4-2**  
**Observational/Streamlined Approach**  
***In Situ* Vacuum-Enhanced Vapor Extraction at Mound (IHSS No. 113)**

Expected Conditions	Potential Deviations	Mechanisms to Identify Deviations	Contingency
RI data provides sufficient information to place vapor extraction and injection wells.	RI data does not provide sufficient information to place vapor extraction and injection wells.	Analysis and interpretation of RI data.	Plan and conduct soil vapor survey to provide additional information.
VOC Contamination limited to upper 30 feet of claystone bedrock.	VOC contamination extends deep into bedrock	Direct observation (i.e., staining and odor) and measurement (i.e. OVA) of soil borehole samples.	Advance boring to lower limit of contamination or 100 feet total depth.
No recoverable alluvial or bedrock ground water.	Recoverable alluvial and/or bedrock ground water.	Direct measurement.	Retrofit existing vapor extraction and injection wells with ground-water pumps.
No free-phase solvents in recovered ground water (if any).	Free-phase solvents are present in recovered ground water (if any).	Direct observation.	Install phase separation unit.
Radionuclide-contaminated particulates not present in vapor stream.	Radionuclide-contaminated particulates present in vapor stream.	Analysis of spent HEPA filter media.	Retain HEPA filters.
GAC adsorption is cost effective vapor treatment technology (based on VOC concentration).	GAC adsorption is not a cost effective vapor treatment technology due to high VOC concentrations.	Sampling and analysis of vapor stream.	a. Install clean air intake upstream of vacuum pump to reduce VOC concentrations. b. Evaluate feasibility of vapor treatment by thermal oxidation or condensation.
VOC concentration in extracted vapors $\geq$ 1 ppm (field measurement)	VOC concentration in extracted vapors < 1 ppm (field measurements)	Direct measurement.	a. Abandon proposed test site. b. Assess feasibility of considering an alternative test site.
Post-pilot operation of <i>in situ</i> vacuum-enhanced vapor extraction system is deemed to be beneficial.	Post-pilot operation of <i>in situ</i> vacuum-enhanced vapor extraction system is not deemed to be beneficial.	Analysis of pilot test data with respect to evaluation criteria (Section 4.3.2).	Post-pilot operation not conducted at test site.

#### **4.4.3.2 Implementability**

Evaluation of the proposed interim remedial action at the Mound Area with respect to CERCLA implementation criteria is the same as the implementability evaluation presented in Section 4.3.3.2.

#### **4.4.3.3 Environmental Impact**

##### **Commitment of Resources**

Commitment of resources for the vapor extraction system proposed for the Subsurface IM/IRA at Mound will be virtually identical to that of the 903 Pad described in Section 4.3.3.3. This level of commitment will be low, and will not have a significant impact on RFP operations.

##### **Transportation Impacts**

Transportation impacts for the Mound vapor extraction system are virtually identical to those described for the 903 Pad in Section 4.3.3.3.

##### **Wetlands**

Wetlands areas have been identified near the Mound proposed action site. These wetlands may be fed by surface seep flow and are located in two areas: approximately 1,000 feet to the north of the site (seeps), and approximately 1,000 feet to the northwest of the site (seeps and South Walnut Creek). These seeps typically have flows that fluctuate seasonally and normally remain below 2 gpm. Many of these seeps dry up during periods of low recharge. South Walnut Creek flows range from 5 gpm to 60 gpm.

Dewatering activities at the Mound are not expected to result in any significant water collection; therefore, no impact on nearby wetlands is expected. However, it is known that there is significant variation in the water table elevations in near surface water bearing units

at OU2. Consequently, it is possible that dewatering may be necessary at Mound and this may have a significant effect on nearby wetlands. The total wetlands area that could be affected by the proposed Mound action is estimated to be less than one-fortieth of an acre. Suitable habitat exists in the surrounding area to accommodate any unlikely wildlife displacement. At the conclusion of the IM/IRA, ground-water flow, if affected, will return to its previous levels and any temporary wetlands impacts will be naturally mitigated.

Water treatment alternatives are the same as those described for 903 Pad in Section 4.3.3.3.

### **Cumulative Impacts**

Cumulative impacts are expected to be the same as those described for the 903 Pad.

#### **4.5 VACUUM-ENHANCED VAPOR EXTRACTION AT EAST TRENCHES AREA (IHSS NO. 111.1)**

This section presents a detailed description of the proposed interim remedial action at the East Trenches Area. This discussion focuses on the expected test site conditions, proposed treatment systems, and Observational/Streamlined Approach considerations with respect to deviations in expected test site conditions.

##### **4.5.1 Test Site Description**

###### **4.5.1.1 Test Site Selection Rationale**

The rationale and criteria used for selection of the subsurface IM/IRA test sites is discussed in Section 4.3.1.1. IHSS No. 111.1 (Trench T-4) burial site at the East Trenches Area, is the third site proposed for pilot testing *in situ* vacuum-enhanced vapor extraction. Its location within OU2 is shown on Figure 2-2. IHSS No. 111.1 satisfies all three test site selection criteria as discussed below.

A review of the literature revealed little specific information about the historical use of IHSS No. 111.1. The available information describes waste disposal activities at the East Trenches Area as a whole. To summarize, the burial trenches in this area were used between 1954 and 1968 for the disposal of sanitary sewage sludge contaminated with uranium and plutonium and approximately 300 flattened empty drums contaminated with uranium (Illsley, 1983). However, IHSS No. 111.1 is not expected to contain flattened drums. Figure 2-2 identifies those trenches where drums were observed or detected by magnetometer survey.

Based on this description, one would not expect to find significant concentrations of chlorinated solvent. However, a water sample collected in May 1988 from a monitoring well 3687 (Figure 2-13) adjacent to IHSS No. 111.1 contained 221.8 mg/l of TCE. The solubility of TCE is 1,100 mg/l at standard pressure and temperature. The concentration of TCE in the water sample represents a significant fraction of the TCE solubility limit suggesting the possibility of free phase TCE near IHSS No. 111.1.

Although the radiation content of the sewage sludge reportedly ranged from 382 pCi/g to 3,590 pCi/g (Owen and Steward, 1973) there are no reports of metallic nuclear material deliberately buried in IHSS No. 111.1. The only other material reportedly buried in IHSS No. 111.1 is plutonium- and uranium-contaminated asphalt planking from the solar evaporation ponds (Illsley, 1983). The potential presence of free phase TCE coupled with a lack of buried drums and metallic nuclear material makes IHSS No. 111.1 a suitable test site for this IM/IRA.

#### **4.5.1.2 Expected Conditions**

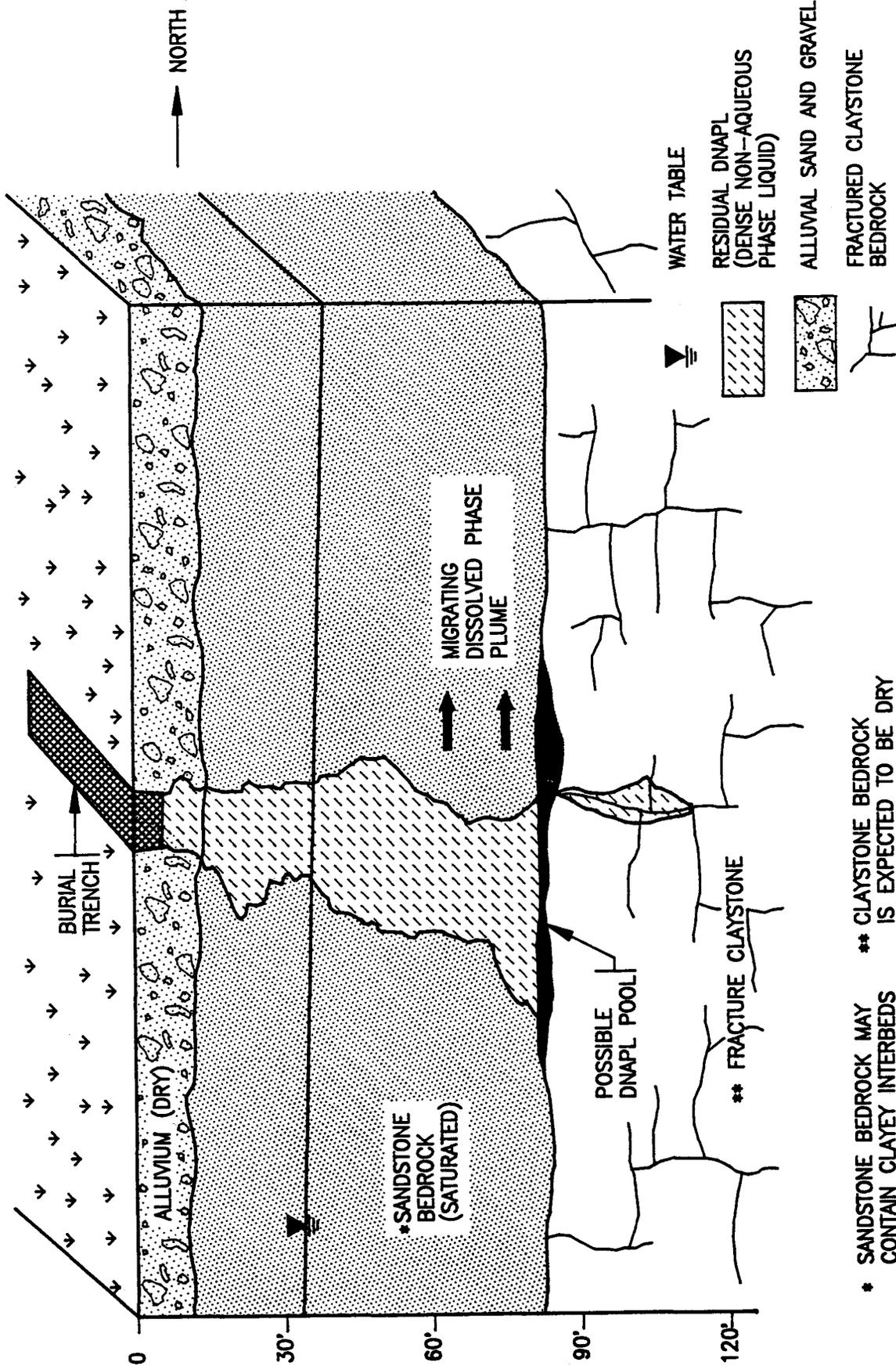
No exploratory borings have been advanced through IHSS No. 111.1; however, two borings were advanced approximately 40 feet north of the trench. Monitoring wells were constructed in these boreholes (Wells 3587 and 3687) (Figure 2-13) and geologic, water level, and chemistry data are available. These data were used to construct a conceptual model of the site hydrogeology and contaminant type and distribution. A geologic log of a borehole advanced for monitoring well 3687 (typical of the test area) is presented in

Appendix D. An idealized block diagram of the test area is presented as Figure 4-10. The diagram illustrates the hydrogeology and contaminant type and distribution within 120 feet of the ground surface.

Sand and gravel alluvium extends to approximately 10 feet below ground surface and overlies primarily sandstone bedrock. At Well 3687 (Figure 2-13), an 11 foot thick interval of sandy claystone was reported directly underlying the alluvium. A fine- to medium-grained sandstone underlies the sandy claystone and extends to at least 75 feet below ground surface. The sandstone is underlain by claystone which may contain isolated or interconnected fractures. Unconfined ground water is expected to be encountered at 35 feet below ground surface in the sandstone. Bedrock geology varies in the area immediately surrounding IHSS No. 111.1. Based on geologic logs of nearby soil borings, claystone underlies the alluvium south of IHSS No. 111.1 and sandstone underlies the alluvium to the west.

TCE is expected to be the primary contaminant at this test site. A sample of water collected in May 1988 from Monitoring Well 3687 contained 221.8 mg/l, which represents 20 percent of the TCE solubility limit. This well is screened in the sandstone bedrock. The high concentration of TCE within 40 feet of IHSS No. 111.1 suggests the presence of residual TCE in the soils and aquifer underlying this burial trench. The block diagram (Figure 4-10) shows the downward migration of DNAPL through the unsaturated alluvium and sandstone leaving a zone of residual free phase solvent. Because the solvent has a specific gravity greater than 1.0, the solvent is shown migrating downward through the saturated zone coming to rest in structural depressions on the claystone, and migrating a short distance along fractures in the claystone. The presence of pools of DNAPL on the claystone is by no means certain. Well cemented zones within the sandstone may have stopped its migration, or the capacity of the sediments overlying the claystone to absorb DNAPL may exceed the volume of DNAPL released from the trench. It is important to note that DNAPL residual and/or pools have not been observed at IHSS No. 111.1 or at OU2 in general. However, it is reasonable to infer its presence by extrapolating from nearby ground water chemistry, physical properties of the contaminants, and historical activities at OU2.

R37053.MB121691



IDEALIZED CROSS-SECTION  
EAST TRENCHES (IHSS 111.1)

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

\* SANDSTONE BEDROCK MAY  
CONTAIN CLAYEY INTERBEDS \*\* CLAYSTONE BEDROCK  
IS EXPECTED TO BE DRY

FIGURE

4-10

## 4.5.2 Remedial Approach

### 4.5.2.1 Proposed Action Based On Expected Conditions

The section provides a detailed description of the interim remedial action proposed for implementation at the East Trenches test site (IHS No. 111.1). The proposed action is based on idealized conceptual hydrogeologic and contaminant distribution model described in Section 4.4.1.2, and involves:

- *In situ* vacuum-enhanced vapor extraction for the alluvial material.
- *In situ* vacuum-enhanced vapor extraction coupled with ground-water depression in the sandstone bedrock.

