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**Final**

# Phase I RFI/RI Work Plan

## Rocky Flats Plant
## Present Landfill IHSS 114 and
## Inactive Hazardous Waste Storage Area IHSS 203
## (Operable Unit No. 7)

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

**Environmental Restoration Program**

**December 1991**

**VOLUME I - TEXT**

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# LIST OF ACRONYMS

| | |
|---|---|
| AEC | Atomic Energy Commission |
| ARAR | Applicable or Relevant and Appropriate Requirement |
| AWQC | Ambient Water Quality Criteria |
| BCF | bioconcentration factor |
| CAD | Corrective Action Decision |
| CCR | Colorado Code of Regulations |
| CDH | Colorado Department of Health |
| CDOW | Colorado Department of Wildlife |
| CEARP | Comprehensive Environmental Assessment and Response Program |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CFR | Code of Federal Regulations |
| CLP | Contract Laboratory Program |
| CMS | Corrective Measures Study |
| COC | contaminants of concern |
| CPT | cone penetrometer testing |
| CRP | Community Relations Plan |
| CWA | Clean Water Act |
| DCA | dichloroethane |
| DCE | dichloroethylene |
| DMC | derived media concentrations |
| DOE | U.S. Department of Energy |
| DRCOG | Denver Regional Council of Governments |
| DQO | data quality objective |
| EEWP | Environmental Evaluation Work Plan |
| EIS | Environmental Impact Statement |
| EM | Environmental Management |
| EPA | U.S. Environmental Protection Agency |
| ER | Environmental Restoration |
| ERDA | Energy Research and Development Administration |
| FIDLER | Field Instrument for Detection of Low-Energy Radiation |
| FS | feasibility study |
| FSP | Field Sampling Plan |
| GC | gas chromatograph |
| GPR | ground-penetrating radar |
| GRRASP | General Radiochemistry and Routine Analytical Services Protocol |

| | |
|---|---|
| HSP | Health and Safety Plan |
| IAG | Interagency Agreement |
| IHSS | Individual Hazardous Substance Site |
| IPPCD | Interim Plan for Prevention of Contaminant Dispersion |
| IRIS | Integrated Risk Information System |
| MATC | maximum allowable tissue concentration |
| MCL | maximum contaminant level |
| NCP | National Contingency Plan |
| NPDES | National Pollutant Discharge Elimination System |
| OU | operable unit |
| PARCC | precision, accuracy, representativeness, completeness, and comparability |
| PCB | polychlorinated biphenyl |
| PCE | tetrachloroethylene |
| PCN | Procedure Change Notice |
| PID | photoionization detector |
| PQL | Practical Quantitation Limit |
| QAA | Quality Assurance Addendum |
| QA/QC | quality assurance/quality control |
| QAPjP | Quality Assurance Project Plan |
| RAAMP | Radiological Ambient Air Monitoring Program |
| RAS | Routine Analytical Service |
| RCRA | Resource Conservation and Recovery Act |
| RfD | risk reference dose |
| RFEDS | Rocky Flats Environmental Database System |
| RFI | RCRA Facility Investigation |
| RFP | Rocky Flats Plant |
| RI | remedial investigation (CERCLA) |
| ROD | Record of Decision |
| RSP | respirable suspended particulate |
| SAS | Special Analytical Services |
| SAP | Sampling and Analysis Plan |
| SARA | Superfund Amendments and Reauthorization Act of 1986 |
| SDWA | Safe Drinking Water Act |
| SOP | Standard Operating Procedure |
| SSH&SP | Site Specific Health and Safety Plan |
| SWMU | Solid Waste Management Unit |
| TAL | Target Analyte List |

| | |
|---|---|
| TBC | To Be Considered |
| TCA | trichloroethane |
| TCE | trichloroethylene |
| TCL | Target Compound List |
| TDS | total dissolved solids |
| TIC | tentatively identified compound |
| TOC | total organic carbon |
| VOC | volatile organic compound |
| WSIC | Waste Stream Identification and Characterization |
| WSRIC | Waste Stream and Residue Identification and Characterization |
| WQC | Water Quality Criteria |
| WQCC | Water Quality Control Commission |

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ENVIRONMENTAL MANAGEMENT DEPARTMENT

ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203
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## EXECUTIVE SUMMARY

This document presents the work plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)/Remedial Investigation (RI) for Operable Unit No. 7 (OU7) at the Rocky Flats Plant in Jefferson County, Colorado.

The RFI/RI investigation is pursuant to an Interagency Agreement (IAG) among the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH) dated January 22, 1991 (U.S. DOE, 1991a). The IAG program developed by DOE, EPA, and CDH addresses RCRA and CERCLA issues. Although the IAG requires general compliance with both RCRA and CERCLA, RCRA regulations apply to remedial investigations at OU7.

As required by the IAG, this Phase I work plan addresses characterization of source materials and soils at OU7. A subsequent Phase II RFI/RI will investigate the nature and extent of surface water, groundwater, and air contamination and evaluate potential contaminant migration pathways. This Phase I work plan addresses characterization of source materials and soil, including (1) landfill waste and leachate at the Present Landfill (Individual Hazardous Substance Site [IHSS] 114), (2) soils beneath the landfill potentially contaminated with leachate, (3) sediments and water in the East Landfill Pond, (4) potentially contaminated soils at the Inactive Hazardous Waste Storage Area (IHSS 203),

and (5) potentially contaminated soils in the vicinity of the East Landfill Pond that were not included in Operable Unit No. 6 (OU6) but where spray evaporation has historically occurred.

The initial step in development of the OU7 work plan was a review of existing information. Available historical and background data were collected through a literature search and a review of the Rocky Flats Environmental Database System (RFEDS). This information was used in characterizing the physical setting and contamination at OU7 and in developing a conceptual model of the site.

Based on this characterization of OU7, data quality objectives (DQOs) have been developed for the Phase I RFI/RI. DQOs are qualitative and quantitative statements that describe the quality and quantity of data required by the RFI/RI. Through application of the DQO process, site-specific RFI/RI goals are established and data needs are identified for achieving these goals.

In accordance with the IAG, the goals identified for the Phase I RFI/RI for OU7 include characterization of the physical features of the sources at the site and definition of the contaminant sources within OU7.

Within these two broad goals, site-specific objectives and data needs have been identified for the Phase I RFI/RI for OU7. The Field Sampling Plan (FSP) presented in this work plan is designed to generate the data needed to meet the site-specific objectives. Based on the amount and reliability of existing information, the sampling/analysis activities specified in the FSP for each area of concern within OU7 require a combination of some or all of the following: screening activities, soil-gas sampling, soil sampling, sediment sampling, surface water sampling, and monitoring well installation and sampling. Site-specific sampling activities are briefly summarized below.

IHSS 114 - Present Landfill: Cone penetrometer testing coupled with in-situ sampling of gas/leachate/groundwater will be performed at 38 locations. Eight boreholes will be drilled into weathered bedrock, and three boreholes will be drilled into unweathered bedrock. Pump-in packer tests will be performed in the weathered and unweathered bedrock boreholes. Groundwater monitoring wells will be installed and sampled at 15 locations. Leachate, surface water, and sediment samples will be collected from the East Landfill Pond. The operation of the groundwater intercept system will be evaluated, discharge points will be identified, and samples will be obtained from the discharge points. All sampling points, borings, and wells will be surveyed using standard land surveying techniques.

IHSS 203 - Inactive Hazardous Waste Storage Area: A radiological survey will be conducted at 35 locations. A total of 58 soil samples will be collected to a depth of 10 inches. A total of 58 soil samples will be collected from depths of 10 to 12 inches for field

analysis of soil-gas constituents. All sampled locations will be surveyed using standard land surveying techniques.

Areas Around the East Landfill Pond: A radiological survey will be conducted at 96 locations. A total of 122 soil samples will be collected to a depth of 10 inches. All sampled locations will be surveyed using standard land surveying techniques.

Data collected during the Phase I OU7 RFI/RI will be incorporated into the existing RFEDS data base. These data will be used to (1) better define site characteristics and source characteristics, (2) to support the baseline risk assessment, and (3) evaluate potential remedial alternatives. An RFI/RI report will be prepared to summarize the data obtained during the Phase I program. This report will also include the Phase I Baseline Human Health Risk Assessment and Environmental Evaluation.

This is a
CONTROLLED DOCUMENT

ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203
Title: Introduction

Manual No. EG&G — ROCKY FLATS PLANT — 21100-WP-OU 07.01
Section No. ENVIRONMENTAL MANAGEMENT DEPARTMENT 1.0, R0
Organization: This is a RFD Environmental Management

Approved by:

12/6/91
Effective Date

Manager

6/23/92
Date

# 1.0 INTRODUCTION

This document presents the work plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)/Remedial Investigation (RI) for Operable Unit No. 7 (OU7) at the Rocky Flats Plant (RFP) in Jefferson County, Colorado.

This investigation is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies, and remedial/corrective actions currently in progress at RFP. These investigations are pursuant to an Interagency Agreement (IAG) among the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH) dated January 22, 1991 (U.S. DOE, 1991a). The IAG program developed by DOE, EPA, and CDH addresses RCRA and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) issues. Although the IAG requires general compliance with both RCRA and CERCLA, RCRA regulations apply to remedial investigations at OU7. In accordance with the IAG, the CERCLA terms "remedial investigation" and "feasibility study" as used in this document are considered equivalent to the RCRA terms "RCRA Facility Investigation" and "Corrective Measures Study" (CMS), respectively. Also in accordance with the IAG, the term "Individual Hazardous Substance Site" (IHSS) is equivalent to the term "Solid Waste Management Unit" (SWMU).

As required by the IAG, this Phase I work plan addresses characterization of source materials and soils at OU7. A subsequent Phase II RFI/RI will investigate the nature and extent of surface water, groundwater, and air contamination and evaluate potential contaminant migration pathways. This Phase I work plan addresses characterization of source materials and soil, including (1) landfill waste and leachate at the Present Landfill (IHSS 114), (2) soils beneath the landfill potentially contaminated with leachate, (3) sediments and water in the East Landfill Pond, (4) potentially contaminated soils at the

Inactive Hazardous Waste Storage Area (IHSS 203), and (5) potentially contaminated soils in the vicinity of the East Landfill Pond that were not included in Operable Unit No. 6 (OU6) but where spray evaporation has historically occurred.

In this work plan, the existing information is summarized to characterize OU7, data gaps are identified, data quality objectives (DQOs) are established, and a Field Sampling Plan (FSP) is presented to characterize site physical features and define contaminant sources.

The Phase I RFI/RI will be conducted in accordance with the *Interim Final RCRA Facility Investigation (RFI) Guidance* (U.S. EPA, 1989a) and *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (U.S. EPA, 1988a). Existing data and the data generated by the Phase I RFI/RI will be used to begin developing and screening remedial alternatives and to estimate the risks to human health and the environment posed by sources within OU7.

## 1.1 ENVIRONMENTAL RESTORATION PROGRAM

The ER Program, designed for investigation and cleanup of environmentally contaminated sites at DOE facilities, is being implemented in five phases. Phase 1 (Installation Assessment) includes preliminary assessments and site inspections to assess potential environmental concerns. Phase 2 (Remedial Investigations) includes planning and implementation of sampling programs to delineate the magnitude and extent of contamination at specific sites and evaluate potential contaminant migration pathways. Phase 3 (Feasibility Studies) includes evaluation of remedial alternatives and development of remedial action plans to mitigate environmental problems identified in Phase 2 as needing correction. Phase 4 (Remedial Design/Remedial Action) includes design and implementation of site-specific remedial actions selected on the basis of Phase 3 feasibility studies. Phase 5 (Compliance and Verification) includes monitoring and performance

assessments of remedial actions as well as verification and documentation of the adequacy of remedial actions carried out under Phase 4. Phase 1 has been completed at the Rocky Flats Plant (U.S. DOE, 1986), and Phase 2 is currently in progress for OU7.

## 1.2 WORK PLAN OVERVIEW

This work plan presents an evaluation and summary of previous data and investigations, defines data quality objectives and data needs based on that evaluation, specifies Phase I RFI/RI tasks, and presents the FSP for the Phase I RFI/RI.

Section 2.0 (Site Characterization) presents a comprehensive review and detailed analysis of all available historical information, previous site investigations, recently published reports, available data, and past and present activities pertinent to OU7. Included in Section 2.0 are characterization results for site geology and hydrology as well as the known nature and extent of contamination in soils, groundwater, surface water, and sediments. Additionally, Section 2.0 presents a conceptual model of the site based on the physical characteristics of the site and available information regarding the nature and extent of contamination. Section 3.0 presents potential sitewide Applicable or Relevant and Appropriate Requirements (ARARs), as required by the IAG, and a discussion of their application to the RFI/RI activities at OU7. Section 4.0 discusses the DQOs and work plan rationale for the Phase I RFI/RI. Section 5.0 specifies tasks to be performed for the Phase I RFI/RI. The schedule for performance of Phase I RFI/RI activities is presented in Section 6.0. Section 7.0 presents the FSP to meet the objectives presented in Section 4.0. The Baseline Human Health Risk Assessment Plan is discussed in Section 8.0, and the Environmental Evaluation Work Plan (EEWP) is discussed in Section 9.0. The site-specific Quality Assurance Addendum (QAA) for OU7 is discussed in Section 10.0. Section 11.0 presents the Standard Operating Procedures (SOPs) and Procedure Change Notices (PCNs) for performing the fieldwork.

The appendices contain all available supporting data used to characterize the physical setting and contamination at OU7. These data are in the process of being validated in accordance with EM Program Quality Assurance (QA) procedures. As of early 1991, only a small fraction of the data has been validated; these data are identified in the appendices by a qualifier adjacent to each datum. The qualifier "V" means the datum is valid, "A" means the datum is acceptable with qualifications (breach of QA), and "R" means the datum is rejected. Data were rejected because (1) sampling/analytical protocol did not conform to significant aspects of the QA/QC Plan (Rockwell International, 1989a) or (2) there is insufficient documentation to demonstrate conformance with these procedures. These data, at best, can be considered only qualitative measures of the analyte concentrations.

Additionally, Appendix H contains information regarding proposed sitewide geologic characterization activities that will provide information pertinent to the Phase II RFI/RI for OU7. Two boreholes to be drilled adjacent to and downgradient of OU7 will be visually and geophysically logged to correlate subsurface units. This information will be used during Phase II of the RFI/RI to characterize subsurface contaminant migration pathways in the vicinity of OU7.

## 1.3 REGIONAL AND PLANT SITE BACKGROUND INFORMATION

### 1.3.1 Facility Background and Plant Operations

RFP is a government-owned, contractor-operator facility, which is part of the nationwide Nuclear Weapons Complex. The plant was operated for the U.S. Atomic Energy Commission (AEC) from its inception in 1951 until the AEC was dissolved in January 1975. At that time, responsibility for the plant was assigned to the Energy Research and Development Administration (ERDA), which was succeeded by DOE in 1977. Dow Chemical U.S.A., an operating unit of the Dow Chemical Company, was the prime operating

contractor of the facility from 1951 until June 30, 1975. Rockwell International was the prime contractor responsible for operating the Rocky Flats Plant from July 1, 1975, until December 31, 1989. EG&G Rocky Flats, Inc. became the prime contractor at RFP on January 1, 1990.

Operations at RFP consist of fabrication of nuclear weapons components from plutonium, uranium, and other nonradioactive metals (principally beryllium and stainless steel). Parts made at the plant are shipped elsewhere for assembly. In addition, the plant reprocesses components after they are removed from obsolete weapons for recovery of plutonium. Other activities at RFP include research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Both radioactive and nonradioactive wastes are generated in the production process. Current waste handling practices involve onsite and offsite recycling of hazardous materials, onsite storage of hazardous and radioactive mixed wastes, and offsite disposal of solid radioactive materials at another DOE facility. However, RFP operating procedures historically included both onsite storage and disposal of hazardous, radioactive, and radioactive mixed wastes. Preliminary assessments under the EM Program identified some of the past onsite storage and disposal locations as potential sources of environmental contamination.

### 1.3.2 Previous Investigations

Various studies have been conducted at RFP to characterize environmental media and to assess the extent of radiological and chemical contaminant releases to the environment. The investigations performed prior to 1986 were summarized by Rockwell International (1986a) and include the following:

1. Detailed description of the regional geology (Malde, 1955; Spencer, 1961; Scott, 1960, 1963, 1970, 1972, and 1975; Van Horn, 1972 and 1976; Dames and Moore, 1981; and Robson et al., 1981a and 1981b)

2. Several drilling programs beginning in 1960 that resulted in construction of approximately 60 monitoring wells by 1982

3. An investigation of surface water and groundwater flow systems by the U.S. Geological Survey (Hurr 1976)

4. Environmental, ecological, and public health studies that culminated in an Environmental Impact Statement (U.S. DOE, 1980)

5. A summary report on groundwater hydrology using data from 1960 to 1985 (Hydro-Search, Inc., 1985)

6. A preliminary electromagnetic survey of the plant perimeter (Hydro-Search, Inc, 1986)

7. A soil-gas survey of the plant perimeter and buffer zone (Tracer Research, Inc., 1986)

8. Routine environmental monitoring programs addressing air, surface water, groundwater, and soils (Rockwell International, 1975 through 1985, and 1986b)

In 1986, two major investigations were completed at the plant. The first was the EM Program Phase 1 Installation Assessment (U.S. DOE, 1986), which included analyses and identification of current operational activities, active and inactive waste sites, current and past waste management practices, and potential environmental pathways through which contaminants could be transported. A number of sites that could potentially have adverse impacts on the environment were identified. These sites were designated as solid waste management units (SWMUs) by Rockwell International (1987a). In accordance with the IAG, SWMUs are now designated as IHSSs, which were divided into three categories:

1. Hazardous waste substance sites that will continue to operate and need a RCRA operating permit

2. Hazardous waste substance sites that will be closed under RCRA interim status

3. Inactive waste substance sites that will be investigated and cleaned up under Section 3004(u) of RCRA or CERCLA

The second major investigation completed at the plant in 1986 involved a hydrogeologic and hydrochemical characterization of the entire plant site. Plans for this study were presented by Rockwell International (1986c and 1986d), and study results were reported by Rockwell International (1986e). Investigation results identified areas considered to be significant contributors to environmental contamination.

Because IHSS 203 was located within IHSS 114, these IHSSs were grouped together and designated as OU7. Although the East Landfill Pond and adjacent areas where spray evaporation operations occurred (and not already included in OU6) were not designated as IHSSs, they are addressed in this work plan for characterization of OU7 based on known

or suspected contamination associated with IHSS 114. Leachate/groundwater from IHSS drains into the East Landfill Pond, and water from the East Landfill Pond is sprayed on areas adjacent to the pond. Therefore, pond water, sediments, and soils adjacent to the pond may also require remediation and have been included in the Phase I RFI/RI.

### 1.3.3 Physical Setting

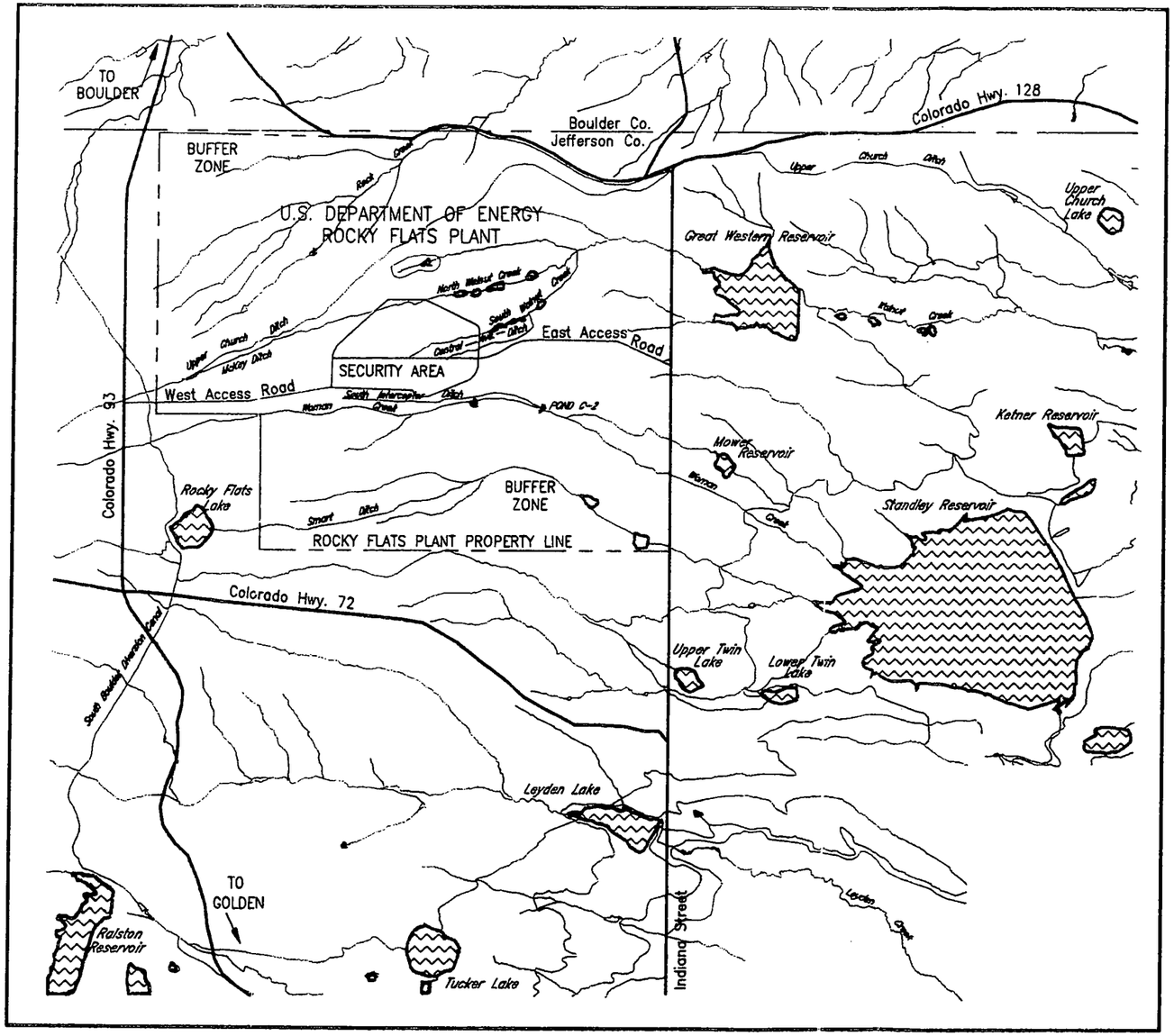
#### 1.3.3.1 Location

RFP is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 1-1). Other surrounding cities include Boulder, Westminster, and Arvada, all of which are located less than 10 miles to the northwest, east, and southeast, respectively. The plant consists of approximately 6,550 acres of federal land in Sections 1 through 4 and 9 through 15 of T2S, R70W, 6th Principal Meridian. Major buildings are located within RFP site of approximately 400 acres. RFP is surrounded by a buffer zone of approximately 6,150 acres.

The plant is bounded on the north by State Highway 128, on the east by Jefferson County Highway 17, (also known as Indiana Street), on the south by agricultural and industrial properties and Highway 72, and on the west by State Highway 93 (Figure 1-1).

#### 1.3.3.2 Topography

RFP is located along the eastern edge of the southern Rocky Mountain region immediately east of the Colorado Front Range. The plant site is located on a broad, eastward-sloping pediment that is capped by alluvial deposits of Quaternary age (Rocky Flats Alluvium). The pediment surface has a fan-like form, with its apex and distal margins approximately 2 miles




SOURCE: EG&G 1991b

SCALE: 1" = 1 MILE

0 1/2 1 MILE

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

Location Map of
Rocky Flats Plant
and Vicinity

Figure 1-1

east of RFP. The tops of alluvial-covered pediments are nearly flat but slope gently eastward at 100 to 50 feet per mile (EG&G, 1991a). At RFP, the pediment surface is dissected by a series of east-northeast trending stream-cut valleys. The valleys containing Rock Creek, North and South Walnut Creeks, and Woman Creek lie 50 to 200 feet below the level of the older pediment surface. These valleys are incised into the bedrock underlying alluvial deposits, but most bedrock is concealed beneath colluvial material accumulated along the gentle valley slopes. The combined effects of the topographic relief (due to stream-cut valleys) and the shallow dip of the bedrock units beneath RFP suggest a potentially shallow depth for the Laramie formation in the valley bottoms.

#### 1.3.3.3 Meteorology

The area surrounding RFP has a semiarid climate characteristic of much of the central Rocky Mountain region. Based on precipitation averages recorded between 1953 and 1976, the mean annual precipitation at the plant is 15 inches. Approximately 40 percent of the precipitation falls during the spring season, much of it as wet 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 (U.S. DOE, 1980).

Winds at RFP, although variable, are predominantly from the west-northwest. Stronger winds occur during the winter, and the area occasionally experiences Chinook winds with gusts up to 100 miles per hour due to its location near the Front Range. The canyons along the Front Range tend to channel the air flow during both upslope and downslope conditions, especially when there is strong atmospheric stability (U.S. DOE, 1980).

Rocky Flats meteorology is strongly influenced by the diurnal cycle of mountain and valley breezes. Two dominant flow patterns exist, one during daytime conditions and one at night. During daytime hours, as the earth heats, air tends to flow toward the higher elevations (upslope). The general air flow pattern during upslope conditions for the Denver area is typically north to south, with flow moving up the South Platte River Valley and then entering the canyons into the Front Range. After sunset, the air against the mountain side is cooled and begins to flow toward the lower elevations (downslope). During downslope conditions, air flows down the canyons of the Front Range onto the plains. This flow converges with the South Platte River Valley flow moving toward the north-northeast (e.g., Hodgin, 1983 and 1984; and U.S. DOE, 1986).

Temperatures at RFP are moderate. Extremely warm or cold weather is usually of short duration. On average, daily summer temperatures range from 55 to 85 degrees Fahrenheit (°F), and winter temperatures range from 20 to 45 °F. Temperature extremes recorded at the plant range from 102 °F on July 12, 1971, to -26 °F on January 12, 1963. The 24-year daily average maximum temperature for the period 1952 to 1976 is 76 °F, the daily minimum is 22 °F, and the average mean is 50 °F. Average relative humidity is 46 percent (U.S. DOE, 1980).

#### 1.3.3.4 Surface Water Hydrology

Three intermittent streams that flow generally from west to east drain RFP area. These drainages are Rock Creek, Walnut Creek, and Woman Creek (Figure 1-1).

Rock Creek drains the northwestern corner of the buffer zone and flows northeastward through the buffer zone to its offsite confluence with Coal Creek. North and South Walnut Creeks and an unnamed tributary drain the northern portion of the plant complex. These three forks of Walnut Creek join in the buffer zone and flow to Great Western Reservoir

approximately 1 mile east of the confluence. Flow is diverted around Great Western Reservoir into Big Dry Creek via the Broomfield Diversion Ditch. Rock Creek, North and South Walnut Creeks, and the unnamed tributary are intermittent streams. Flow occurs in these streams only after precipitation events and spring snowmelt. An east-west trending interfluve separates Walnut Creek from Woman Creek. Woman Creek, a perennial stream, drains the southern Rocky Flats buffer zone and flows eastward into Mower Reservoir. The South Interceptor Ditch is located between the plant and Woman Creek. The South Interceptor Ditch collects runoff from the southern portion of the plant complex and diverts it to pond C-2, where it is monitored in accordance with RFP National Pollutant Discharge Elimination System (NPDES) permit.

#### 1.3.3.5 Ecology

A variety of vegetation is found within the buffer zone surrounding RFP. Included are species of flora representative of tall-grass prairie, short-grass plains, lower montane, and foothill ravine regions. Riparian vegetation exists along the site's drainages and wetlands. None of these vegetative species present at RFP have been reported to be on the endangered species list (EG&G, 1991b). Since acquisition of RFP property, vegetative recovery has occurred, as evidenced by the presence of disturbance-sensitive grass species such as big bluestem (*Andropogon gerardii*) and side oats grama (*Bouteloua curtipendula*). No vegetative stresses attributable to hazardous waste contamination have been identified within the buffer zone (U.S. DOE, 1980). Vegetative stress has been reported at the West Spray Field, however, it has not been determined whether this stress is related to nitrates or hazardous waste.

The fauna inhabiting the Rocky Flats Plant and its buffer zone consists of species associated with western prairie regions. The most common large mammal is the mule deer (*Odocoileus hemionus*), with an estimated 100 to 125 permanent residents. There are a number of small

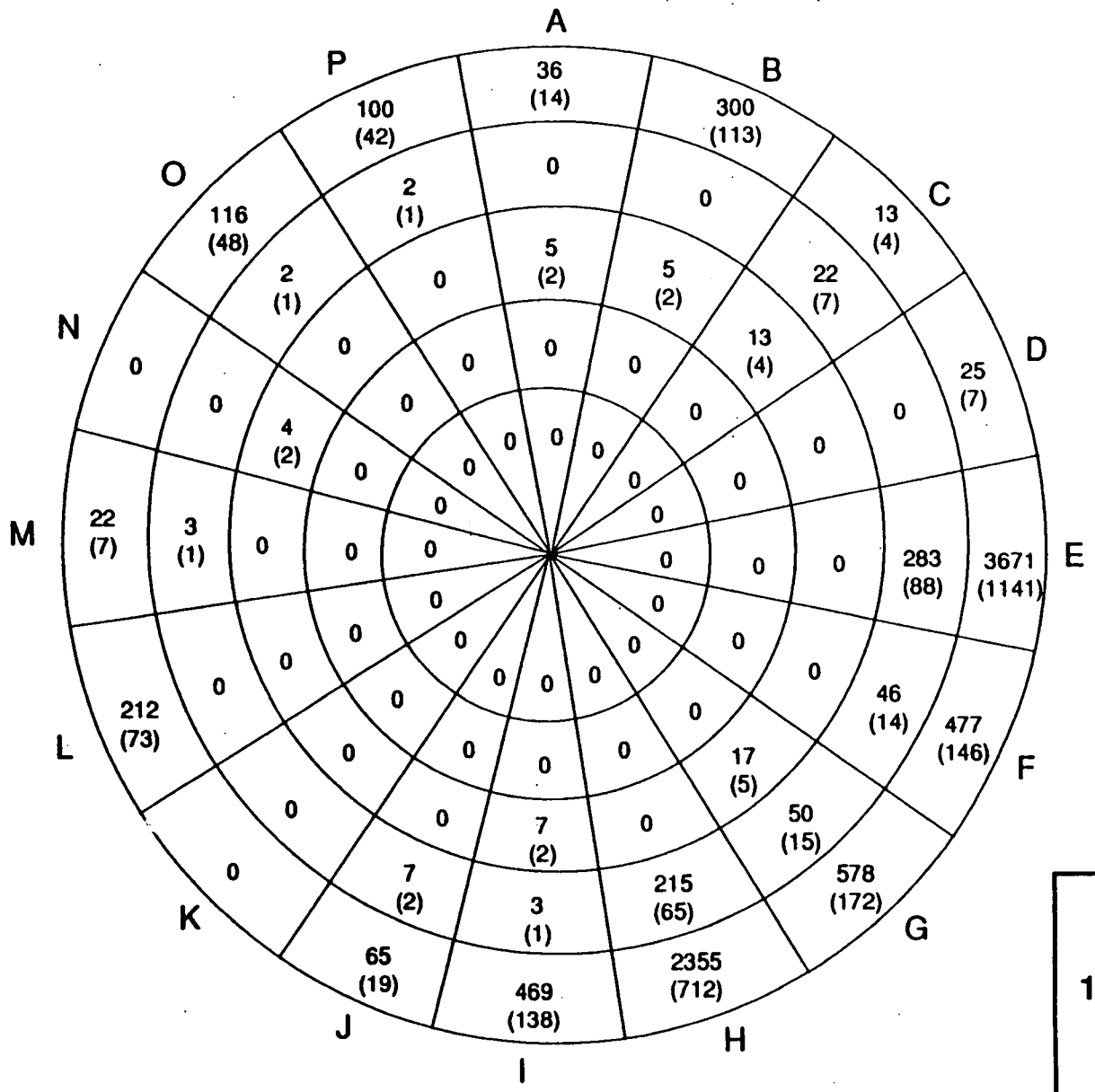
carnivores, such as the coyote (*Canis latrans*), red fox (*Vulpes fulva*), striped skunk (*Mephitis mephitis*), and long-tailed weasel (*Mustela frenata*). Small herbivores can be found throughout the plant complex and buffer zone, including species such as the pocket gopher (*Thomomys talpoides*), white-tailed jackrabbit (*Lepus townsendii*), and the meadow vole (*Microtus pennsylvanicus*) (U.S. DOE, 1980).

Commonly observed birds include western meadowlarks (*Sturnella neglecta*), horned larks (*Eremophila alpestris*), mourning doves (*Zenaidura macroura*), and vesper sparrows (*Pooecetes gramineus*), western kingbirds (*Tyrannus vociferans*), black-billed magpies (*Pica pica*), American robins (*Turdus migratorius*), and yellow warblers (*Dendroica magnolia*). A variety of ducks, killdeer (*Charadrius vociferus*), and red-winged black birds (*Agelaius phoeniceus*) are seen in areas adjacent to ponds. Mallards (*Anas platyrhynochos*) and other ducks (*Anas sp.*) frequently nest and rear young on several of the ponds. Common birds of prey in the area include marsh hawks (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*Buteo regalis*), rough-legged hawks (*Buteo lagopus*), and great horned owls (*Bubo virginianus*) (U.S. DOE, 1980).

Bull snakes (*Pituophis melanoleucus*) and rattlesnakes (*Crotalus sp.*) are the most frequently observed reptiles. Eastern yellow-bellied racers (*Coluber constrictor flaviventris*) have also been seen. The eastern short-horned lizard (*Phrynosoma douglassi brevirostre*) has been reported on the site, but these and other lizards are not commonly observed. The western painted turtle (*Chrysemys picta*) and the western plains garter snake (*Thamnophis radix*) are found in and around many of the ponds (U.S. DOE, 1980).

### 1.3.3.6 Surrounding Land Use and Population Density

The population, economics, and land use of areas surrounding RFP are described in a 1989 Rocky Flats vicinity demographics report prepared by DOE (U.S. DOE, 1991b). This report




| Miles | Sector Name |
|---|---|
| 0-1 | Sector 1 |
| 1-2 | Sector 2 |
| 2-3 | Sector 3 |
| 3-4 | Sector 4 |
| 4-5 | Sector 5 |

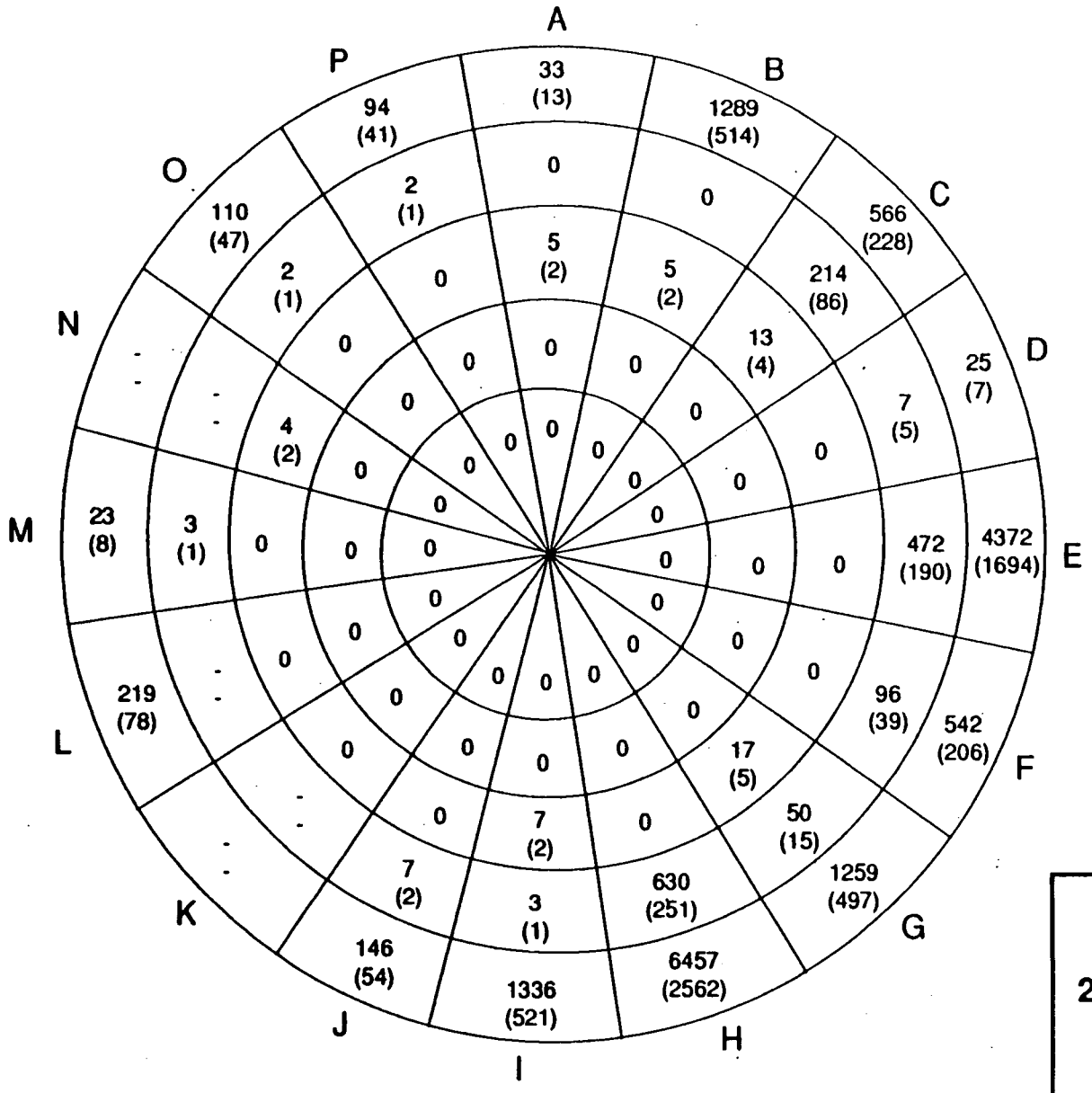
**Figure 1-2**
**1989 POPULATIONS AND (HOUSEHOLDS), SECTORS 1-5**

SOURCE: DOE, "1989 POPULATION, ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT", (IN PRESS)

divides general use of areas within 0 to 10 miles of RFP into residential, commercial, industrial, parks and open spaces, agricultural and vacant, and institutional classifications and considers current and future land use near the plant.