### Vapor and Ground-Water Extraction

The claystone will not be addressed in this action. The depth to claystone at the test site is many times deeper than at other proposed OU2 test sites. Therefore, it is less likely that recoverable contamination has penetrated to claystone. Figure 4-11 illustrates the configuration of the vapor recovery system in cross-section and plan view.

Two vapor extraction wells will be installed in both the alluvium and the sandstone bedrock. One pair of alluvial and bedrock wells will be installed on either side of the burial trench. Because materials were buried in the trench and historical records of material type and quality may be inaccurate, it was believed appropriate to avoid drilling through the trench itself. The Phase II RI that is currently in progress at OU2 includes the advancement of two soil borings within IHSS No. 111.1. Prior to implementation of this portion of the IM/IRA, a review of available RI data will be conducted with respect to the presence of residual DNAPL or buried drums at this location.

Remedial efforts in the alluvium and sandstone will be isolated from each other in order to prevent cross-contamination between the two distinct formations. Sandstone wells will be isolated from the alluvium by the installation of steel surface casing set in sandstone.

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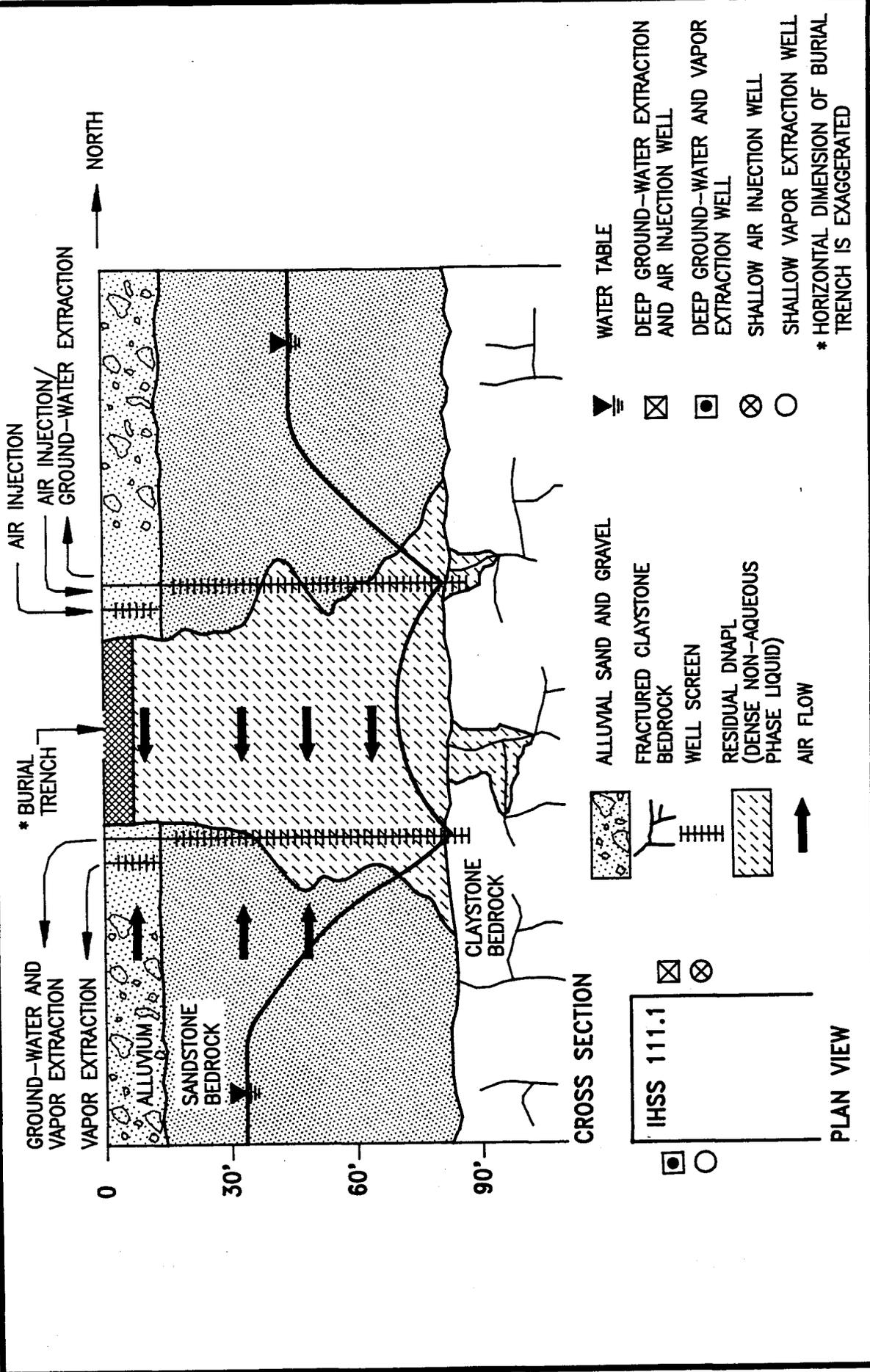


FIGURE 4-11

**SCHEMATIC GROUND-WATER AND VAPOR RECOVERY SYSTEM EAST TRENCHES AREA (IHSS 111.1)**

**U.S. DEPARTMENT OF ENERGY Rocky flats Plant Golden, Colorado**

Alluvial and sandstone well construction schematics are presented as Figure 4-5. One alluvial well will be used for vapor extraction and the second well installed on the opposite side of the trench will be used as an ambient or heated air injection well to induce an air sweep under the trench. Both sandstone wells will be fitted with ground water depression pumps in order to expose any residual DNAPL held in the sandstone by capillary forces. One sandstone well will be manifolded to a vacuum pump. The second well installed on the opposite side of the trench will be used to inject ambient and heated air to induce an air sweep through the test site. For reasons discussed in Section 4.3.2.1, bedrock wells will extend several feet into the claystone bedrock. This is to allow for the collection and recovery of free-phase DNAPL should it be encountered at the sandstone/claystone interface.

The proposed test site selection was based on qualitative data from the proposed test site and conditions extrapolated from quantitative data collected near the proposed test site. Should the proposed test site prove inadequate, an alternative test site will be selected. The most likely reason for poor site conditions is the absence of residual free phase DNAPL. A preliminary threshold for determining success will be a recovery rate of 0.5 lbs/day of volatile hydrocarbons. The test will be conducted for a minimum of seven days before abandonment and new site selection. If the recovery rate equals or exceeds 0.5 lbs/day, the test duration will be decided while the test is in progress. In any case, test duration will not exceed three months.

#### **Vapor and Ground-Water Treatment**

A discussion of the systems proposed for treatment of vapors and ground water extracted from the subsurface at the IHSS No. 111.1 test site are presented in Section 4.5.2.1.

#### **4.5.2.2 Observational/Streamlined Approach Considerations**

A summary of the expected conditions, potential deviations and contingencies relevant to the proposed action at East Trenches is presented in Table 4-3. Many of the items presented in Table 4-3 are identical for each proposed OU2 test site. Therefore, this

**Table 4-3**  
**Observational/Streamlined Approach**  
***In Situ* Vacuum-Enhanced Vapor Extraction at East Trenches (IHSS 111.1)**

Expected Conditions	Potential Deviations	Mechanisms to Identify Deviations	Contingency
RI data provides sufficient information to place vapor extraction and injection wells.	RI data does not provide sufficient information to place vapor extraction and injection wells.	Analysis and interpretation of RI data.	Plan and conduct soil vapor survey to provide additional information.
No recoverable alluvial groundwater.	Saturated thickness greater than 3 feet.	Direct measurement.	Retrofit existing alluvial wells with ground-water pumps.
No free-phase solvents in recovered ground water (bedrock or alluvium).	Free-phase solvents are present in recovered ground water.	Direct observation.	Install phase separation unit.
Saturated sandstone encountered within 60 feet of the surface.	No ground water within 60 feet of the surface.	Direct observation of recovered soil samples during drilling and measurement of water level in completed well.	Eliminate ground-water depression portion of proposed action.
Radionuclide-contaminated particulates not present in vapor stream.	Radionuclide-contaminated particulates present in vapor stream.	Analysis of spent HEPA filter media.	Retain HEPA filters.
GAC adsorption is cost effective vapor treatment technology (based on VOC concentration).	GAC adsorption is not a cost effective vapor treatment technology due to high VOC concentrations.	Sampling and analysis of vapor stream.	a. Install clean air intake upstream of vacuum pump to reduce VOC concentrations.  b. Evaluate feasibility of vapor treatment by thermal oxidation or condensation.
All OU2 contaminants of concern present in recovered ground-water and condensate (VOCs; radionuclides, including Pu, Am, and U; and metals).	All OU2 contaminants of concern not present in recovered ground water and condensate.	Sampling and analysis of recovered ground water and condensate.	Use most appropriate RFP treatment system to process recovered ground water and condensate.
Ground-water recovery rates $\leq$ 1 gpm.	Ground-water recovery rates $>>$ 1 gpm.	Direct observation.	Use most appropriate RFP treatment system(s) to process recovered ground water, and assess pipeline vs. tank truck transport.
VOC concentration in extracted vapors $\geq$ 1 ppm (field measurement)	VOC concentration in extracted vapors $<$ 1 ppm (field measurements)	Direct measurement.	a. Abandon proposed test site.  b. Assess feasibility of considering an alternative test site.
Post-pilot operation of <i>in situ</i> vacuum-enhanced vapor extraction system is deemed to be beneficial.	Post-pilot operation of <i>in situ</i> vacuum-enhanced vapor extraction system is not deemed to be beneficial.	Analysis of pilot test data with respect to evaluation criteria (Section 4.3.2).	Post-pilot operation not conducted at test site.

section will address only those items which are unique to the Mound test site. The reader is referred to Section 4.3.2.2 for a detailed discussion of the items common to all OU2 test sites.

The East Trenches test site is unique in that ground water is expected to be present in sandstone bedrock within 35 feet of the surface. However, available data suggest considerable variability in bedrock geology near the test site. Therefore, a potential deviation from expected conditions would be the presence of claystone or interbedded sandstone and claystone under the proposed test site. This condition may result in a lack of recoverable ground water. The mechanism to identify this deviation would include visual observation of soil samples recovered during drilling and by establishing the presence or absence of water in the extraction wells using an electronic water level indicator. The contingency would involve abandoning the ground water pumping effort and performing a vacuum enhanced vapor recovery action similar to that proposed for the Mound Area test site.

#### **4.5.3 Evaluation of Remedial Approach**

##### **4.5.3.1 Effectiveness**

Evaluation of the proposed interim remedial action at the East Trenches Area with respect to CERCLA effectiveness criteria is the same as the effectiveness evaluation presented in Section 4.3.3.1

##### **4.5.3.2 Implementability**

Evaluation of the proposed interim remedial action at the East Trenches Area with respect to CERCLA implementation criteria is the same as the implementability evaluation presented in Section 4.3.3.2.

### **4.5.3.3 Environmental Impact**

#### **Commitment of Resources**

Commitment of resources for the East Trenches vapor extraction system will be very low and virtually the same as that described in Section 4.3.3.3 for the 903 Pad.

#### **Transportation Impacts**

These will be similar to the 903 Pad vapor extraction system impacts. Given the limited extent of transportation activities associated with the collection system and the health effect estimates presented in Appendix E, transportation health effects are predicted to be very small. Additional discussion details are provided in Appendix E.

#### **Wetlands**

Wetlands areas have been identified near the East Trenches proposed action site. These wetlands are associated with South Walnut Creek and Pond B-1 that are located approximately 800 feet to the north of the site. South Walnut Creek has flows which fluctuate seasonally, ranging from 5 to 60 gpm.

Dewatering activities at the East Trenches are predicted to result in a water collection rate of 1 gpm or less. Inasmuch as there are no technologies for effectively conducting vapor extraction when ground water is present, removal or collection of the water is a necessity. This is not expected to have a significant impact on nearby wetlands because of the small expected flow and the limited duration (3 years or less). However, it is known that there is considerable variation in the water table elevations in near surface water bearing units at OU2. Therefore it is possible that dewatering rates may be different than predicted and may have an indirect effect on wetlands.

The total wetlands area that could be affected by the proposed East Trenches action is estimated to be less than one-twentieth of an acre. Suitable habitat exists in the surrounding

area to accommodate any temporary wildlife displacement. At the conclusion of the IM/IRA, ground-water flow will return to its previous levels, and any temporary wetlands impacts will be naturally mitigated.

### Cumulative Impacts

Cumulative impacts of the vapor extraction system at the East Trenches will be the same as for the 903 Pad described in Section 4.3.3.3.

## **4.6 DESCRIPTION OF ALTERNATIVE WATER TREATMENT FACILITIES**

The Subsurface IM/IRA considers the use of existing or planned RFP water treatment facilities for treatment of contaminated ground water and condensate associated with operation of the proposed vapor extraction systems at the 903 Pad, Mound, and East Trenches Areas. This section describes each of the RFP treatment facilities with respect to operation, contaminant removal capabilities, and available processing capacity. The RFP water treatment facilities include:

- South Walnut Creek Basin Surface Water Treatment System.
- 881 Hillside Ground-Water Treatment System.
- Building 231B GAC Adsorption System/Building 374 Evaporation System.

### **4.6.1 South Walnut Creek Basin Surface Water Treatment System**

The South Walnut Creek Basin Surface Water Treatment System is being constructed as part of an IM/IRA at OU2 (EG&G, 1991f). The system includes chemical precipitation/microfiltration and GAC adsorption units for removal of radionuclides, metals, and VOCs from surface water. Installation of the GAC adsorption portion of this treatment facility has been completed, and operation began on 13 May 1991. Startup of the chemical precipitation and microfiltration unit operations is currently scheduled in 1992.

The South Walnut Creek Basin Surface Water Treatment System is illustrated in Figure 4-12. Chemical treatment involves addition of iron salts and lime to cause coagulation and flocculation of suspended particulates present in the wastewater to produce a filterable ferric hydroxide precipitate or floc. Since the predominant state of radionuclide and metal contaminants in natural waters is particulate, these inorganic contaminants will be removed through enmeshment in the ferric hydroxide floc (EG&G, 1991f). Removal of radionuclides and metals existing in a soluble state may also be achieved during chemical treatment by adsorption to the floc. The floc will be removed from the process stream by cross-flow membrane filtration. The membrane filter is in a shell and tube configuration with the membrane located on the inside of the tubes. Water is pumped through the filter tubes and water passes through the membrane (i.e., permeate) under the force of the process operating pressure. The filters are designed so that clean water will pass through the membrane in a direction perpendicular to the main process flow (i.e. cross-flow filtration). Flow not passing through the membrane will be recycled to the concentration tank. A fraction of the recycle slurry will be bled from the process for solids removal by gravity separation and pressure filtration. The filter press cake is expected to be approximately 30 percent solids by weight, and will be stabilized with the addition of portland cement. The cross-flow filter permeate will be neutralized by the addition of sulfuric acid and will be further processed by GAC adsorption units for removal of VOCs as described below.

Figure 4-12 shows that the GAC Adsorption Treatment System for the South Walnut Creek Basin surface water treatment system consists of two on-line GAC units and two on-line, standby GAC units. Each GAC unit is 60 inches high and 87 inches in diameter and contains 2,000 pounds of GAC. The on-line units are operated in series (i.e., lead and polishing positions). Once the GAC in the lead unit is determined to be spent, it is taken out of service. The GAC unit in the on-line, polishing position becomes the new lead unit and one of the on-line, standby units is placed in the on-line, polishing position. "Rotation" of the GAC units into the lead, polishing, and standby positions is accomplished by changing the open/closed configuration of the process valves. Physical movement of unspent GAC units is not necessary during this procedure. The spent GAC is replaced with a new unit containing virgin GAC. The newly installed unit is immediately placed in the on-line, standby mode. Spent GAC will be analyzed for the presence of radionuclides and for

toxicity by the EPA Toxicity Characteristic Leaching Procedure (TCLP). Results of these analytical tests will determine if spent GAC from this process may be regenerated or must be managed as a hazardous mixed waste. As of this writing, the process has not yet generated spent GAC.

The South Walnut Creek Basin Surface Water Treatment System was designed to continuously process surface water influent at a rate of 60 gpm. This flow rate corresponds to the design flows established for the South Walnut Creek Basin IM/IRA surface water collection systems. However, design flows are maximum anticipated surface water flows for the collection systems, and influent flows from the South Walnut Creek Basin sources will, on the average, be substantially less than 60 gpm. For example, GAC Adsorption System operating data for May and June 1991, two relatively high precipitation months, indicate that on the average the South Walnut Creek Basin sources have produced less than 50 percent of collection system design flows. The unused processing capacity could be used to treat ground water and condensate generated by the Subsurface IM/IRA.

#### **4.6.2 881 Hillside Ground-Water Treatment System**

The 881 Hillside Ground-Water Treatment System is currently being installed under the ground-water IM/IRA for OU1. The system was designed to treat ground water recovered at the 881 Hillside Area. The rate of ground-water recovery is expected to be approximately 5 to 10 gpm and the ground-water contaminants of concern include VOCs, metals, and uranium. The treatment process operating plan includes treatment of collected ground water at the process design rate of 30 gpm during one 8-hour shift per day. The equipment remains idle throughout the remaining two shifts. Ground water and condensate generated by the Subsurface IM/IRA, therefore, be treated during one of the remaining 8-hour shifts.

Figure 4-13 shows that the design of the 881 Hillside Ground-Water Treatment System includes UV/ peroxide and ion exchange unit operations. A pumped feed system will be used to inject a 50 percent hydrogen peroxide solution into the wastewater influent line. The surface water/hydrogen peroxide mixture will then pass through an in-line static mixer

before entering the UV oxidation reactor. In the reactor, the mixture is exposed to UV light where VOCs are oxidized to carbon dioxide and water.

The effluent from the UV oxidation reactor will then be pumped through fabric filtration units to remove any suspended solids that may be present in the processing stream. Dissolved uranium and metal contaminants will then be removed by the anion and cation exchange units, respectively. Regeneration of the anion exchange resin will not be required because of the high affinity and capacity of the resin for uranium. The expected life of the anion exchange units is greater than 30 years at the expected influent flows and uranium concentrations. Although other anions (e.g., chlorides, sulfates) will initially be adsorbed to the resin, the preferential adsorption of uranium will result in displacement of the other anions. The spent resin will ultimately require solidification and disposal as a low-level hazardous waste. The cation exchange resin has a high affinity for high molecular weight metals (e.g., mercury, copper, lead). It is assumed that, unlike the anion exchanger, the cation exchange resin will require regeneration. Effluent from the ion exchange column train is stored in holding tanks pending laboratory analysis results. Upon verification that contaminants have been removed to achieve the effluent standards established for the facility, the treated water is discharged to the SID.

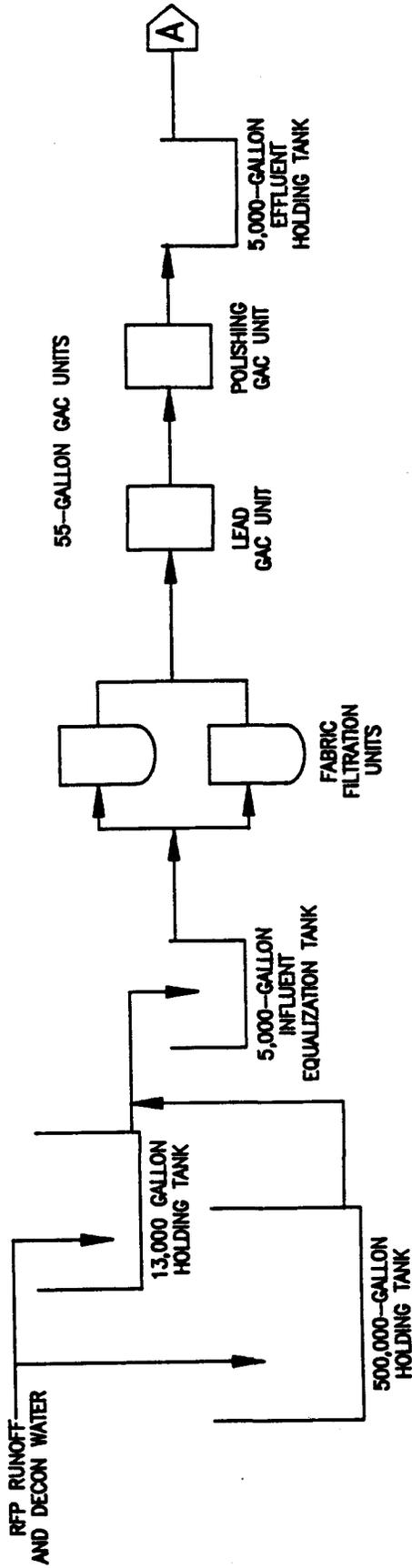
#### **4.6.3 Building 231B GAC Adsorption System/Building 374 Evaporation System**

A final alternative for treatment of ground water and condensate generated by the Subsurface IM/IRA is the use of the planned Building 231B GAC Adsorption System and the existing Building 374 Evaporation System. These treatment system configurations are illustrated in Figure 4-14, and are described below in detail.

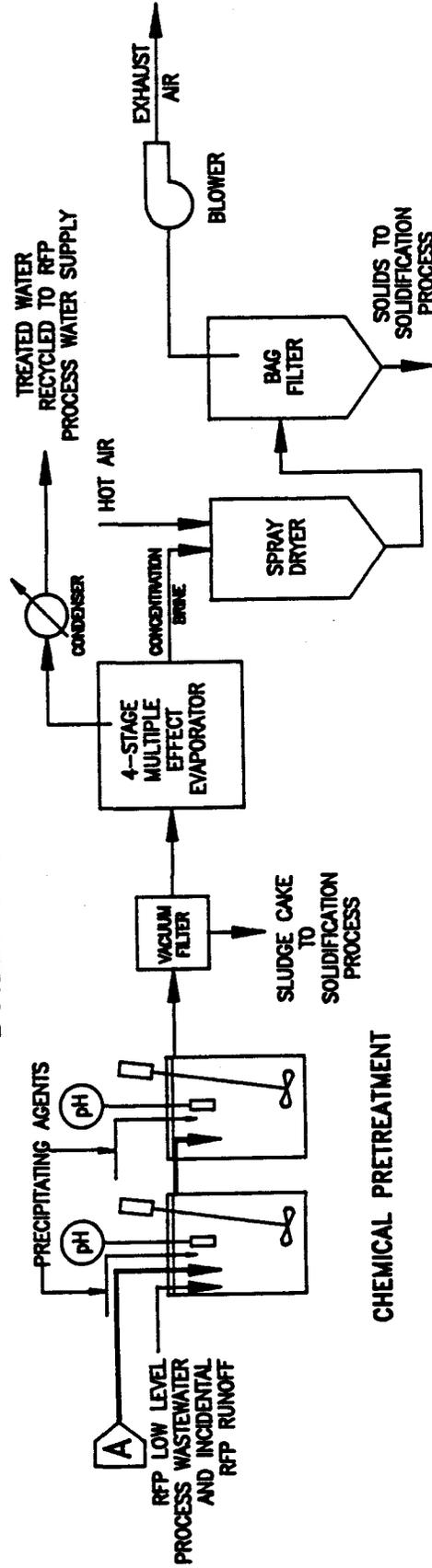
The GAC adsorption system illustrated in Figure 4-14 is planned for construction near Building 231B in March 1992. This facility is being installed to provide VOC treatment for decontamination wastewater generated at the RFP (e.g., drill rig decontamination). Current treatment system design includes installation of a 13,000-gallon wastewater holding tank and a 5,000-gallon influent equalization tank. The 500,000-gallon wastewater holding tank shown in Figure 4-14 currently exists, but is not in use. Operating plans for the 231B GAC

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### BUILDING 231B TREATMENT SYSTEM



### BUILDING 374 TREATMENT SYSTEM



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Golden, Colorado

SUBSURFACE IM/IRA  
BUILDING 231B GAC SYSTEM (PLANNED)/  
BUILDING 374 LOW-LEVEL WASTE TREATMENT SYSTEM

Adsorption System include use of this storage tank for additional influent storage capacity, when required. Treatment system design includes at least two fabric filtration units configured in parallel. The parallel configuration allows water to be treated with one filter on line while filtration media in the other filter is being replaced. Due to the relatively small quantities of decontamination wastewater generated annually (approximately 500,000 gallons) treatment system design includes disposable GAC units. The process will include two 55-gallon GAC units in a lead/polisher arrangement. Each 55-gallon unit is 36 inches high and 22 inches in diameter, and contains approximately 165 pounds of GAC. The maximum rated flow capacity through each unit is 10 gpm. Although the fabric filtration units will remove the majority of the suspended solids from the process influent, small particulates will pass through to the GAC units. It is, therefore, expected that the GAC units will be contaminated with particulate radionuclides and, thus, require disposal as a hazardous mixed waste. The treatment system includes a 5,000-gallon effluent storage tank to temporarily hold processed water prior to transport to Building 374.

The plan of operation for the Building 231B GAC Adsorption Treatment System includes tank truck transport of decontamination wastewater to the facility, batch processing of approximately 10,000 gallons per week at a flow rate of approximately 7 gpm, and tank truck transport of the treated effluent to the Building 374 Low-Level Wastewater Treatment System. The one-way travel distance between Building 231B and Building 374 is approximately 1 mile via 7th Street, Central Avenue, PA Portal #1, and west on Patrol Road.

The Building 374 Low-Level Wastewater Treatment System (Figure 4-14) processes approximately 12 to 15 million gallons per year of low level wastewater (i.e., < 13,500 pCi/l of radioactivity). Influent sources for this system include RFP process wastewater and incidental RFP surface waters (i.e. site runoff). The treatment system includes chemical precipitation, vacuum filtration, and evaporation unit operations. Chemical treatment involves addition of iron salts and lime to cause coagulation and flocculation of suspended particulates present in the wastewater to produce a filterable precipitate or floc. Radionuclide and metals contaminants present in the wastewater stream in a particulate state tend to become enmeshed in the floc as discussed in Section 4.6.1. The floc is then

removed from the process stream by vacuum filtration. The filter cake produced is approximately 30 percent solids by weight, and is stabilized with the addition of portland cement. The inorganic contaminants in the filtered process stream are then concentrated by a four-stage multiple effect evaporator. Evaporator vapors, which are free of inorganic contaminants, are condensed and recycled to the RFP process water supply. The "brine" concentrate is processed by a spray dryer to evaporate the remaining liquid. The resulting byproduct solids (i.e., salts) are removed from the process by a bag filter unit, and subsequently solidified with the addition of portland cement. The volume of solidified waste or "saltcrete" from this action represents a small fraction of RFP's annual production of this type of waste. Storage and disposal plans for such waste were discussed in the environmental assessment for the partial closure action at the solar ponds (DOE, 1991c), for which a finding of no significant impact was issued. Because of the relatively low concentrations of the contaminants, the solid form of the waste, the protectiveness of the packaging, and the compliance with applicable RCRA requirements, storing these materials at the RFP or other DOE location pending disposal would not materially change the impacts assessed for this action.

The treatment technologies that comprise the Building 231B GAC Adsorption System and the Building 374 Low-Level Wastewater Treatment System (GAC adsorption, chemical precipitation/vacuum filtration, and evaporation) are well suited for removal of VOCs, radionuclides, and metals that may be present in the Subsurface IM/IRA ground water and condensate. In addition, extra processing capacity currently exists at both facilities. Although the Building 374 treatment facility often operates at its maximum capacity, influent storage at Building 231B and batch processing of collected ground water and condensate allow use of the facility during off-peak periods.