The majority of residential use within 5 miles of RFP is located immediately northeast, east, and southeast of RFP. The 1989 population distribution within areas up to 5 miles from RFP is illustrated in Figure 1-2. Commercial development is concentrated near residential developments north and southwest of Standley Lake as well as around Jefferson County Airport, approximately 3 miles northeast of RFP. Industrial land use within 5 miles of the plant is limited to quarrying and mining operations. Open space lands are located northeast of RFP near the City of Broomfield and in small parcels adjoining major drainages and small neighborhood parks in the cities of Westminster and Arvada. Standley Lake is surrounded by Standley Lake Park. Irrigated and non-irrigated croplands, producing primarily wheat and barley, are located northeast of RFP near the cities of Broomfield, Lafayette, and Louisville; north of RFP near Louisville and Boulder; and in scattered parcels adjacent to the eastern boundary of the plant. Several horse operations and small hay fields are located south of RFP. The demographic report characterizes much of the vacant land adjacent to RFP as rangeland (U.S. DOE, 1991b).

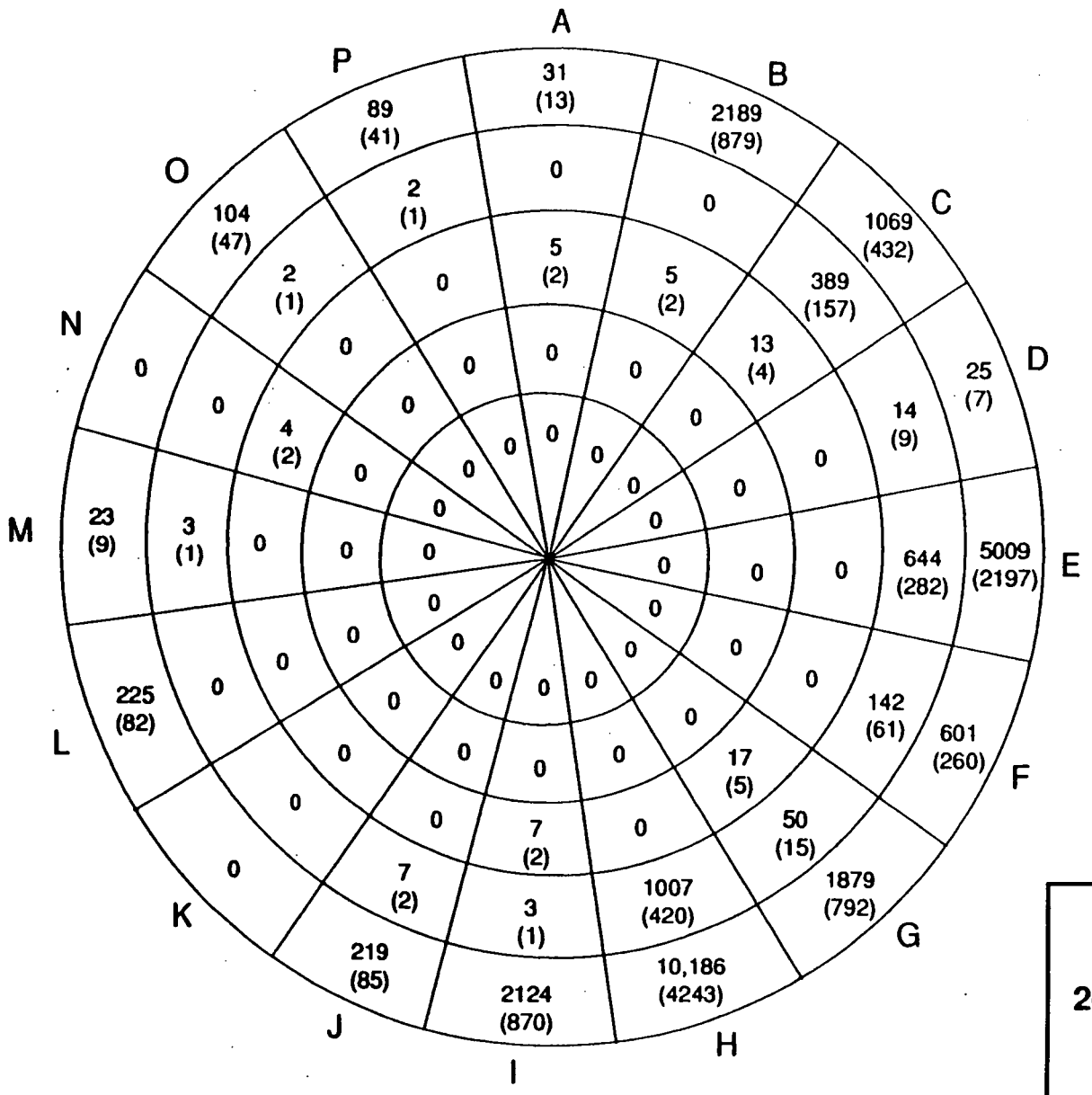
Future land use in the vicinity of RFP most likely involves continued urban expansion, increasing the density of residential, commercial, and perhaps industrial land use in the areas. The expected trend in population growth in the vicinity of RFP is also addressed in the DOE demographic study (U.S. DOE, 1991b). The report considers expected variations in population density by comparing the current (1989) setting to population projections for the years 2000 and 2010. A 21-year profile of projected population growth in the vicinity of RFP can thus be examined. DOE's projections are based primarily on long-term population projections developed by the Denver Regional Council of Governments (DRCOG). Expected population density and distribution around RFP for the years 2000 and 2010 are shown in Figures 1-3 and 1-4, respectively.




| Miles | Sector Name |
|---|---|
| 0-1 | Sector 1 |
| 1-2 | Sector 2 |
| 2-3 | Sector 3 |
| 3-4 | Sector 4 |
| 4-5 | Sector 5 |

**Figure 1-3**
**2000 POPULATIONS AND (HOUSEHOLDS), SECTORS 1-5**

SOURCE: DOE, "1989 POPULATION, ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT", (IN PRESS)




| Miles | Sector Name |
|---|---|
| 0-1 | Sector 1 |
| 1-2 | Sector 2 |
| 2-3 | Sector 3 |
| 3-4 | Sector 4 |
| 4-5 | Sector 5 |

SOURCE: DOE, "1989 POPULATION, ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT", (IN PRESS)

**Figure 1-4**
**2010 POPULATIONS AND (HOUSEHOLDS), SECTORS 1-5**

RFP is located on a broad, eastward-sloping pediment surface along the western edge of the Denver Basin. The area is underlain by more than 10,000 feet of Pennsylvanian to Upper Cretaceous sedimentary rocks that have been locally folded and faulted. Along the foothills west of RFP, sedimentary strata are steeply east-dipping to overturned. West of the buffer zone, Upper Cretaceous sandstones of the Laramie formation make up an east-dipping (45 to 55 degrees) hogback that strikes approximately north-northwest (Scott, 1960). Immediately west of the plant, steeply dipping sedimentary strata abruptly flatten to less than 2 degrees under and east of RFP (EG&G, 1991a). The sedimentary bedrock is unconformably overlain by Quaternary alluvial gravels that cap pediment surfaces of several distinct ages (Scott, 1965).

Figure 1-5 shows the local stratigraphic section for the Rocky Flats area. Upper Cretaceous bedrock units directly underlying RFP and pertinent to plant site hydrogeology include, in descending stratigraphic order, the Arapahoe formation, the Laramie formation, and the Fox Hills Sandstone. These bedrock units and the younger surficial geologic units at RFP are described below.

Rocky Flats Alluvium

The Rocky Flats Alluvium is the oldest and topographically highest alluvial deposit in RFP area. The Rocky Flats Alluvium is a terrace alluvial deposit that occupies an extensive pediment surface sloping eastward from the mouth of Coal Creek Canyon. The thickness of the Rocky Flats Alluvium ranges from 10 to 50 feet (Malde, 1955). The thinnest deposits occur on top of bedrock ridges or hogbacks. The thickest deposits occur as local channel fills in scoured bedrock or behind bedrock ridges. The Rocky Flats Alluvium is composed

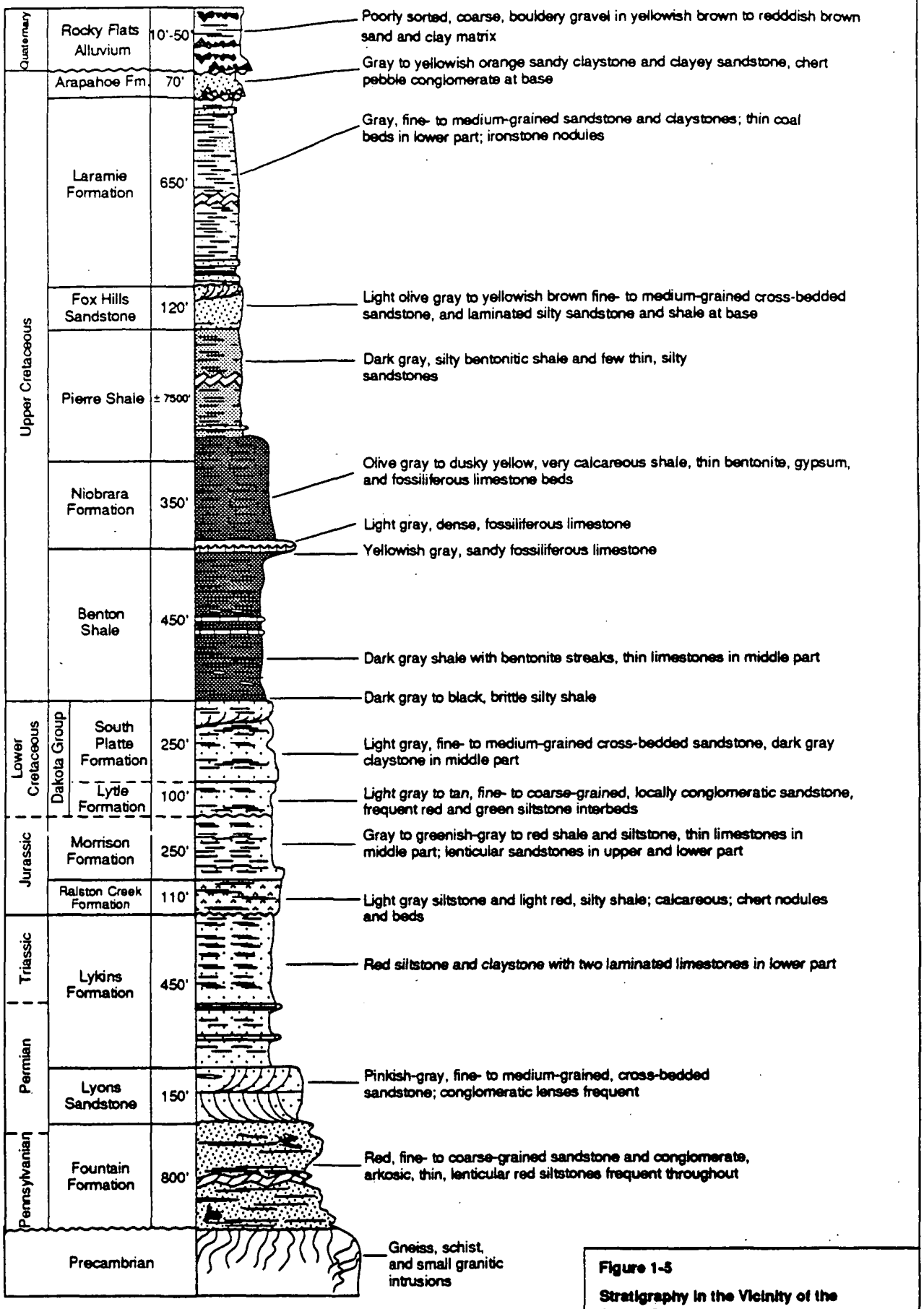



**Figure 1-5**

**Stratigraphy in the Vicinity of the Rocky Flats Plant**

(After LeRoy and Weimer, 1971)

of yellowish brown to reddish brown, poorly sorted, coarse bouldery gravel in a sand matrix with lenses of clay, silt, and sand and varying amounts of caliche, where weathered.

Unconfined groundwater flows in the Rocky Flats Alluvium, which is relatively permeable compared to claystone, siltstones, and silty sandstones. Recharge to the alluvium is from precipitation, snowmelt, and water losses from ditches, streams, and ponds that are cut into the alluvium. In general, water movement in the Rocky Flats Alluvium is from west to east and toward the drainages. The water table surface in the Rocky Flats Alluvium rises in response to recharge during the spring and declines during the remainder of the year. Fluctuations in the water table surface vary approximately 2 to 25 feet at RFP (Hurr, 1976). Discharge from the alluvium occurs at minor seeps in colluvial materials that cover the contact between the alluvium and bedrock along the edges of the valleys. The Rocky Flats Alluvium thins, becomes discontinuous, and is eroded from the drainages east of the plant boundary. Thus, the alluvium does not directly supply water to wells located downgradient of RFP (Rockwell International, 1988a).

Other Surficial Deposits

Other surficial deposits within the Rocky Flats area consist of younger terrace alluvial deposits, colluvium, slumps, and valley fill (EG&G, 1991a). The younger alluvial deposits cap pediment surfaces that are topographically lower than the Rocky Flats pediment. Erosion has formed deposits of colluvium on the sides of steep slopes and in the stream valleys. The valley bottoms consist of valley-fill deposits from sedimentation by streams. Gentle stream-cut valley walls are often covered in part by shallow slumps. These features are recognized by a curved scarp at the top, a coherent mass of material downslope that may be rotated back toward the slip plane, and hummocky topography at the base. Surficial deposits are composed of gravel, sand, silt, and clay. These deposits are primarily

derived from Precambrian rocks to the west but also from younger sedimentary bedrock and older surficial deposits.

Unconfined groundwater flows in these surficial units. Recharge occurs through precipitation, infiltration from streams during periods of surface water runoff, and seeps discharging from the Rocky Flats Alluvium. Discharge occurs through evapotranspiration and by seepage into other geologic formations, subcrops, and streams. The direction of groundwater flow is generally to the east and downgradient through colluvial materials into valley-fill deposits that occur in the active drainages. During periods of high surface water flow, some of the water is lost to bank storage in the valley-fill alluvium and returns to the stream after the runoff subsides.

Arapahoe Formation

The Arapahoe formation is composed predominantly of sandstones and claystones. The base of the Arapahoe formation is marked by thick-bedded, planar-laminated to trough cross-bedded, calcareous, conglomeratic sandstones and coarse sandstones. These basal conglomerates and sandstones fill low-relief, discontinuous drainages that were cut into the underlying claystones of the Laramie formation (EG&G, 1991a). The formation is more than 300 feet thick in the Golden area south of RFP (Weimer, 1973); however, the upper portions of the Arapahoe formation are not seen at RFP, having been eroded prior to deposition of the Rocky Flats Alluvium. Only the lower 70 to 100 feet of the Arapahoe formation are present at RFP (EG&G, 1991a). The Arapahoe formation is a fluvial deposit. The coarse sediments at its base indicate a braided-channel fluvial environment. Arapahoe formation sediments overlying the basal sandstones and conglomerates are predominantly claystones and interbedded silty claystones and sandstones that may represent fine-grained overbank flood deposits or low-energy fluvial deposits. Sandstone bodies within

the Arapahoe formation likely represent point-bar deposits and are therefore considered to be lenticular in shape and laterally discontinuous (EG&G, 1991a).

The Arapahoe formation is recharged by groundwater movement from overlying surficial deposits and by infiltration from streams. The main recharge areas are under the Rocky Flats Alluvium, although some recharge from the colluvium likely occurs along stream valleys and drainages (Rockwell International, 1988a). 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. Regionally, groundwater flow in the Arapahoe formation is toward the South Platte River in the center of the Denver Basin (Robson et al., 1981a).

Laramie Formation

The Laramie formation conformably underlies the Arapahoe formation. The formation is approximately 600 to 700 feet thick at RFP. The lower portion (lowest 300 feet) of the Laramie formation is composed of thick sandstones, siltstones, and claystones with discontinuous coal beds. The upper part of the Laramie formation consists primarily of massive claystones. Thin to medium lenticular beds of platy, ripple-laminated, and friable sandstones are also present in the upper Laramie. The Laramie formation is a delta plain and fluvial flood plain deposit (EG&G, 1991a). At RFP, the Rocky Flats Alluvium unconformably overlies the Laramie in areas where the Arapahoe formation was completely eroded prior to deposition of the Rocky Flats Alluvium. (To the extent known, the Arapahoe Formation is present beneath OU7).

Fox Hills Sandstone

The Fox Hills Sandstone is composed primarily of thick-bedded to massive, very fine to medium grained, silty sandstone. The Fox Hills Sandstone underlies the Laramie formation and is approximately 80 to 100 feet thick under RFP.

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 quickly flatten to the east (less than 2 degree dip) (EG&G, 1991a). Recharge to the aquifer occurs along the rather limited outcrop area exposed to surface water flow and infiltration along the Front Range and by leakage from overlying units (Robson et al., 1981b).

This is a
CONTROLLED DOCUMENT

ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203
Title: Site Characterization

Manual ENG — ROCKY FLATS ENVIRONMENTAL MANAGEMENT DEPARTMENT 21100-WP-OU 07.01
Section No. 2.0, R0

Organization: Environmental Management

This is a RED Stamp

Approved by:

12/6/91
Effective Date

Manager

6/23/92
Date

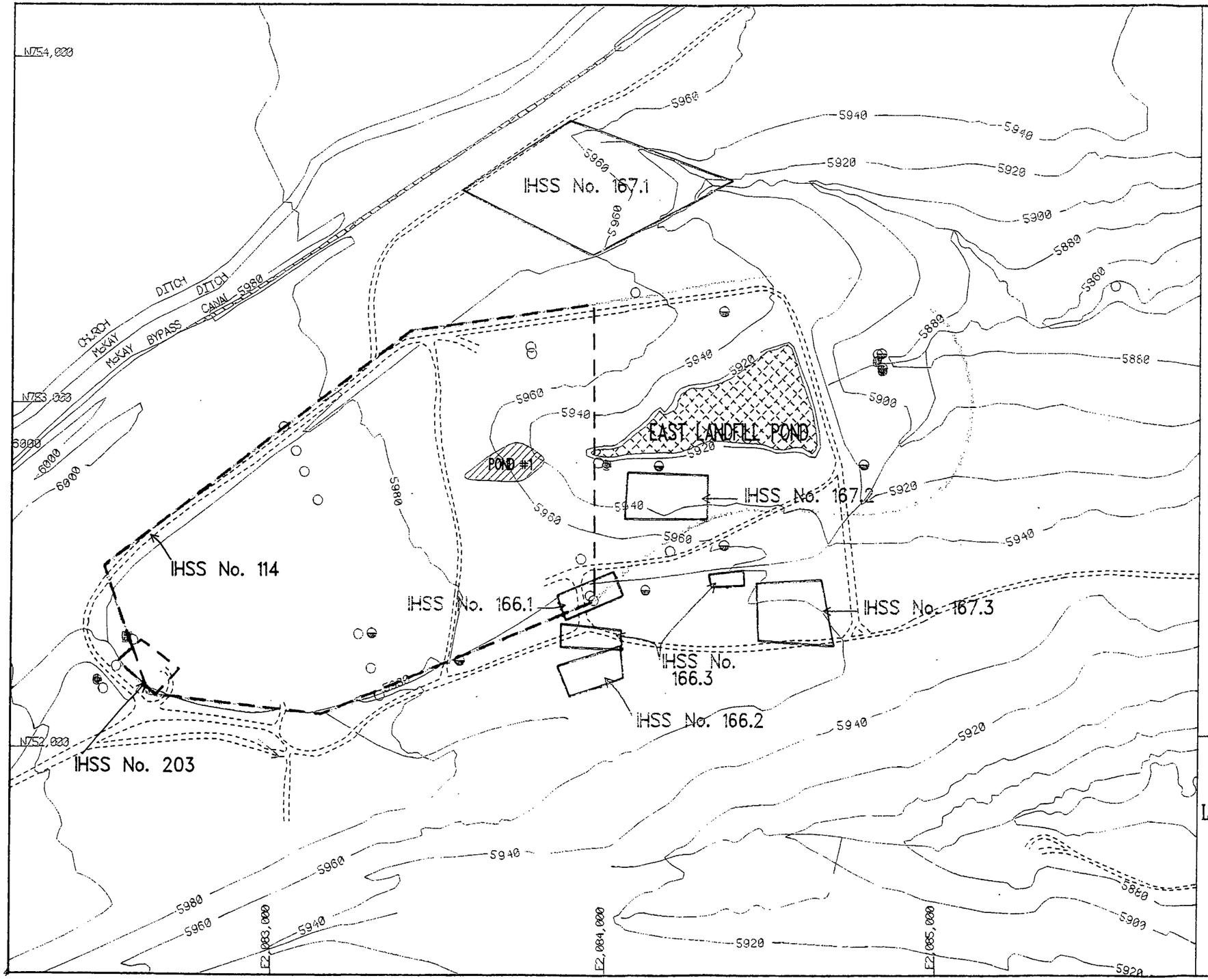
## 2.0 SITE CHARACTERIZATION

This RFI/RI Work Plan addresses the Present Landfill (IHSS 114), the Inactive Hazardous Waste Storage Area (IHSS 203), the East Landfill Pond, and spray evaporation areas near the pond. These areas are located north of RFP (Figure 2-1). The Present Landfill and the Inactive Hazardous Waste Storage Area were assigned an IHSS (formerly SWMU) reference number by Rockwell International (1987a). During 1991, the boundary of OU7 was modified to include the East Landfill Pond and adjacent spray evaporation areas not included in OU6. Details of the IHSS locations and operations are presented in Section 2.2.1. In Section 2.2.2, previous investigations, physical characteristics, and interim corrective measures for OU7 are summarized.

The initial step in development of the OU7 work plan was a review of existing information. Available historical and background data for each IHSS were collected through a literature search, which included references at the Rocky Flats Public Reading Room, various RFP libraries, and a review of the Rocky Flats Environmental Database System, (RFEDS). Information regarding existing alluvial and bedrock wells within and near OU7 has been collected for this study. Personal communications with plant personnel were also used as a source of information during the background data review so that each IHSS could be better described.

### 2.1 REGULATORY HISTORY OF OU7

Since 1968, when the landfill became operational, operations have continuously evolved in response to changes in the regulatory statutes. The landfill was originally constructed for disposal of the plant's uncontaminated solid wastes. In October 1972, the policies applicable to waste disposal at the landfill were reviewed and judged to be in accordance with applicable state and federal regulations (Rockwell International, 1988a).




## EXPLANATION

- ALLUVIAL WELL
- WEATHERED BEDROCK WELL
- UNWEATHERED BEDROCK WELL
- DECOMMISSIONED WELL
- OU6 INDIVIDUAL HAZARDOUS SUBSTANCE SITE AREAS
- OU7 INDIVIDUAL HAZARDOUS SUBSTANCE SITE AREAS
- OU7 BOUNDARY
- DIRT ROADS
- STREAMS, DITCHES, DRAINAGE FEATURES
- SURFACE WATER IMPOUNDMENTS
- APPROXIMATE EXTENT OF POND #1 (WEST LANDFILL POND)

0 feet 300 600

CONTOUR INTERVAL = 20 FEET

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

# Locations of Remedial Investigation Areas and Associated Individual Hazardous Substance Sites

Figure 2-1

Additional guidelines were issued in February 1973 to control burial of solid and liquid wastes in the landfill. In fall 1973, Health Physics Operations began a program of radioactive monitoring and scanning of the waste after it had been dumped and prior to compaction and burial.

In July 1977, a Solid Waste Management Plan was prepared to establish guidelines and procedures for landfill disposal. This plan was prepared in compliance with 40 CFR 241 (Rockwell International, 1988a). Guidelines for waste disposal were redefined to prevent disposal of waste material with detectable radioactivity. Further guidelines were established to prohibit disposal of liquids, "special items," and "non-routine wastes" in the landfill, except by special permit. Permits were issued by the Waste Management Section and the Hazardous Materials Committee of Rockwell International. Procedures established by the 1977 Solid Waste Management Plan included both radiation monitoring and groundwater monitoring programs. Radiation monitoring included measurements at the point of waste origination and at the landfill. The groundwater monitoring program consisted of sampling wells at the landfill site once every five months. The water samples were analyzed for plutonium, gross alpha, conductivity, pH, and nitrate.

At the request of Rockwell International, CDH inspected the landfill in 1978 and 1979. CDH stated that the landfill appeared to comply with state and federal minimum standards and department regulations (CDH, 1979).

In 1986 and 1987, studies were conducted to identify waste streams generated at RFP (Rockwell International, 1986f, 1986g, 1986h, and 1986i). As stated in the Waste Stream Identification and Characterization Reports, 338 identified waste streams were being disposed in the landfill (Rockwell International, 1986f, 1986g, 1986h, and 1986i), including 241 waste streams identified as nonhazardous solid waste and 97 solid waste streams that contained hazardous waste or hazardous constituents. As of November 1986, the waste streams identified as hazardous in the 1986 studies (Rockwell International, 1986f, 1986g, 1986h, and 1986i) were no longer disposed in the landfill. In 1987, recommendations were

made that outlined how the waste streams identified at RFP should be disposed (Rockwell International, 1987b). The report identified 144 waste streams that were recommended for continued disposal in the landfill.

Because records indicate that some hazardous waste was disposed at the landfill, it was designated as an interim status RCRA-regulated unit and was included in the Part B Permit Application for RFP. The landfill currently accepts only nonhazardous solid waste and therefore will not be permitted as an operating RCRA unit. Since 1988, an alternate groundwater monitoring program has been implemented at OU7 in accordance with 6CCR 1007-3 and 40 CFR 265.90 (d) for interim status RCRA units. OU7 will remain under interim status until closure. A closure plan (Rockwell International, 1988a) was prepared for OU7 and submitted to CDH and EPA in July 1988. However, prior to approval, the closure plan was superseded by the requirements of the IAG.

A new closure plan for the landfill will be developed on the basis of the findings of the Phase I and Phase II RFI/RI studies being performed in accordance with the IAG. Post-closure inspection, maintenance, and monitoring of the landfill will be performed in accordance with 6 CCR 1007-3 Part 264 (40 CFR Part 264). In accordance with the IAG, this will be developed through the Interim Measure/Interim Remedial Action decision document.

IHSS 203 was actively used between 1986 and 1987 as a hazardous waste storage area. This IHSS was included in the November 1986 Part B Permit Application for RFP as an operating RCRA hazardous waste unit. In that application, it was referred to as Unit #1. Cargo containers used to store drums of hazardous waste were designed to meet the requirements for secondary containment in accordance with 6 CCR 1007-3 Section 264.175. Because IHSS 203 is located within the Present Landfill (IHSS 114), post-closure inspection, maintenance, and monitoring of the landfill will be performed in accordance with 6 CCR 1007-3 Part 264 (40 CFR Part 264). As mentioned previously, this will be developed

through the Interim Measure/Interim Remedial Action decision document, in accordance with the IAG.

## 2.2 BACKGROUND AND PHYSICAL SETTING OF OU7

OU7 is located north of the plant complex on the western end of an unnamed tributary of North Walnut Creek (Figure 2-1). The background and physical setting of the IHSSs and other areas that constitute OU7 are discussed below. Also located within the unnamed tributary of North Walnut Creek are IHSSs included in OU6 (Figure 2-1). These include the North, South, and Pond Spray Fields (IHSSs 167.1, 167.2, and 167.3, respectively) and Trenches A, B, and C (IHSSs 166.1, 166.2, and 166.3, respectively). Information regarding the operational history of these IHSSs is presented in the Final Draft Phase I RFI/RI Work Plan, Walnut Creek Priority Drainage (OU6) (EG&G, 1991c). The spray field areas were used during the 1960s and 1970s to spray water from retention ponds over the ground surface to enhance evaporation. Trenches A and B received uranium- and/or plutonium-contaminated sludge from the Sewage Treatment Plant (Building 995) from approximately 1964 to 1974. Materials placed in Trench C are unknown, but it is probable that sewage sludge was also placed in this trench. These IHHSs are discussed throughout Section 2.0, where applicable to the characterization of OU7.

### 2.2.1 Locations and Operational Histories of IHSSs 114 and 203

#### 2.2.1.1 Present Landfill (IHSS 114)

The Present Landfill is located north of the plant complex on the western end of an unnamed tributary of North Walnut Creek (Figure 2-1).



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Operational History

Operation of the landfill was initiated on August 14, 1968. A portion of the natural drainage was filled with soils from an onsite borrow area to a depth of up to 5 feet to construct a surface on which to start landfilling. The landfill was originally constructed to provide for disposal of the plant's nonradioactive solid wastes. However, the criteria used historically to define nonradioactive material is not presently known. These wastes included paper, rags, floor sweepings, cartons, mixed garbage and rubbish, demolition material, and miscellaneous items. Characterization of landfill material is discussed further in Section 2.3.1.

From 1968 to 1978, the landfill received approximately 20 cubic yards of compacted waste per day. By 1974, the landfill had expanded in surface area to approximately 300,000 square feet. The volume occupied by the landfill was estimated to be approximately 95,000 cubic yards. Of this total, the cover material was estimated at 30,000 cubic yards. The remaining 65,000 cubic yards consisted of compacted waste intermixed with the daily cover material placed during disposal. Estimates made in 1986 indicate that approximately 160,000 cubic yards of material had been placed between 1974 and 1986, for a total landfill volume of 255,000 cubic yards. This volume included solid wastes, wastes with hazardous constituents, and soil cover material. Between 1986 and 1988, waste was disposed at a rate of 115 cubic yards per work day (Rockwell International, 1988a). Using this rate and assuming 260 work days per year for four years, approximately 120,000 cubic yards of waste material have been disposed since 1986. Daily cover volumes have been estimated at approximately 25 percent of the volume of material disposed. Based on these assumptions, the volume of material in the landfill is currently estimated to be approximately 405,000 cubic yards.

In September 1973, tritium was detected in leachate draining from the landfill. In response, a sampling program was initiated to determine the location of the tritium source (Section 2.3.1), monitoring of waste prior to burial was initiated to prevent further disposal of

radioactive material, and interim response measures were undertaken to control the generation and migration of the landfill leachate.

Interim response measures included construction of two ponds (Ponds #1 and #2) immediately east of the landfill, a subsurface interception system for diverting groundwater around the landfill, a subsurface leachate collection system, and surface water control ditches. Construction of these systems began in October 1974 and was completed in January 1975. These interim response actions are discussed briefly below and in greater detail in Section 2.2.4. The locations of the landfill structures constructed as interim response measures are shown in Figure 2-2.

The surface water control ditches intercept surface water runoff flowing toward the landfill and direct it away from the landfill. The purpose of Pond #1 (the West Landfill Pond) was to provide a permanent structure to impound any leachate generated by the landfill. The purpose of Pond #2 (the East Landfill Pond) was to provide a permanent structure to collect groundwater flowing from the groundwater diversion system. The leachate collection system drained only to the West Landfill Pond. Discharge of the intercepted groundwater could be directed to the west pond, east pond, or surface drainages downgradient of the east pond by a series of valves in the subsurface pipes.

In 1974, an engineered pond embankment was constructed to replace the temporary embankment of Pond #2. The engineered embankment included a low-permeability clay core keyed into bedrock. The area of the new pond, now called the East Landfill Pond, was approximately 2.5 acres (Figure 2-2). Details of these structures are discussed further in Section 2.2.4.

To prevent the two ponds from overfilling and discharging into the drainage, water was periodically sprayed on the ground surface adjacent to the landfill to enhance evaporation. Areas where spray evaporation operations historically occurred were designated as IHSSs and incorporated into OU6 (Figure 2-1). Water collected in Pond #1 was sprayed on a

3.9-acre plot, designated as IHSS 167.1 and located approximately 800 feet northeast of the pond. Two other spray fields, IHSSs 167.2 and 167.3, were located along the banks of the East Landfill Pond and were used for spray evaporation of water collected in the East Landfill Pond. Water from the East Landfill Pond is currenly sprayed along the banks of the East Landfill Pond in areas not presently designated as IHSSs. These areas where recent spray evaporation is practiced are considered part of OU7.

Between 1977 and 1981, portions of the leachate and groundwater diversion system were buried during landfill expansion. The eastward expansion covered the discharge points of the leachate collection system into Pond #1. The west embankment and Pond #1 were covered in May of 1981 during further eastward expansion of the landfill. In 1982, two slurry walls were constructed to prevent groundwater migration into the expanded landfill area. These slurry walls were tied into the north and south arms of the groundwater diversion system. Details of the slurry walls are discussed in Section 2.2.4.

Waste Operations

The disposal procedures currently utilized at the landfill have not significantly changed since the landfill went into operation in 1968. Waste is delivered to the landfill throughout the morning and early afternoon. In mid-afternoon, waste is spread across the work area. Since 1973, after the discovery of a tritium source within the landfill wastes, a radiation monitoring program initiated by the Health Physics Operations at Rocky Flats has been implemented to prevent further disposal of radioactive material. After the waste has been dumped and before compaction and burial, measurements are obtained with a Field Instrument for Detection of Low Energy Radiation (FIDLER) probe. Radioactive items are removed and stored onsite.

After radiation monitoring is completed, the waste layer is compacted and covered with 6 inches of soil from onsite stockpiles (Photo 2-1). Waste disposal continues in this manner until the waste layer is within 3 feet of the final elevation. The lift is then completed by the

addition of a 3-foot-thick layer of compacted soil. In different sections of the landfill, the total landfill thickness consists of between 1 and 3 such lifts. Based on visual observation (Rockwell International, 1988a), some areas of the landfill surface may not have received a full 3-foot layer of compacted soil.

#### 2.2.1.2 Inactive Hazardous Waste Storage Area (IHSS 203)

The Inactive Hazardous Waste Storage Area is located at the southwest corner of the Present Landfill (Figure 2-1 and Photo 2-2). This area was actively used between 1986 and 1987 as a hazardous waste storage area for both drummed liquids and solids (Rockwell International, 1988b). Fifty-five-gallon containers with free liquids were stored in 14 cargo containers. One additional container was used to store spill control items such as oil sorbent and sorbent pillows.

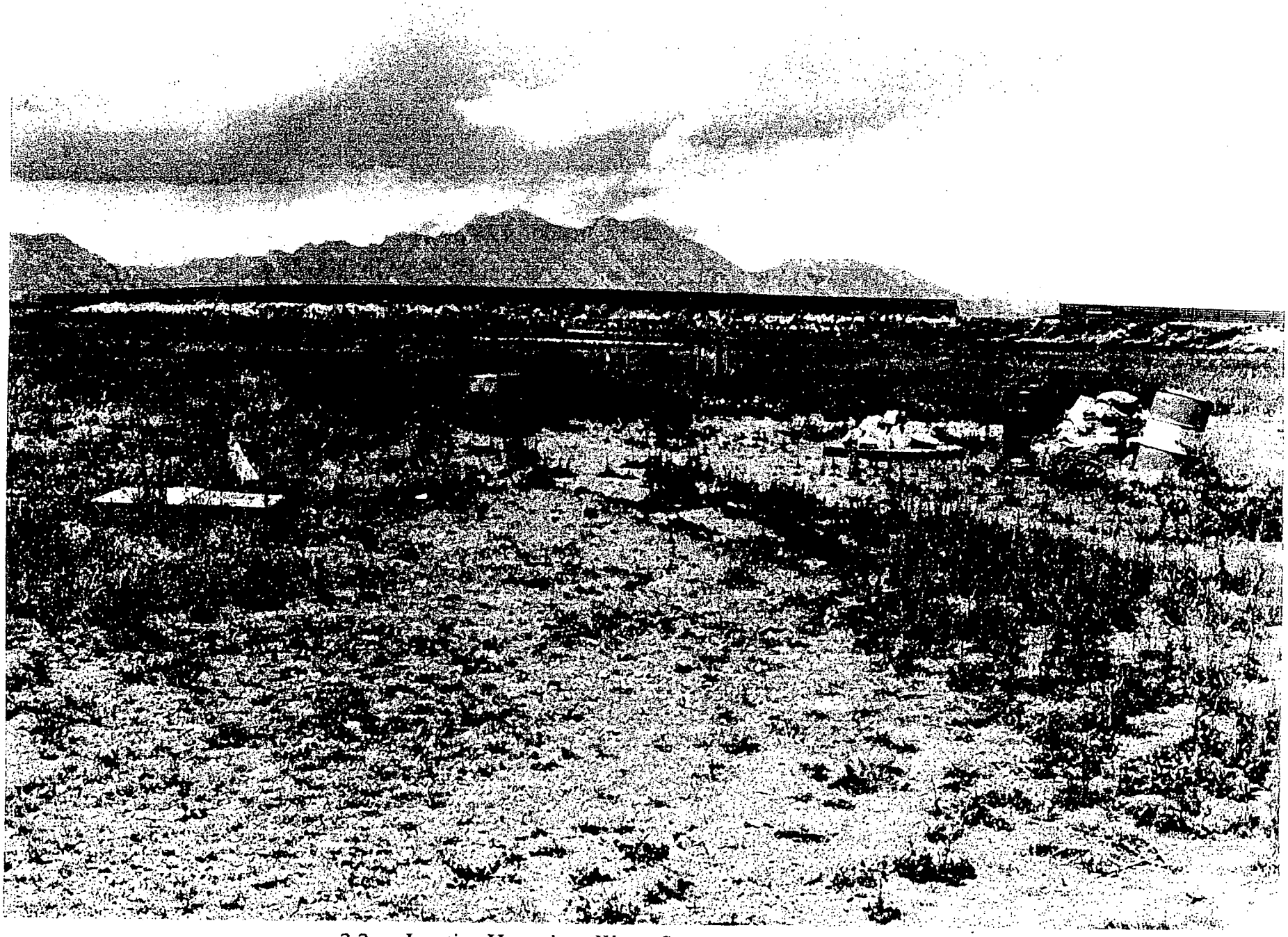
During maximum inventory, the hazardous waste area consisted of eight 20-foot-long cargo containers, each capable of holding eighteen 55-gallon drums, and six 40-foot-long cargo containers, each capable of holding forty 55-gallon drums. Fifty-five-gallon drums were placed and conveyed in the cargo containers on rollers constructed of aluminum. Two conveyors extended the full length of the cargo container. A 3-foot-wide aisle extended down the center of the cargo container to permit access and inspection. The rollers elevated the drums approximately 2 inches above the catch basin floor. The approximate location of the storage containers in IHSS 203 during maximum inventory is shown in Figure 2-3 (Baker, 1988).