#### **4.7 ENVIRONMENTAL EVALUATION OF NO ACTION**

##### **4.7.1 Air Quality Impacts**

The No Action Alternative will not further impact the existing air quality as discussed in the RFP Final Environmental Impact Statement, 1980 (DOE, 1980).

#### **4.7.2 Water Quality Impacts**

The No Action Alternative would not contain or remove radionuclides, VOCs, or metals from the subsurface at OU2. As a result, the No Action Alternative would pose a long-term release risk to the general public. However, short-term risks associated with the No Action Alternative are insignificant because contaminated ground water is contained well within the RFP boundary, and surface water discharges from the RFP are monitored and treated, if necessary, in accordance with the Plant's NPDES permit. The No Action Alternative would require that the current quarterly site monitoring be continued.

#### **4.7.3 Terrestrial and Aquatic Impacts**

The No Action Alternative will not involve any short-term impacts to terrestrial and aquatic biota.

#### **4.7.4 Wetlands and Floodplains**

The No Action Alternative will not involve any short-term impacts to wetlands and floodplains.

#### **4.7.5 Threatened and Endangered Species**

The No Action Alternative will not impact threatened and endangered species.

#### **4.7.6 Cultural Resources**

The No Action Alternative will not impact cultural resources, as no sites at the RFP have potential eligibility for the National Register of Historic Places (EG&G, 1991a).

#### **4.7.7 Short-Term Uses and Long-Term Productivity**

Land within OU2 is currently undeveloped and will remain so as part of the RFP for the foreseeable future. OU2 lies within the RFP security boundaries and is not accessible to the general public. Therefore, the No Action Alternative will have no effect on the short-term uses and long-term productivity of lands at OU2.

#### **4.7.8 Personnel Exposures**

The No Action Alternative will have minimal impact on current workers involved at OU2 or at adjacent RFP sites. Workers will continue to monitor ground water quarterly which would not present any additional impacts. Because the sources of hazardous wastes would neither be removed nor controlled, the possibility of contaminated ground water migrating off site would increase over time. This could then become a source for public exposure in the long term.

#### **4.7.9 Commitment of Resources**

The No Action Alternative will not require any additional commitment of resources.

#### **4.7.10 Transportation Impacts**

The No Action Alternative will not require construction or transport of materials. Therefore, will be no additional on-site or off-site transportation activities.

#### **4.7.11 Cumulative Impacts**

Because there are no additional remedial activities associated with the No Action Alternative, there are no cumulative impacts relating to the environmental criteria identifiers in Sections 4.7.1 through 4.7.10.

#### 4.8 COMPARISON OF ENVIRONMENTAL EFFECTS OF RFP IM/IRAs

Table 4-4 compares the environmental impacts of the proposed Subsurface IM/IRA at OU2 with other IM/IRAs currently being implemented at RFP. There are no environmental impacts associated with the No Action Alternative with respect to subsurface VOC contamination at OU2 as indicated in Table 4-4. This is consistent with the absence of any threat posed by the subsurface VOC contamination at OU2 (Section 1). Impacts in all categories from the proposed action (environmental, long-term, public exposure, worker exposure, off-site and on-site transportation) are not expected to be significant.

Table 4-4

Cumulative Impacts of Interim Remedial Actions at Rocky Flats Plant

Impact Category	No Action Alternative	881 Hillside Ground-Water IM/IRA at OU1 UV Peroxide Oxidation/Ion Exchange	South Walnut Creek Basin Surface Water IM/IRA at OU2 Chemical Precipitation/ Microfiltration and GAC Adsorption System	Subsurface IM/IRA at OU2 Vapor Extraction System	Cumulative Impacts
<b>Environmental Impacts</b> Aquatic Impacts Threatened and Endangered Species Historic and Archeological Sites Short- and Long-Term Land Productivity Wetland and Floodplain Excavation Well Drilling	None	None	None	None	None
	None	None	None	None	None
	None	None	None	None	None
	None	None	None	None	None
	None None None	None 10,300 yd <sup>3</sup> None	Minimal None None	Minimal 15 yd <sup>3</sup> 6 yd <sup>3</sup>	Minimal 10,315 yd <sup>3</sup> 6 yd <sup>3</sup>
<b>Long-Term Considerations</b> Interim Removal Action VOC Contamination Removal VOC Contaminant Destruction Inorganic Contaminant Removal	No	Approximately 30 years Yes	Approximately 30 years Yes	30 years* Yes	N/A
	No	Yes	Yes	Yes	N/A
	No	Yes	Yes	Yes	N/A
	No	Yes	Yes	No	N/A
<b>Exposure to General Public</b> Construction Routine Accident	No	Yes	No	No	Yes
	No	No	No	No	No
	No	No	No	No	No

Table 4-4 (Continued)

Cumulative Impacts of Interim Remedial Actions at Rocky Flats Plant

Impact Category	No Action Alternative	881 Hillside Ground-Water IM/IRA at OU1 UV Peroxide Oxidation/Ion Exchange	South Walnut Creek Basin Surface Water IM/IRA at OU2 Chemical Precipitation/Microfiltration and GAC Adsorption System	Subsurface IM/IRA at OU2 Vapor Extraction System	Cumulative Impacts
Exposure to Workers Construction Routine Accident	No	Negligible	Yes	Minimal	Yes
	No	Negligible	Minimal	Minimal	Minimal
	No	Yes	Yes	Minimal	Yes
Off-Site Transportation Construction (truckloads) Operation (loads/year) Contaminated Materials (truckloads)	None	<10	<5	<5	<18
	None	<5	<5	<5	<20
	None	Not Determined	Not Determined	1 <sup>b</sup>	Not Determined
On-Site Transportation Construction (truckloads) Operation (loads/year)	None	<20	<10	<3	<35
	None	<10	<10	<365	<400

<sup>a</sup> Assuming 3 years as IM/IRA

<sup>b</sup> Solidified filter cake & spent GAC

## SECTION 5 IMPLEMENTATION PLAN

This section presents the implementation plan for conduct of the Subsurface IM/IRA. Implementation involves the preparation of a Test Plan for each of the three pilot tests proposed in the IM/IRAP/EA. The Test Plans will provide all the engineering designs, performance specifications, and procedures necessary for well installation and fabrication of the vapor extraction and treatment unit. The Test Plans will also provide the necessary procedures and guidance to successfully execute the pilot tests. Following completion of each pilot study, a Test Report will be prepared summarizing the test data. Recommendations for post-pilot study operation of the *in situ* vacuum-enhanced vapor extraction system will also be presented in each Test Report based on evaluations of the test data. Sections 5.1 and 5.2 discuss the elements of the Pilot Test Plans and Test Report, respectively.

### 5.1 PILOT STUDY TEST PLANS

Test Plans will be prepared to provide comprehensive and detailed guidance for conduct of the Subsurface IM/IRA pilot studies at OU 2. A Test Plan will be prepared for each of the three pilot studies (i.e., 903 Pad, Mound, and East Trenches). Although the Test Plans will be similar in format and content, each will be tailored to test-specific objectives. Table 5-1 provides a preliminary outline that will be used to prepare the Test Plans. Although the final Test Plan format may differ from that shown in Table 5-1, the elements represented by each of the sections listed will be addressed.

Section 1 of the Test Plan briefly describes the purpose of the pilot study and notes its role within RI/FS activities at OU 2. The introduction will also present a summary of Phase II RI data pertinent to the pilot test that has become available since preparation of the Subsurface IM/IRAP/EA. Section 2 will discuss the scope of the pilot test. Section 3 will define the data quality objectives (DQOs) for conduct of the pilot test. DQOs will be developed, based on

**Table 5-1**  
**Subsurface IM/IRA Test Plan Outline**

- I. Introduction
- II. Scope of Pilot Study
- III. Data Quality Objectives
- IV. Well Design and Installation
- V. Vapor Extraction and Treatment System Design, Construction, and Commissioning
- VI. Pilot Test and Data Collection Procedures
- VII. Data Evaluation

Appendices

Quality Assurance Project Plan

Sampling and Analysis Plan

Health and Safety Plan

Data Management Plan

the goals of the proposed IRA. These goals include: assessment of vapor extraction as a means for removing subsurface, free-phase VOC contamination at OU2; determination of the area of influence of the vapor extraction system; and prediction of post-pilot study system performance. Section 4 will include the specifications and engineering design drawings for completion of the vapor and ground-water extraction and air injection wells. This section will specify the procedures to be followed for well installation and field engineering change requests. Criteria for well abandonment and alternative well placement will also be provided. Similarly, Section 5 will provide equipment specifications, system design drawings, and system performance specifications for the vapor extraction pilot unit. This section will also provide system start-up and troubleshooting guidance. Section 6 will present detailed procedures for conduct of the pilot test. Vapor extraction and treatment system operating procedures will be specified, including system shutdown criteria. This section will also present pilot study data collection requirements. Section 7 of the Test Plan will present guidance for evaluation of pilot test data. This guidance will include, but not be limited to, equipment and system performance assessment, contaminant mass recovery computation, subsurface areal influence estimation, and post-pilot study operation assessment.

The Test Plans will also include project-specific quality assurance/quality control (QA/QC), sampling and analysis, health and safety, and data management guidance for conduct of the pilot studies. QA/QC guidance will be provided in the form of a project-specific addendum to the EM Site-Wide Quality Assurance Program Plan (EG&G, 1991) and the ER RCRA/CERCLA Quality Assurance Project Plan (EG&G, 1991). Health and safety guidance will be provided in the form of a project-specific addendum to the ERHSPP (EG&G, 1989). EM Department Standard Operating Procedures will also be referenced in the Test Plans when applicable.

Preparation of the first Pilot Test Plan will begin immediately after regulatory agency approval of the Subsurface IM/IRAP/EA. Draft and final Test Plans will be submitted to EPA and CDH for approval prior to implementation. The Test Plans will be available for public review, but will not be subject to formal public comment.

## 5.2 PILOT TEST REPORTS

A Pilot Test Report will be prepared at the conclusion of each OU2 *in situ* vapor extraction pilot test. The Test Reports will summarize the tests conducted, present test data and data evaluation results, and present recommendations for post-pilot study operation of the vapor extraction systems. As-built design drawings will also be included in the Pilot Test Report to document the actual systems employed to conduct the tests.

Draft and final Pilot Test Reports will be prepared and submitted to the regulatory agencies for review and approval of post-pilot study recommendations. The final Test Report will be made available to the public.

## SECTION 6

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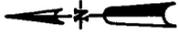
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EXPLANATION

-  INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) AND IHSS DESIGNATION
-  LOCATION OF BARRELS DETERMINED BY VISUAL INSPECTION OR MAGNETOMETER SURVEY
-  REMEDIAL INVESTIGATION AREAS



Scale: 1" = 600'  
0' 300' 600'  
CONTOUR INTERVAL = 20'

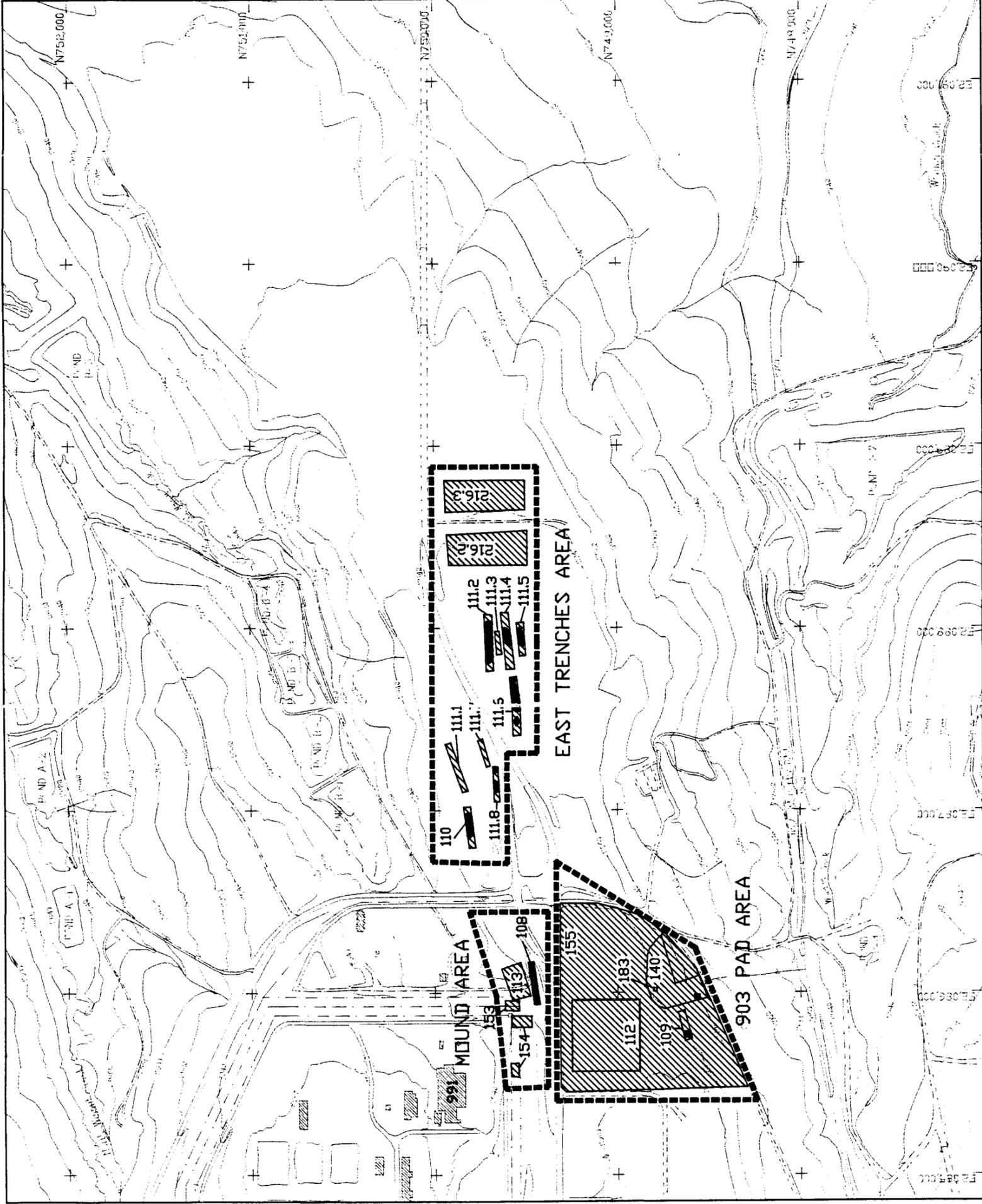
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 2  
SUBSURFACE IM/IRA