The cargo containers were modified to meet the requirements for secondary containment in accordance with 6 CCR 1007-3 Section 264.175. Containers were fitted with signs, air vents, electrical grounding, and locks. A catch basin, constructed of 11-gauge steel with a welded steel rim and a minimum height of 6 inches, was placed within each cargo container to contain spills. The basins, as designed, were capable of containing at least 10 percent of the total volume of hazardous waste. The largest container stored in these cargo containers

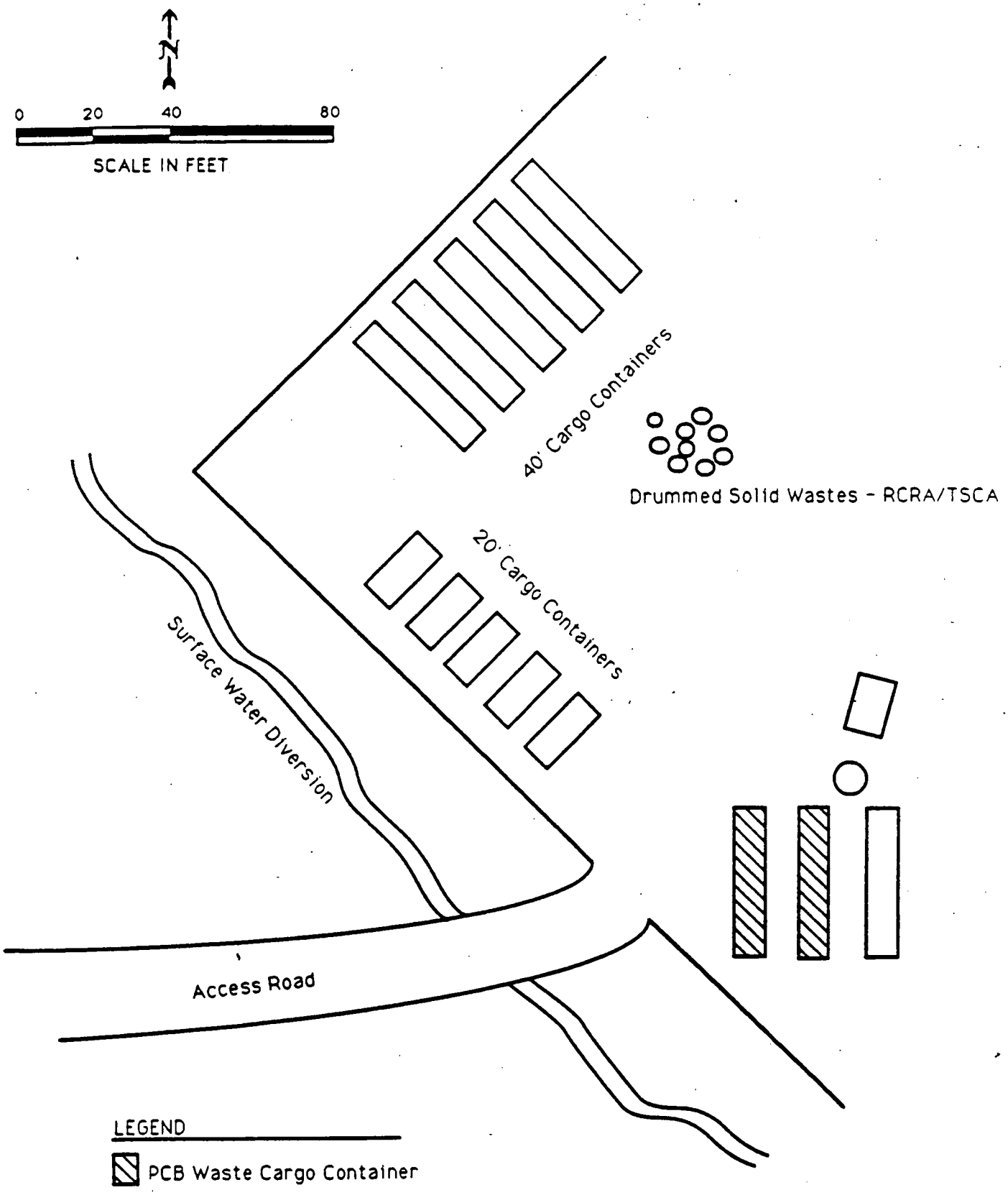
41973-09

2-1 Present Landfill Waste Operations - Placement of Daily Soil Cover

41973-01



2-2 Inactive Hazardous Waste Storage Area - IHSS 203




Source Rockwell International 1988c

INACTIVE HAZARDOUS WASTE
STORAGE AREA SWMU Ref. No. 203
Figure 2-3

was 55 gallons. Drummed solids (in 55-gallon containers) were placed outside the cargo containers on the ground surface.

Total liquid storage capacity for the 14 cargo containers was 21,120 gallons. Maximum inventory recorded for all wastes, including solids, is unknown (Rockwell International, 1988b). Because wastes were transfered between drums for consolidation, small spills may have occurred. However, no spills greater than reportable quantities occurred in this area during transfer operations (Rockwell International, 1988b).

RCRA-listed wastes were stored in 12 of the 14 cargo containers and included solvents, coolants, machining wastes, cuttings, lubricating oils, organics, and acids. No information is available regarding the separation of waste types between the individual cargo containers. Two of the 20-foot-long cargo containers also were used to store polychlorinated biphenyl (PCB) contaminated soil and debris as well as PCB-contaminated oil from transformers taken out of service (Baker, 1988). During the first week of May 1987, all cargo containers were removed from the Inactive Hazardous Waste Storage Area. Hazardous materials are no longer stored at the site. However, drilling and monitoring well construction materials are presently stored at IHSS 203.

### 2.2.2 Previous Investigations at OU7

A number of previous investigations have been conducted at the site for the purpose of evaluating physical characteristics and potential contamination. Previous studies that were the primary sources of information for this work plan include:

1. Present Landfill Closure Plan, U.S. DOE Rocky Flats Plant (Rockwell International, 1988a)

2. 1990 RCRA Groundwater Monitoring Report for Regulated Units at the Rocky Flats Plant (EG&G, 1991d)

3. Phase II Geologic Characterization Task 6 Surface Geologic Mapping Draft Report (EG&G, 1991a)

4. (Draft) 1989 Surface Water and Sediment Geochemical Characterization Report, Rocky Flats Plant (EG&G, 1991e)

5. Final Background Geochemical Characterization Report for 19898, Rocky Flats Plant (EG&G, 1991f)

6. Closure Plan, Inactive Interim Status Facilities, Hazardous Waste Storage Area, SWMU 203, Rocky Flats Plant (Rockwell International, 1988b)

7. Present Landfill Hydrogeologic Characterization Report, Rocky Flats Plant (Rockwell International, 1988c)

Other studies conducted at the Present Landfill, including brief summaries of the results, are discussed below.

Soil-Gas Surveys

During 1987, a soil-gas survey was performed using portable gas chromatography methods to detect gases commonly generated by landfill wastes. Results were reported by Rockwell International (1988a) and are presented in Appendix B of this work plan. Methane was detected at 2 of the 20 sampling locations at concentrations less than 0.4 part per million. Other compounds were detected but not identified in the landfill soil gas. Hydrogen sulfide was not detected. Sampling methodology used during the investigation was not documented in the report. In 1986, Tracer Research conducted a sitewide soil-gas survey for chlorinated organic compounds. Samples were analyzed for chloroform, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, and 1,1-dichloroethylene. Only one sampling site was located at the landfill. Tetrachloroethylene was the only target analyte detected at this

site. Another soil-gas survey using the Petrex method was initiated in 1987 in the landfill area; however, no data were obtained in the landfill area because the sampling points had been improperly located. Because of limited sampling and/or the lack of documentation of sampling methods, data from these investigations are of limited value.

Geophysical Investigations

Geophysical surveys employing ground-penetrating radar (GPR) and electromagnetics were conducted at OU7 during early 1991. GPR was utilized in an attempt to delineate the individual components of the groundwater intercept system and the slurry walls (EG&G, 1991g). Although clays and buried conductive materials (landfilled debris) presented difficulties in locating the groundwater intercept system, the slurry wall locations approximated the as-built drawings. The GPR data suggest that the intersection of the slurry wall with the groundwater intercept system on the north side is located further to the west than previously thought.

The electromagnetic geophysical survey was performed to determine its effectiveness in mapping subsurface total dissolved solids (TDS) plumes (EG&G, 1991h). Suspected areas of high TDS content were delineated by the survey; however, these potential plumes could also be interpreted as lenses of conductive clay. The report concluded that additional characterization of the physical properties of alluvial and bedrock materials was required to delineate high TDS plumes from naturally occurring, conductive geologic material.

Geotechnical Investigations

A geotechnical engineering study was performed to evaluate proposed landfill expansion (Lord, 1977). The claystone bedrock beneath the landfill was adequate to serve as a subsurface hydraulic barrier, and the overburden soils were determined to be adequate for daily landfill cover (Rockwell International, 1988a).

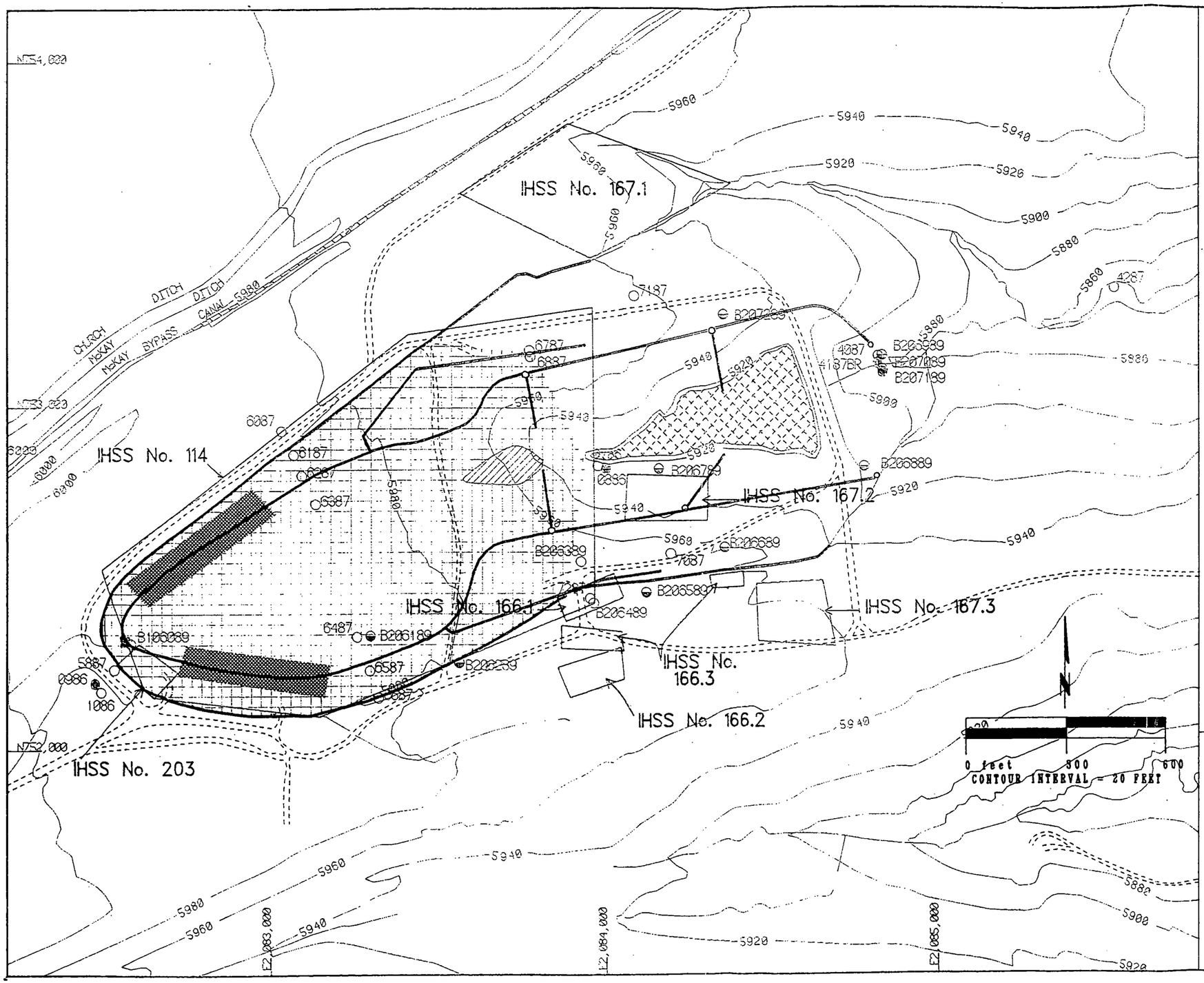
A geotechnical engineering study for landfill remediation was performed in 1974 (Zeff et al., 1974). Recommendations were made and plans were developed for a groundwater diversion and leachate collection system around the perimeter of the landfill. (As-built drawings are presented as Appendix B to this work plan.)

Tritium Investigation

On September 20, 1973, tritium was detected in leachate at the drainage of the landfill. Monitoring wells were installed by Woodward-Clevenger (1974), and leachate samples were collected and analyzed to locate the source. Analytical data from testing on the leachate were the basis for an internal memorandum from F.J. Blaha to T.C. Greengard regarding "Radioactive Sources in Rocky Flats Sanitary Landfill" (Rockwell International, 1987c). The memorandum is provided in Appendix C; this investigation is discussed in detail in Section 2.3.1. In brief summary, 47 wells were installed to locate the tritium source (Figure 2-20). The highest concentration of tritium detected was 301,609 picocuries per liter (pCi/ℓ), centered within the 100 pCi/ℓ contour shown in Figure 2-20. Concentrations of tritium in leachate seeping from the landfill decreased from a high in 1973 to substantially lower concentrations in 1980. Concentrations of tritium during 1980 were approximately equal to the CDH Water Quality Control Commision (WQCC) surface water standard of 500 pCi/ℓ promulgated in April 1991.

### 2.2.3 Site Geology

The description of the geology in the vicinity of OU7 was derived from previous studies performed at the site. Much of the information has been summarized from the Present Landfill Hydrogeologic Characterization Report (Rockwell International, 1988c). Additional information was obtained from data generated during the 1989 borehole drilling and well installation program and from the Draft Phase II Geologic Characterization Report (EG&G, 1991a). The surficial geology map presented as Figure 2-4 is based on the surficial geology map presented in the 1988 Hydrogeologic Characterization Report, with recent field




## EXPLANATION

- 6087 — ALLUVIAL WELL WITH MEASURED WATER LEVEL SHOWN
- B106089 — WEATHERED BEDROCK WELL
- 0986 — UNWEATHERED BEDROCK WELL
- 5987 — DECOMMISSIONED WELL
- DIRT ROADS
- STREAMS, DITCHES, DRAINAGE FEATURES
- GROUNDWATER INTERCEPT SYSTEM WITH VALVE
- SLURRY WALLS
- SURFACE WATER DRAINAGE DITCH
- SURFACE WATER IMPOUNDMENTS
- APPROXIMATE EXTENT OF POND #1 (WEST LANDFILL POND)
- APPROXIMATE EXTENT OF LANDFILL MATERIAL, 1988
- AREA OF POTENTIAL GROUNDWATER FLOW BENEATH GROUNDWATER INTERCEPT SYSTEM

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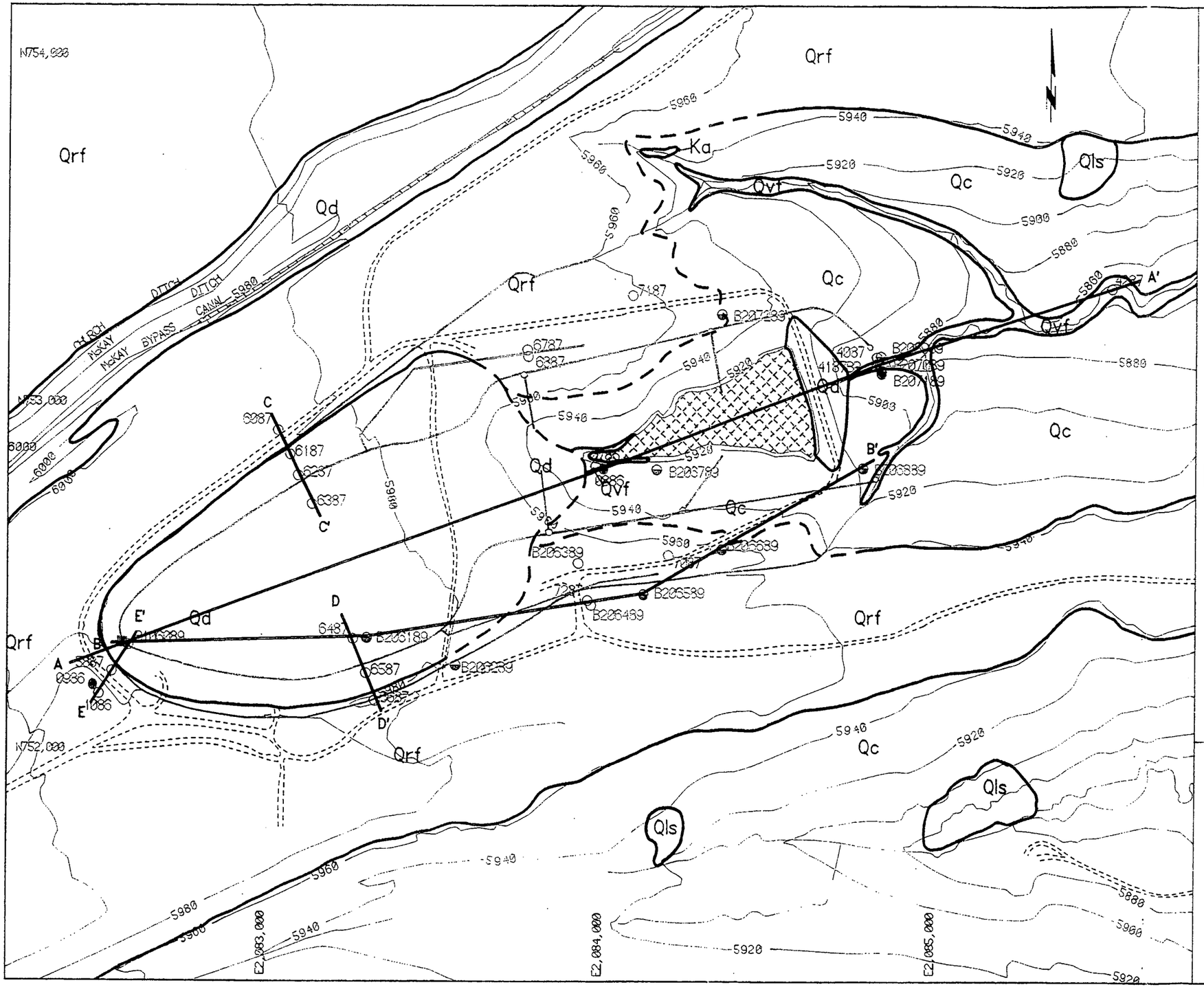
# Landfill Structures

Figure 2-2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Qrf
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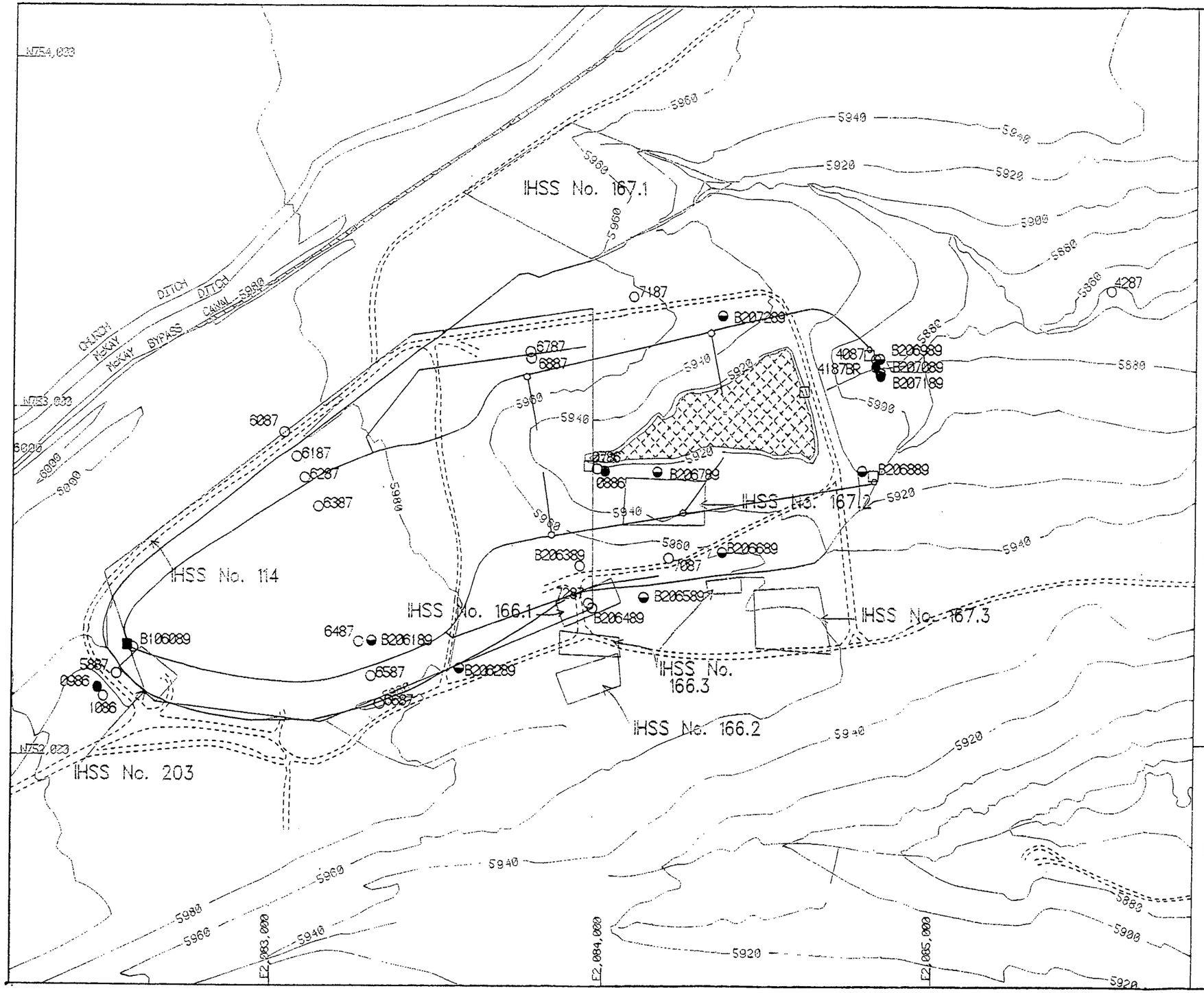


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# Locations of Monitoring Wells and Surface Water Sampling Sites

Figure 2-5

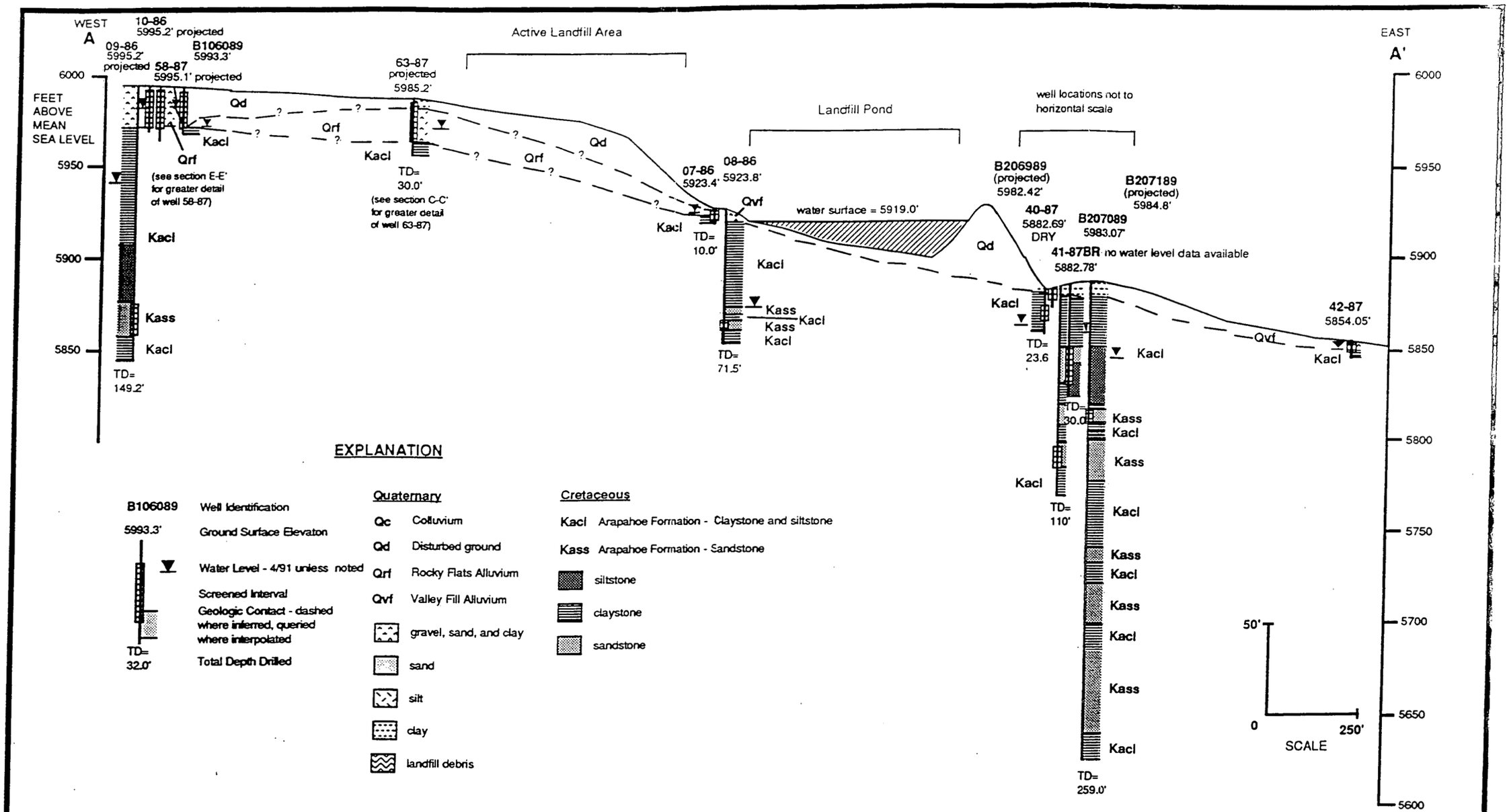
confirmation. This map also shows the locations of the geologic cross sections presented in Figures 2-6, 2-7, 2-8, and 2-9. These cross sections incorporate data obtained from boreholes drilled during 1986, 1987, and 1989. Recent water level data from 1991 are shown on the cross sections. Borehole logs are presented in Appendix D, and well construction details are presented in Appendix F. Borehole and well construction details for these wells are summarized in Table 2-1. A well location map is presented as Figure 2-5.

Surficial Geology

Four types of Quaternary surficial materials are present in the vicinity of OU7: Rocky Flats Alluvium, colluvium (slope wash), valley-fill alluvium, and artificial fill or disturbed ground. These surficial deposits unconformably overlie the bedrock units. As noted above, the landfill is located on the western end of the unnamed tributary to North Walnut Creek. Rocky Flats Alluvium caps the top of the slopes on the north and south sides of the drainage, and colluvium covers the hillsides down to the drainage. Artificial fill or disturbed surficial materials are present within the boundaries of the landfill, along man-made drainages surrounding the landfill, and northwest of the landfill. Valley-fill alluvium is present along the channel of the unnamed tributary.

The Rocky Flats Alluvium is the oldest and topographically highest alluvial deposit at RFP. The erosional surface on which the alluvium was deposited slopes gently eastward, truncating the Arapahoe formation at the landfill area.

Eastward-flowing streams began dissecting the post-depositional Rocky Flats Alluvium by headward erosion and planation. All of the alluvium was eroded from the unnamed tributary. Colluvium and valley-fill alluvium were subsequently deposited along the slopes and in the unnamed tributary drainage.




## EXPLANATION

**B106089** Well Identification

**5993.3'** Ground Surface Elevation

Water Level - 4/91 unless noted

Screened Interval

Geologic Contact - dashed where inferred, queried where interpolated

TD= 32.0' Total Depth Drilled

**Quaternary**

- Qc Colluvium
- Qd Disturbed ground
- Qrf Rocky Flats Alluvium
- Qvf Valley Fill Alluvium
- gravel, sand, and clay
- sand
- silt
- clay
- landfill debris

**Cretaceous**

- Kacl Arapahoe Formation - Claystone and siltstone
- Kass Arapahoe Formation - Sandstone
- siltstone
- claystone
- sandstone

**Notes:**

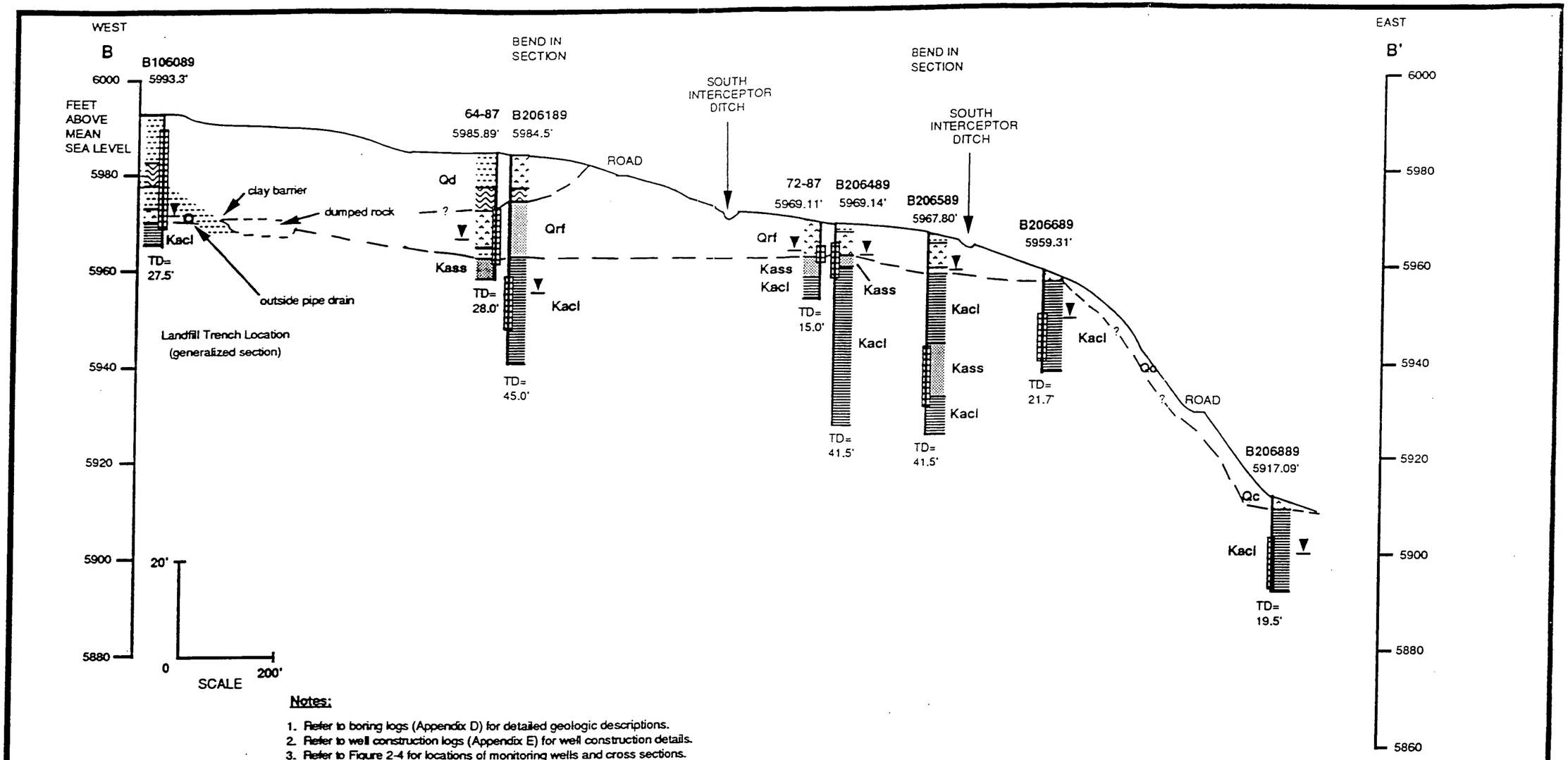
1. Refer to boring logs (Appendix D) for detailed geologic descriptions.
2. Refer to well construction logs (Appendix E) for well construction details.
3. Refer to Figure 2-4 for locations of monitoring wells and cross sections.

U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado
Contract: BA94471CL Date: 6/28/91
Prepared by: CCA Checked by:

# CROSS SECTION A - A'

PRESENT LANDFILL

FIGURE 2 - 6




**Notes:**

1. Refer to boring logs (Appendix D) for detailed geologic descriptions.
2. Refer to well construction logs (Appendix E) for well construction details.
3. Refer to Figure 2-4 for locations of monitoring wells and cross sections.

## EXPLANATION

B106089 — Well Identification

5993.3' — Ground Surface Elevation

Water Level - 4/91 unless noted

Screened Interval

Geologic Contact -dashed where inferred; queried where interpolated

TD= 32.0' — Total Depth Drilled

**Quaternary**

- Qc — Colluvium
- Qd — Disturbed ground
- Qrf — Rocky Flats Alluvium
- Qvf — Valley Fill Alluvium

- gravel, sand, and clay
- sand
- silt
- clay
- landfill debris

**Cretaceous**

- Kacl — Arapahoe Formation - Claystone and siltstone
- Kass — Arapahoe Formation - Sandstone
- siltstone
- claystone
- sandstone

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

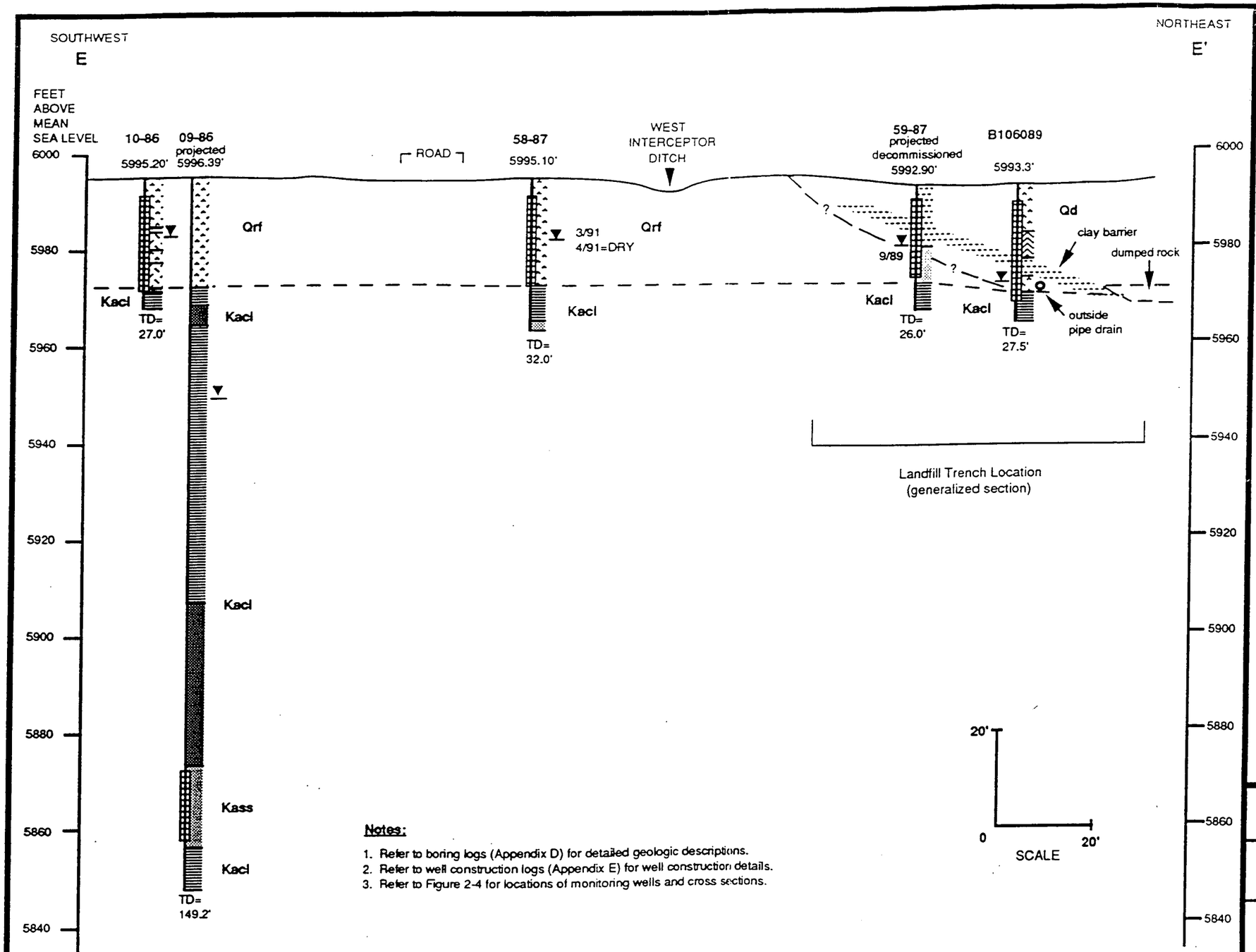
**CROSS SECTION B - B'**

PRESENT LANDFILL

Contract: BA94471CL Date: 6/28/91

Prepared by: CCA **FIGURE 2 - 7**

Checked by:




**Notes:**

1. Refer to boring logs (Appendix D) for detailed geologic descriptions.
2. Refer to well construction logs (Appendix E) for well construction details.
3. Refer to Figure 2-4 for locations of monitoring wells and cross sections.

## EXPLANATION

B106089 Well Identification

5993.3' Ground Surface Elevaton

Water Level - 4/91 unless noted

Screened Interval

Geologic Contact -dashed where inferred; queried where interpolated

TD= 32.0' Total Depth Drilled

**Quaternary**

- Qc Colluvium
- Qd Disturbed ground
- Qrf Rocky Flats Alluvium
- Qvf Valley Fill Alluvium
- gravel, sand, and clay
- sand
- silt
- clay
- landfill debris

**Cretaceous**

- Kacl Arapahoe Formation - Claystone and siltstone
- Kass Arapahoe Formation - Sandstone
- siltstone
- claystone
- sandstone

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

**CROSS SECTION E -E'**
PRESENT LANDFILL

Contract: BA94471CL Date: 6/28/91
Prepared by: CCA
Checked by:

**FIGURE 2 - 9**

Table 2-1: Borehole and Well Construction Details for Groundwater Monitoring Wells in the Vicinity of the Present Landfill.

| WELL ID | PURPOSE | FORMATION COMPLETED | GROUND SURFACE ELEVATION (ft.) | TOP OF CASING (ft.) | SCREENED INTERVAL (ft.) | TOTAL DEPTH OF CASING (ft.) | TOTAL DEPTH DRILLED (ft.) | DEPTH TO TOP OF BEDROCK (ft.) | INSIDE CASING DIAMETER (in.) |
|---|---|---|---|---|---|---|---|---|---|
| 0786 | 1,4 | Qrf | 5923.4 | 5925.66 | 3.0 - 5.74 | 5.74 | 10.0 | 5.00 | 2.0 |
| 0886 | 3,4,6 | Kass(u) | 5925.03 | 5926.83 | 59.08 - 63.79 | 63.80 | 71.5 | 0.90 | 2.00 |
| 0986 | 3,4,6 | Kass(u) | 5996.39 | 5998.23 | 122.57 - 135.35 | 135.35 | 151.0 | 22.00 | 2.00 |
| 1086 | 1,4,6 | Qrf | 5996.2 | 5998.21 | 3.29 - 23.78 | 23.78 | 27.0 | 23.00 | 2.00 |
| 4087 | 1,4 | Qvf | 5882.69 | 5884.69 | 3.5 - 6.46 | 6.70 | 13.0 | 6.20 | 2.00 |
| 4187BR | 3,4 | Kass(u) | 5882.78 | 5884.55 | 81.21 - 93.78 | 94.03 | 110.0 | 4.50 | 2.00 |
| 4287 | 1,5 | Qvf | 5854.05 | 5855.93 | 3.0 - 6.36 | 6.60 | 12.4 | 6.10 | 2.00 |
| 5887 | 1,4,6 | Qrf | 5995.1 | 5996.75 | 3.5 - 22.26 | 22.50 | 32.0 | 22.00 | 2.00 |
| 6087 | 1,4,6 | Qrf | 5984.03 | 5985.96 | 3.5 - 27.47 | 27.70 | 32.0 | 27.20 | 2.00 |
| 6187 | 1,4,6 | Qaf/Qrf | 5984 | 5985.75 | 3.5 - 28.24 | 28.50 | 34.0 | 28.00 | 2.00 |
| 6287 | 1,4,6 | Qaf/Qrf | 5984.16 | 5986.36 | 3.5 - 26.56 | 26.80 | 30.0 | 26.30 | 2.00 |
| 6387 | 1,4,6,8 | Qaf/Qrf | 5985.42 | 5987.06 | 3.5 - 25.4 | 25.50 | 30.0 | 25.00 | 2.00 |
| 6487 | 1,4,6,8 | Qaf/Qrf | 5985.89 | 5987.33 | 13.30 - 23.3 | 23.80 | 28.0 | 23.30 | 2.00 |
| 6587 | 1,4,6 | Qrf | 5983.08 | 5985.02 | 10.7 - 23.96 | 24.20 | 27.0 | 21.00 | 2.00 |
| 6687 | 1,4,6 | Qrf | 5981.9 | 5983.64 | 3.4 - 17.96 | 18.20 | 23.0 | 17.80 | 2.00 |
| 6787 | 1,4,7 | Qrf | 5969.5 | 5971.72 | 11.72 - 16.46 | 16.80 | 21.4 | 16.40 | 2.00 |
| 6887 | 1,4,7 | Qrf | 5968.48 | 5970.31 | 11.15 - 15.75 | 16.00 | 20.0 | 15.30 | 2.00 |
| 7087 | 1,4,6 | Qrf | 5966.3 | 5968.35 | 3.5 - 16.26 | 16.50 | 17.0 | 13.50 | 2.00 |
| 7187 | 1,4,6 | Qrf | 5963.39 | 5965.47 | 3.50 - 13.57 | 13.85 | 18.5 | 13.50 | 2.00 |
| 7287 | 1,4,7 | Qrf | 5969.11 | 5971.18 | 3.50 - 7.00 | 8.76 | 15.0 | 6.50 | 2.00 |
| B106089 | 4,6,8 | Qaf/Qrf | 5993.3 | 5995.35 | 3.66 - 23.2 | 24.47 | 27.5 | 22.70 | 4.00 |
| B206189 | 2,4,6 | Kacl | 5984.5 | 5986.57 | 25.90 - 35.36 | 36.61 | 45.0 | 20.90 | 4.00 |
| B206289 | 2,4,6 | Kacl | 5977.59 | 5979.49 | 32.37 - 41.82 | 43.05 | 47.5 | 14.80 | 4.00 |
| B206389 | 2,4,7 | Qaf/Qrf | 5969.7 | 5971.56 | 4.0 - 13.50 | 14.74 | 20.0 | 13.30 | 4.00 |
| B206489 | 1,4,7 | Qrf/Kass(w) | 5969.14 | 5971.46 | 3.25 - 10.0 | 11.35 | 41.5 | 7.50 | 4.00 |
| B206589 | 2,4,7 | Kass(w) | 5967.8 | 5969.72 | 23.50 - 35.14 | 36.24 | 41.5 | 9.50 | 4.00 |
| B206689 | 2,4,6 | Kacl | 5959.31 | 5961.2 | 8.70 - 18.17 | 19.41 | 21.7 | 3.70 | 4.00 |
| B206789 | 2,4,6 | Kacl | 5927.9 | 5930.19 | 9.8 - 19.28 | 20.52 | 30.0 | 4.80 | 4.00 |
| B206889 | 2,4,6 | Kacl | 5917.09 | 5919.15 | 8.0 - 17.45 | 18.20 | 19.5 | 3.00 | 4.00 |
| B206989 | 2,4 | Kacl | 5882.42 | 5884.32 | 11.8 - 21.30 | 22.50 | 23.6 | 6.00 | 4.00 |
| B207089 | 2,4 | Kass(w) | 5883.07 | 5884.95 | 31.32 - 53.0 | 54.00 | 60.0 | 0.20 | 4.00 |
| B207189 | 2,4 | Kass(u) | 5884.8 | 5886.72 | 70.98 - 75.43 | 77.76 | 259.0 | 7.10 | 2.00 |
| B207289 | 2,4,6 | Kacl | 5948.27 | 5950.49 | 5.2 - 14.65 | 15.89 | 19.5 | 0.20 | 4.00 |

Key to Purpose:

1 - Alluvial Groundwater Quality
2 - Weathered Bedrock Groundwater Quality
3 - Unweathered Bedrock Groundwater Quality
4 - RCRA Groundwater Quality Monitoring Well
5 - NON-RCRA Groundwater Quality Monitoring Well
6 - Evaluation of Effectiveness of Groundwater Intercept System
7 - Evaluation of Effectiveness of Slurry Wall
8 - Chemical Quality of Landfill Leachate

Key to Geologic Strata:

Qrf - Rocky Flats Alluvium
Qvf - Valley Fill Alluvium
Qaf - Artificial Fill
Kacl - Weathered Arapahoe Formation Claystone
Kass(u) - Unweathered Arapahoe Formation Sandstone
Kass(w) - Weathered Arapahoe Formation Sandstone

Rocky Flats Alluvium

The Rocky Flats Alluvium in the area of the landfill is described as a generally poorly sorted, unconsolidated deposit of clays, silts, sands, gravels, and cobbles. In the areas that have been drilled, the alluvium ranges from 6.5 feet thick at Well 7287 to 27.2 feet thick at Well 6087. Wells 1086, 5887, 6087, 6187, 6287, 6387, 6487, 6587, 6687, 6787, 6887, 7087, 7187, 7287, B206389, and B206489 are either partially or entirely completed in the Rocky Flats Alluvium (Figure 2-4).

Colluvium

Colluvial materials are present on the slopes descending to the drainage in which the landfill is located. The colluvium consists predominately of poorly consolidated clay with common occurrences of silty clay, sandy clay, and gravel layers. None of the monitoring wells at the landfill are completed in the colluvium. In the areas that have been drilled, colluvium was noted at Well B206889 (3.0 feet thick) and Well B207189 (7.1 feet thick) (Figure 2-4).

Valley-Fill Alluvium

The most recent deposit in the landfill area is the valley-fill alluvium that is present along the unnamed tributary channel. The unconsolidated valley fill consists of poorly sorted sand, gravel, and pebbles in a silty clay matrix. The valley-fill alluvium is derived from reworked and redeposited older alluvium and bedrock materials. Valley-fill alluvium was noted in five of the locations that were drilled in the area of the landfill (Wells 0786, 0886, 4087, 4187, and 4287). Valley-fill alluvium ranges between 0.9 foot thick at Well 0886 and 6.2 feet thick at Well 4087. Wells 0786 and 4287 are completed in the valley-fill alluvium.

Artif ial Fill

Two types of artificial fill are present in the vicinity of the landfill. The first type is derived from excavations of Church Ditch (located northwest of the landfill) and ground associated with construction of the dam used to contain the East Landfill Pond. The core of the East Landfill Pond embankment was constructed of compacted clay and claystone. The outer shell of the dam consists of clayey sands, gravels, and cobbles. Materials used to construct the groundwater intercept system (clay, coarse sand, and gravels) were detected in Well B106089 (Figure 2-9).

The second type of artificial fill consists of waste and cover soil materials. The fill is described as a mixture of clay, sand, gravel, asphalt, insulated wire, wood, construction ribbon, surgical gloves, saranex suits, and other materials associated with RFP landfilling activities. This type of fill was noted at nine of the locations drilled (Wells 6187, 6287, 6387, 6487, 6587, B106089, B206189, B206289, and B206389). Thicknesses ranged from approximately 1.5 feet at Well B206289 to 23.3 feet at Well 6487. A previous investigation by Woodward-Clevenger (1974) reported fill at a thickness of 27 feet (Rockwell International, 1988a). Although the reported thickness seems reasonable, logs from the Woodward-Clevenger report were not available to validate this thickness. Within the artificial fill, waste material was noted at Wells 6487 (7.0 feet thick), B106089 (5.0 feet thick), B206189 (2.0 feet thick), and B206389 (up to 4.0 feet thick). The maximum waste thickness of the landfill has not yet been confirmed. Wells B106089 and B206389 are completed in artificial fill.

Bedrock Geology

The Cretaceous Arapahoe formation unconformably underlies surficial materials in the vicinity of the Present Landfill. Seventeen wells have been completed in various zones of the bedrock during previous drilling and well installation programs. The Arapahoe formation in this area consists of claystone with interbedded sandstones and siltstones. Contacts between lithologies are logged as both gradational and sharp. Weathered bedrock was encountered directly beneath surficial materials in all of the boreholes drilled during

previous investigations at the landfill. Weathering is observed to penetrate up to approximately 30 feet into the bedrock. A thin shale layer interbedded with coal seams is noted on the Well 08-86 borehole log at 13.8 to 15.0 feet below ground surface, and six distinct lignite layers are noted on the Well B207189 borehole log. These layers range in thickness from 0.3 foot to 1.7 feet and are interspersed at depths from 66.6 to 252.3 feet below ground surface.

Arapahoe Formation Claystone

Claystone was the most frequently encountered lithology in the Arapahoe formation immediately below the Quaternary/Cretaceous angular unconformity (Figures 2-6 through 2-9). Claystones present in the area are described as massive and blocky, containing occasional thin laminae and interbeds of sandstones and siltstones. Borehole logs indicate vertical to subvertical fractures in both the unweathered and weathered claystones. Leaf fossils and black organic matter were logged within the claystone during drilling investigations at the landfill. Wells B206189, B206289, B206689, B206789, B206889, B206989, and B207289 are completed in the claystones.

Arapahoe Formation Sandstone

During drilling, sandstones were encountered in the Arapahoe formation in Wells 0886 (53.5 to 55.5 feet), 0986 (122 to 139 feet), 4187 (32.5 to 53 feet, 64.7 to 75 feet, and 79.6 to 110 feet), 5887 (29.5 to 32 feet), 6487 (24.5 to 28.0 feet), 6587 (22.1 to 24.2 feet), 6887 (15.3 to 15.5 feet), 7087 (13.5 to 16.0 feet), 7287 (6.5 to 13.0 feet), B206489 (7.5 to 9.5 feet), B206589 (23.5 to 34.5 feet), B206789 (8.0 to 8.3 feet), B207089 (31.5 to 37.5 feet), and B207189 (91 to 108.4 feet, 145 to 152.7 feet, 163 to 173.5 feet, 179.9 to 184 feet, and 199.5 to 244 feet). Sandstones are described as being composed of moderately to well sorted, subrounded to rounded, very fine to medium-grained quartz sand. Cementation generally increases with depth as weathering decreases. Cementing agents in the sandstones are predominately argillic with minor calcium carbonate and silica cement noted. Sandstone

bed thicknesses range from approximately 0.3 foot in Well 6887 to 44.5 feet in Well B207189. Weathered sandstone is lithologically similar to the unweathered sandstone. Wells 0886, 0986, 4187, B206589, B2067089, and B207189 are completed in sandstones. During drilling, subcropping sandstones were encountered in Wells 6587, 6887, 7087, 7287, and B206489. Thicknesses of these subcropping sandstones range from 0.2 foot at Well 6887 to 6.5 feet at Well 7287. The subcropping sandstones are generally clayey in nature and are underlain by sandy claystones, except at Well 6887, which is underlain by claystone. Wells 6587, 7087, and B206489 are completed in Rocky Flats Alluvium and the subcropping sandstones.

Shallow sandstones (within 15 feet of the Quaternary/Cretaceous angular unconformity) were encountered while drilling Wells 5887, 6487, B206589, and B206789. Thicknesses of the shallow sandstone beds that were fully penetrated while drilling range from 0.3 foot at Well B206789 to 11 feet at Well B206589. The shallow sandstone beds encountered while drilling Wells 5887 and 6487 were not fully penetrated.

During drilling, siltstones associated with the claystones and sandstones were encountered in the Arapahoe formation in Wells 0886 (41 to 46.5 feet), 0986 (89 to 122 feet and 139 to 144 feet), B206289 (34.5 to 47.5 feet), B207089 (37.5 to 60 feet), and B207189 (36 to 39 feet, 43 to 65 feet, 133.7 to 137 feet, 139 to 145 feet, and 177.8 to 179.9 feet). The siltstones are described as gradational units of clayey siltstone or sandy siltstone. Relatively homogeneous layers of unweathered siltstones were encountered while drilling Wells 0986 and B207189. These siltstones are described as greenish gray to dark gray, clayey, trace very fine sand, and laminated.

Based on a 7-degree regional eastward dip of the Arapahoe formation and an interpretation that sandstone units were laterally continuous, previous investigations suggested that the sandstone units beneath the landfill were continuous and possibly subcropped beneath the East Landfill Pond (Rockwell International, 1988c). Recent sitewide investigations conducted by EG&G indicate that the Arapahoe dips approximately 2 degrees to the east

and that the sandstone units may not be continuous. Applying the 2-degree dip to the subcropping sandstones suggests that they may not subcrop beneath the East Landfill Pond as previously thought. Further study in Phase II is necessary to delineate the areal extent of the potentially subcropping sandstones.

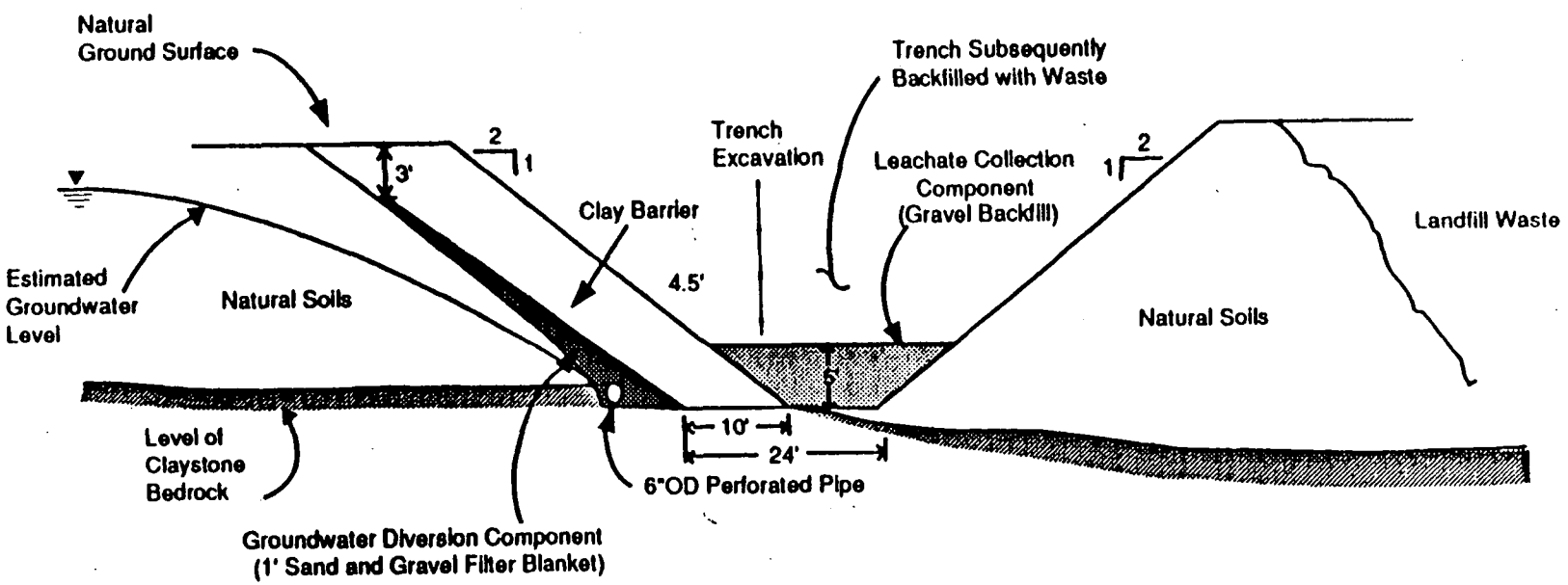
### 2.2.4 Landfill Structures/Interim Response Actions

Subsurface Drainage Structures

As discussed in Section 2.2.1, a subsurface drainage control system was installed around the perimeter of the landfill in 1974 in response to the detection of tritium downstream of the landfill. The subsurface drainage system included both a leachate collection system located directly beneath the landfill wastes and a groundwater intercept system constructed between the surface water interceptor ditch and the landfill wastes. The leachate collection system was designed to collect and discharge leachate generated by the landfill and to lower fluid levels within the landfill. Leachate was discharged into Pond #1. The groundwater diversion system was designed to intercept and divert groundwater flow around the landfill. This system also provided an expanded disposal area.

The two-part system was constructed by excavating around the perimeter of the landfilled wastes to depths of 10 to 25 feet. The trench excavation for the system was 24 feet wide at the base, as shown in Figure 2-10. As-built drawings of the intercept system are presented in Appendix B to this work plan.

The groundwater collection and diversion portion of the system was installed on the side of the trench away from the landfill waste. This system consisted of a 1-foot-thick sand and gravel filter blanket installed along the trench face. This filter blanket drain was designed to intercept groundwater and drain to a 6-inch-diameter perforated pipe installed in the bottom of the trench. The intercepted groundwater could then be discharged to Pond #1, the East Landfill Pond, or to surface drainage downslope of the East Landfill Pond. Control




Approximate Scale: 1" = 20'

Source: Rockwell International 1988b

Design Section of Groundwater Intercept and Leachate Collection System

Figure 2-10

of discharge was accomplished by a series of valves (Figure 2-2). A 4.5-foot-thick clay barrier was placed on top of the sand and gravel filter blanket to separate the groundwater intercept system from the leachate collection system. The as-built sections and profile sheets (Sheets 2 and 3 of 12, Sanitary Landfill Renovations, Appendix B) indicate the bottom of the system to be above the bedrock surface approximately halfway between Wells B106089 and 6587 on the south side of the intercept system and approximately halfway between Wells B106089 and 6387 on the north side of the intercept system (Figure 2-2). Although the design drawings specified a 6-inch-diameter perforated pipe for the leachate collection system, as-built drawings indicate that the leachate collection system consisted of a 5-foot-thick gravel backfill placed in the bottom of the trench on the landfill side. Collected leachate drained into Pond #1, which was intended to retain the leachate without discharging to the east pond (Rockwell International, 1988a).

Between 1977 and 1981, the leachate collection and groundwater intercept system was buried beneath waste during landfill expansion. Lateral expansion of waste placement has resulted in wastes being located beyond the extent of the subsurface drains (Rockwell International, 1988a). Eastward expansion covered the points where the leachate collection system discharged into Pond #1.

Slurry Walls

Two soil-bentonite slurry walls were constructed in 1982 to extend the groundwater intercept system already in place. These slurry walls (shown in Figure 2-2) were tied into the north and south arms of the groundwater intercept system constructed in 1974. The slurry walls were constructed to reduce groundwater migration from the north and south into the landfill as it expanded to the east. As-built drawings of the slurry wall construction are presented in Appendix B to this work plan.

Details of the connection in the design drawings indicate that the west end of each slurry wall intersects but does not break the groundwater intercept system. At these intersections,

the existing drainpipe was replaced with ductile iron pipe, which was joined with the existing drainpipe using mechanical compression joints. These sections of ductile iron pipe and the joints at each end were then encased with concrete poured against undisturbed bedrock at the bottom of the excavation. This concrete block interrupted the hydraulic continuity of the sand and gravel filter blanket located outside of the clay barrier, and the only hydraulic connection of the groundwater diversion drain across the slurry trench was through the new segment of pipe. As a result, if these pipes were to be damaged or clogged, there would be no outlet from the groundwater intercept system. The slurry walls extend eastward approximately 700 feet from these points of intersection. Based on as-built drawings, the slurry walls vary in depth from 10 to 25 feet.

East Pond Embankment

As mentioned above, two ponds were constructed as part of the interim response measure to control leachate generated by the landfill. These ponds were formed by constructing temporary berms in the drainage immediately downstream of the landfill. Both ponds were approximately 1/2 acre in size. Pond #1 impounded leachate generated by the landfill. Pond #2 provided a back-up system for any overflow from Pond #1 and was also used to collect intercepted groundwater, as needed.

In 1974, a new embankment was constructed for Pond #2 (now called the East Landfill Pond) in approximately the same location as the original dike. The new embankment was an engineered dam structure with a spillway designed to retain the majority of the water in the channel. A low-permeability clay core keyed into bedrock was constructed within the embankment to reduce seepage. The remaining shell of the embankment was constructed of more permeable silty to clayey granular soils. The East Landfill Pond is approximately 2.4 acres in size.

### 2.2.5 Hydrogeology

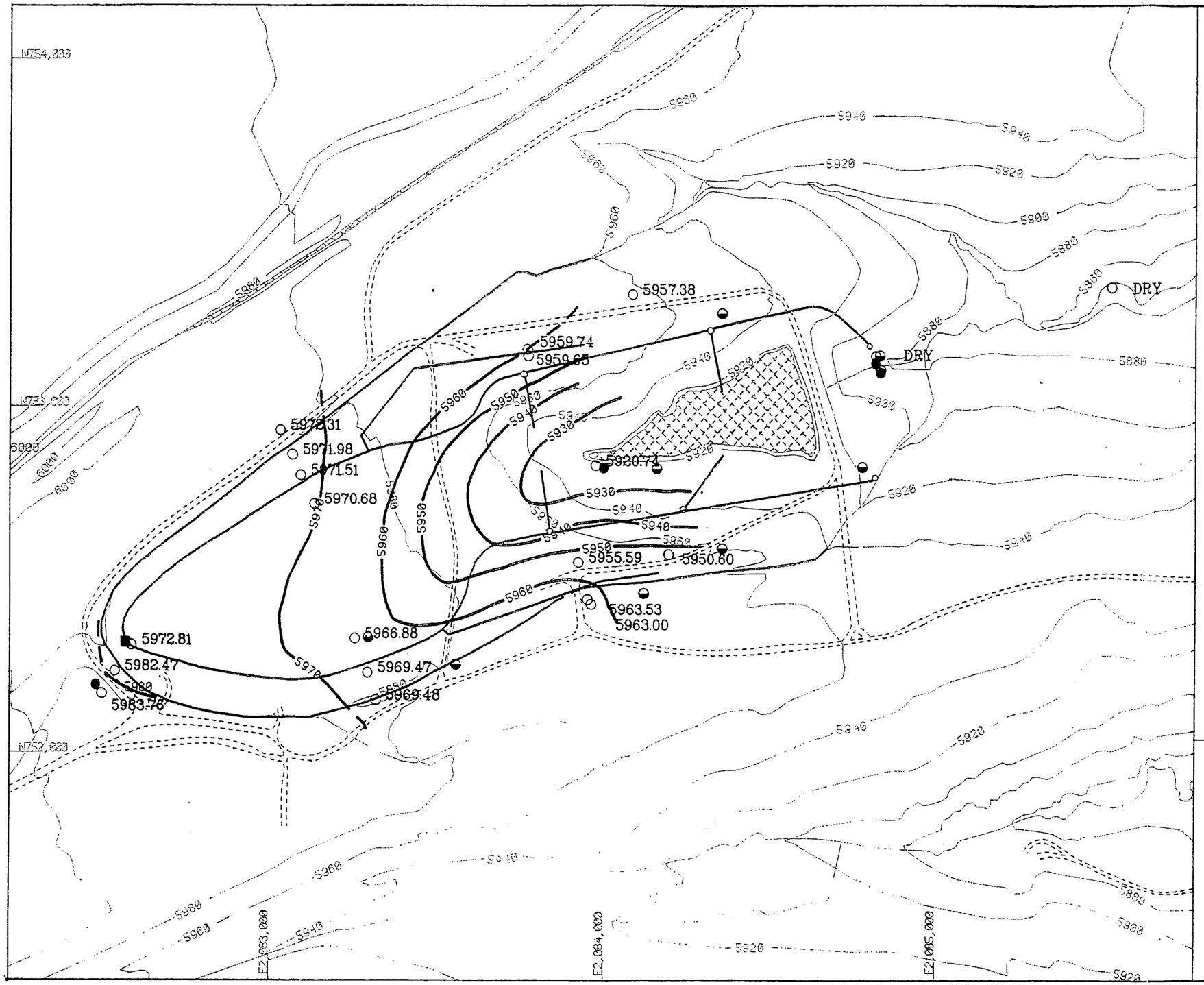
Groundwater flows in surficial material (Rocky Flats Alluvium, colluvium, valley-fill alluvium, and artificial fill) and in Arapahoe sandstones and claystones in the area of the Present Landfill. Although discussed separately below, these two flow systems are hydraulically connected and exhibit relatively steep downward gradients that may potentially affect downward transport of contaminants. The "uppermost aquifer" at OU7 consists of surficial materials and weathered bedrock units of the Arapahoe formation. This discussion is based on Rockwell International (1988c) and more recent groundwater level data presented by Rockwell International (1989b) and EG&G (1990a).

Groundwater System in Surficial and Bedrock Materials

Groundwater is present in surficial materials at the Present Landfill under unconfined conditions. Groundwater recharge occurs as infiltration of incident precipitation and from localized spraying of water from the landfill pond (conducted to enhance evaporation). In addition, intermittent recharge occurs as infiltration from ditches and creeks and possibly as seepage from the landfill pond. Discharge from the water table occurs as evapotranspiration and as seepage into the landfill pond, creeks, and springs. Groundwater also leaks from the surficial groundwater system into the underlying bedrock groundwater system.

The surficial groundwater flow system is dynamic, with relatively large water level changes occurring in response to precipitation events and to stream and ditch flow (Hurr, 1976). There are also seasonal variations in the saturated thickness of the surficial materials.

In general, groundwater flows eastwardly in surficial material toward the landfill, as indicated by the potentiometric surface maps constructed for surficial materials using the most recent data from the first and second quarters of 1991 (Figures 2-11 and 2-12, respectively). However, groundwater also flows in southeastern and northeastern directions




## EXPLANATION

5970.32
ALLUVIAL WELL WITH MEASURED WATER LEVEL SHOWN

WEATHERED BEDROCK WELL

UNWEATHERED BEDROCK WELL

DECOMMISSIONED WELL

DIRT ROADS

STREAMS, DITCHES, DRAINAGE FEATURES

LANDFILL STRUCTURES

OU7 REMEDIAL INVESTIGATION AREA

WATER TABLE CONTOURS AND ELEVATIONS, DASHED WHERE APPROXIMATELY LOCATED

SURFACE WATER IMPOUNDMENTS

0 feet 300 600

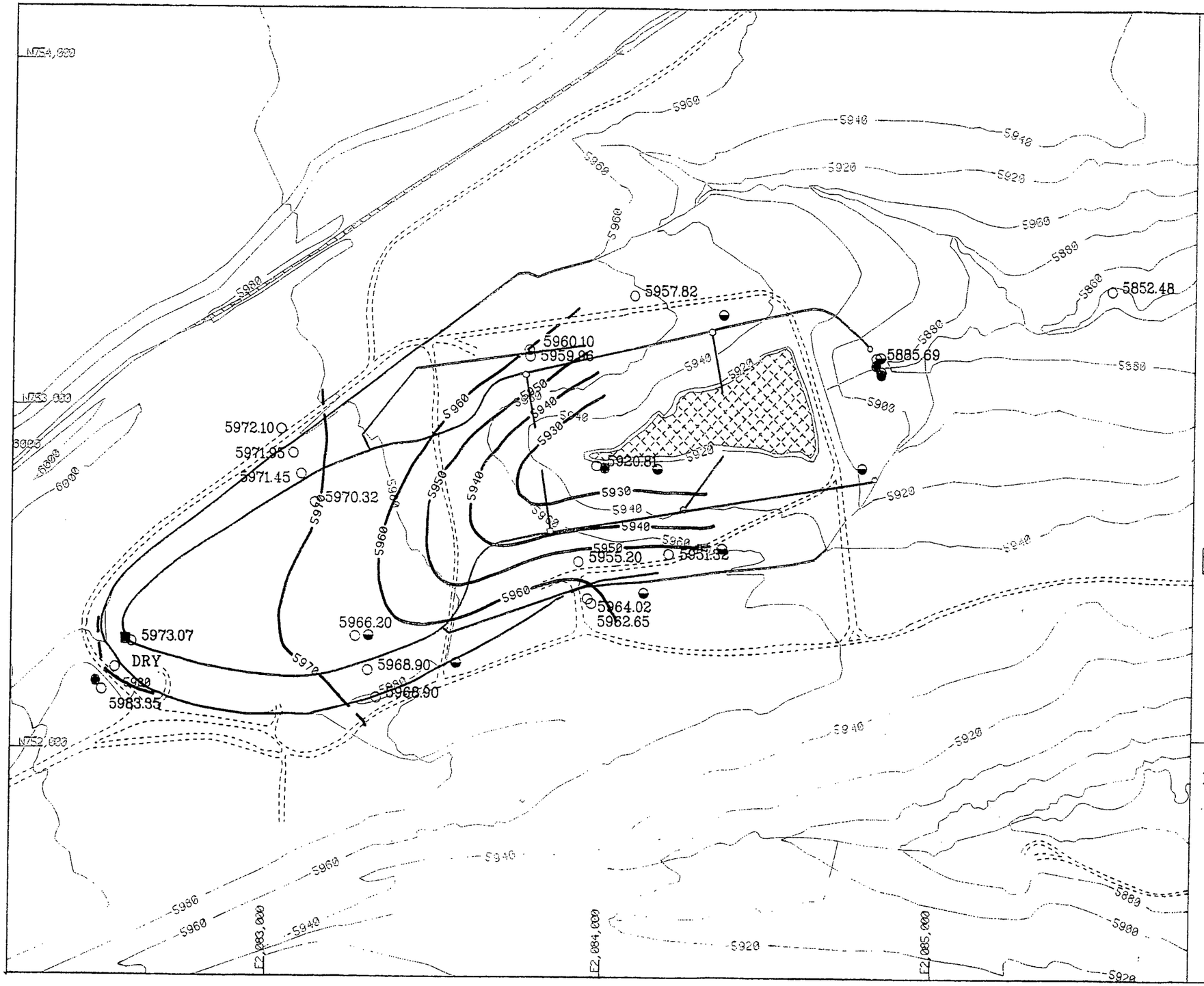
CONTOUR INTERVAL = 20 FEET

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

Potentiometric Surface in Surficial Materials

January 2, 1991
(First Quarter, FY91)

Figure 2-11




## EXPLANATION

5970.32 ○ ALLUVIAL WELL WITH MEASURED WATER LEVEL SHOWN

◒ WEATHERED BEDROCK WELL

● UNWEATHERED BEDROCK WELL

■ DECOMMISSIONED WELL

DIRT ROADS

STREAMS, DITCHES, DRAINAGE FEATURES

LANDFILL STRUCTURES

OU7 REMEDIAL INVESTIGATION AREA

WATER TABLE CONTOURS AND ELEVATIONS, DASHED WHERE APPROXIMATELY LOCATED

SURFACE WATER IMPOUNDMENTS

N

0 feet 300 600

CONTOUR INTERVAL = 20 FEET

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

Potentiometric Surface in Surficial Materials

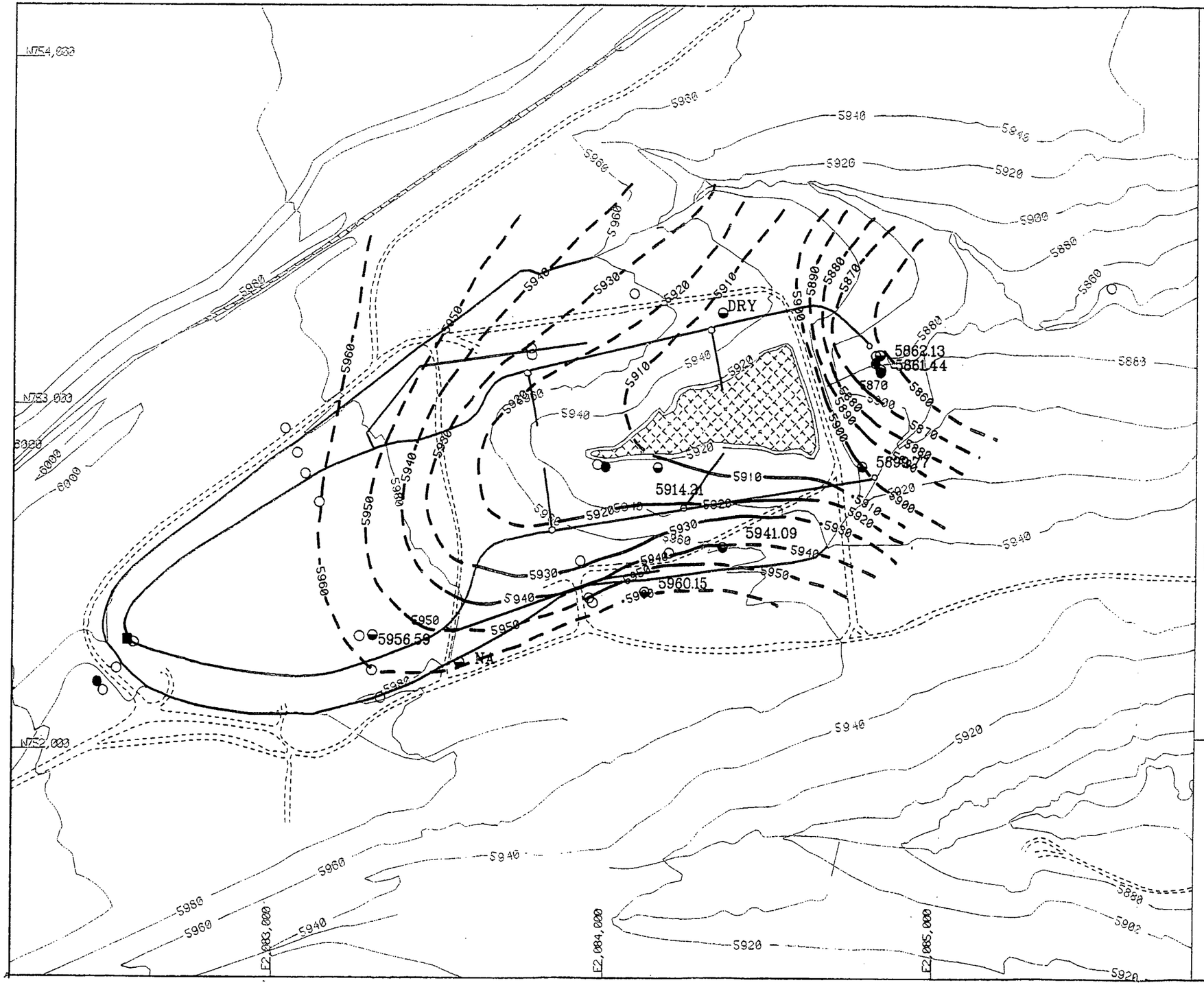
April 2, 1991
(Second Quarter, FY91)

Figure 2-12

toward the East Landfill Pond. Groundwater flow in the weathered bedrock units during the first and second quarters of 1991 (Figures 2-13 and 2-14, respectively) is similar to groundwater flow in the surficial units. The potentiometric surfaces observed during 1991 are consistent with the potentiometric surfaces presented in EG&G (1991d) for 1990.