REMEDIAL INVESTIGATION AREAS AND  
INDIVIDUAL HAZARDOUS SUBSTANCE  
SITES

FIGURE 2-2

January 1992



**EXPLANATION**

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)

POTENTIOMETRIC SURFACE ELEVATION (feet above mean sea level)

ALL DATA BASED ON MEASUREMENTS MADE APRIL 4-8, 1988 INCLUSIVE

LINE OF EQUAL POTENTIOMETRIC SURFACE ELEVATION (feet above mean sea level)-DASHED WHERE APPROXIMATELY LOCATED

NO DATA

2587 ● BEDROCK MONITOR WELL  
 3789 ○ ALLUVIAL MONITOR WELL  
 0382 ▲ PRE-1988 MONITOR WELL



Scale: 1" = 600'  
 0' 300' 600'  
 CONTOUR INTERVAL = 20'

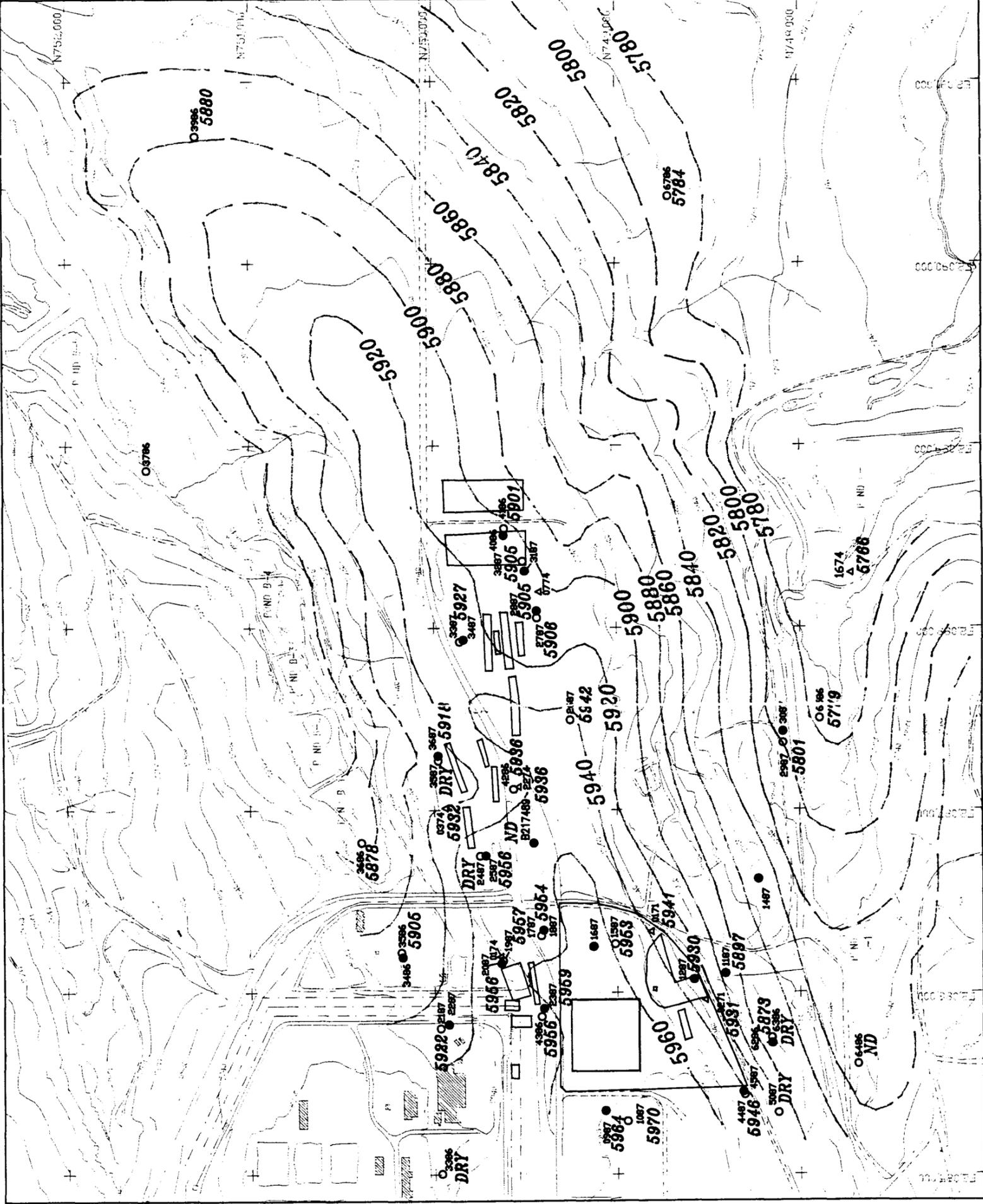
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 Rocky Flats Plant, Golden, Colorado

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 SUBSURFACE IM/IRA

**POTENTIOMETRIC SURFACE OF THE UNCONFINED GROUND-WATER FLOW SYSTEM**

FIGURE 2-7

January 1982

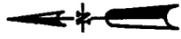


**EXPLANATION**

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS)



SOIL SAMPLING LOCATION



Scale: 1" = 600'  
0' 300' 600'  
CONTOUR INTERVAL = 20'

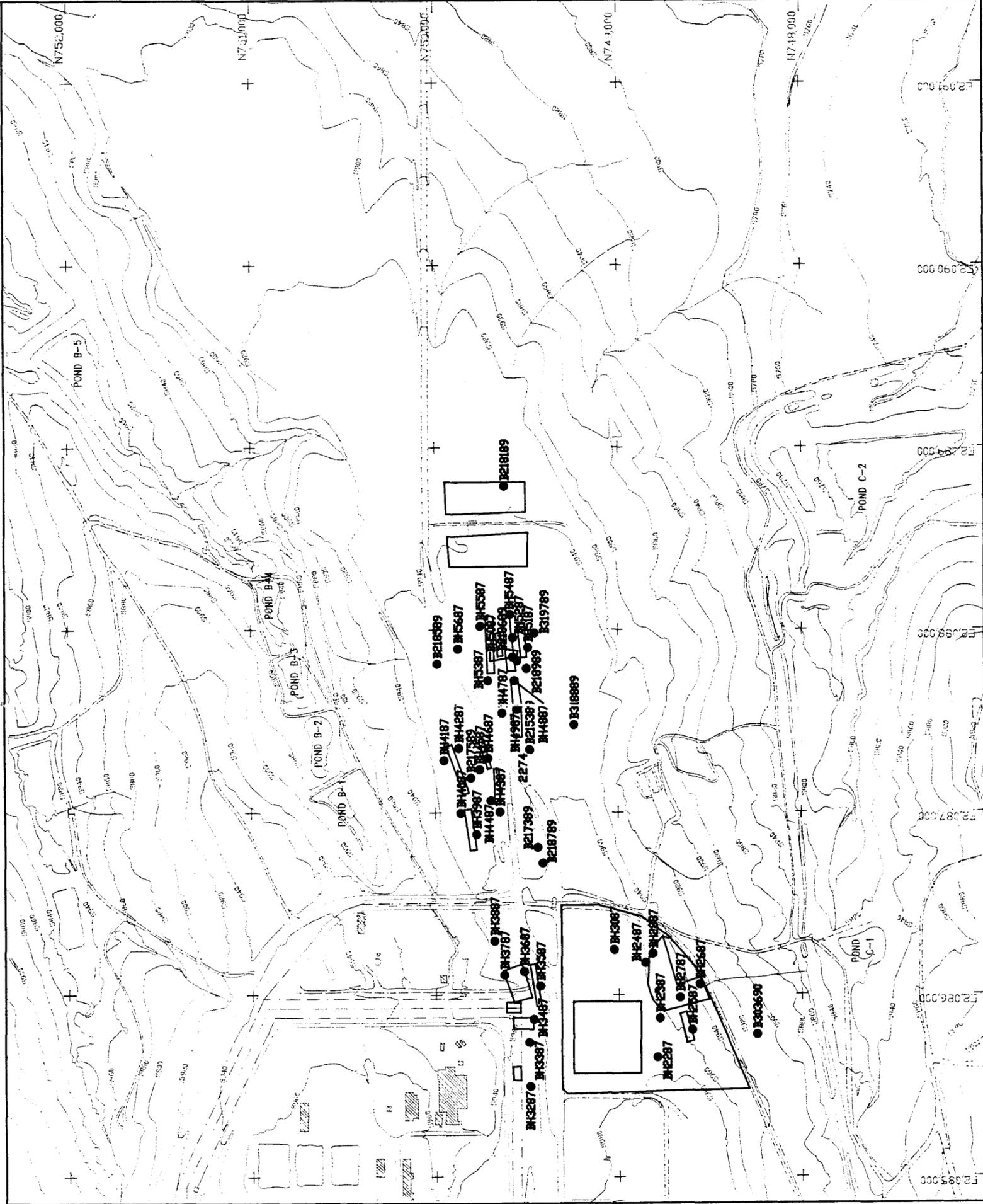
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Rocky Flats Plant, Golden, Colorado

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SUBSURFACE IM/IRA

**SOIL SAMPLING LOCATION MAP**

FIGURE 2-9

January 1992



837M027,CM-012482/600

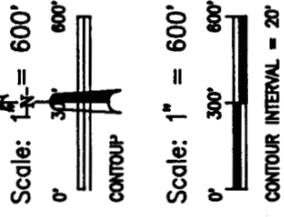
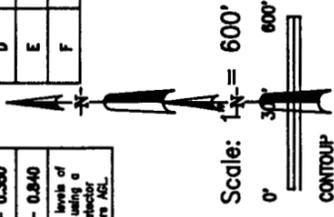
**EXPLANATION**

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS)

SOIL SAMPLING AND IN SITU MEASUREMENT LOCATION ● 87A

SYMBOL AND COLOR CODE FOR IN SITU SURFACE CONCENTRATION MEASUREMENTS	
CONCENTRATION	CONCENTRATION (μCi/m <sup>2</sup> )
●	<0.008
■	0.008 - 0.050
▲	0.050 - 0.100
○	0.100 - 0.350
□	0.350 - 0.840

AERIAL DATA PHOTO PEAK AMERICIUM-241 CONVERSION SCALE	
LETTER LABEL	COUNTS PER SECOND
A	< 50
B	50 - 120
C	120 - 240
D	240 - 600
E	600 - 2,400
F	2,400 - 9,600



Source: An Aerial Radiological Survey of the U.S. DOE's Rocky Flats Plant and Surrounding Area, EGG-10617-1044, May 1990.

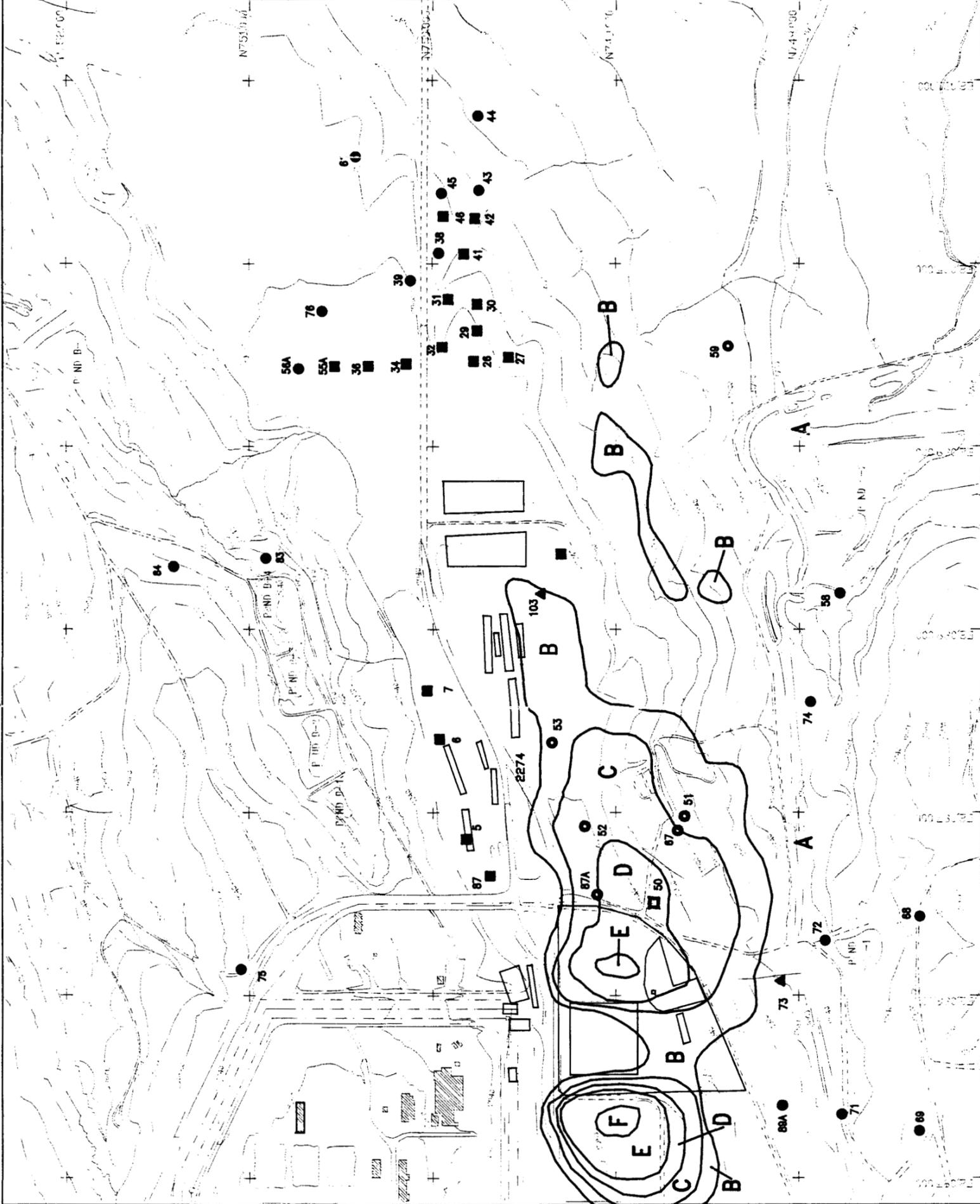
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Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 2  
SUBSURFACE IM/IRA

**SURFACE AND AERIAL AMERICIUM-241 CONCENTRATION DATA FOR THE RFP**

FIGURE 2-10

January 1992



527M029.SM-012482/909

**EXPLANATION**



INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS)



Scale: 1" = 600'  
0' 300' 600'  
CONTOUR INTERVAL = 20'

Source: In Situ Surveys of the U.S. DOE's Rocky Flats Plant, EGG-10817-1128, May 1991.