Groundwater elevations in surficial materials at the landfill are characterized by seasonal variations of up to approximately 8 feet. Based on a full year of data from 1990, fourth quarter 1990 appears to be the driest, having relatively lower water table elevations. Three wells (Wells 7287, 4087, and 4287) were dry during this quarter. In contrast, water table elevations are comparatively higher during the second quarter of 1990 and no wells were dry. Groundwater elevations in the weathered claystone units typically show seasonal variations of less than 1 foot, although variations up to 8 feet have been observed in Well B206189 (EG&G, 1990a). Groundwater flows within sandstones, siltstones, and claystones of the Arapahoe formation. Groundwater recharge to the Arapahoe formation occurs as infiltration of alluvial groundwater.

Nine monitoring wells have been completed within weathered bedrock in the Present Landfill area. Typically, the water level elevation is below that of the top of bedrock, indicating a downward component to the hydraulic gradient between the surficial materials and the weathered bedrock. It is likely that a downward hydraulic gradient exists between weathered and unweathered bedrock, although wells pairs do not exist at OU7 to quantify the gradient. Only at wells B206189 and B206589 does the elevation of the potentiometric surface exceed that of the top of bedrock. Two surficial material/weathered bedrock well pairs were installed at the Present Landfill. Vertical gradients (Table 2-2) fluctuate throughout the year as a result of seasonal changes in groundwater elevations in the surficial materials. A vertical gradient ranging from 1.109 feet per feet (ft/ft) to 1.505 ft/ft downward has been calculated for well pair 4087/B206989 during 1990. Well 4087 has been dry during the first two quarters of 1991; therefore, a gradient cannot be determined for this period of time. A vertical gradient ranging from 0.019 ft/ft to 1.146 ft/ft downward has been calculated for well pair 6487/B206189 during 1990 and the first two quarters of 1991.




## EXPLANATION

- ALLUVIAL WELL
- 5960.15 WEATHERED BEDROCK WELL WITH MEASURED WATER LEVEL SHOWN
- UNWEATHERED BEDROCK WELL
- DECOMMISSIONED WELL
- DIRT ROADS
- STREAMS, DITCHES, DRAINAGE FEATURES
- LANDFILL STRUCTURES
- OU7 REMEDIAL INVESTIGATION AREA
- WATER TABLE CONTOURS AND ELEVATIONS, DASHED WHERE APPROXIMATELY LOCATED
- SURFACE WATER IMPOUNDMENTS

NA = water elevation not available/measured

0 feet 300 600

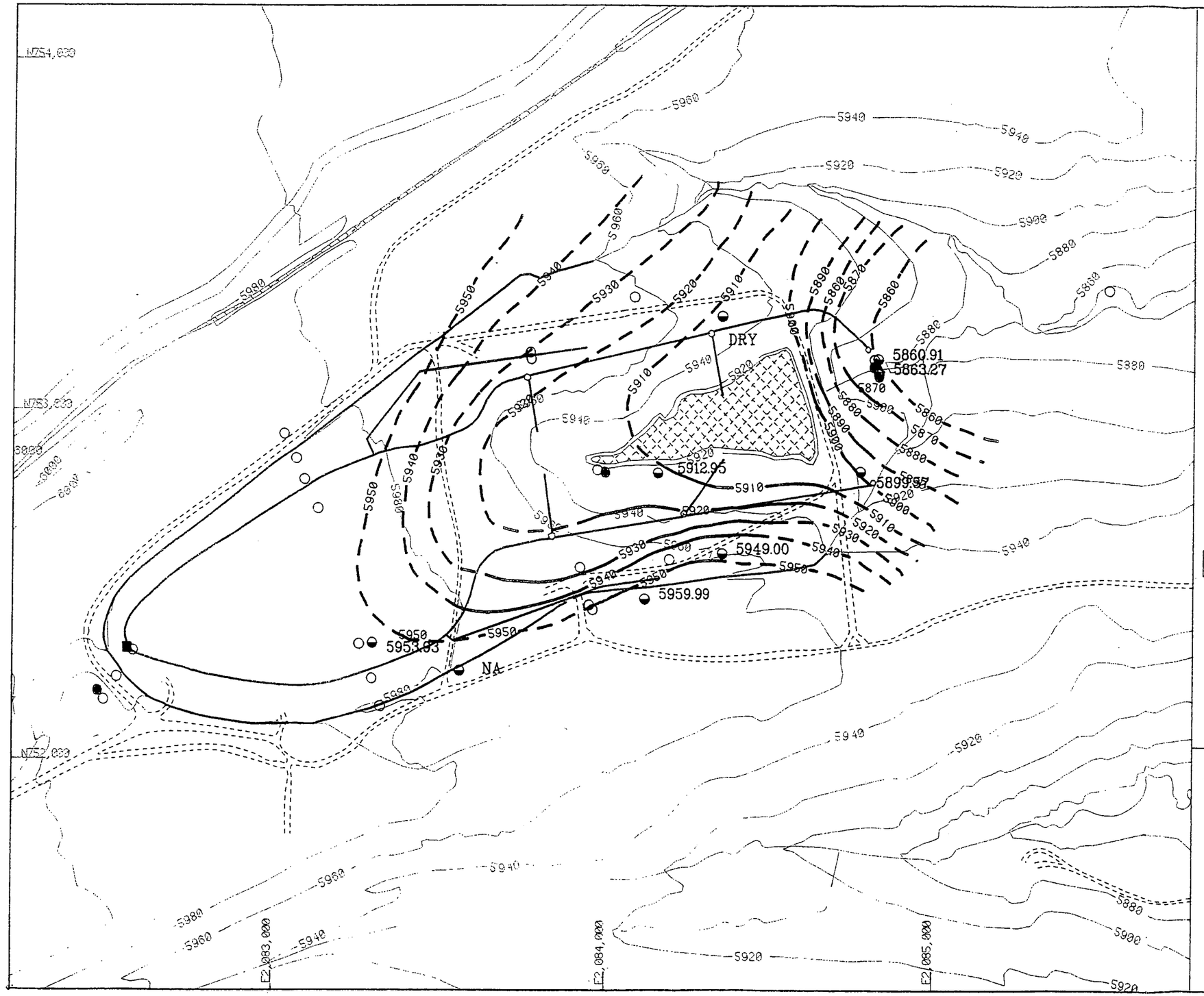
CONTOUR INTERVAL = 20 FEET

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

# POTENTIOMETRIC SURFACE IN WEATHERED BEDROCK

January 2, 1991
(First Quarter, FY91)

Figure 2-13




## EXPLANATION

- ALLUVIAL WELL
- 5960.15 WEATHERED BEDROCK WELL WITH MEASURED WATER LEVEL SHOWN
- UNWEATHERED BEDROCK WELL
- DECOMMISSIONED WELL
- DIRT ROADS
- STREAMS, DITCHES, DRAINAGE FEATURES
- LANDFILL STRUCTURES
- OU7 REMEDIAL INVESTIGATION AREA
- WATER TABLE CONTOURS AND ELEVATIONS, DASHED WHERE APPROXIMATELY LOCATED
- SURFACE WATER IMPOUNDMENTS

NA = water elevation not available/measured

0 feet 300 600

CONTOUR INTERVAL = 20 FEET

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

# POTENTIOMETRIC SURFACE IN WEATHERED BEDROCK

April 2, 1991
(Second Quarter, FY91)

Figure 2-14

## Table 2-2: Present Landfill Vertical Hydraulic Gradients Between Surficial Materials and Weathered Bedrock

| Alluvial Well | Screened Unit | Bedrock Well | Screened Unit | Hydraulic Gradient (i) (ft/ft) | Date(s) |
|---|---|---|---|---|---|
| 6487 | Qrf/Kass (w) | B206189 | Kacl(w) | 0.289 | 1/15/90 |
| | | | | 1.385 | 4/10/90 |
| | | | | 1.027 | 6/15/90, 6/21/90 |
| | | | | 1.146 | 7/10/90 |
| | | | | 0.179 | 8/7/90, 8/17/90 |
| | | | | 0.275 | 10/1/90 |
| | | | | 0.019 | 12/6/90, 12/3/90 |
| | | | | 0.869 | 01/03/91 |
| | | | | 0.062 | 03/11/91 |
| | | | | 1.036 | 04/02/91 |
| 4087 | Qvf | B206989 | Kacl(w) | 1.505 | 4/10/90 |
| | | | | 1.260 | 6/5/90 |
| | | | | 1.216 | 7/10/90 |
| | | | | 1.109 | 8/16/90, 8/10/90 |

Note: Positive vertical hydraulic gradients indicate downward flow.

The vertical gradient was calculated as the quotient of the difference between elevations in water levels divided by the vertical distance between the screened intervals. Specifically, the divisor was the difference between the elevation at the center of the screened interval for the well completed in the surficial materials and the elevation at the center of the screened interval completed in the weathered bedrock.

Water elevations used in calculations were taken on the date(s) listed in the table. When water elevation dates differ for the alluvial well and bedrock well in the well pair the appropriate dates are shown respectively.

Qrf: Rocky Flats Alluvium
Qvf: Valley Fill Alluvium
Kacl(w): Weathered Arapahoe Formation Claystone
Kass(w): Weathered Arapahoe Formation Sandstone

Hydraulic conductivity values were measured in surficial materials from drawdown-recovery tests performed on 1986 wells during the initial site characterization (Rockwell International, 1988c) and from slug tests performed on selected 1987 wells (Table 2-3). Hydraulic conductivity values for the Arapahoe formation at the Present Landfill were estimated from drawdown-recovery tests performed in 1986, a slug test performed in 1987, and packer tests performed in 1986 and 1987 (Table 2-4). The geometric mean of hydraulic conductivity for the Rocky Flats Alluvium varies from $1.8 \times 10^{-5}$ centimeter per second (cm/s) for drawdown-recovery tests to $4.6 \times 10^{-4}$ cm/s for slug tests. These values are two to three orders of magnitude greater than the geometric mean for unweathered claystone of the Arapahoe formation at Well 4187 (i.e., $6.2 \times 10^{-7}$ cm/s). Hydraulic conductivity values in Arapahoe formation sandstones range from $2.3 \times 10^{-8}$ cm/s to $5.8 \times 10^{-6}$ cm/s. A horizontal gradient of 0.05 ft/ft has been calculated for surficial materials at the Present Landfill based on the third quarter 1990 water table map (EG&G, 1991d). The horizontal gradients calculated from the 1991 water table maps are consistent with this value. A site-specific horizontal gradient was not calculated for Arapahoe sandstone (Rockwell International, 1988c) because it was not thought that any two wells were completed in a common continuous sandstone at appropriate locations to do so. Groundwater flow within individual sandstones is from west to east at an average gradient of 0.09 ft/ft based on wells completed in the same sandstones at the 903 Pad and East Trenches Areas (EG&G, 1991b) and on regional data (Robson et al., 1981a).

Impact of Landfill Structures on Alluvial Groundwater

Groundwater in the vicinity of the Present Landfill generally flows eastward through the alluvium, following original natural topography toward the center of the drainage. To control groundwater flow in and around the landfill, a two-part groundwater diversion and leachate collection system was constructed in 1974. This system was intended to collect and divert groundwater around the outside of the landfill, collect leachate generated in the landfill, and discharge it into the west pond. Details of the design and construction of the system are discussed in Section 2.2.4.

## Table 2-3: Present Landfill Results of Hydraulic Conductivity Tests in Surficial Materials



| Well No. | Formation | Lithology Screened | Drawdown Recovery Test (cm/s) (1) | Slug Tests (cm/s) (2) |
|---|---|---|---|---|
| 45-86 | Qrf | Sand and poorly sorted gravel | $2.1 \times 10^{-5}$ | |
| 58-87 | Qrf | Sand, poorly sorted gravel, and clayey sand and clay | $1.6 \times 10^{-5}$ | |
| 60-87 | Qrf | Sand and gravel grading to clayey sand and clay | | $1.3 \times 10^{-3}$ |
| 61-87 | Qrf | Sand | | $9.9 \times 10^{-4}$ |
| 62-87 | Qrf | Sand and gravel, clayey sand and clay | | $6.2 \times 10^{-4}$ |
| 63-87 | Qrf | Sand and gravel, sandy clay | | $6.7 \times 10^{-4}$ |
| 65-87* | Qrf, Kass | Clayey sand, sandstone | | $4.6 \times 10^{-4}$ |
| 66-87 | Qrf | Sand and sandy clay | | $1.8 \times 10^{-4}$ |
| 67-87 | Qrf | Clayey sand | | $6.4 \times 10^{-5}$ |
| 71-87 | Qrf | Clayey sand grading to sandy clay | | $6.6 \times 10^{-4}$ |
| Geometric Mean for Rocky Flats Alluvium | | | $1.8 \times 10^{-5}$ | $4.6 \times 10^{-4}$ |

Qrf = Rocky Flats Alluvium

Kass = Arapahoe Sandstone

*Completed in two formations. Not used in calculation of geometric mean.

Note: To convert from cm/s to ft/year, multiply by:

$$\frac{365.25\ day}{year} \times \frac{86400s}{day} \times \frac{ft}{30.48cm}$$

Note:

(1) Drawdown-recovery test data analyzed using the Residual Drawdown Plot (Driscoll 1986) and the method of Bouwer (1987).

(2) Slug test data analyzed using the methods of Bouwer and Rice (1976).

## Table 2-4: Present Landfill Results of Hydraulic Tests in the Arapahoe Formation



| Well No. | Lithology Screened | Drawdown Recovery Test (cm/s) (1) | Slug Tests (cm/s) (2) | Packer Test* (cm/s) |
|---|---|---|---|---|
| 8-86 | Claystone | - | - | $5.7 \times 10^{-7}$ |
| | Unweathered Sandstone | $7 \times 10^{-8}$ | - | |
| 9-86 | Siltstone | - | - | $2.0 \times 10^{-8}$ |
| | Unweathered Sandstone | $4 \times 10^{-8}$ | - | $9.0 \times 10^{-8}$ |
| 41-87BR | Claystone | - | - | $6.7 \times 10^{-7}$ |
| | Unweathered Sandstone | - | $2.78 \times 10^{-8}$ | $3.1 \times 10^{-7}$ |
| B206589 | Weathered Sandstone | - | $5.8 \times 10^{-6}$ | |
| | | | $5.8 \times 10^{-7}$ | |
| B207089 | Weathered Siltstone | - | $2.3 \times 10^{-6}$ | |
| B207189 | Unweathered Siltstone | - | $1.4 \times 10^{-7}$ | |
| | | | $1.5 \times 10^{-7}$ | |

*Represents geometric mean value from three tests at various intervals.

(1) Drawdown-recovery test data analyzed using the Residual Drawdown Plot (Driscoll 1986) and the method of Bouwer (1978).

(2) Slug test data analyzed using the methods of Bouwer and Rice (1976).

To some extent, the effectiveness of the groundwater barriers may be evaluated on the basis of water level data from four alluvial monitoring wells along an approximate north-south section through the north side of the landfill (Section C-C′), three monitoring wells along a north-south section through the south side of the landfill (Section D-D′), and three alluvial monitoring wells along a section immediately upgradient (west) of the west end of the groundwater diversion and leachate collection system (Section E-E′). The locations of these sections are shown in Figure 2-4. Sections C-C′ and D-D′ are shown in Figure 2-8, and Section E-E′ is shown in Figure 2-9. Water level hydrographs for these 10 wells are presented in Figures 2-15, 2-16, and 2-17.

The groundwater level data from the wells along Section C-C′ and Section D-D′ are shown in Figures 2-15 and 2-16, respectively. In general, water levels within the landfill are similar to, but somewhat lower than, those outside of the groundwater intercept system, suggesting that the groundwater diversion system is operating effectively in this area. The hydrographs also indicate seasonal fluctuations in water level elevations in wells located inside and outside the groundwater intercept system, suggesting that the soil cover material is susceptible to infiltration.

The water level elevations for wells located along Section E-E′ (Figure 2-9) are shown in Figure 2-17. Data indicate that groundwater is drawn down toward the groundwater intercept system. The hydrographs indicate that water levels have fluctuated seasonally outside of the intercept system and that water levels have remained constant in well B106089 near the drain. The constant water level in well B106089 suggests that the groundwater diversion is operating effectively in this area. However, water level data are not available on this section further east of the intercept system within the landfill cover. Therefore, it cannot be determined whether water levels within the system are lower than those outside the system.

In addition to the groundwater intercept system, slurry walls excavated into bedrock were constructed on the north and south sides of the eastern portion of the landfill (Figure 2-2).

# WELL HYDROGRAPHS

(See cross section C-C', Figure 2-8, for well locations)

Wells 6087, 6187, and 6287 are located outside of groundwater intercept system.
Well 6387 is located inside of groundwater intercept system.

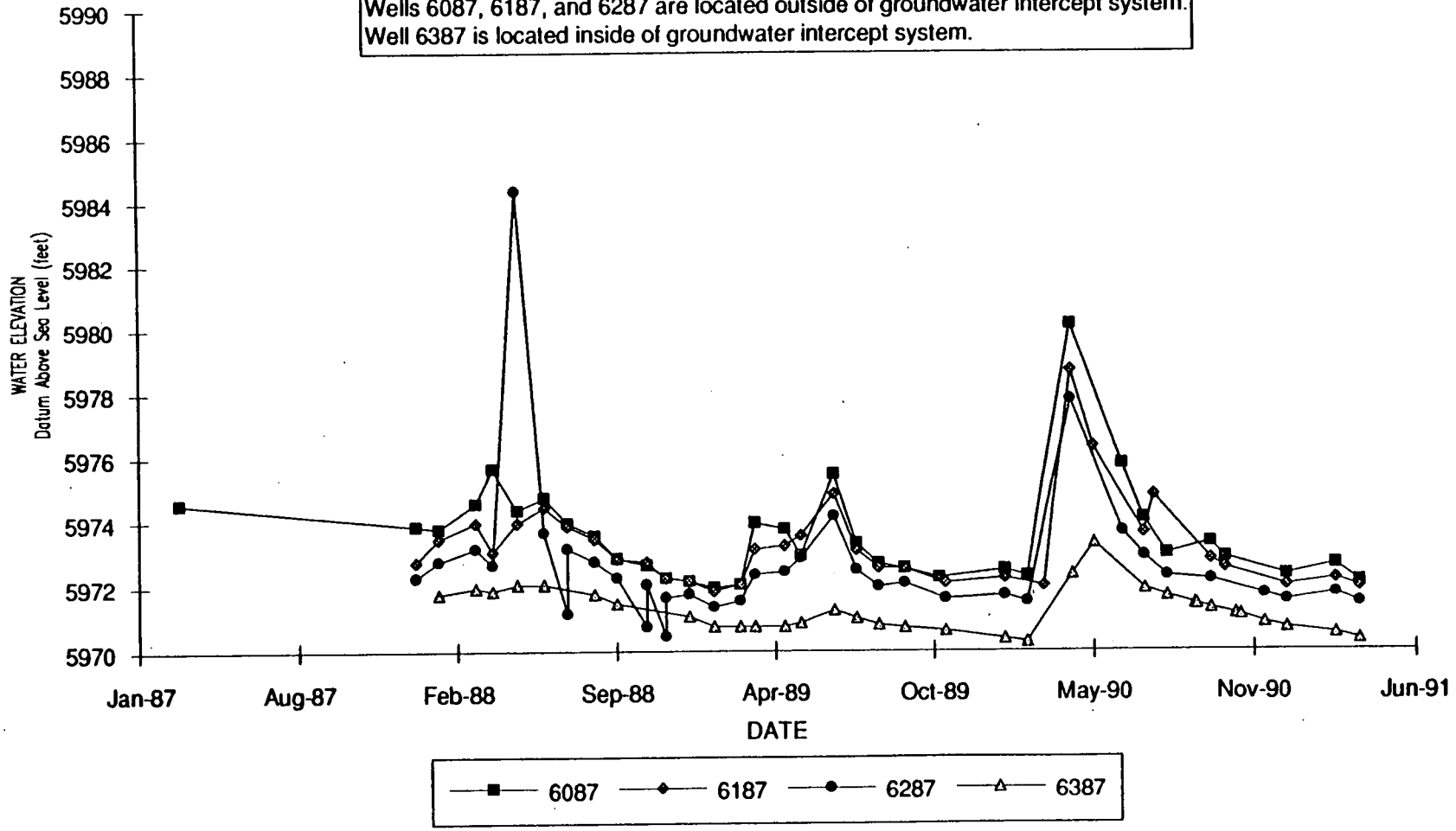



Figure 2-15

# WELL HYDROGRAPHS

(See cross section D-D', Figure 2-8, for well locations)

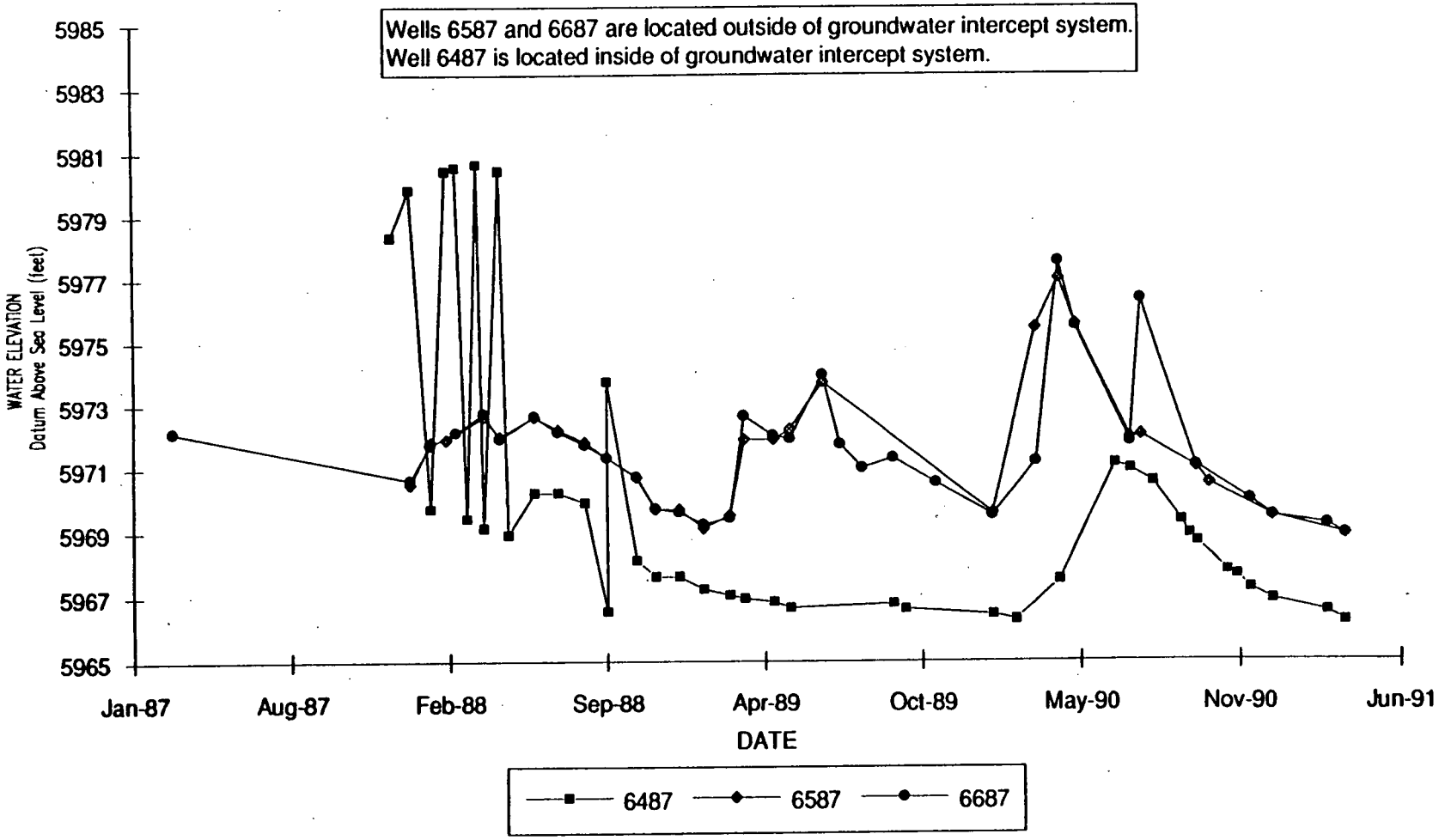



Figure 2-16

# WELL HYDROGRAPHS

(See cross section E-E', Figure 2-9, for well locations)

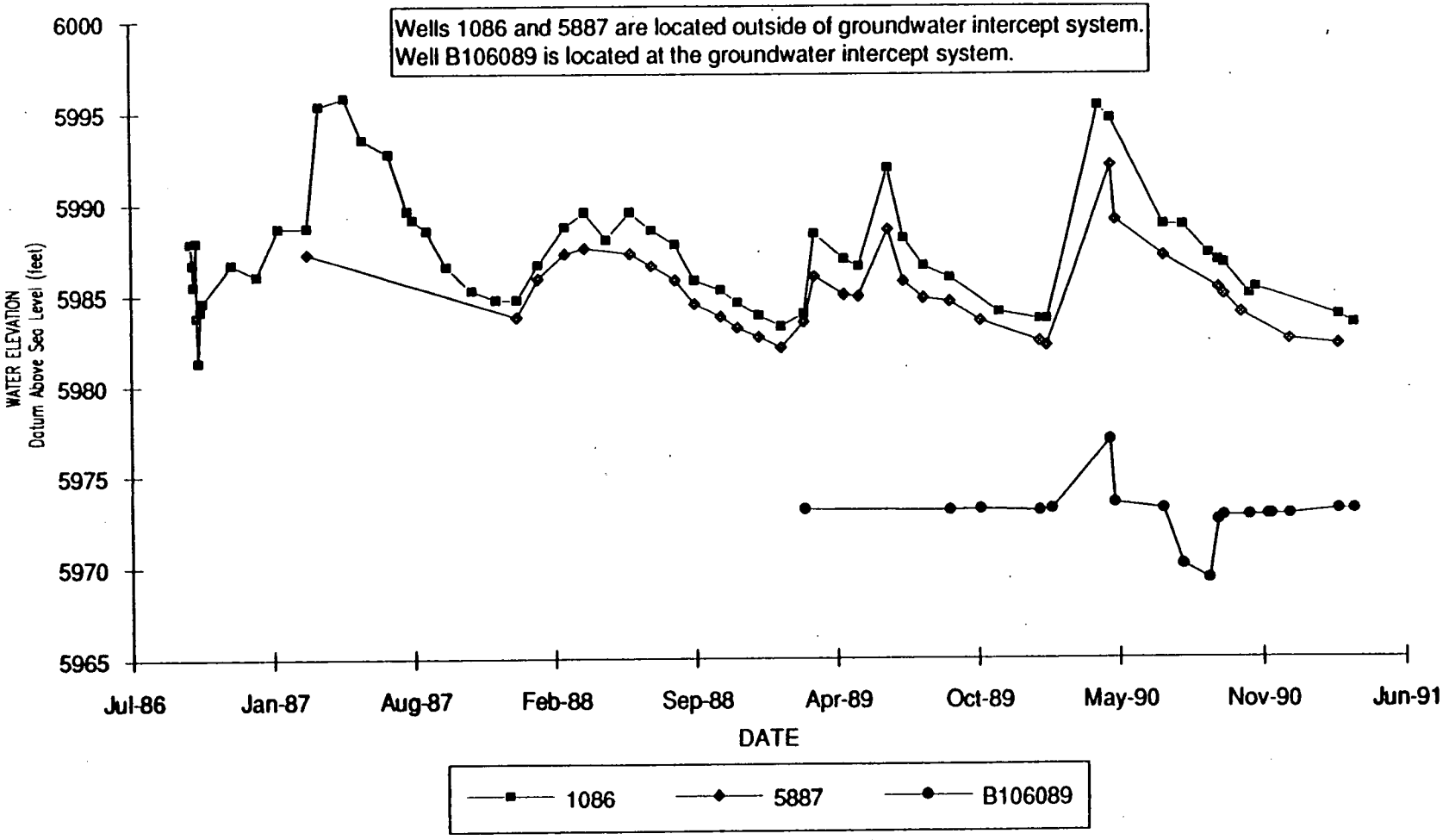



Figure 2-17

The slurry walls were constructed to serve as groundwater barriers for the eastward expansion of the landfill. The effectiveness of the slurry walls can be evaluated by comparing water levels located on either side of the slurry wall.

Hydrographs for well pair 67-87 and 68-87, located on either side of the north slurry wall, indicate that water levels are generally within 0.2 to 0.3 foot of each other (Figure 2-18). This may indicate that the slurry trench is not operating effectively in this area, the slurry wall does not extend this far to the east, or the monitoring wells are not properly located to straddle the slurry wall.

The effectiveness of the south slurry trench can be evaluated by comparing water levels in Wells B206389, 7287, and B206489 (Figure 2-19). The hydrographs indicate that water level elevations within the slurry wall are 2 to 6 feet lower than water elevations outside the wall. Water level elevations fluctuate seasonally in wells located inside and outside the south slurry wall. Because the water level elevations inside the slurry wall are lower than water level elevations outside the slurry wall, the seasonal fluctuations are most likely due to infiltration through the landfill cover rather than slurry wall failure.

### 2.2.6 Surface Water Hydrology and Landfill Drainage

The Present Landfill area is drained by an eastward-flowing unnamed tributary to North Walnut Creek. The East Landfill Pond, located immediately downstream of the Present Landfill on the unnamed tributary, collects both surface runoff and leachate from the landfill (Photo 2-3). The unnamed tributary joins North and South Walnut Creeks approximately 0.7 mile downstream of the eastern boundary of the plant security area before flowing offsite.

The surface of the landfill is generally poorly drained. Based on the topography shown in Figure 2-2, the average ground surface slope across the landfill is approximately 1.5 percent down to the east. However, the ground surface is irregular and hummocky, resulting in

11973-04

2-3 East Landfill Pond

# WELL HYDROGRAPHS

North Slurry Wall

Well 6787 is located outside of the slurry wall.
Well 6887 is located inside of the slurry wall.

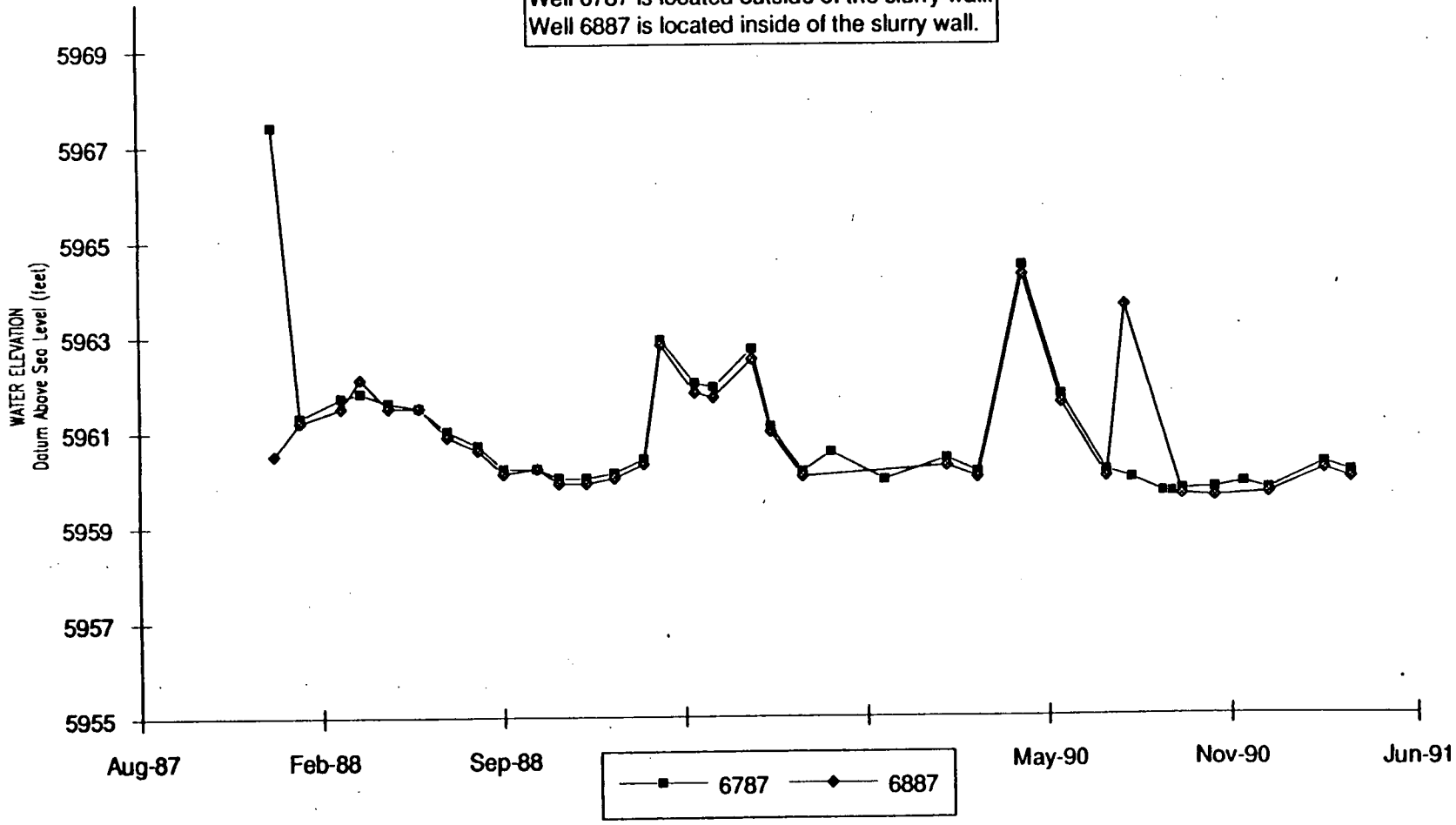



Figure 2-18

# WELL HYDROGRAPHS

South Slurry Wall

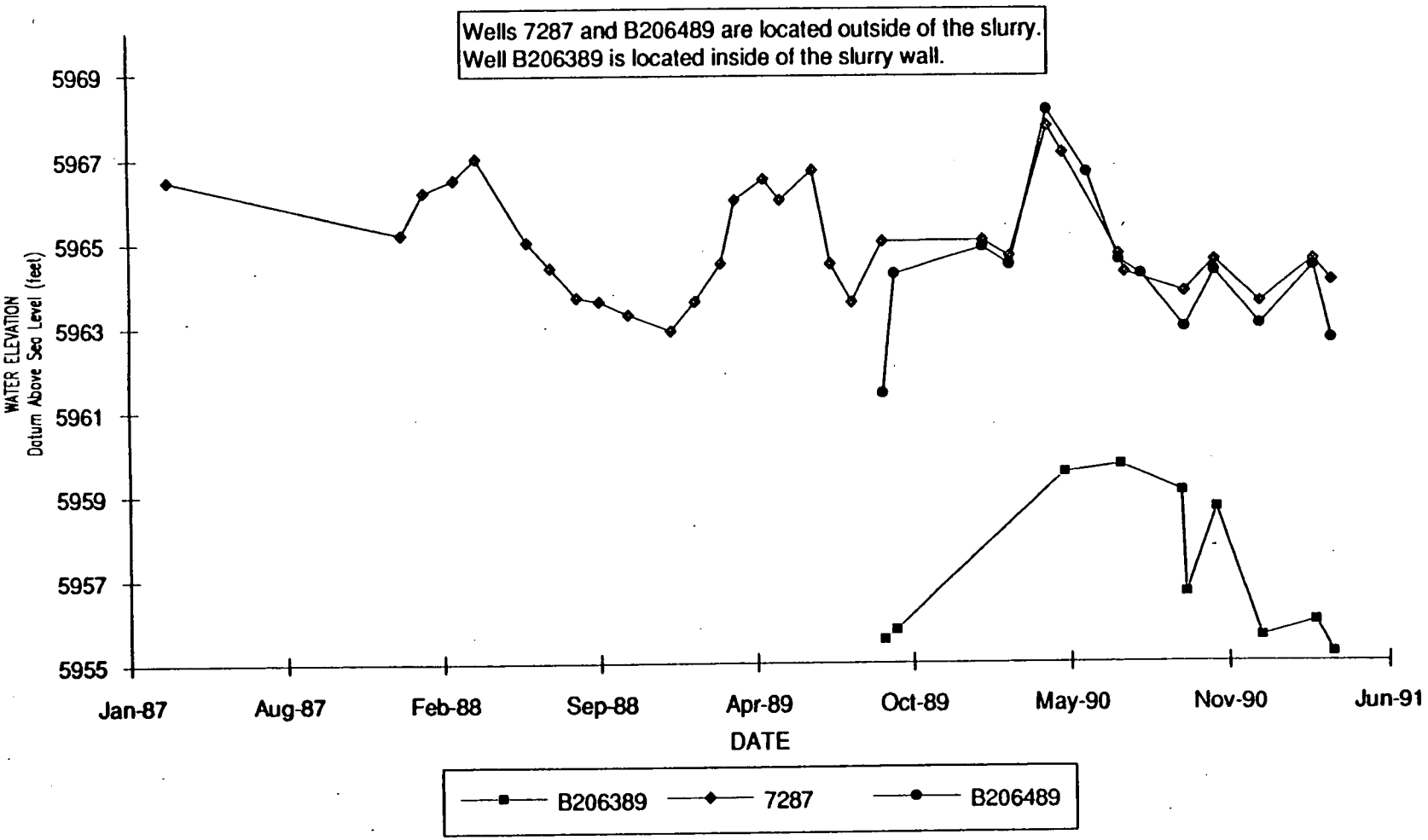



Figure 2-19

impeded surface drainage. Standing water collects in many areas during precipitation and snowmelt (Photo 2-4). Surface water flow to the landfill is controlled by a perimeter interceptor ditch constructed around the north, west, and south sides of the landfill during the 1974 improvements (Photo 2-5). This ditch is an approximately 3-foot-deep trapezoidal ditch with a 5-foot bottom width. The north and south branches of this ditch discharge into natural drainage features that drain to points downslope of the East Landfill Pond embankment.

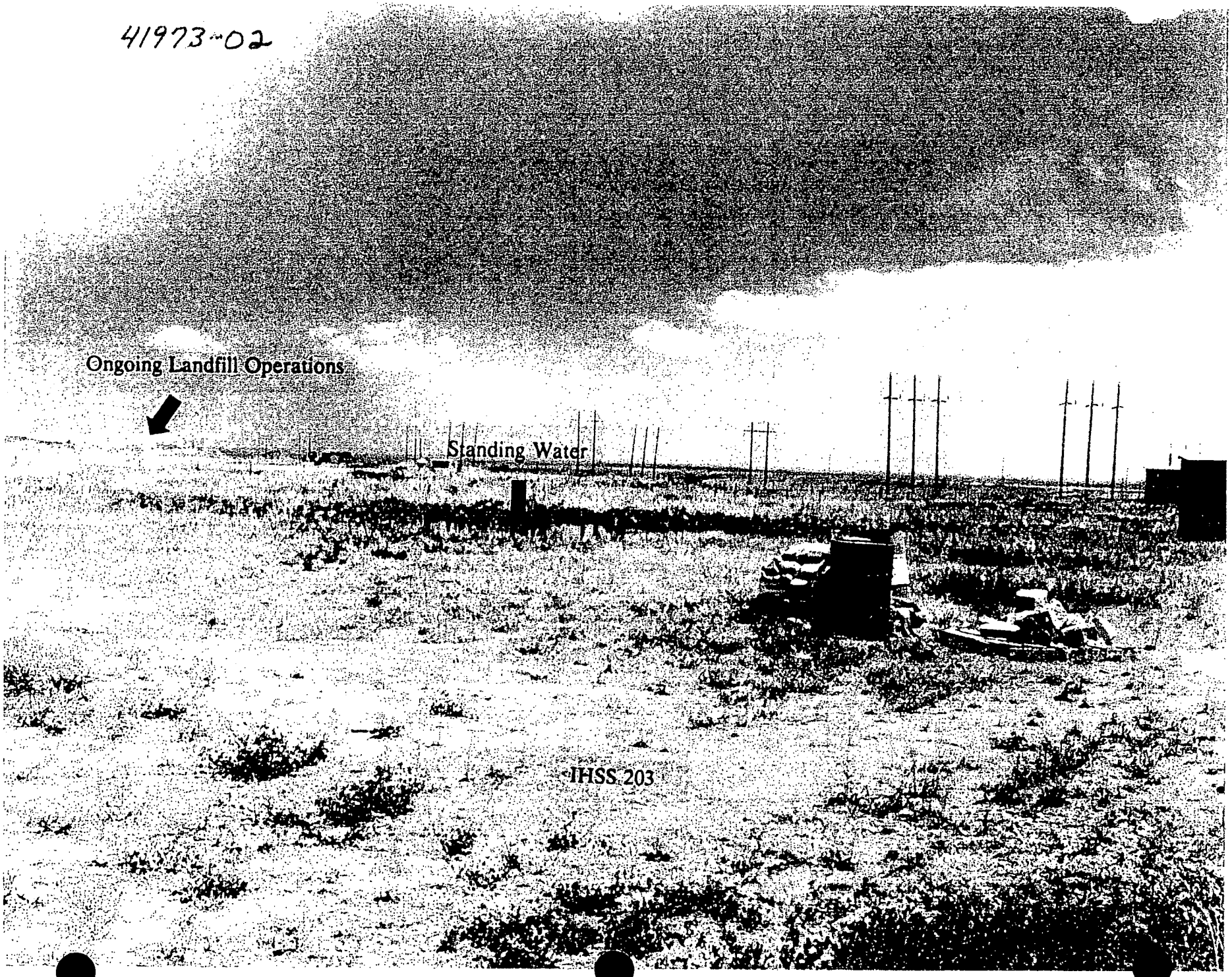
The landfill pond is recharged by groundwater and surface runoff from the landfill and surrounding slopes to the north and south, which are located upgradient. However, surface water/groundwater interactions have not been quantified. Water loss from the pond consists of natural evaporation, which is enhanced by spraying water through fog nozzles and spray evaporation over the pond and on the hill to the south of the pond (Photo 2-6). Seepage through and beneath the pond embankment is presumed to be limited because the embankment contains a clay core keyed into bedrock. The pond does not directly discharge surface water to the drainage downgradient (Rockwell International, 1988a).

## 2.3 NATURE OF CONTAMINATION

### 2.3.1 Sources

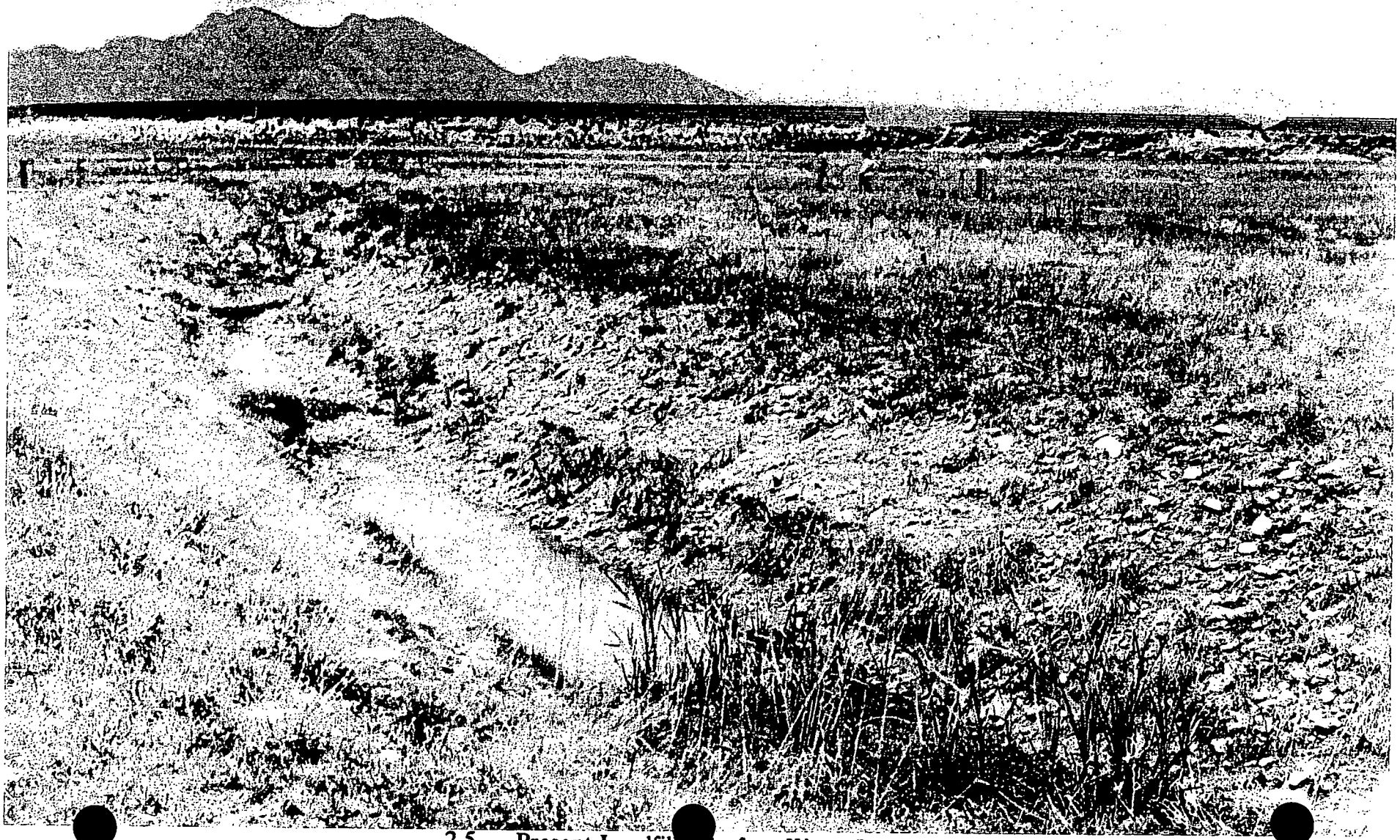
The landfill was designed for disposal of the plant's nonradioactive solid waste. Based on estimates of historical disposal rates, the volume of material in the landfill is currently estimated to be approximately 405,000 cubic yards. Landfill wastes have been emplaced on top of and beyond the groundwater intercept system. Other than testing for radioactivity, little testing was performed to characterize the landfilled wastes prior to 1986. However, in 1986 and 1987, waste streams generated at RFP were characterized under the Waste Stream Identification and Characterization (WSIC) Program (Rockwell International, 1986f, 1986g, 1986h, 1986i, and 1987b). At that time, approximately 1,500 waste streams were identified, 338 of which were being sent to the landfill for disposal. This included 241 waste

41973-02



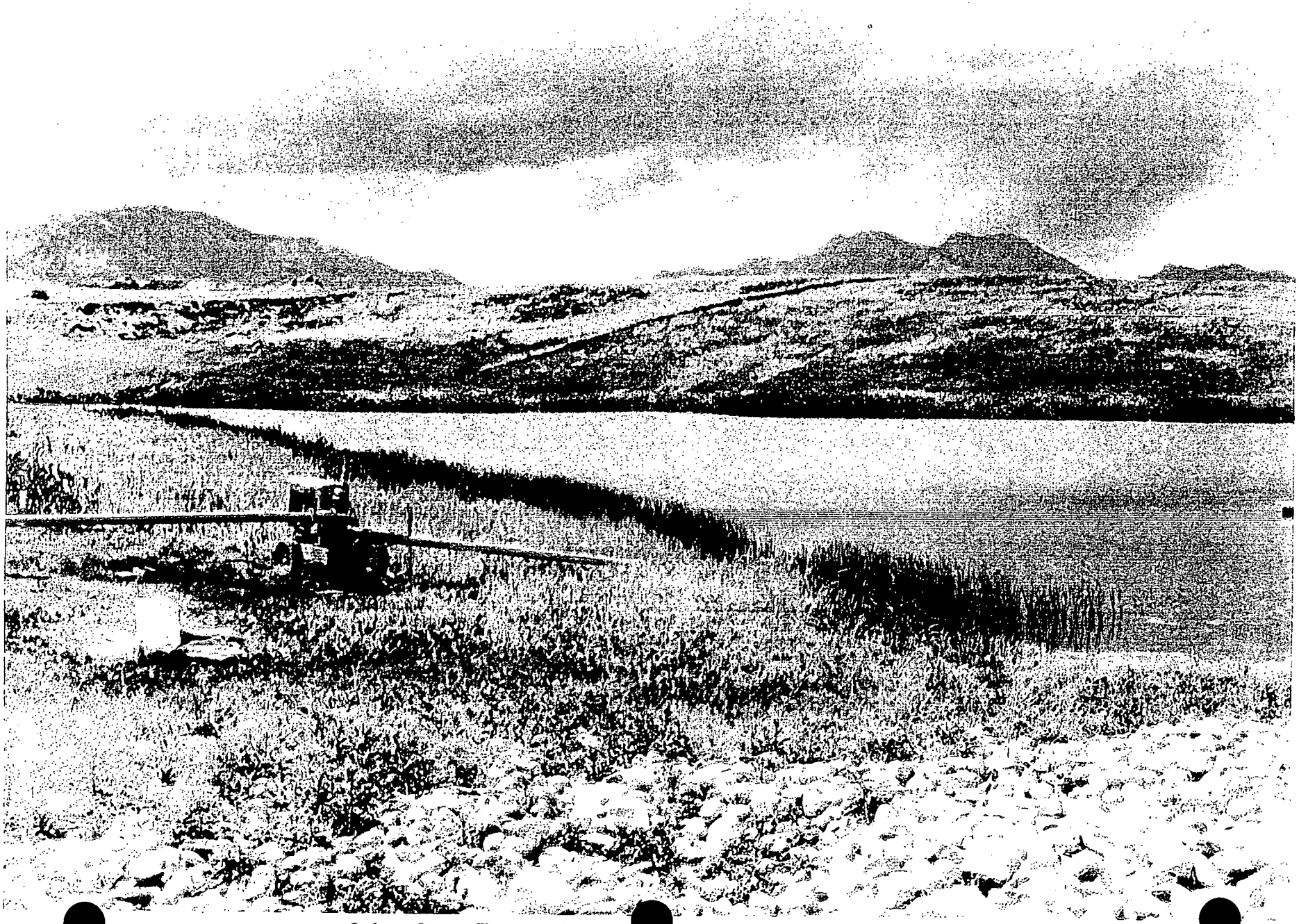

2-4 Standing Water on Present Landfill Soil Cover

41973-03



2-5 Present Landfill - Surface Water Interceptor Ditch

41972-01



2-6 Spray Evaporation Area Adjacent to the East Landfill Pond

streams identified as nonhazardous solid waste (Table 2-5) and 97 solid waste streams that contained hazardous waste or hazardous constituents (Table 2-6). In fall 1986, landfill disposal of wastes with hazardous constituents ceased.

The nonhazardous solid waste streams being disposed in the landfill included office trash, paper, rags, demolition materials, empty cans and containers, used filters, and various electrical components. Also included in the nonhazardous solid waste stream were dried sanitary sewage sludge placed during the 1970s, solid sump sludge, and other miscellaneous sludges. These sludges were classified as nonhazardous (based on an evaluation of the processes that generated the waste sludge) on the likelihood that RCRA-listed wastes were generated and on the possibility that the sludge might be a characteristic waste under RCRA. Limited analytical testing, including the Extraction Procedure (EP) Toxicity test, was performed as part of the WSIC program. More detailed characterization and analytical testing of Rocky Flats waste streams are currently being performed under the Waste Stream and Residue Identification and Characterization (WSRIC) program. As this information becomes available, it will be incorporated into the characterization of the Present Landfill source.

Four general categories of hazardous waste streams were identified by the WSIC program. The first consisted of containers partially filled with paint, solvents, degreasing agents, and foam polymers. The second category included wipes and rags that were contaminated with these materials. Filters were included as the third hazardous waste stream and typically included silicone oil filters, paint filters, oil filters, and other used filters that may have contained hazardous constituents. The fourth category consisted of metal cuttings and shavings, including mineral and asbestos dust and miscellaneous metal chips coated with hydraulic oil and carbon tetrachloride.

In September 1973, tritium and strontium 89 + 90 were detected in leachate draining from the landfill into Pond #1 (the west pond) (Rockwell International, 1987c). Monitoring wells (at the time, called "environmental test holes") were installed in a phased drilling program

# Table 2-5
Solid Waste Stream to Landfill
(1986)

| BUILDING NO. | WASTE NO. | WASTE NAME | WASTE TYPE | QUANTITY GENERATED | UNITS | GENERATION FREQUENCY |
|---|---|---|---|---|---|---|
| 460 | 00820 | used kimwipes | solid | 0 | lbs/yr | as needed |
| 460 | 00830 | used oil filters | solid | 0 | | as needed |
| 460 | 01110 | empty containers | empty containers | 100 | | intermittent |
| 460 | 01100 | kimwipes and rags | solid | 165 | | as needed |
| 460 | 00450 | used kimwipes and rags (ult) | solid | 280 | | as needed |
| 460 | 01270 | kimwipes | solid | 40 | | as needed |
| 460 | 23650 | apron filter | solid | 2 | | once/6 mon |
| 460 | 23790 | bijur filter screen | solid | | | once 6/mon |
| 460 | 01240 | empty containers | empty containers | 100 | | as needed |
| 460 | 09000 | used oil filters | solid | 0 | | to be determined |
| 460 | 23640 | turret res. filter | solid | 2 | | once/6 mon |
| 460 | 23750 | inline coolant filter | solid | 2 | | once/6 mon |
| 460 | 01190 | kimwipes | solid | 100 | | as needed |
| 460 | 01340 | kimwipes and rags | solid | 60 | | as needed |
| 460 | 01170 | sludge | solid | 1200 | | to be determined |
| 460 | 01120 | kimwipes and rags | solid | 165 | | as needed |
| 460 | 00630 | film packs | solid | 48 | | |
| 460 | 01110 | empty containers | empty containers | 100 | | intermittent |
| 460 | 23740 | rough inline filter | solid | 2 | | once/6 mon |
| 460 | 23720 | oil filter | solid | 2 | | once/6 mon |
| 460 | 01070 | used kimwipes and floor dry | solid | 48 | | as needed |
| 460 | 00760 | used kimwipes | solid | 24000 | | as needed |
| 460 | 01320 | kimwipes | solid | 200 | | as needed |
| 460 | 01180 | used oil filters | solid | 2000 | | weekly |
| 460 | 00780 | used kimwipes and floor dry | solid | 350 | | as needed |
| 460 | 00980 | metal chips | metal | 40 | | |
| 460 | 01010 | used oil filters | solid | 15 | | as needed |
| 551 | 06320 | metal cuttings | metal | 300 | | |
| 551 | 06310 | spray paint cans | empty containers | 100 | | |
| 551 | 06300 | kimwipes and degreasing residue | solid | 300 | | |
| 560 | 11810 | sump sludge | solid | 200 | | 1 to 2 years |
| 563 | 20580 | sump sludge | solid | 200 | | intermittent |
| 662 | 04040 | used filters | solid | 20 | | intermittnat |
| 662 | 04000 | kimwipes | solid | 200 | | continuous |
| 662 | 04030 | broken parts | solid | 100 | | as occurs |
| 664 | 17500 | empty containers | empty containers | 100 | | daily |
| 664 | 17510 | used rags | solid | 200 | | daily |
| 664 | 17590 | solid waste | solid | 500 | | continuous |
| 701 | 17620 | solid waste | solid | 200 | | daily |
| 705 | 20280 | kimwipes | solid | 1 | | as needed |
| 705 | 20240 | polishing pads | solid | 2 | | as needed |
| 705 | 20300 | metal and glass scraps | solid | 100 | | daily |
| 705 | 20250 | kimwipes | solid | 3 | | as needed |
| 705 | 20620 | dumpster | solid | | | |
| 705 | 20060 | kimwipes | solid | 20 | | as needed |
| 705 | 20310 | office trash | solid | 1000 | | daily |
| 705 | 20410 | sump sludge | solid | 20 | | continuous |
| 708 | 10650 | HEPA filters | solid | 200 | | PMO schedule |
| 709 | 11700 | sump sludge | solid | 200 | | varies |
| 711 | 20530 | sump sludge | solid | 200 | | varies |
| 712 | 20590 | sump sludge | solid | 200 | | varies |
| 713 | 20600 | sump sludge | solid | 200 | | varies |
| 732 | 15020 | filters | solid | 300 | | once per month |
| 750 | 09100 | empty toner/developer containers | empty containers | 3 | | intermittent |
| 750 | 09020 | empty fixer/developer containers | empty containers | 100 | | as required |
| 750 | 09110 | kimwipes | solid | 100 | | intermittent |
| 750 | 09070 | microfilm wrapper | solid | 100 | | continuous |
| 750 | 09060 | empty containers | empty containers | 100 | | intermittent |
| 750 | 09090 | kimwipes | solid | 100 | | intermittent |
| 770 | 22570 | rags | solid | 365 | | occasionally |
| 770 | 22650 | combustibles | solid | 4700 | | daily |

(After Weston, 1986a, b, c, d, 1987)

TABLE 2-5
Solid Waste Stream to Landfill
(1986)

| BUILDING NO. | WASTE NO. | WASTE NAME | WASTE TYPE | QUANTITY GENERATED | UNITS | GENERATION FREQUENCY |
|---|---|---|---|---|---|---|
| 111 | 06780 | developer and fixer containers | empty containers | 10 | lbs/yr | as needed |
| 111 | 06630 | kimwipes and rags | solid | 240 | | continous |
| 111 | 06610 | toner and dispersant containers | empty containers | 3 | | 2 per month |
| 111 | 06820 | empty developer and fixer container | empty containers | 100 | | as needed |
| 111 | 06680 | empty solvent containers | empty containers | 3 | | 1 per month |
| 111 | 06640 | empty toner containers | empty containers | 10 | | 3 per week |
| 111 | 06690 | kimwipes and rags | solid | 240 | | continous |
| 111 | 06670 | empty ink cans | empty containers | 12 | | 3-4 per month |
| 111 | 06800 | kimwipes and filmpacks | solid | 100 | | as needed |
| 111 | 06650 | demineralizer system filters | solid | 24 | | 1 per month |
| 111 | 06760 | kimwipes and rags | solid | 100 | | |
| 111 | 06740 | empty chemical containers | empty containers | 100 | | as needed |
| 121 | 04810 | solid waste | solid | 100 | | intermittant |
| 121 | 04780 | gun patches | solid | 50 | | continuous |
| 123 | 02830 | waste resin | aqueous | 3 | | batch |
| 123 | 03080 | batteries,metalwire,used elec.comp. | solid | 500 | | continuous |
| 123 | 03000 | empty vials | solid | 100 | | batch |
| 123 | 02880 | waste resin | solid | 50 | | batch |
| 123 | 03070 | kimwipes | solid | 200 | | continuous |
| 124 | 01910 | settling basin sludge | aqueous | 500000 | gal/yr | batch |
| 124 | 00010 | microstrainer backwash | aqueous | 180000 | gal/yr | summer operation |
| 124 | 00020 | clarifier underflow | aqueous | 1500000 | gal/yr | continuous |
| 124 | 00030 | sand filter backwash | aqueous | 1500000 | gal/yr | intermittent |
| 124 | 01660 | dried sludge | solid | 5000 | lbs/yr | once/ 6 months |
| 125 | 02550 | kimwipes | solid | 100 | | continuous |
| 125 | 02730 | oil filters | solid | 5 | | intermittant |
| 130 | 07350 | copy machine toner | empty containers | 100 | | as needed |
| 130 | 07400 | rejected bags | solid | 200 | | as needed |
| 130 | 07330 | polaroid film backings | solid | 100 | | as needed |
| 130 | 07390 | kimwipes | solid | 100 | | as needed |
| 130 | 07360 | packing materials | solid | 100 | | intermittent |
| 130 | 07380 | water conditioning filters | solid | 5 | | twice per month |
| 130 | 07340 | floor sweepings | solid | 100 | | as needed |
| 223 | 06840 | compressor oil filter | solid | 1 | | 1 filter/2 years |
| 331 | 06430 | oil filters and used parts | solid | 500 | | daily |
| 331 | 06440 | paint and body-filler cans | solid | 200 | | as needed |
| 333 | 06230 | shavings | solid | 100 | | daily |
| 333 | 06220 | sawdust | solid | 100 | | as needed |
| 333 | 06110 | filters | solid | 200 | | weekly |
| 333 | 06210 | blast waste | solid | 1500 | | as needed |
| 333 | 06140 | empty cans | empty containers | 100 | | as needed |
| 333 | 06080 | empty paint cans | solid | 200 | | as needed |
| 333 | 06200 | scrapings | solid | 200 | | as needed |
| 333 | 06180 | empty cans | empty containers | 100 | | as needed |
| 333 | 06130 | rags | solid | 300 | | as needed |
| 333 | 06150 | disposed equipment | solid | 1000 | | as needed |
| 333 | 06090 | empty paint cans | solid | 500 | | as needed |
| 334 | 07050 | wood/plastic shavings | solid | 500 | | continous |
| 334 | 07060 | floor scrap | solid | 200 | | daily |
| 334 | 07110 | other metal waste | metal | 500 | | |
| 334 | 06950 | enamel residue | solid | 100 | | intermittent |
| 334 | 07250 | miscellaneous solid waste | metal | 500 | | daily |
| 334 | 07140 | scrap metal | metal | 500 | | daily |
| 334 | 07160 | fluorescent light tubes | solid | 1000 | | as needed |
| 334 | 07120 | used filters | solid | 2 | | as needed |
| 334 | 07130 | metal and silica waste | solid | 500 | | intermittent |
| 335 | 07040 | fire extinguisher chemicals | aqueous | 200 | gal/yr | as needed |
| 373 | 11640 | sump sludge | solid | 100 | lbs/yr | yearly |
| 439 | 00070 | kimwipes and rags | solid | 200 | | as needed |
| 439 | 00110 | empty cans and containers | empty containers | 100 | | as needed |
| 439 | 00060 | metal chips | metal | 500 | | daily |

(After Weston, 1986a, b, c, d, 1987)

## Table 2-5
Solid Waste Stream to Landfill
(1986)

| BUILDING NO. | WASTE NO. | WASTE NAME | WASTE TYPE | QUANTITY GENERATED | UNITS | GENERATION FREQUENCY |
|---|---|---|---|---|---|---|
| 439 | 00090 | kimwipes | solid | 200 | lbs/yr | as needed |
| 440 | 00140 | aluminum and sst chips | metal | 500 | | |
| 440 | 00180 | kimwipes and rags | solid | 500 | | as needed |
| 440 | 00160 | empty containers | empty containers | 100 | | as needed |
| 440 | 01390 | kimwipes and rags | solid | 500 | | |
| 440 | 00200 | kimwipes and rags | solid | 500 | | as needed |
| 441 | 00220 | toner | empty containers | 100 | | as needed |
| 442 | 00260 | respirator cartridges | solid | 100 | | |
| 442 | 00250 | defective HEPA filters | solid | 50 | | as appropriate |
| 445 | 15340 | trash | solid | 500 | | continuous |
| 445 | 15280 | trash | solid | 500 | | continuous |
| 445 | 15260 | carbon dust | solid | 20800 | | continuous |
| 445 | 15290 | steel shavings | metal | 5000 | | continuous |
| 445 | 15270 | carbon scraps | solid | 10000 | | continuous |
| 445 | 15300 | steel scraps | metal | 5000 | | continuous |
| 449 | 11070 | rags | organic | 200 | | |
| 449 | 11060 | empty paint cans and containers | empty containers | 10 | | |
| 449 | 11090 | miscellaneous trash | solid | 660 | | |
| 454 | 11890 | sump sludge | solid | 800 | | intermittent |
| 457 | 11860 | sump sludge | solid | 200 | | intermittent |
| 460 | 00910 | used kimwipes and floor dry | solid | 0 | | as needed |
| 460 | 00940 | used kimwipes | solid | 302 | | as needed |
| 460 | 23630 | bijur filter screen | solid | 2 | | once/6 mon |
| 460 | 00600 | used kimwipes and rags | solid | 200 | | as needed |
| 460 | 23770 | bijur filter screen | solid | | | once/6 mon |
| 460 | 00770 | used oil filters | solid | 70 | | as needed |
| 460 | 23690 | air filter | solid | 2 | | once/6 mon |
| 460 | 00880 | metal chips | metal | 0 | | to be determined |
| 460 | 01000 | used kimwipes | solid | 55 | | as needed |
| 460 | 23710 | bijur filter screen | solid | 2 | | once/6 mon |
| 460 | 00370 | used oil filters | solid | 20 | | 4 per year |
| 460 | 01080 | kimwipes | solid | 150 | | as needed |
| 460 | 00840 | used kimwipes and floor dry | solid | 0 | | as needed |
| 460 | 01250 | kimwipes and rags | solid | 165 | | as needed |
| 460 | 23800 | bijur filter screen | solid | | | |
| 460 | 00460 | used kimwipes and rags (vap) | solid | 280 | | as needed |
| 460 | 01310 | kimwipes | solid | 50 | | as needed |
| 460 | 23680 | hydraulic intake filter | solid | 2 | | once/6 mon |
| 460 | 00640 | kimwipes and rags | solid | 110 | | |
| 460 | 23850 | air inlet filter | solid | | | once/6 mon |
| 460 | 00810 | metal chips | metal | 0 | | to be determined |
| 460 | 01090 | empty paint cans | empty containers | 100 | | |
| 460 | 23700 | bijur filter screen | solid | 2 | | once/6 mon |
| 460 | 00930 | used filters | solid | 1800 | | to be determined |
| 460 | 01360 | kimwipes and floor dry | solid | 20 | | as needed |
| 460 | 23660 | hydraulic system filter | solid | 2 | | once/6 mon |
| 460 | 01060 | discarded containers | empty containers | 100 | | intermittent |
| 460 | 00890 | used kimwipes | solid | 0 | | as needed |
| 460 | 01050 | metal chips | metal | 300 | | to be determined |
| 460 | 01200 | empty chem. and solvent containers | empty containers | 100 | | intermittent |
| 460 | 01230 | kimwipes w/Freon | solid | 165 | | as needed |
| 460 | 00710 | kimwipes, gloves and gauze | solid | 0 | | as needed |
| 460 | 00710 | used kimwipes, gloves and gauze | solid | 580 | | as needed |
| 460 | 00490 | used kimwipes and gloves | solid | 110 | | as needed |
| 460 | 00950 | used kimwipes and floor dry | solid | 110 | | as needed |
| 460 | 01140 | kimwipes and rags | solid | 165 | | as needed |
| 460 | 00570 | nuocure | solid | 100 | | |
| 460 | 00750 | metal chips | metal | 0 | | to be determined |
| 460 | 23780 | bijur filter screen | solid | | | |
| 460 | 00380 | used kimwipes and gauze | solid | 150 | | as needed |
| 460 | 01280 | kimwipes and floor dry | solid | 40 | | as needed |

(After Weston, 1986a, b, c, d, 1987)

## Table 2-5

Solid Waste Stream to Landfill
(1986)

| BUILDING NO. | WASTE NO. | WASTE NAME | WASTE TYPE | QUANTITY GENERATED | UNITS | GENERATION FREQUENCY |
|---|---|---|---|---|---|---|
| 770 | 22640 | metal chips/scraps | metal | 3276 | lbs/yr | biweekly |
| 771 | 22250 | empty containers & surgical gloves | solid | 5000 | | every 2 weeks |
| 771 | 22470 | plastic scraps | solid | 2900 | | daily |
| 771 | 22450 | metal chips | metal | 3275 | | weekly |
| 771 | 22460 | combustibles | solid | 5000 | | daily |
| 776 | 12020 | wood & plastic chips/dust | solid | 10400 | | weekly (200 lbs./w |
| 776 | 12010 | empty containers | empty containers | 100 | | occasionally |
| 776 | 12030 | soiled kimwipes | solid | 2080 | | weekly (40 lbs/wk) |
| 776 | 12040 | empty containers | empty containers | 2080 | | weekly (40 lbs/wk) |
| 778 | 15040 | trash in canisters | solid | 800 | | continuous |
| 778 | 15210 | sanitary trash | solid | 500 | | continuous |
| 778 | 15050 | metal/wood shavings | solid | 2000 | | continuous |
| 778 | 15060 | sanitary trash | solid | 500 | | continuous |
| 778 | 15090 | sanitary trash | solid | 500 | | continuous |
| 778 | 15210 | metal/wood shavings | solid | 2000 | | continuous |
| 778 | 15140 | trash | solid | 1000 | | continuous |
| 778 | 15310 | sanitary trash | solid | 500 | | continuous |
| 779 | 19050 | sanitary trash | solid | 1300 | | continuous |
| 779 | 15480 | trash | solid | 1000 | | continuous |
| 779 | 15400 | kimwipes | solid | 480 | | periodically |
| 779 | 19060 | metal shavings/fines | metal | 300 | | continuous |
| 779 | 15730 | water chiller filters | solid | 10 | | monthly |
| 779 | 15460 | plastics grindings | organic | 500 | gal/yr | continuous |
| 779 | 19200 | machine fines | metal | 300 | lbs/yr | continuous |
| 779 | 15410 | mixed trash | solid | 500 | | continuous |
| 779 | 19190 | sanitary trash | solid | 500 | | continuous |
| 779 | 15450 | grindings metal | metal | 1000 | | continuous |
| 783 | 11780 | sump sludge | solid | 200 | | intermittent |
| 850 | 04940 | toner and dispersant bottles | empty containers | 5 | | intermittant |
| 865 | 04240 | stainless steel grinding paper | solid | 6 | | per year |
| 865 | 04280 | mold compound | solid | 50 | | |
| 865 | 04290 | photography lab solid wastes | solid | 240 | | |
| 865 | 04330 | metal scraps | metal | 260 | | |
| 881 | 04670 | aerosol, paint and thinner cans | empty containers | 200 | | |
| 881 | 04620 | dirty kimwipes | solid | 200 | | as needed |
| 881 | 04710 | uncontaminated solid waste | solid | 5000 | | |
| 881 | 04610 | other metal chips | metal | 600 | | |
| 881 | 05070 | rags and kimwipes | solid | 100 | | |
| 885 | 05110 | rags | solid | 100 | | |
| 886 | 03190 | copy machine waste | solid | 40 | | |
| 910 | 06360 | diatomaceous earth | solid | 54750 | | weekly/monthly |
| 910 | 07560 | wastewater sludge | solid | 0 | | intermittant |
| 966 | 06840 | empty containers | empty containers | 100 | | intermittent |
| 980 | 06550 | kimwipes | solid | 1500 | | daily |
| 980 | 06980 | sawdust soaked with oil seepage | solid | 900 | | daily |
| 980 | 06590 | metal scrap | metal | 5000 | | daily |
| 980 | 06530 | metal scrap | metal | 2000 | | daily |
| 980 | 06520 | fiberglass resins and catalysts | solid | 1000 | | intermittent |
| 980 | 06500 | metal scraps | metal | 5000 | | daily |
| 980 | 06570 | oily rags | solid | 480 | | daily |
| 980 | 06510 | rags with mineral spirits | solid | 1480 | | daily |
| 980 | 06490 | empty containers | empty containers | 100 | | intermittent |
| 980 | 06580 | oily rags | solid | 480 | | daily |
| 991 | 07510 | toner & dispersant containers | empty containers | 100 | | monthly |
| 991 | 07500 | empty paint containers | empty containers | 100 | | |
| T750 | 06010 | empty toner/dispersant containers | empty containers | 100 | | monthly |
| T750 | 06040 | kimwipes | solid | 100 | | as needed |
| T750 | 06020 | soiled kimwipes | solid | 100 | | as needed |

(After Weston, 1986a, b, c, d, 1987)

## Table 2-6

Hazardous Waste Stream to Landfill
(1986)

| BUILDING NO. | WASTE NO. | WASTE NAME | WASTE TYPE | QUANTITY GENERATED | UNITS | GENERATION FREQUENCY |
|---|---|---|---|---|---|---|
| 111 | 06700 | film packs and positives | solid | 50 | lbs/yr | |
| 123 | 03100 | broken badges | solid | 200 | | as occurs |
| 123 | 03120 | waste vials | solid | 100 | | batch |
| 123 | 02930 | waste resin | solid | 5 | | batch |
| 123 | 03160 | waste resin | solid | 100 | | as required |
| 125 | 02560 | filters | solid | 5 | | Change once/year |
| 125 | 02640 | silicone oil filters | solid | 5 | | |
| 125 | 02580 | kimwipes | solid | 100 | | continuous |
| 334 | 07070 | mineral and asbestos dust | solid | 200 | | as appropriate |
| 367 | 06930 | empty cans, bags and containers | empty containers | 100 | | as needed |
| 377 | 09960 | oil filters | solid | 5 | | pmo schedule |
| 440 | 01500 | kimwipes and rags from paint booth | solid | 500 | | |
| 440 | 00120 | composite kimwipe drum | solid | 600 | | |
| 440 | 01460 | foam trimmings | solid | 200 | | |
| 440 | 01410 | empty paint cans | empty containers | 100 | | |
| 440 | 00390 | metal chip dumpster | solid | 2000 | | |
| 440 | 00170 | R-compound | organic | 2640 | | |
| 440 | 01470 | kimwipes and rags | solid | 500 | | |
| 440 | 01480 | kimwipes and rags | solid | 500 | | |
| 440 | 01440 | kimwipes and rags | solid | 500 | | |
| 440 | 01420 | paint filters | solid | 300 | | |
| 443 | 00320 | contaminated rags | solid | 200 | | as needed |
| 444 | 14120 | sst, iron metal chips | metal | 1200 | | continuous |
| 444 | 11920 | sump sludge | solid | 200 | | varies |
| 453 | 11130 | paper towels | solid | 2 | | intermittent |
| 460 | 23520 | metal chips | metal | 0 | | |
| 460 | 23560 | metal chips | metal | 0 | | |
| 460 | 01640 | air filters | solid | 0 | | |
| 460 | 23540 | metal chips | metal | 0 | | |
| 460 | 23610 | metal chips | metal | 0 | | |
| 460 | 02350 | metal chips | metal | 0 | | |
| 460 | 02460 | metal chips | metal | 0 | | |
| 460 | 23620 | metal chips | metal | 0 | | |
| 460 | 02300 | metal chips | metal | 0 | | |
| 460 | 01750 | metal chip composite | metal | 100000 | | |
| 460 | 23510 | metal chips | metal | 0 | | |
| 460 | 02290 | metal chips | metal | 0 | | |
| 460 | 02480 | metal chips | metal | 0 | | |
| 460 | 02440 | metal chips | metal | 0 | | |
| 460 | 01650 | water filters | solid | 0 | | |
| 460 | 01830 | water filters (x-ray) | solid | 50 | | |
| 460 | 02280 | metal chips | metal | 0 | | |
| 460 | 01600 | compressor filters | solid | 40 | | |
| 460 | 23580 | metal chips | metal | 0 | | |
| 460 | 02270 | metal chips | metal | 0 | | |
| 460 | 02370 | metal chips | metal | 0 | | |
| 460 | 23550 | metal chips | metal | 0 | | |
| 460 | 01370 | film packs | solid | 30 | | |
| 460 | 02390 | metal chips | metal | 0 | | |