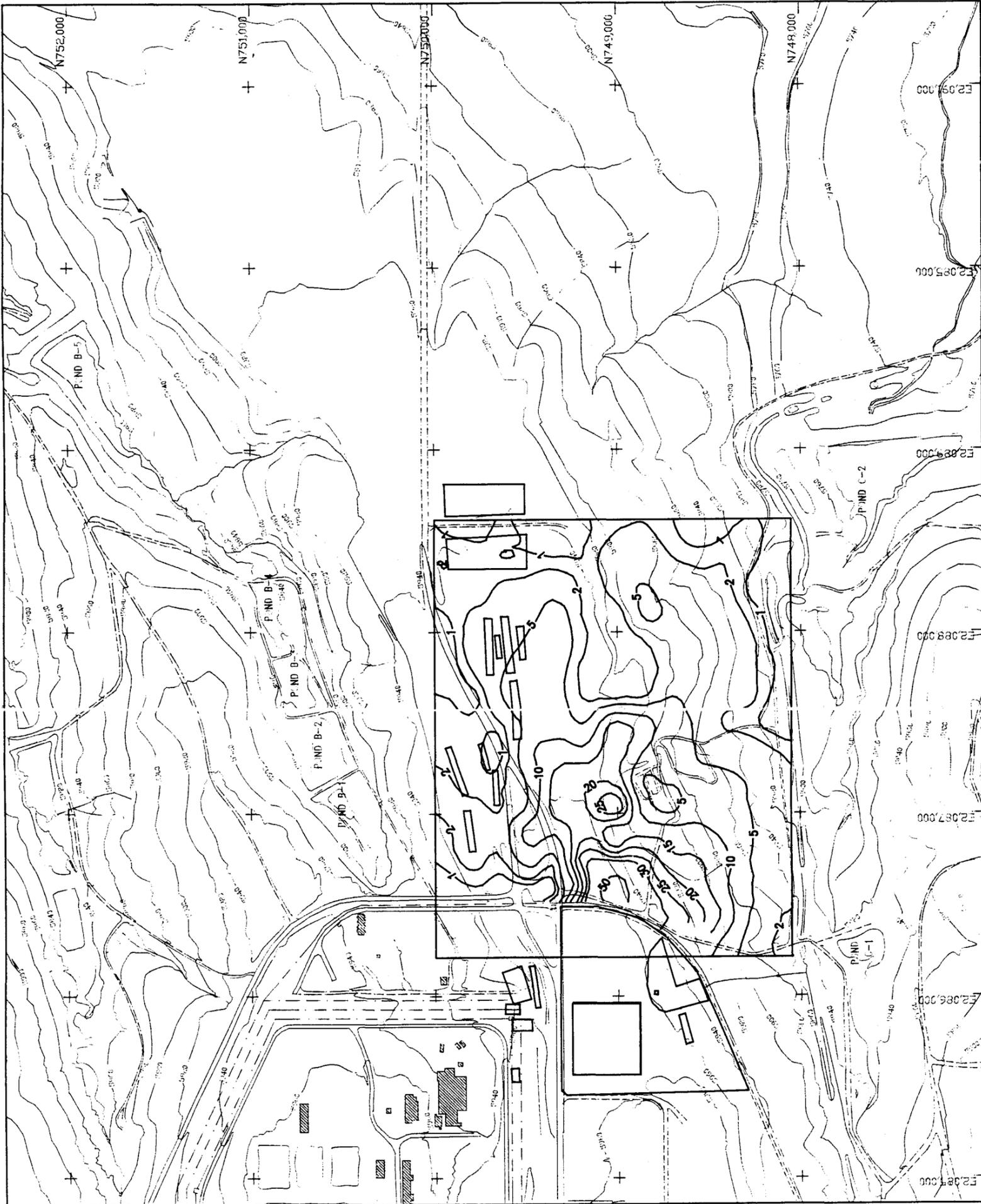
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 2  
SUBSURFACE IM/IRA

**AMERICIUM-241  
ISOCONCENTRATION CONTOURS  
(pCi/g)**

FIGURE 2-11

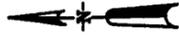
January 1992





**EXPLANATION**

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)
- LINE OF EQUAL PCE CONCENTRATION ( $\mu\text{g/l}$ ) DASHED WHERE APPROXIMATELY LOCATED
- PCE CONCENTRATION ( $\mu\text{g/l}$ )
- SECONDARY DILUTION FACTOR
- 3789 O ALLUVIAL MONITOR WELL
- 0382 A PRE-1986 MONITOR WELL



Scale: 1" = 600'  
 0' 300' 600'  
 CONTOUR INTERVAL = 20'

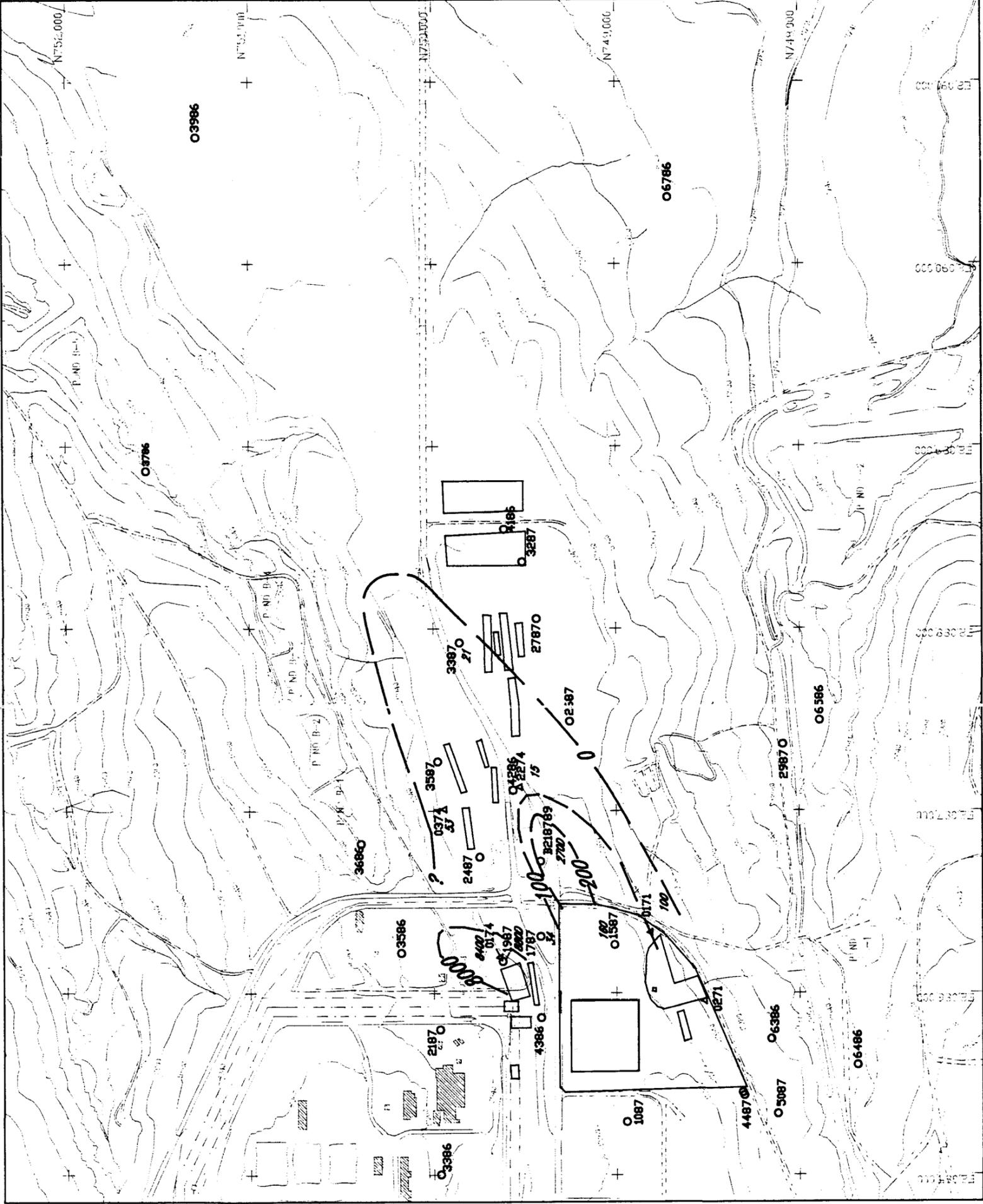
U.S. DEPARTMENT OF ENERGY  
 Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 2  
 SUBSURFACE IM/IRA

**TETRACHLOROETHENE ISOPLETHS FOR THE UNCONFINED ALLUVIAL GROUND-WATER FLOW SYSTEM Third Quarter 1991**

FIGURE 2-13

January 1992

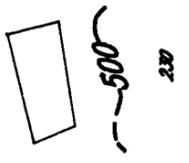


**EXPLANATION**

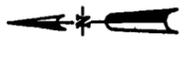
INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)

LINE OF EQUAL TCE CONCENTRATION ( $\mu\text{g/l}$ )  
DASHED WHERE APPROXIMATELY LOCATED

TCE CONCENTRATION ( $\mu\text{g/l}$ )



3789 O ALLUVIAL MONITOR WELL  
0382 A PRE-1988 MONITOR WELL



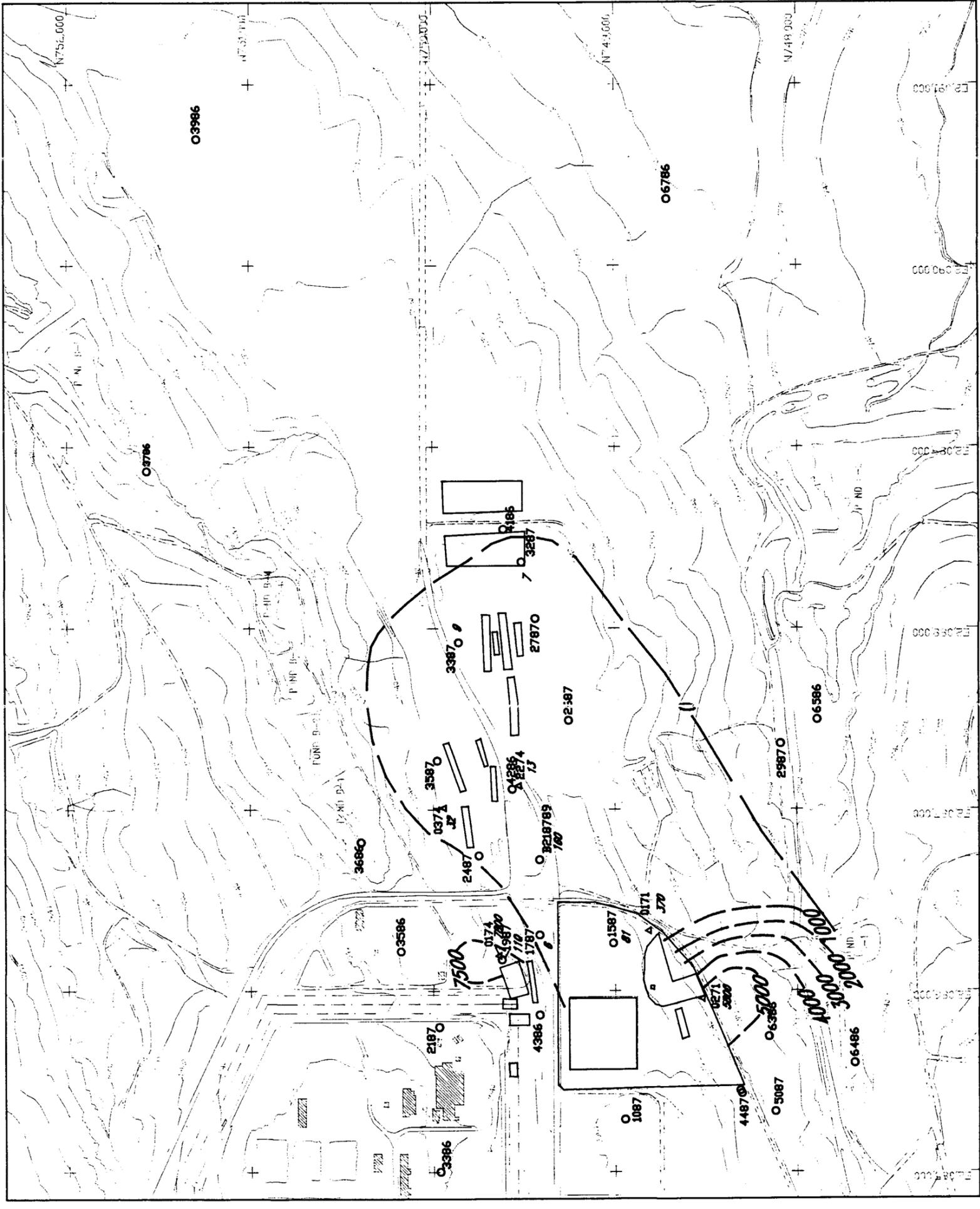
Scale: 1" = 600'