(After Weston, 1986a, b, c, d, 1987)

Table 2-6
Hazardous Waste Stream to Landfill
(1986)

| BUILDING NO. | WASTE NO. | WASTE NAME | WASTE TYPE | QUANTITY GENERATED | UNITS | GENERATION FREQUENCY |
|---|---|---|---|---|---|---|
| 460 | 02410 | metal chips | metal | 0 | | |
| 460 | 02500 | metal chips | metal | 0 | | |
| 460 | 23570 | metal chips | metal | 0 | | |
| 460 | 02340 | metal chips | metal | 0 | | |
| 460 | 00590 | mercury light bulbs | solid | 5 | | |
| 460 | 02320 | metal chips | metal | 0 | | |
| 460 | 02400 | metal chips | metal | 0 | | |
| 460 | 23590 | metal chips | metal | 0 | | |
| 460 | 01780 | empty containers | empty containers | 100 | | |
| 460 | 02380 | metal chips | metal | 0 | | |
| 460 | 02330 | metal chips | metal | 0 | | |
| 460 | 01580 | kimwipes and rags | solid | 165 | | |
| 460 | 02360 | metal chips | metal | 0 | | |
| 460 | 02450 | metal chips | metal | 0 | | |
| 460 | 23600 | metal chips | metal | 0 | | |
| 460 | 23530 | metal chips | metal | 0 | | |
| 460 | 02310 | metal chips | metal | 0 | | |
| 460 | 23470 | metal chips | metal | 0 | | |
| 460 | 02430 | metal chips | metal | 0 | | |
| 460 | 02490 | metal chips | metal | 0 | | |
| 460 | 02420 | metal chips | metal | 0 | | |
| 528 | 15360 | kimwipes | solid | 10 | | periodically |
| 549 | 07300 | empty containers | empty containers | 100 | | as needed |
| 562 | 09840 | paper towels with oil | solid | 20 | | varies |
| 668 | 09570 | rags with methyl alcohol | solid | 50 | | intermittant |
| 705 | 20180 | kimwipes | solid | 15 | | as needed |
| 708 | 10690 | rags w/freon and trichloroethane | solid | 200 | | |
| 727 | 09520 | paper towels with oil/freon TF | solid | 100 | | intermittant |
| 771 | 22010 | deionizer exchange resin column | solid | 5 | | yearly |
| 771 | 22230 | bottles, cartons, gloves, kimwipes | solid | 15000 | | continuous |
| 771 | 22210 | liquid chemical containers | solid | 4000 | | continuous |
| 775 | 22030 | trash paper | solid | 200 | | none |
| 776 | 12120 | soiled kimwipes | solid | 365 | | daily |
| 776 | 12130 | empty containers | empty containers | 365 | | daily |
| 776 | 12100 | empty containers | empty containers | 365 | | daily |
| 776 | 12000 | soiled kimwipes | solid | 1200 | | once per day |
| 776 | 12180 | soiled kimwipes | solid | 4000 | | daily |
| 776 | 12090 | soiled kimwipes | solid | 365 | | daily |
| 779 | 19730 | metal chips | metal | 10000 | | 2/week |
| 780 | 09590 | rags with trichloroethane | solid | 50 | | infrequent |
| 780 | 09580 | empty paint cans | solid | 50 | | infrequent |
| 881 | 04660 | metal and plastic chips | solid | 10000 | | |
| 881 | 04760 | dirty kimwipes | solid | 100 | | |
| 881 | 03240 | waste resin | solid | 4 | | continuous |
| 886 | 03180 | kimwipes | solid | 10 | | |
| 886 | 03200 | chemicals in cabinet | organic | 50 | | infrequent |
| 910 | 06340 | filter backwash | aqueous | 00000 | | weekly |
| 991 | 07490 | reject rings | solid | 1880 | | weekly |

(After Weston 1986a, b, c, d, 1987)

## Table 2-7: Volatile Organic Compounds (in µg/ℓ) Detected in Present Landfill Borehole Samples



Well B106089

| ID | Depth (ft) | Acetone | 2-Butanone | Methylene Chloride | Toluene | Total Xylenes |
|---|---|---|---|---|---|---|
| LF01890001 | 0-1.2 | ND | ND | 27 | 6 | ND |
| LF01890305 | 3.4-4.8 | 39 | ND | 11 | 21 | 6 |
| LF01890709 | 7.5-7.7 | 830 | ND | ND | ND | ND |
| LF01891214 | 11.5-13 | ND | 220 | ND | 71 | ND |
| LF01891618 | 15.5-15.7 | 990 | 330 | ND | 33 | ND |
| LF01892021 | 19.5-20.5 | ND | ND | ND | ND | ND |
| LF01892224 | 21.5-23.5 | ND | ND | ND | ND | ND |
| LF01892426 | 23.5-25.5 | ND | ND | 15 | ND | ND |

## Table 2-8: Concentrations of Total Metals (in mg/Kg) Exceeding Background in Present Landfill Borehole Samples



Well B106089

| | | As | Ba | Ca | Cu | Fe | Hg | Mg | Mn | Ni | Pb | V | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Background: | 4.3 | 79.4 | 4.7 | 11.1 | 13753 | 0.32 | 2484 | 235 | 21.4 | 12.2 | 37.2 | 39.7 |
| ID | Depth (ft) | | | | | | | | | | | | |
| LF01890006 | 0-6 | 8.1 | 103 | 9200 | 15.4 | 14100 | | | | | 29.4 | | 80 |
| LF01890612 | 6-12 | | 110 | 10700 | | | 1.6 | | | | | 37.5 | 104 |
| LF01891218 | 12-15.7 | 4.8 | 102 | 1130 | | | 0.44 | | | | | | 469 |
| LF01891822 | 17.5-21.5 | 14.1 | 132 | | 26.9 | 32500 | 0.37 | 2630 | | 35.6 | | 93.4 | 40.7 |
| LF01892327 | 22.7-27.3 | | 121 | | 11.7 | | 0.42 | | | | | | |

Well B206189

| | | As | Ba | Ca | Cu | Fe | Hg | Mg | Mn | Ni | Pb | V | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Background: | 4 | 121.9 | 7566 | 16.3 | 14726 | 0.44 | 2799 | 203 | 20.2 | 18.7 | 37.2 | 62.3 |
| ID | Depth (ft) | | | | | | | | | | | | |
| LF02890309 | 3-9 | | | | | | | | | | | | |
| LF02891016 | 10-15.7 | | | | | 15000 | | | | | | | |
| LF02891620 | 16-19.9 | | | | 21.5 | 24600 | | | | 34.7 | | 54.7 | |
| LF02892127 | 20-26.9 | | 146 | | 17.9 | 60700 | | | 665 | 63 | 26.1 | 42.3 | 143 |
| LF02892733 | 26.9-32.9 | 6.7 | | | | | | | | | 24.9 | | |

Well B206389

| ID | | As | Ba | Ca | Cu | Fe | Hg | Mg | Mn | Ni | Pb | V | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Background: | 4.3 | 79.4 | 4.7 | 11.1 | 13753 | 0.32 | 2484 | 235 | 21.4 | 12.2 | 37.2 | 39.7 |
| | Depth (ft) | | | | | | | | | | | | |
| LF04890003 | 0-3 | | 154 | 8680 | 15.8 | 15700 | | 3190 | | | 17.2 | 41 | |
| LF04890309 | 3-4.9 | | | | | | | | | | | | |
| LF04890913 | 9.0-9.7 | | | | | | | | | | | | |
| LF04891319 | 14.5-15.9 | | 93.5 | | 11.5 | | | | | | 18.8 | | |

## Table 2-9: Strontium Concentrations (in pCi/ℓ) in Landfill Ponds



| Month | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 | 1974 | 1973 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | N.A. | 0.5 | <3 | 3.5 E<br>7.5 W | 3.6 E<br><3 W | N.A. | N.A. | N.A. | N.A. | -- | -- | N.A. |
| February | N.A. | <3 | <3 | <3 E<br><3 W | 3.0 E<br>3.0 W | N.A. | N.A. | <3 | N.A. | -- | -- | N.A. |
| March | 2.3 | <3 | N.A. | 3.2 E<br>3.2 W | 4.6 E<br><3 W | N.A. | 7.2 | <3 | <3 | -- | -- | N.A. |
| April | N.A. | 2.4 | N.A. | N.A. | <3 E<br><3 W | N.A. | 5.7 | <3 | <3 | -- | -- | N.A. |
| May | N.A. | N.A. | <3 | <3 | 3.5 E<br><3 W | N.A. | N.A. | <3 | 3.5 | -- | -- | N.A. |
| June | | N.A. | <3 | <3 | 4.3 E<br><3 W | N.A. | <3 | <3 | 3.3 | -- | -- | N.A. |
| July | | N.A. | <3 | 4.2 | 4.3 E<br><3 W | N.A. | 3.3 | <3 | 4 | -- | -- | N.A. |
| August | | N.A. | <3 | <3 | 3.5 E<br>2.1 W | 3.2 E | <3 | <3 | 4.5 | -- | -- | N.A. |
| September | | N.A. | <3 | <3 | 4.1 E<br>5.0 W | <3 E | N.A. | N.A. | 3 | -- | -- | N.A. |
| October | | 7.9 | <3<br>3.4 W | <3<br>3.4 W | 4.4 E<br><3 W | 4.3 E<br><3 W | <3 | N.A. | 3 | -- | -- | 16 |
| November | | N.A. | <3 | <3 | 3.6 E<br><3 W | 5.8 E<br><3 W | 3.6 | N.A. | <10 | -- | -- | 16 |
| December | | N.A. | 0.6 | <3 | 3.7 E<br><3 W | 45 E<br><3 W | N.A. | N.A. | NS | 3 | -- | N.A. |

Notes: Results prior to April 1983 were $Sr^{89}$ + $Sr^{90}$ in most cases, except for 1973.
N.A. - Not Analyzed
E - East Landfill Pond (Pond #2)
W - West Landfill Pond (Pond #1)
EPA Drinking Water Standard: $Sr^{89}$ = 80 pCi/ℓ, $Sr^{90}$ = 8 pCi/ℓ
All concentrations in pCi/ℓ

Source: Rockwell International 1987c

## Table 2-10: Tritium Concentrations (in pCi\ℓ) in Western Landfill Pond



| Month | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 | 1974 | 1973 |
|---|---|---|---|---|---|---|---|---|
| January | 738 | 1316 | 1136 | 1365 | 1740 | 1143 | N.A. | |
| February | 709 | 780 | 1368 | 922 | 1733 | 1429 | N.A. | |
| March | 520 | 844 | 775 | 1303 | 1323 | 1837 | 7922 | |
| April | 886 | 886 | 944 | 1113 | 1431 | 924 | N.A. | |
| May | 639 | 805 | 956 | 818 | 1121 | 1445 | N.A. | |
| June | 530 | 816 | 720 | 740 | 1172 | 984 | 5875 | |
| July | 546 | 694 | 953 | 856 | 1378 | 1520 | 4797 | |
| August | 508 | 976 | 1022 | 983 | 1305 | 1258 | 3724 | |
| September | 576 | 564 | 768 | 863 | 1143 | 1777 | 5056 | 34,000<br>39,000<br>57,000 |
| October | 495 | 938 | 818 | 806 | 869 | 1762 | 3304 | N.A. |
| November | 490 | 575 | 1033 | 812 | 1005 | 1553 | 1800 | N.A. |
| December | 530 | 436 | 863 | 880 | 1067 | 1542 | N.A. | N.A. |

Notes: Concentrations in pCi/ℓ
N.A. - Not Analyzed

Source: Rockwell International 1987c

**Table 2-11: 1989 Surface Water Quality Data (Mean Concentrations) for the Present Landfill**

| Analyte | Background Limit | SW097 | SW098 | SW099 | SW100 | Units |
|---|---|---|---|---|---|---|
| **Field Parameters** | | | | | | |
| Conductivity | NA | 2310 | 1260 | 890 | 2800 | umhos/cm |
| Dissolved Oxygen | NA | 3.46 | 3.44 | 5.28 | 5.23 | mg/ℓ |
| Field pH | 9.023-High<br>5.582-Low | 6.82 | 7.93 | 6.72 | 7.07 | pH units |
| Temperature | NA | 17.8 | 16.7 | 17.8 | 17.7 | °C |
| **Anions and Indicators** | | | | | | |
| Bicarbonate as $CaCO_3$ | 202.1725 | 692 | 478 | 342 | 283 | mg/ℓ |
| Carbonate as $CaCO_3$ | 5 | ND | 6.39 | ND | ND | mg/ℓ |
| Chloride | 15.7253 | 92.6 | 184 | 95.6 | 36.2 | mg/ℓ |
| Cyanide | .0452 | ND | ND | ND | .461 | mg/ℓ |
| Nitrate | NA | .177 | .142 | 3.74 | 24 | mg/ℓ |
| Nitrate/Nitrite | 3.9883 | .0617 | .113 | .708 | 5.43 | mg/ℓ |
| Oil and Grease | NA | .556 | ND | ND | ND | mg/ℓ |
| Sulfate | 36.9676 | 5.67 | 42.6 | 68 | 1250 | mg/ℓ |
| Total Dissolved Solids | NA | 757 | 760 | 2200 | 2670 | mg/ℓ |
| Total Suspended Solids | NA | 378 | 5.56 | 88.8 | 2420 | mg/ℓ |
| Lab pH | NA | 6.87 | 8.26 | 7.75 | 7.37 | pH units |

| Analyte | Background Limit | SW097 | SW098 | SW099 | SW100 | Units |
|---|---|---|---|---|---|---|
| **Total Metals** | | | | | | |
| Aluminum | 60.4235 | 4.86 | ND | 2.18 | 56.6 | mg/ℓ |
| Arsenic | 1.03 | ND | ND | ND | .0197 | mg/ℓ |
| Barium | 4.49 | .745 | .118 | .286 | .84 | mg/ℓ |
| Beryllium | .0107 | ND | ND | ND | .054 | mg/ℓ |
| Calcium | 43.3643 | 170 | 35.5 | 100 | 418 | mg/ℓ |
| Chromium | .275 | .00775 | ND | ND | .0511 | mg/ℓ |
| Cobalt | .489 | ND | ND | ND | .0414 | mg/ℓ |
| Copper | .607 | .0248 | ND | .0168 | .0633 | mg/ℓ |
| Iron | 87.1476 | 71.3 | .242 | 2.03 | 44.4 | mg/ℓ |
| Lead | .516 | 0.127 | .0035 | .00594 | .0632 | mg/ℓ |
| Lithium | .1 | .0551 | ND | ND | .0747 | mg/ℓ |
| Magnesium | 8.9377 | 40.3 | 39.6 | 29.4 | 83.8 | mg/ℓ |
| Manganese | 1.9654 | 1.79 | .0579 | .0263 | 1.07 | mg/ℓ |
| Mercury | .0014 | ND | ND | .00032 | .0003 | mg/ℓ |
| Nickel | .646 | ND | ND | ND | .048 | mg/ℓ |
| Potassium | 10.2 | 7.5 | 8.61 | ND | 30.7 | mg/ℓ |
| Selenium | .025 | ND | ND | ND | .155 | mg/ℓ |
| Sodium | 23.0992 | 93.5 | 166 | 58.8 | 229 | mg/ℓ |
| Strontium | 1.46 | 1.05 | .525 | .832 | 2.29 | mg/ℓ |
| Tin | .969 | .0805 | ND | ND | .181 | mg/ℓ |
| Zinc | .3765 | 4.62 | .0425 | .157 | .354 | mg/ℓ |

| Analyte | Background Limit | SW097 | SW098 | SW099 | SW100 | Units |
|---|---|---|---|---|---|---|
| **Total Radioisotopes** | | | | | | |
| Americium-241 | .1769 | 0.00333 | 0.00244 | 0.004 | 0.11 | pCi/ℓ |
| Cesium-137 | 3.9312 | -0.055 | 0.223 | 0.06 | -0.1 | pCi/ℓ |
| Gross Alpha-Suspended | 117.4289 | 11.1 | 1.47 | 35.8 | 90.3 | pCi/ℓ |
| Gross Beta-Suspended | 163.2045 | 19.9 | 10.5 | 25.4 | 144 | pCi/ℓ |
| Plutonium-239 | 1.4577 | 0.0262 | 0.00389 | 0.002 | 0.02 | pCi/ℓ |
| Radium-226 | 29.2468 | 1.5 | NS | 1.4 | 4.6 | pCi/ℓ |
| Strontium-90 | 1.6121 | 1.02 | 0.896 | 0.44 | 0.633 | pCi/ℓ |
| Tritium | 2022.4548 | 153 | 119 | 34 | 36.7 | pCi/ℓ |
| Uranium-total | | 1.24 | 1.98 | 5.22 | 27 | pCi/ℓ |
| Uranium-233, 234 | 1.1054 | 0.905 | 1.4 | 2.96 | 14.7 | pCi/ℓ |
| Uranium-235 | 0.1863 | -0.005 | 0.0622 | 0.12 | 0.433 | pCi/ℓ |
| Uranium-238 | .9186 | 0.61 | 1.29 | 2.9 | 11.9 | pCi/ℓ |

| Analyte | Background Limit | SW097 | SW098 | SW099 | SW100 | Units |
|---|---|---|---|---|---|---|
| **Semi-volatiles** | | | | | | |
| 2,4-Dimethylphenol | DL | 3.5 | ND | ND | ND | µg/ℓ |
| 2-Methylnaphthalene | DL | 12 | ND | ND | ND | µg/ℓ |
| 4-Methylphenol | DL | 16.5 | ND | ND | 1 | µg/ℓ |
| Acenaphthene | DL | 1.5 | ND | ND | ND | µg/ℓ |
| Benzoic Acid | DL | 15.5 | ND | ND | ND | µg/ℓ |
| Benzyl Alcohol | DL | 3.5 | ND | ND | ND | µg/ℓ |
| Bis(2-ethylhexyl)phthalate | DL | 3 | 1 | 0.5 | 1 | µg/ℓ |
| Butyl Benzyl phthalate | DL | 3 | 0.5 | ND | ND | µg/ℓ |
| Di-n-Butyl phthalate | DL | 4.5 | ND | ND | ND | µg/ℓ |
| Diethyl phthalate | DL | 1 | ND | ND | ND | µg/ℓ |
| Fluorene | DL | 1 | ND | ND | ND | µg/ℓ |
| Naphthalene | DL | 1 | ND | ND | ND | µg/ℓ |
| Phenanthrene | DL | 0.5 | ND | ND | 1 | µg/ℓ |
| Phenol | DL | ND | ND | 0.5 | ND | µg/ℓ |

| Analyte | Background Limit | SW097 | SW098 | SW099 | SW100 | Units |
|---|---|---|---|---|---|---|
| **Volatiles** | | | | | | |
| 1,1-Dichloroethane | DL | 5.36 | ND | ND | ND | µg/ℓ |
| 1,1-Dichloroethene | DL | 10.9 | ND | ND | ND | µg/ℓ |
| 1,2-Dichloroethylene | DL | 2.71 | ND | ND | ND | µg/ℓ |
| 2-Butanone | DL | 8.29 | ND | ND | ND | µg/ℓ |
| 4-Methyl-2-Pentanol | DL | 7.71 | ND | 0.2 | ND | µg/ℓ |
| Acetone | DL | 16.2 | 0.25 | 0.6 | 0.5 | µg/ℓ |
| Benzene | DL | 13.8 | ND | ND | ND | µg/ℓ |
| Chlorobenzene | DL | 15.6 | ND | ND | ND | µg/ℓ |
| Chloroethane | DL | 9.14 | ND | ND | ND | µg/ℓ |
| Chloroethene | DL | 4.57 | ND | ND | ND | µg/ℓ |
| Ethylbenzene | DL | 7.64 | ND | ND | ND | µg/ℓ |
| Methylene Chloride | DL | 6.83 | 0.333 | 0.5 | 0.5 | µg/ℓ |
| Tetrachloroethene | DL | 2.29 | ND | ND | ND | µg/ℓ |
| Toluene | DL | 34.3 | ND | ND | ND | µg/ℓ |
| Total Xylenes | DL | 5.71 | ND | ND | ND | µg/ℓ |
| Trichloroethene | DL | 16.2 | ND | ND | ND | µg/ℓ |
| Vinyl Chloride | DL | 4.57 | ND | ND | ND | µg/ℓ |

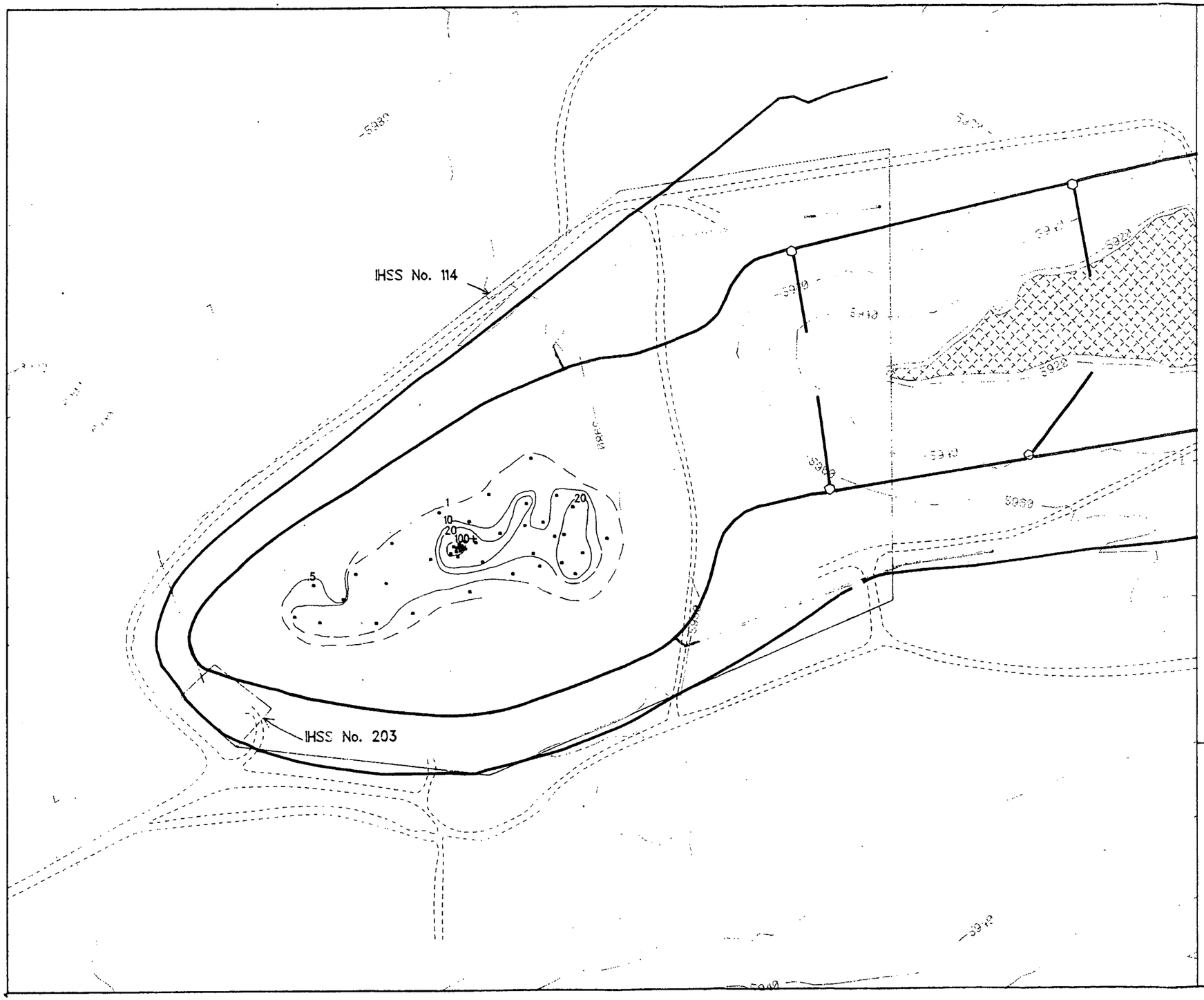
ND - Not Detected
NS - Not Sampled
DL - Detection Limit
NA - Background limit not available/determined

to identify the general location of the sources of tritium and strontium 89 + 90. Wells were installed directly in the landfilled waste or directly below the saturated waste materials. When elevated concentrations were detected, additional borings/wells were drilled until the general location of the source had been identified (Rockwell International, 1987c). In total, 47 wells were installed. Well locations are shown in Figure 2-20, and coordinates for the wells are listed in Appendix C.

Samples of groundwater/leachate from boreholes in the landfill were analyzed for strontium 89 + 90, and elevated concentrations (7 pCi/ℓ) appeared in (Woodward-Clevenger, 1974). All other samples of groundwater/leachate contained strontium 89 + 90 at concentrations less than 1 pCi/ℓ. The detection limit of the analytical method for strontium 89 + 90 at the time was 0.1 pCi/ℓ. Strontium 89 + 90 was analyzed in the landfill ponds, drainages, and the groundwater intercept system and was generally found at background levels. These data are discussed in Section 2.3.4.

The concentrations of tritium detected in groundwater/leachate during 1973 are shown in Figure 2-20. The highest measured concentration of tritium was 301,609 pCi/ℓ, centered within the 100 pCi/ℓ contour shown in Figure 2-20. The coordinates of the well from which this highest reading was obtained were 20,015 feet east and 39,535 feet north (Rocky Flats coordinates). The depth of the tritium source, total activity, configuration, and container, if any, were not determined. The tritium source is located in an area of the landfill used in 1970. The wells near the eastern end of the landfill exhibited decreasing tritium concentrations. No information is available regarding abandonment of these wells. Tritium concentrations in surface water are discussed in Section 2.3.4.

In summary, the nature of contamination contained within the landfilled wastes can be assessed on the basis of historical records and the 1986 and 1987 solid and hazardous waste stream characterizations. Some data are available on tritium and strontium 89 + 90 in the landfill leachate and east and west pond water. The pond data indicate a reduction in radioactive contaminants with time. Additional analytical data are available for




## EXPLANATION

- TRITIUM CONCENTRATION CONTOURS, DASHED WHERE APPROXIMATELY LOCATED (IN THOUSANDS OF pCi/l)
- GROUNDWATER INTERCEPT SYSTEM
- SLURRY WALLS
- SURFACE WATER DRAINAGE DITCH
- INDIVIDUAL HAZARDOUS SUBSTANCE SITE AREAS
- DIRT ROADS
- TRITIUM SAMPLING LOCATIONS
- SURFACE WATER IMPOUNDMENTS

NOTE: BACKGROUND (UPPER TOLERANCE INTERVAL) FOR TRITIUM IS .359 pCi/l.

0 feet 200 400

CONTOUR INTERVAL = 20 FEET

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# CONCENTRATIONS OF TRITIUM IN PRESENT LANDFILL LEACHATE 1973

Figure 2-20

groundwater/leachate, surface water, and borehole samples from within and around the landfilled materials (as discussed in the following sections). Although water level data from wells located within the groundwater intercept system (Wells 6387, 6487, and B206189) indicate that the groundwater/leachate is beneath the waste material, waste and fill materials located toward the center of the landfill are likely saturated. The volume of fill and waste material in the landfill is currently estimated to be 405,000 cubic yards. However, no information is available on the volume of leachate in the Present Landfill or the volumes of saturated and unsaturated landfilled material.

### 2.3.2 Soils

Analytical data for daily soil cover and fill material at the Present Landfill are limited to chemical analyses of samples obtained during drilling of Wells B106089, B206189, B206389, and B206789. Analyses performed on samples from the first three wells include total metals, volatile organic compounds (VOCs), and selected inorganic parameters (nitrate/nitrite, sulfide, and pH). Additionally, radiochemical analyses were performed on one sample from the upper 6 feet of Well B106089. Samples from Well B206789 were analyzed only for nitrate/nitrite, sulfide, pH, and cesium-137. Analytical data are presented in Appendix F. The sample identification numbers are also indicated on the borehole logs (Appendix D).

Concentrations of inorganic parameters were typically below the detection limits for these analytes. Values for pH ranged from 7.7 to 9.0 and showed no consistent trend. No analytes exceeding sitewide background values were detected in any of the samples from Well B206789.

Radionuclides detected in Well B106089 include plutonium-239, tritium, uranium-233,234, and uranium-238. However, none of these radionuclides were detected at concentrations exceeding the sitewide background values presented in the Background Geochemical Characterization Report (EG&G, 1991f).

VOCs were not detected in any samples from Wells B206189 or B206389. In Well B106089, VOCs were detected only in samples of fill material. Detections of VOCs in borehole samples from Well B106089 are listed in Table 2-7. VOCs detected include acetone, 2-butanone, methylene chloride, toluene, and xylenes (total).

There were numerous occurrences of total metals concentrations exceeding sitewide background values (Table 2-8). In Well B106089, elevated concentrations of metals are associated with a clayey layer in the upper portion of the Rocky Flats Alluvium (approximately 17 to 21.5 feet). In Well B206189, elevated metals are associated with the upper portion of the weathered Arapahoe formation claystone at a depth of 20 to 26.9 feet. In Well B206389, elevated metals occur primarily in the top 3 feet of fill material. At a depth of 14 to 20 feet, elevated metals (barium, copper, and iron) were detected in the upper portion of the weathered Arapahoe formation claystone.

Analytical data have not been obtained for the purpose of characterizing contaminated soil at the Inactive Hazardous Waste Storage Area or at spray irrigation areas located adjacent to the East Landfill Pond. Additionally no information exists to characterize contamination in sediments in the (now buried) West Landfill Pond or in sediments in the East Landfill Pond.

### 2.3.3 Groundwater

Because few data exist on direct characterization of the soils and source at the Present Landfill, a comparison of upgradient and downgradient groundwater quality data has been used to (1) identify potential contaminants within the landfill, (2) assess potential migration pathways, (3) evaluate the impact of the groundwater intercept system on the movement of groundwater/leachate, and (4) preliminarily assess potential contributions of contaminants from other IHSSs in OU6.

The following summary of groundwater quality is based on the 1988, 1989, and 1990 Annual RCRA Groundwater Monitoring Reports for Regulated Units at Rocky Flats Plant (Rockwell International, 1989b; EG&G, 1990a; and EG&G, 1991d). Appendices A-4 and A-5 to the 1990 Annual RCRA Groundwater Monitoring report for Regulated Units at Rocky Flats Plant (EG&G, 1991d) list analytical results for the sampling completed for 1990.

Monitoring of groundwater quality in the uppermost aquifer beneath the Present Landfill (an interim status waste management unit) complies with Colorado Hazardous Waste Act Regulations 6CCR 1007-3, Subpart F, Section 265.90, for RCRA. Monitoring wells in the vicinity of OU7 are shown in Figure 2-5 and are listed in Table 2-1, which includes pertinent information regarding the purpose of the well, unit monitored, total depth, etc. For RCRA groundwater quality monitoring at the Present Landfill, the "uppermost aquifer" is defined as the geologic formation nearest the natural ground surface that is an aquifer and lower aquifers that are hydraulically interconnected with this aquifer within the boundary of the facility. The uppermost aquifer in the vicinity of the Present Landfill comprises surficial deposits, weathered bedrock, and lenses of weathered or unweathered sandstone that may be subcropping beneath the regulated unit.

In the 1990 RCRA Groundwater Monitoring Report, groundwater quality data from the monitoring wells were compared to background groundwater quality data for the uppermost aquifer, as defined in the 1990 RFP Background Geochemical Characterization Report (EG&G, 1991f) to evaluate the impact of the landfill on groundwater quality. The Geochemical Characterization Report established background chemical quality based on samples collected at stations located in buffer zone areas west, north, and south of the plant site. Chemical data for each sample medium were classified into groups by geographic location (all media) and by lithology (groundwater and boreholes). Summary statistics were computed for each of these groups. Statistical methods used to define the groups included multivariate analysis of variance, parametric and non-parametric analysis of variance, multiple comparison testing, and tests of proportions. Various summary statistics were

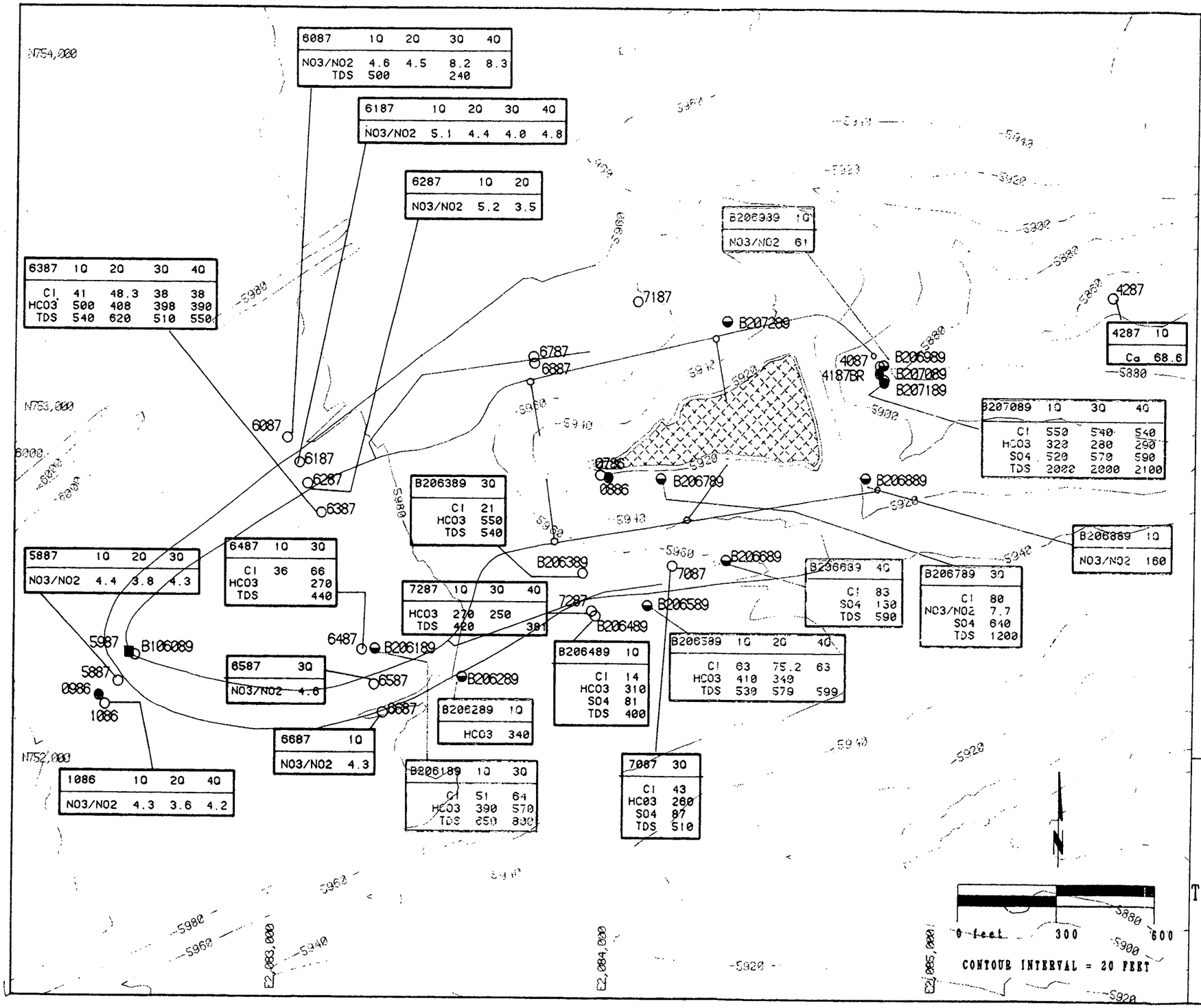
computed for each chemical data set within each group, including mean, standard deviation, upper tolerance limit, maximum concentration, sample size, and percentage of detectable concentrations. Tolerance intervals are the principal statistics used to characterize the chemistry of background stations at RFP. To evaluate environmental degradation resulting from past work practices at RFP, data from non-background areas may be compared to background values. When analyte concentrations in the monitoring wells exceed the tolerance intervals, or the maximum detected value when there are insufficient data to calculate a tolerance interval, contamination may be indicated.

However, to accurately characterize contamination within OU7 and to comply with RCRA, site-specific definitions of background groundwater quality should be developed using chemical data from wells located immediately upgradient of OU7. At present, only alluvial Well 1086 and bedrock Well 0986 are located immediately upgradient of the landfill. Data from these wells are insufficient to account for potential variability in upgradient groundwater quality in these units. Additionally, no upgradient well monitors groundwater quality in the weathered bedrock or individual sandstone lenses in the Arapahoe formation. Therefore, additional monitoring wells are needed to establish site-specific background for groundwater in the units upgradient of OU7.

#### 2.3.3.1 Surficial Groundwater Quality

Concentrations of analytes in monitoring wells located in and around the landfill exceeding background values during 1990 are shown in Figures 2-21 through 2-24. Although the groundwater quality in surficial and bedrock materials is discussed separately below, analytical data for both units are presented together because these units are hydraulically connected.