CONTOUR INTERVAL = 20'

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

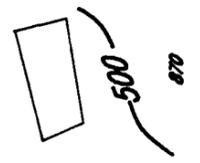
OPERABLE UNIT NO. 2  
SUBSURFACE IM/IRA  
**TRICHLOROETHENE ISOPLETHS  
FOR THE UNCONFINED ALLUVIAL  
GROUND-WATER FLOW SYSTEM  
Third Quarter 1991**

FIGURE 2-14  
January 1992

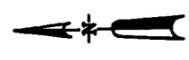


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**EXPLANATION**



- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)
- LINE OF EQUAL CCl<sub>4</sub> CONCENTRATION (µg/l) DASHED WHERE APPROXIMATELY LOCATED
- CCl<sub>4</sub> CONCENTRATION (µg/l)
- BEDROCK MONITOR WELL



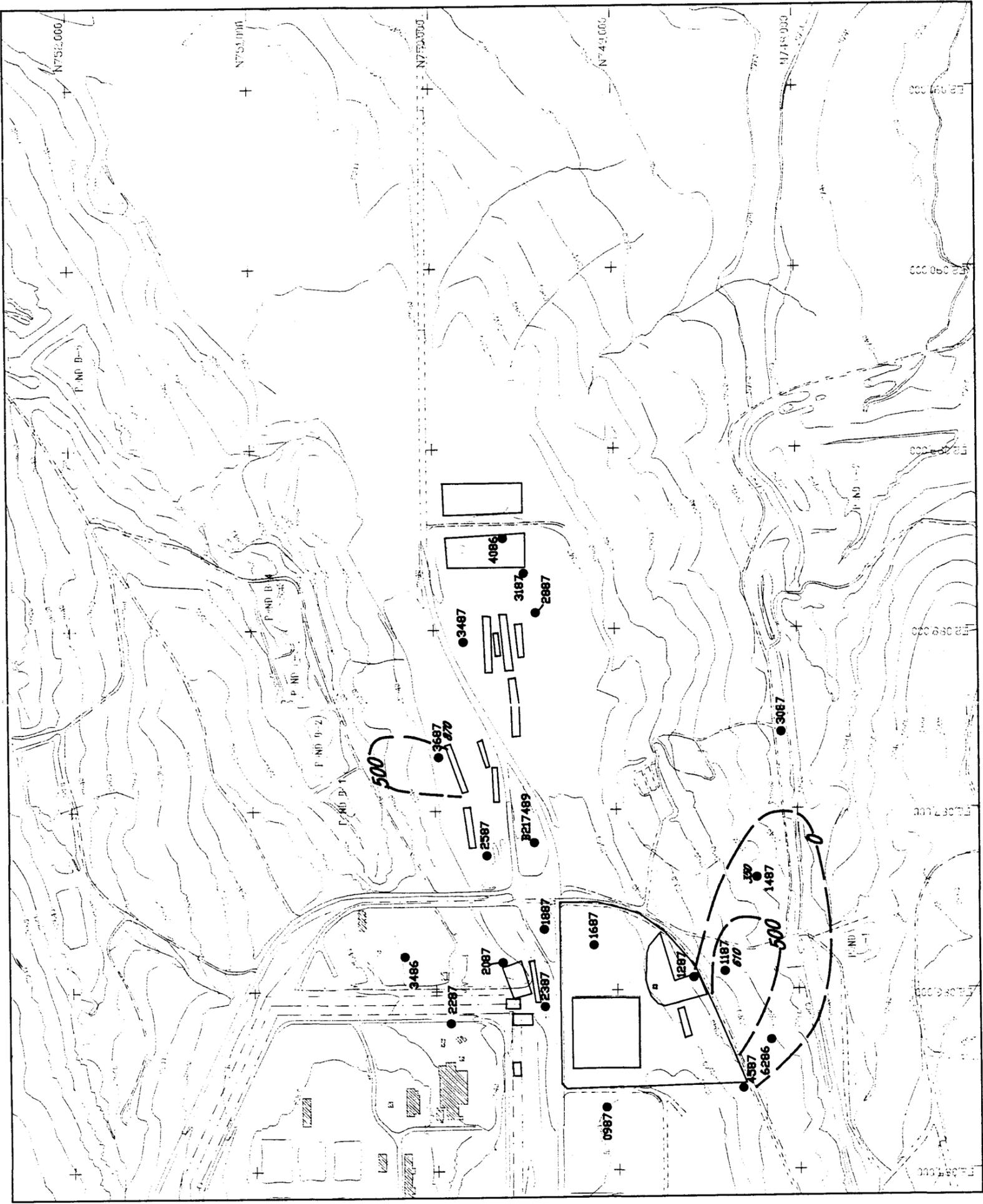
Scale: 1" = 600'  
 0' 300' 600'  
 CONTOUR INTERVAL = 20'

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

OPERABLE UNIT NO. 2  
 SUBSURFACE IM/IRA

**CARBON TETRACHLORIDE ISOPLETHS FOR THE UNCONFINED BEDROCK GROUND-WATER FLOW SYSTEM Third Quarter 1991**

FIGURE 2-15  
 January 1992



**EXPLANATION**

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS)
- LINE OF EQUAL PCE CONCENTRATION ( $\mu\text{g/l}$ ) DASHED WHERE APPROXIMATELY LOCATED
- PCE CONCENTRATION ( $\mu\text{g/l}$ )
- ESTIMATED
- BEDROCK MONITOR WELL



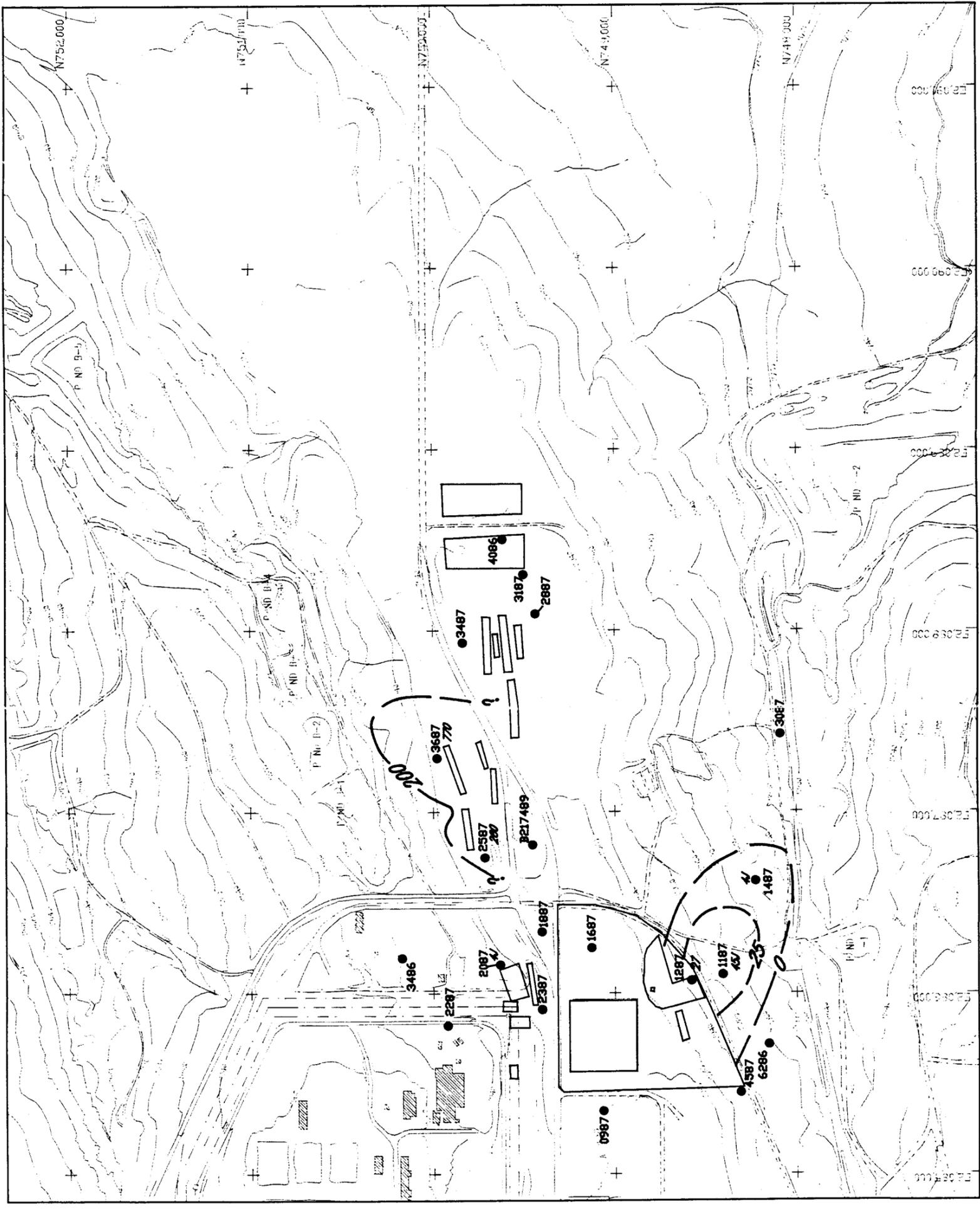
Scale: 1" = 600'  
0' 300' 600'  
CONTOUR INTERVAL = 20'

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

OPERABLE UNIT NO. 2  
SUBSURFACE IM/IRA

**TETRACHLOROETHENE ISOPLETHS FOR THE UNCONFINED BEDROCK GROUND-WATER FLOW SYSTEM Third Quarter 1991**

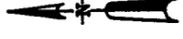
FIGURE 2-16  
January 1992



137/023-PI-012392/500

EXPLANATION

-  INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)
-  LINE OF EQUAL TCE CONCENTRATION ( $\mu\text{g/l}$ ) DASHED WHERE APPROXIMATELY LOCATED
-  TCE CONCENTRATION ( $\mu\text{g/l}$ )
-  SECONDARY DILUTION FACTOR
-  BEDROCK MONITOR WELL



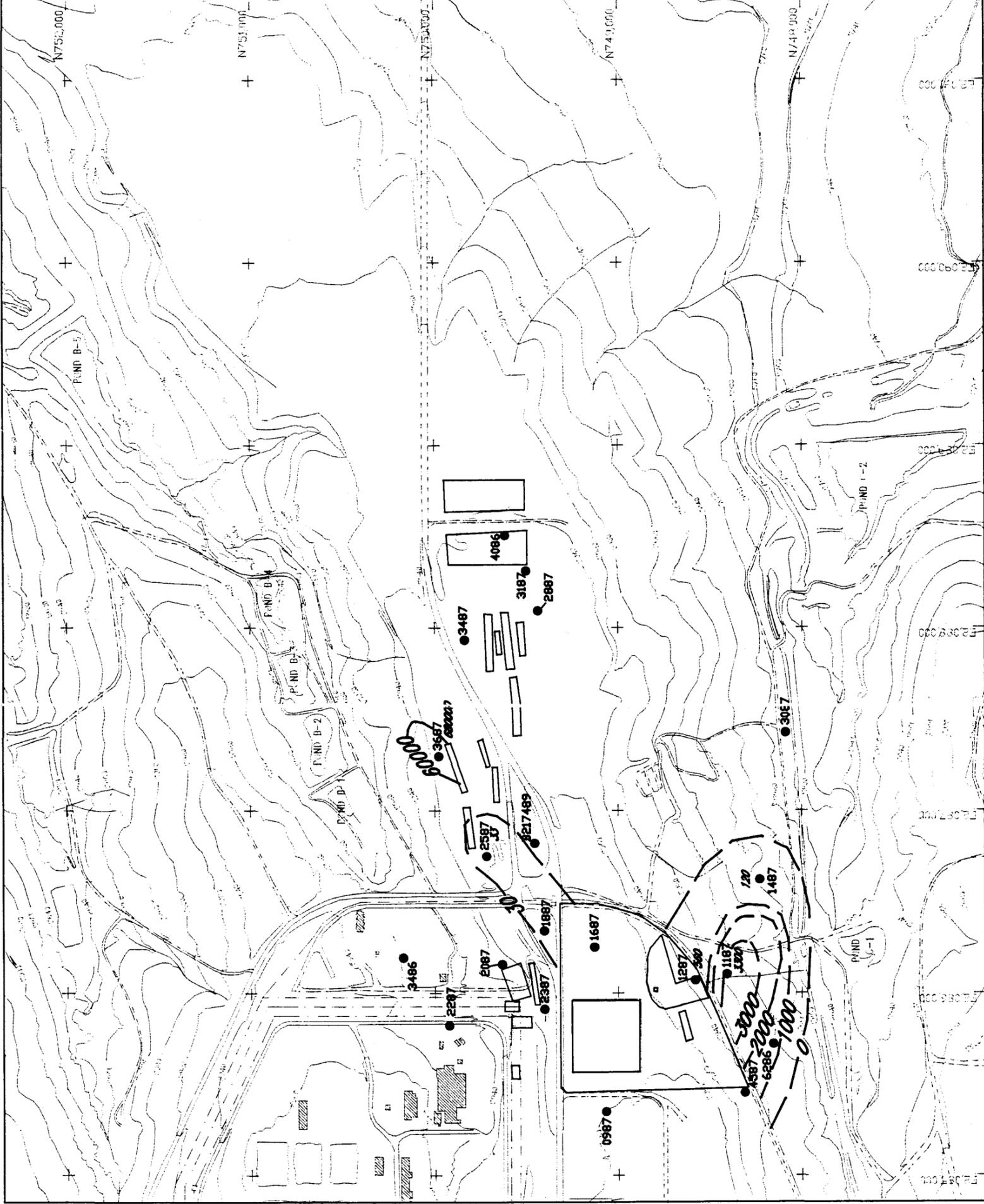
Scale: 1" = 600'  
0 300' 600'  
CONTOUR INTERVAL = 20'

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SUBSURFACE IM/IRA

TRICHLOROETHENE ISOPLETHS  
FOR THE UNCONFINED BEDROCK  
GROUND-WATER FLOW SYSTEM  
Third Quarter 1991

FIGURE 2-17  
January 1992



837025.P1-012392/500

**EXPLANATION**

-  INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS)
-  SURFACE WATER MONITORING STATION
-  SEDIMENT MONITORING STATION



Scale: 1" = 600'  
 0' 300' 600'  
 CONTOUR INTERVAL = 20'

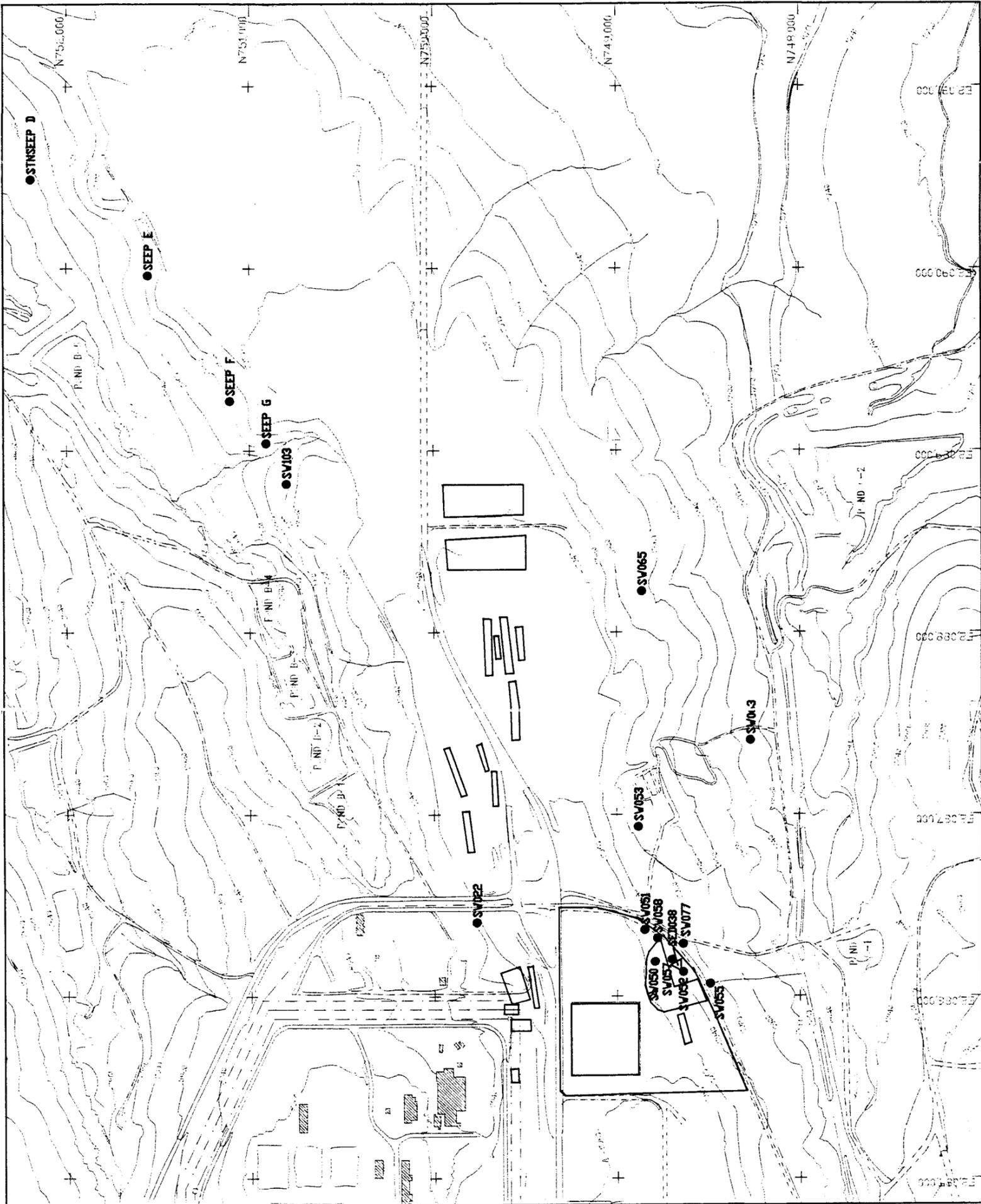
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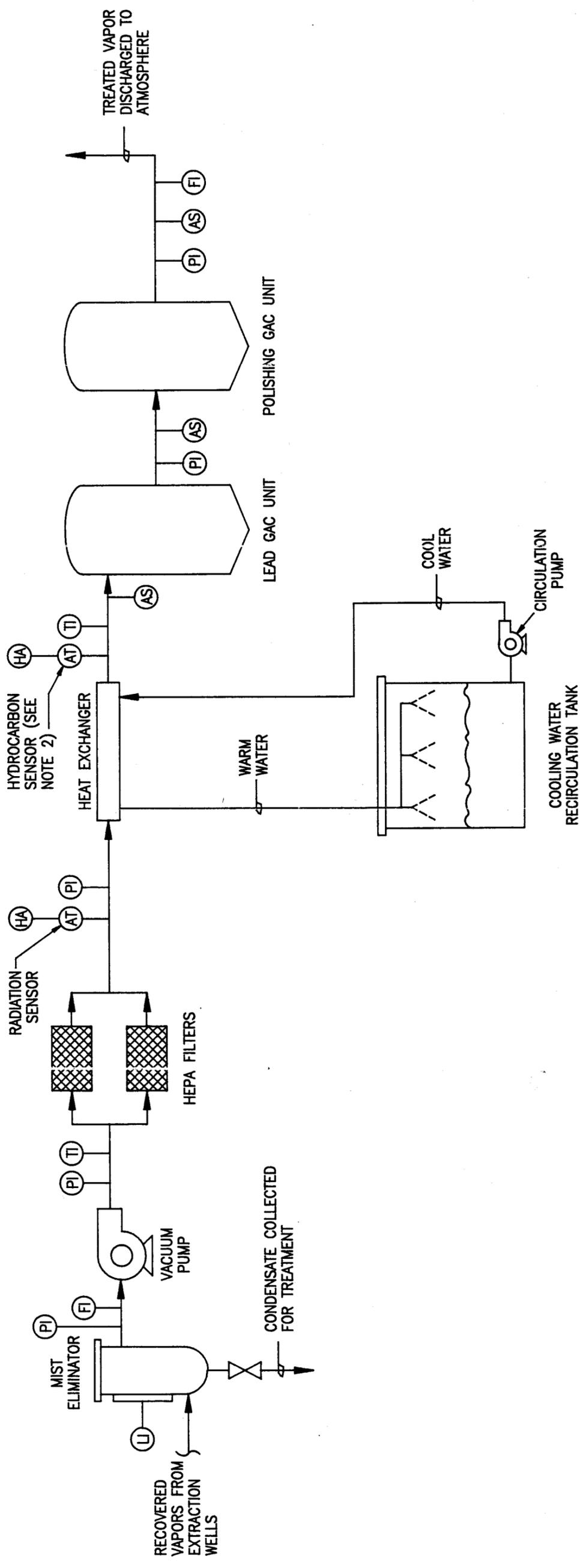
**SURFACE WATER AND  
 SEDIMENT MONITORING STATIONS**

FIGURE 2-18

January 1992



R37M028.CW-012482/600



**NOTES:**

1. VAPOR TREATMENT SYSTEM EQUIPMENT IS MOUNTED ON A FLATBED TRAILER FOR EASE OF TRANSPORT TO EACH PILOT TEST SITE.
2. HYDROCARBON SENSORS ARE PLACED DOWNSTREAM OF THE VACUUM PUMP IN THE SECONDARY CONTAINMENT CAVITIES OF THE PROCESS PIPING AS NECESSARY TO MONITOR FOR VOC-CONTAMINATED VAPOR LEAKS.

**LEGEND**

- GAC GRANULAR ACTIVATED CARBON
- HEPA HIGH EFFICIENCY PARTICULATE AIR
- (AT) ANALYTICAL TRANSMITTER
- (SA) ANALYTICAL SAMPLING LOCATION
- (FI) FLOW INDICATOR
- (HA) HIGH ALARM
- (LI) LEVEL INDICATOR
- (PI) PRESSURE INDICATOR
- (TI) TEMPERATURE INDICATOR
- ∇ VALVE

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PILOT TEST UNIT  
VAPOR EXTRACTION SYSTEM

FIGURE 4-6

January 1992

SOUTH WALNUT CREEK BASIN  
SURFACE WATER  
INFLUENT

10,000-GALLON  
EQUALIZATION  
TANK

CHEMICAL  
PRETREATMENT

PRECIPITATING AGENTS

pH

pH

REACTION TANK

REACTION TANK

CONCENTRATION TANK

RECIRCULATION PUMP

CROSS FLOW FILTRATION

MEMBRANE MODULES

CLEANING LOOP

CLEANING TANK

CLEANING TANK

DRAIN TO STORAGE TANK OR NEUTRALIZATION

NEUTRALIZATION

NEUTRALIZATION ACID

pH

ON LINE UNITS

LEAD CARBON COLUMN

POLISHING CARBON COLUMN

STAND-BY UNITS

LEAD CARBON COLUMN (STAND-BY)

POLISHING CARBON COLUMN (STAND-BY)

TREATED WATER

DISCHARGED TO THE SOUTH WALNUT CREEK DRAINAGE

RECYCLE STREAM

TO A

TO A

SETTLING TANK

FILTER PRESS

SOLIDS DEWATERING EQUIPMENT

SOLIDS TO DISPOSAL

TO A

TO A

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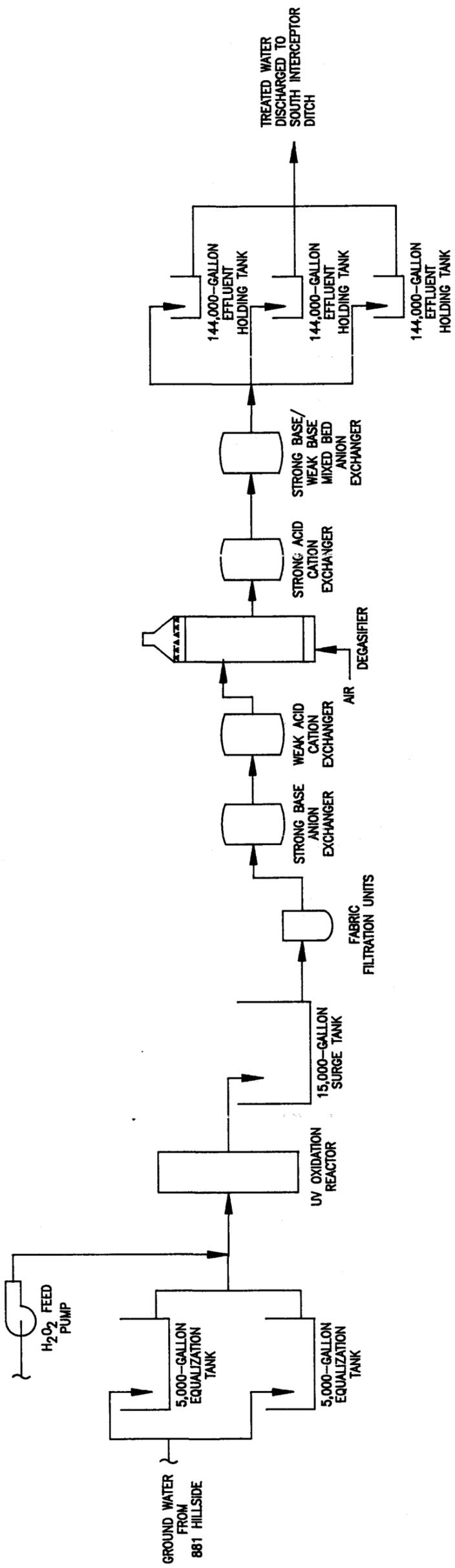
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SOUTH WALNUT CREEK BASIN CHEMICAL  
PRECIPITATION/MICROFILTRATION AND GAC  
ADSORPTION TREATMENT SYSTEM

FIGURE 4-12

January 1992

R37058.MB121391



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OPERABLE UNIT NO. 2  
SUBSURFACE IM/IRA

881 HILLSIDE  
GROUND-WATER TREATMENT SYSTEM  
(PLANNED)

FIGURE 4-13

January 1992