Inorganic analytes that exceed sitewide background include nitrate/nitrite, bicarbonate, chloride, sulfate, and TDS (Figure 2-21). Concentrations of nitrate exceeded sitewide background concentrations in many of the wells during 1990. However, nitrate




# EXPLANATION

WELL NUMBER — QUARTER SAMPLED

| 6887 | 30 |
|---|---|
| Cu | 0.231 |
| Ni | 0.084 |
| Zn | 0.599 |

ANALYTE — ANALYTE CONCENTRATION

- ALLUVIAL WELL
- WEATHERED BEDROCK WELL
- UNWEATHERED BEDROCK WELL
- DECOMMISSIONED WELL
- LANDFILL STRUCTURES
- EAST LANDFILL POND

Alluvial well data are shown in black
Weathered bedrock well data are shown in green

All concentrations are given in milligrams per liter (mg/L)

Upper Tolerance Interval or Maximum Background Concentration - Uppermost Flow System

| | |
|---|---|
| Cl | 10.6 |
| HCO3 | 249.4 |
| NO3/NO2 | 3.4 |
| SO4 | 67.1 |
| TDS | 388.7 |

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# INORGANIC ANALYTES ABOVE BACKGROUND IN THE UPPERMOST AQUIFER 1990

FIGURE 2-21

concentrations also exceeded background concentrations in alluvial Well 10-86, located immediately upgradient of the landfill. Therefore, elevated concentrations of nitrate/nitrite may not necessarily represent contamination from the landfill. Dissolved metals exceeding sitewide background concentrations include primarily calcium, barium, magnesium, sodium, zinc, copper, chromium, iron, manganese, and nickel and, to a lesser extent aluminum, silver, arsenic, cobalt, lead, mercury, and selenium (Figure 2-22). Dissolved radiochemical parameters exceeding sitewide background concentrations include americium-241, cesium-137, and uranium-233, 234 (Figure 2-23). VOCs exceeding sitewide background (defined as the detection limit for VOCs) include 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), tetrachloroethylene (PCE), 1,2-dichloroethylene (DCE), vinyl chloride, 1,2-dichloroethane (DCA), acetone, methylene chloride, and carbon tetrachloride (Figure 2-24). Generally, VOC concentrations are low and sporadic in occurrence. The cause of the variability in concentrations of VOCs is not known. VOCs detected most frequently (three of four quarters) at the landfill include TCE and its degradation products 1,1,1-TCA and 1,2-DCE. Acetone and methylene chloride were detected frequently in laboratory quality control (QC) blanks. Insufficient data exist to evaluate potential laboratory contamination for the first and second quarters of 1990. However, during the third and fourth quarters of 1990, methylene chloride was detected in 12 of 24 and 12 of 29 QC blanks, respectively, and acetone was detected in 9 of 24 and 3 of 29 QC blanks, respectively. Therefore, these analytes may represent laboratory contamination rather than actual groundwater quality.

Based on inorganic parameters exceeding background levels, groundwater quality at Wells 63-87, 7087, 65-87, 72-87, 58-87, 66-87, 67-87, 71-87, B106089, and B206489 indicates potential contamination from the landfill. Three of these wells are located in the landfilled wastes. Groundwater at all other wells completed in the Rocky Flats Alluvium did not appear degraded (EG&G, 1990a and 1991d).

### 2.3.3.2 Bedrock Groundwater Quality

The distributions of inorganic analytes, dissolved metals, dissolved radionuclides, and VOCs that exceed sitewide background values in bedrock units are presented in Figures 2-21, 2-22, 2-23, and 2-24, respectively.

Wells B206189, B206289, B206689, B206789, B206889, B206989, and B207289 were installed in 1989 to monitor groundwater within weathered claystone at the Present Landfill. Inorganic and dissolved metal analytes exceeding sitewide background concentrations were detected in all wells screened in weathered claystone, except for Well B207289, which was dry during 1990. Analytes typically included nitrate/nitrite, chloride, bicarbonate, TDS, calcium, magnesium, and sodium. In addition, elevated concentrations of aluminum, barium, nickel, and silver were detected in Well B206189 during 1990. Uranium was detected in Well B206689 at a concentration (20 pCi/ℓ) that was almost two orders of magnitude greater than that detected in any alluvial well, but this value has not yet been validated. VOCs were not detected in any wells completed in weathered claystone, except for B206189, in which 1,1-DCA was detected during the fourth quarter of 1990 at a concentration equal to the detection limit of 5 micrograms per liter (μg/ℓ).

Groundwater quality in weathered sandstone at the Present Landfill is monitored in Wells B206589 and B207089. Concentrations of bicarbonate, TDS, and chloride in groundwater at both wells exceed sitewide background concentrations for these analytes. Additionally, the concentration of sulfate (520 mg/ℓ) in Well B207089 is above the background value of 67 mg/ℓ established for this analyte.

Concentrations of bicarbonate, chloride, and TDS in Well B206589 are similar but slightly higher in magnitude to concentrations of the same analytes in alluvial groundwater from Well 7287. Inorganic data are not available for Well 7087, which is also located in the vicinity of Well B206589. Alluvial and weathered sandstone water quality in the vicinity of Well B207089 cannot be compared because only one quarter of the inorganic data are

available for Well 4087. VOCs were not detected in either of these wells, suggesting that groundwater quality in weathered sandstone in the vicinity of these wells has not been impacted by the landfill.

#### 2.3.3.3 Summary of Groundwater Impacts

Groundwater quality data collected in and adjacent to the landfill during 1990 indicate that concentrations of major inorganic ions, dissolved metals, dissolved radionuclides, and VOCs in surficial materials exceed sitewide background concentrations. Naturally occurring analytes detected at elevated concentrations include nitrate/nitrite, bicarbonate, chloride, sulfate, TDS, calcium, chromium, barium, iron, magnesium, manganese, copper, nickel, and zinc. Concentrations of individual VOCs are typically at or near their detection limits and are at least one to two orders of magnitude lower than their respective solubility limits in water. VOCs detected frequently (three of four quarters) in groundwater include TCE, 1,1,1-TCA, and 1,2-DCE.

Limited 1990 analytical data for radionuclides prevent an evaluation of the frequency of these analytes exceeding background concentrations. Americium-241, cesium-137, and uranium-233, 234 have been detected at concentrations exceeding sitewide background levels. However, most radiochemical data have been rejected. Data were rejected because (1) sampling/analytical protocol did not conform to significant aspects of the QA/QC Plan (Rockwell International, 1989a) or (2) there is insufficient documentation to demonstrate conformance with these procedures. These data, at best, can be considered only qualitative measures of the analyte concentrations.

Analytes have been detected at concentrations exceeding sitewide background concentrations in wells located outside of the groundwater barrier systems. The occurrence of these analytes may be due to the emplacement of landfill waste beyond the limit of the groundwater intercept system and slurry walls. Additionally, the source of these analytes may be IHSSs included in OU6 but located adjacent to the landfill. The highest detected

VOC was TCE in Well 6087 at a concentration of 160 $\mu g/\ell$. However, the occurrence of this analyte has not been verified by subsequent sampling and analysis. TCE has also been detected in Wells 7287 (96 $\mu g/\ell$), B206389 (84 $\mu g/\ell$), and B206489 (46 $\mu g/\ell$). These wells are located within or downgradient of IHSS 166.1 in OU6. This IHSS was used from 1964 to 1974 for disposal of sludges from the Sewage Treatment Plant (Building 995). VOCs including TCE, 2-butanone, 1,1,1-TCA, and toluene have been detected in soils from IHSS 166.1 (EG&G, 1991c).

### 2.3.4 Surface Water

Surface water quality information has been obtained from the Present Landfill Hydrogeologic Characterization Report (Rockwell International, 1988c), Present Landfill Area Groundwater/Surface Water Collection Study (EG&G, 1991i), the Draft 1989 Surface Water and Sediment Geochemical Characterization Report (EG&G, 1991e), and the Final Draft Phase I RFI/RI Work Plan Rocky Flats Plant - Walnut Creek Priority Drainage (Operable Unit No. 6) (EG&G, 1991c).

The Present Landfill area is drained by an eastwardl-flowing tributary to North Walnut Creek. The East Landfill Pond is located immediately downstream (east) of the landfill on the tributary in which the landfill is located. This retention pond receives both surface and subsurface flow from the landfill. The confluence of the unnamed tributary and Walnut Creek is approximately 0.7 mile west of the eastern perimeter of RFP.

Tritium and strontium were detected in the drainage of the Present Landfill in September 1973. Two retention ponds were constructed in response to the discovery of these elements (Figure 2-1). The west pond, Pond #1, was installed to impound any leachate generated by the landfill. The east pond, Pond #2, was installed to provide a permanent structure suitable for collection of groundwater flowing from the groundwater intercept system. The landfill leachate drained only to Pond #1. The groundwater intercept system was plumbed with valves so that any collected groundwater could flow to Pond #1 or Pond #2 or be

discharged downgradient of the ponds associated with the landfill. The present status of the valves and diversion of water is unknown. However, because spray operations are ongoing, it is believed that water is diverted into the East Landfill Pond. Pond #1 was removed (buried) in 1981 to allow for eastward expansion of the landfill; Pond #2 is presently collecting leachate from the landfill and surface runoff.

Beginning in 1973, water samples were obtained from both ponds on a monthly basis and analyzed for tritium and strontium. Strontium concentrations from samples obtained from both landfill ponds were reported from 1973 until 1984; results are presented in Table 2-9 (Rockwell International, 1987c). Analytical results indicated that strontium concentrations in samples obtained from both ponds were similar and that, in general, strontium concentrations have decreased from a high in 1973 to a low in 1984. Strontium concentrations listed in Table 2-9 may be compared to the CDH WQCC surface water standard of 8 pCi/ℓ. Tritium concentrations from samples from the West Landfill Pond were reported from 1973 until 1980; results are presented in Table 2-10 (Rockwell International, 1987c). The results indicate that tritium concentrations in the West Landfill Pond decreased from a high during 1973 sampling to substantially lower levels during 1980 sampling, the last year that the west pond was in existence. Concentrations of tritium during 1980 were approximately equal to the CDH GWCC surface water standard of 500 pCi/ℓ. Comparison of gross alpha, gross beta, tritium, nitrate, pH, total organic carbon (TOC), conductivity, chemical oxygen demand (COD), metals, and TDS data indicate the water quality of both ponds to be similar (Rockwell International, 1988a).

There are four permanent locations where surface water is monitored in the vicinity of the landfill. Surface water station SW097 is located at the eastern slope of the landfill, where leachate from the landfill is seeping into the East Landfill Pond, and is used to monitor the landfill leachate. Surface water station SW098 is located at the eastern shore of the East Landfill Pond and is used to monitor the quality of water in the landfill pond. Surface water station SW099 is located downstream of the landfill pond where the north arm of the groundwater intercept system discharges. Surface water station SW100 is located

downstream of the landfill pond where the south arm of the groundwater intercept system discharges. Surface water stations SW099 and SW100 are used to monitor the quality of water discharging from the groundwater intercept system. The locations of surface water monitoring stations are plotted in Figure 2-5.

These four stations are sampled on a monthly basis as part of the surface water quality monitoring program at RFP. The mean concentrations for selected analytes that were detected during 1989 sampling at the four monitoring stations and the sitewide background limits (where available) are presented in Table 2-11. The data used to construct this table were obtained from the Draft 1989 Surface Water and Sediment Geochemical Characterization Report (EG&G, 1991e).

Table 2-11 is used for comparison of the relative quality of the waters being sampled. All measured field parameters, selected anions and indicators, selected total metals, selected total radioisotopes, selected semivolatiles, and selected volatiles are listed. Soluble metals and radioisotopes are not presented. Total metals, total radioisotopes, semivolatiles, and volatile compounds that were not detected in at least one of the stations are not presented.

The data presented in Table 2-11 indicate that the leachate contains elevated concentrations of semivolatile and volatile compounds that are not detected at the other sampling locations. The mean concentrations of total metals and total radiochemical analytes in the leachate (SW097) are typically greater than in the pond (SW098). Metal and radiochemical analytes have likely been incorporated into the pond sediments. (No analytical data are available for sediments in the East Landfill Pond.) The mean concentration for bicarbonate, magnesium, and sodium exceeded the sitewide background concentrations at SW097 and SW098. The mean concentrations for calcium and zinc exceeded the background concentration at SW097. The mean concentrations for carbonate as $CaCO_3$, sulfate, and uranium-235 exceeded sitewide background concentrations at SW098.

A comparison of the two groundwater intercept system discharge points indicated that the southern outlet (SW100) contributes consistently more chemically degraded water than the northern outlet (SW099). The mean concentrations for bicarbonate, magnesium, calcium, sulfate, uranium-233, 234, uranium-238, and sodium exceeded the sitewide background concentrations at SW099 and SW100. The mean concentrations for potassium, selenium, strontium, and uranium-235 exceeded sitewide background concentrations at SW100. The occurrence of elevated analytes in SW100 may be the result of landfill waste present on the outside (intercept side) of the intercept system. Alternately, IHSSs located adjacent to the landfill but included in OU6 may contain sources that contribute analytes to groundwater that is then intercepted along the south side of the landfill and discharged at SW100.

A comparison of RFP landfill leachate with typical municipal landfill leachate indicates that it is fairly dilute and is typically near the minimum concentrations of detected pollutants in municipal landfill leachate (EG&G, 1991i).

### 2.3.5 Air

Disposal of solid waste by landfilling can create conditions in which gases are produced. If unconfined, these gases can either be vented to the atmosphere or migrate through the soil. Typical components of landfill-generated gas are methane, hydrogen sulfide, and carbon dioxide. Other gases may also be present as a result of the types of wastes disposed.

A soil-gas survey was conducted at the landfill to evaluate the levels of methane and hydrogen sulfide being generated. The results of the survey, which are presented in Appendix A, did not indicate significant methane or hydrogen sulfide generation at the landfill. Readings from the portable gas chromatograph used in the survey did indicate the presence of other compounds, which were neither identified nor quantified as part of the survey. However, because sampling methodology was not documented, the usability of these data is questionable.

## 2.4 SITE CONCEPTUAL MODEL

This section develops a site conceptual model based on the site physical characteristics and nature of contamination discussed in Sections 2.2 and 2.3. A site conceptual model is intended to describe known and suspected sources of contamination, types of contamination, affected media, contaminant migration pathways, and environmental receptors. The site conceptual model is used to assist in identifying sampling needs to obtain information for evaluating risks to human health and potential remedial alternatives.

Figure 2-25 shows the elements of a generic site conceptual model. The elements of the site conceptual model for OU7 are discussed below and are depicted in Figure 2-26.

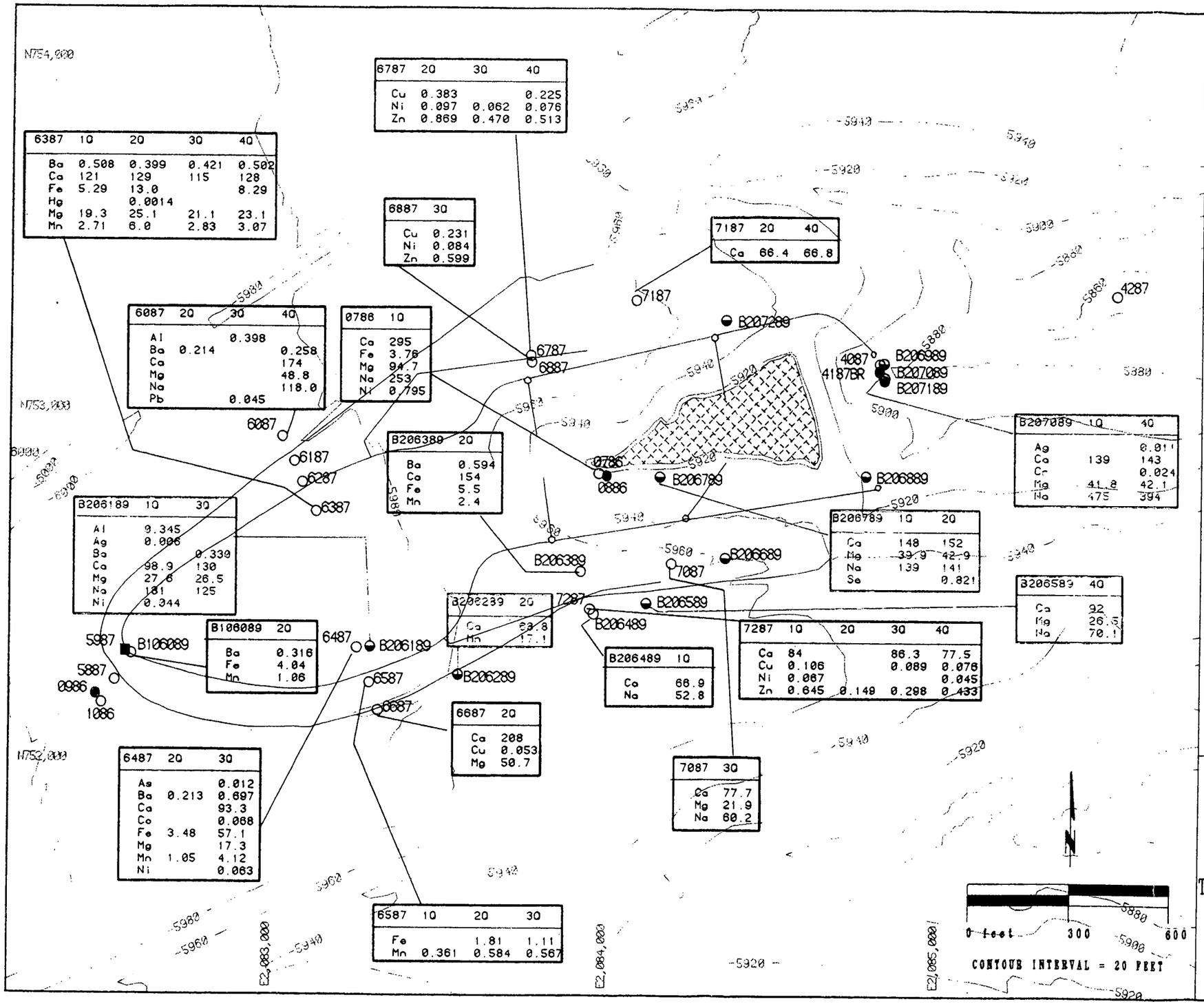
### 2.4.1 Sources of Contamination

The primary source of contamination at the Present Landfill (IHSS 114) is landfilled wastes and leachate. Secondary sources of contamination include (1) soils and other geologic material beneath the landfill that may have been contaminated by leachate, (2) leachate seeping from the landfill, (3) surface water in the East Landfill Pond, (4) sediments in the East Landfill Pond, and (5) potentially contaminated surficial soils in the spray areas.

At the Inactive Hazardous Waste Storage Area (IHSS 203), the primary source of contamination is potentially contaminated soil near the ground surface.

### 2.4.2 Types of Contamination

Little direct characterization of the types of contaminants in the landfill has been conducted to-date. Most of what is known is based on waste stream identification studies (Section 2.3.1) and groundwater, soil, and surface water quality monitoring. As discussed in Section 2.3.3, groundwater monitoring has indirectly identified a number of potential contaminants in the landfill. Groundwater at the landfill appears to contain elevated concentrations of




# EXPLANATION

WELL NUMBER — QUARTER SAMPLED

ANALYTE — ANALYTE CONCENTRATION

| 6887 | 3Q |
|---|---|
| Cu | 0.231 |
| Ni | 0.084 |
| Zn | 0.599 |

- ALLUVIAL WELL
- WEATHERED BEDROCK WELL
- UNWEATHERED BEDROCK WELL
- DECOMMISSIONED WELL
- LANDFILL STRUCTURES
- EAST LANDFILL POND

Alluvial well data are shown in black
Weathered bedrock well data are shown in green

All concentrations are given in milligrams per liter (mg/L)

Upper Tolerance Interval or Maximum Background Concentration - Uppermost Flow System

| | | | |
|---|---|---|---|
| Al | 0.327 | Hg | 0.0008 |
| Ag | 0.004 | Mg | 16.08 |
| As | 0.010 | Mn | 0.210 |
| Ba | 0.200 | Na | 46.74 |
| Ca | 62.59 | Ni | 0.043 |
| Co | 0.050 | Pb | 0.040 |
| Cr | 0.020 | Se | 0.221 |
| Cu | 0.048 | Zn | 0.141 |
| Fe | 0.944 | | |

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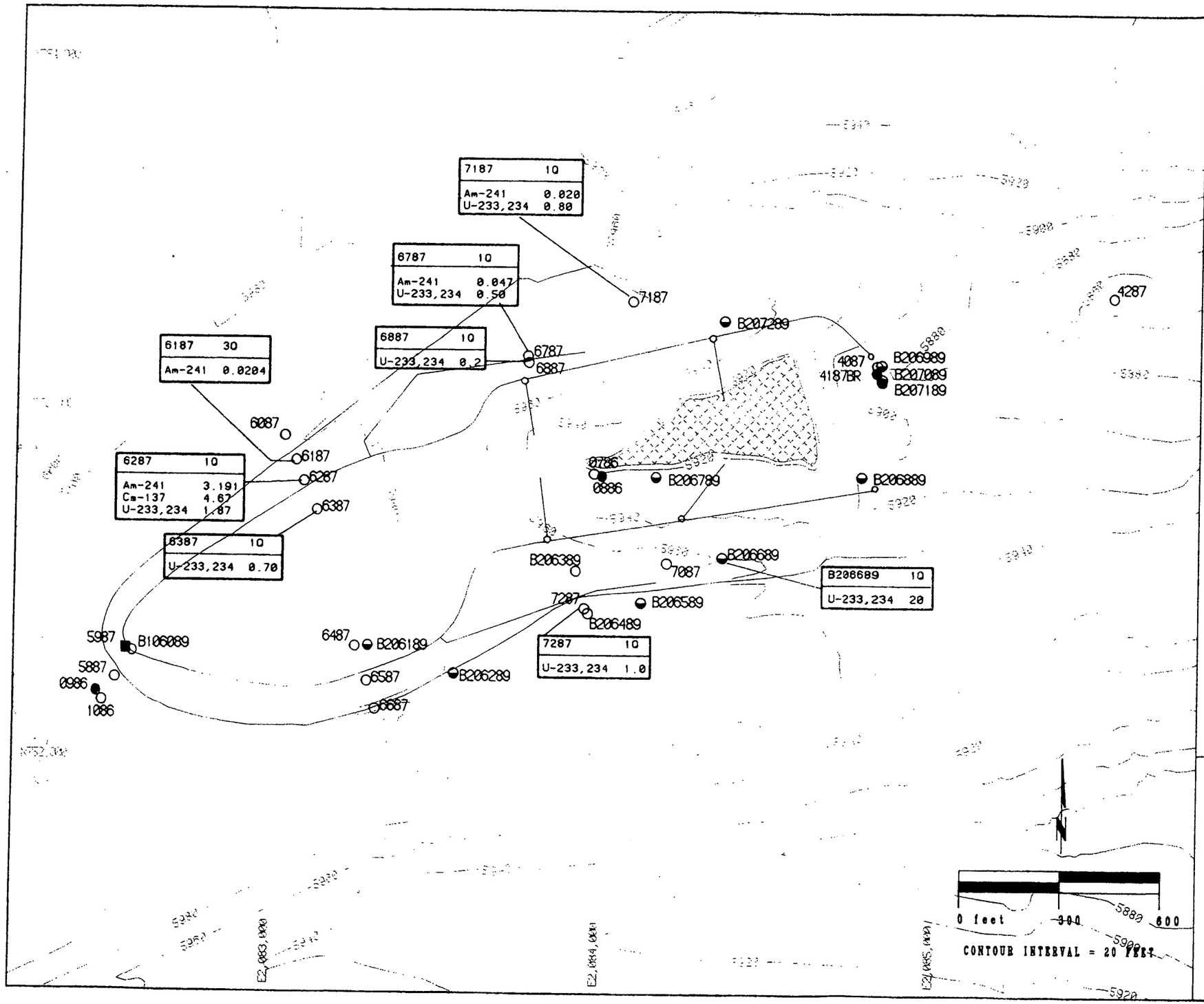
# DISSOLVED METALS ABOVE BACKGROUND IN THE UPPERMOST AQUIFER 1990

FIGURE 2-22




## EXPLANATION

WELL NUMBER — QUARTER SAMPLED

| 6887 | 30 |
|---|---|
| Cu | 0.231 |
| Ni | 0.084 |
| Zn | 0.599 |

ANALYTE — ANALYTE CONCENTRATION

- ALLUVIAL WELL
- WEATHERED BEDROCK WELL
- UNWEATHERED BEDROCK WELL
- DECOMMISSIONED WELL
- LANDFILL STRUCTURES
- EAST LANDFILL POND

Alluvial well data are shown in black

Weathered bedrock well data are shown in green

All concentrations are given in picocuries per liter (pCi/L)

Upper Tolerance Interval or Maximum Background Concentration - Uppermost Flow System

| | |
|---|---|
| Am-241 | 0.017 |
| Cs-137 | 0.506 |
| U-233,234 | 0.1 |

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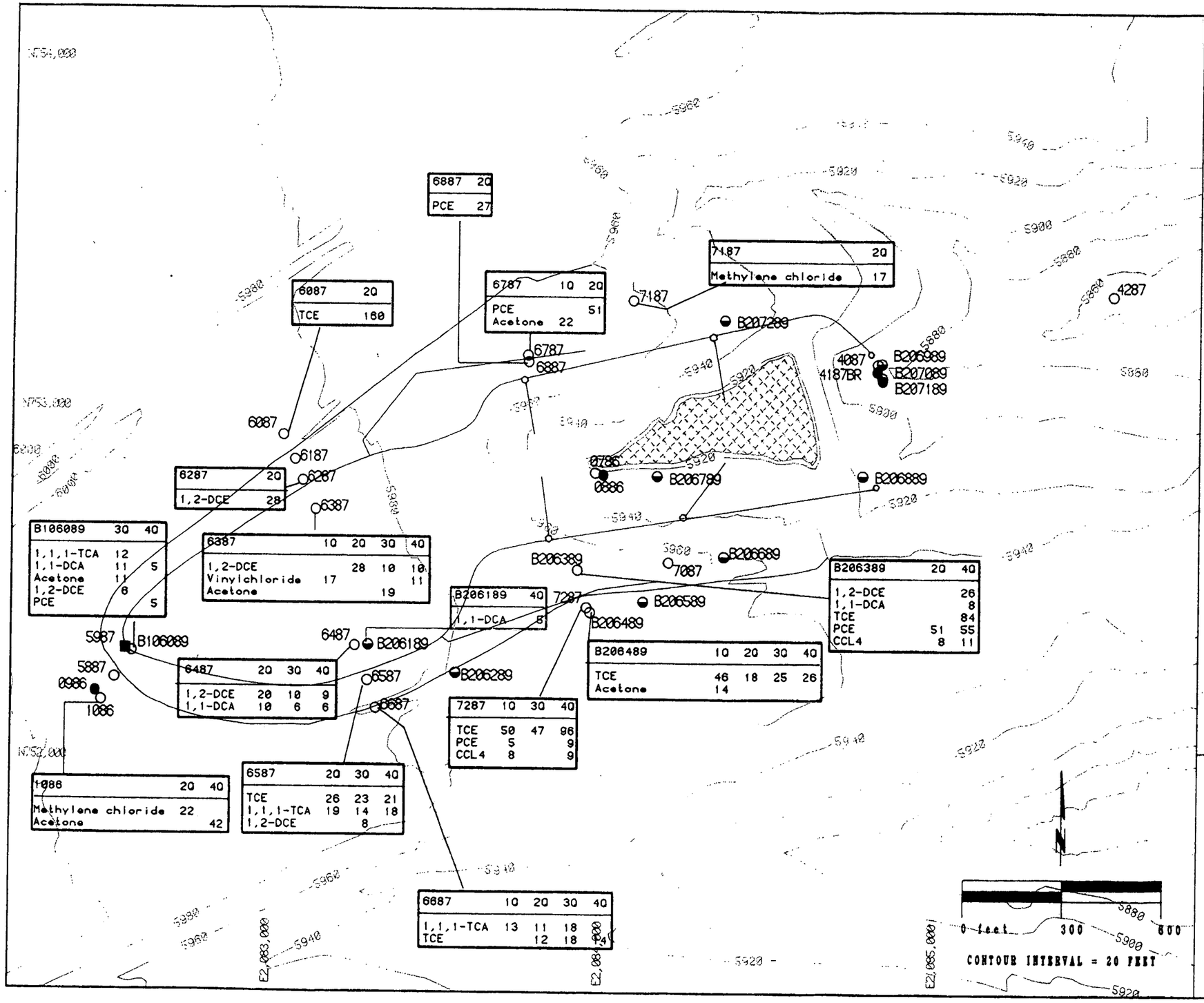
# DISSOLVED RADIONUCLIDES ABOVE BACKGROUND IN THE UPPERMOST AQUIFER, 1990

**FIGURE 2-23**




## EXPLANATION

WELL NUMBER — QUARTER SAMPLED

| 6887 | 30 |
|---|---|
| Cu | 0.231 |
| Ni | 0.084 |
| Zn | 0.599 |

ANALYTE — ANALYTE CONCENTRATION

- 6087 — ALLUVIAL WELL
- B106089 — WEATHERED BEDROCK WELL
- 0986 — UNWEATHERED BEDROCK WELL
- 5987 — DECOMMISSIONED WELL
- LANDFILL STRUCTURES
- EAST LANDFILL POND

Alluvial well data are shown in black

Weathered bedrock well data are shown in green

All concentrations are given in micrograms per liter (ug/L)

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# VOLATILE ORGANIC COMPOUNDS DETECTED IN THE UPPERMOST AQUIFER, 1990

FIGURE 2-24

# Generic Site Conceptual Model

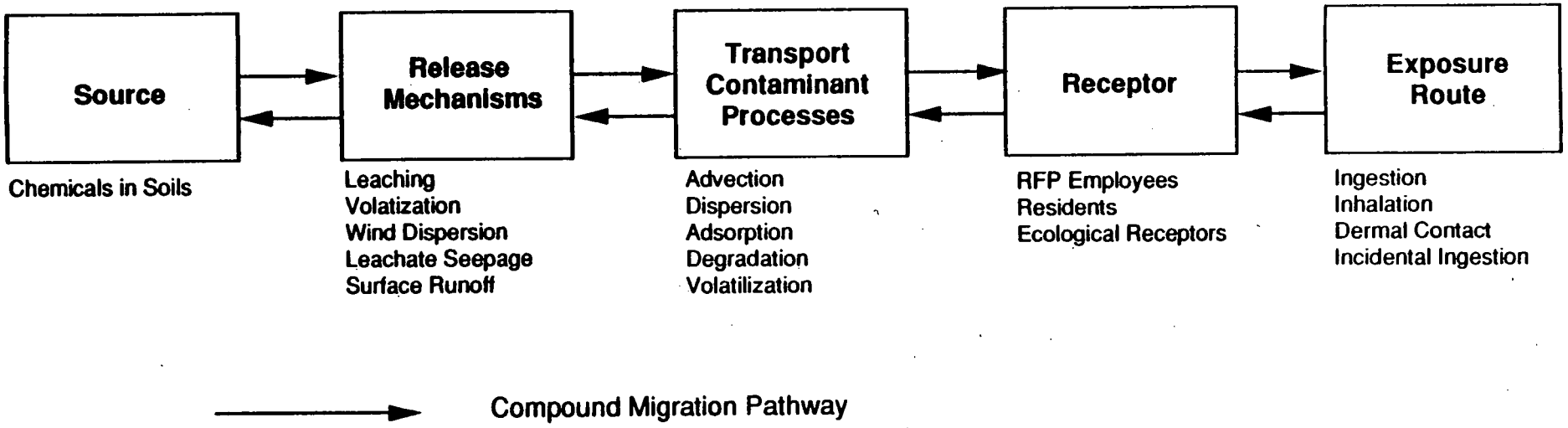
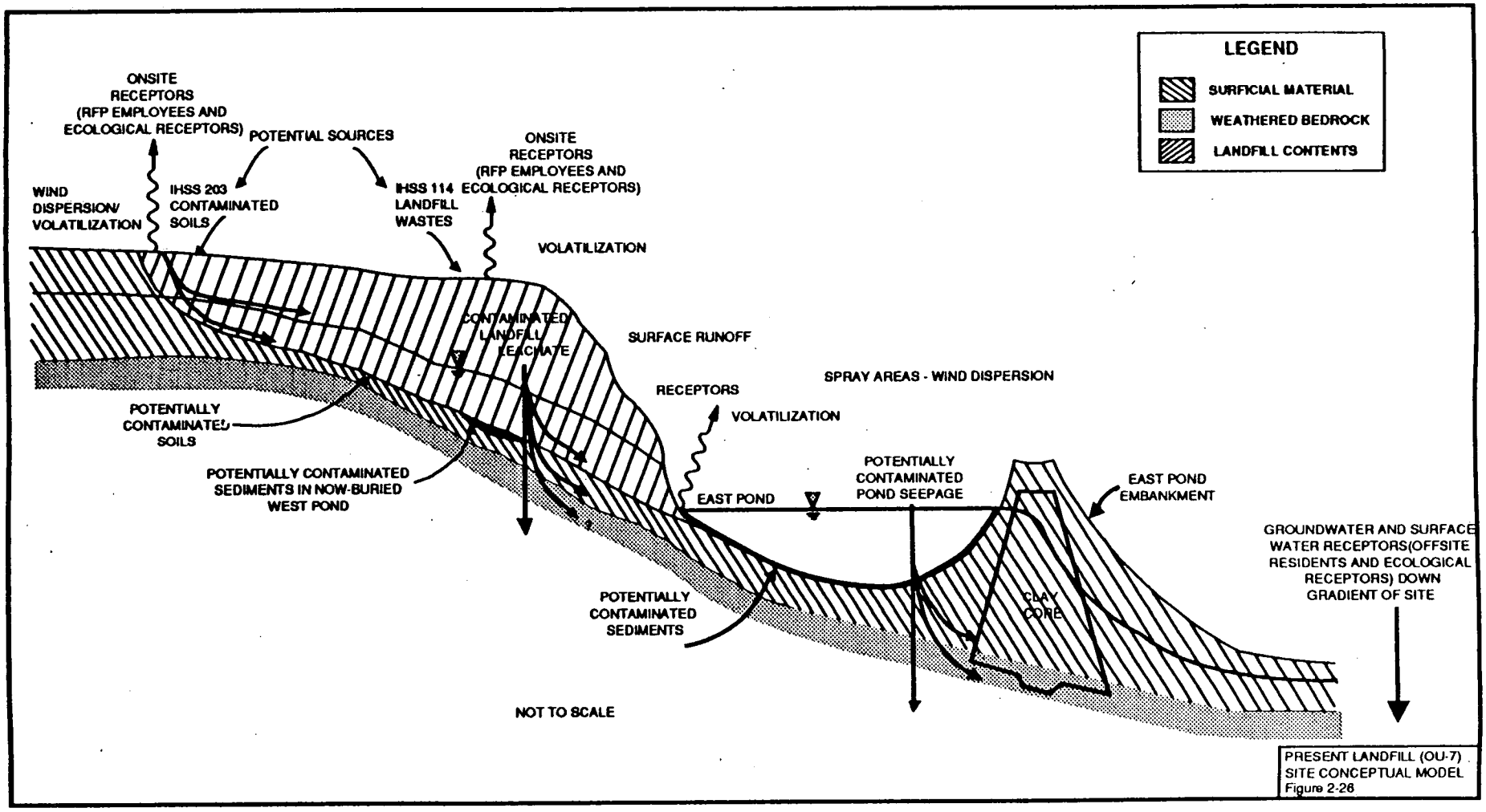



Figure 2-25


LEGEND
SURFICIAL MATERIAL
WEATHERED BEDROCK
LANDFILL CONTENTS
ONSITE RECEPTORS (RFP EMPLOYEES AND ECOLOGICAL RECEPTORS)
POTENTIAL SOURCES
ONSITE RECEPTORS (RFP EMPLOYEES AND ECOLOGICAL RECEPTORS)
WIND DISPERSION/ VOLATILIZATION
IHSS 203 CONTAMINATED SOILS
IHSS 114 LANDFILL WASTES
VOLATILIZATION
CONTAMINATED LANDFILL LEACHATE
SURFACE RUNOFF
SPRAY AREAS - WIND DISPERSION
RECEPTORS
VOLATILIZATION
POTENTIALLY CONTAMINATED SOILS
POTENTIALLY CONTAMINATED SEDIMENTS IN NOW-BURIED WEST POND
POTENTIALLY CONTAMINATED POND SEEPAGE
EAST POND
EAST POND EMBANKMENT
GROUNDWATER AND SURFACE WATER RECEPTORS(OFFSITE RESIDENTS AND ECOLOGICAL RECEPTORS) DOWN GRADIENT OF SITE
POTENTIALLY CONTAMINATED SEDIMENTS
CLAY CORE
NOT TO SCALE
PRESENT LANDFILL (OU-7) SITE CONCEPTUAL MODEL
Figure 2-26

VOCs, dissolved metals, radionuclides, and dissolved inorganic analytes. Concentrations of VOCs in groundwater are typically sporadic in occurrence and at or slightly above the detection limits for individual analytes. The concentrations of VOCs in both groundwater and leachate from the landfill seep (SW097) are orders of magnitude lower than the solubility limits for individual compounds. Therefore, nonaqueous phase liquids are not expected within the landfill source.

Surface water draining into the East Landfill Pond contains volatile and semivolatile organic compounds, metals, radionuclides, and major inorganic analytes. Sediments in the pond are not well characterized but are expected to contain elevated concentrations of metals, radionuclides, and volatile and semivolatile organic compounds.

The presence or absence of soil contamination at IHSS 203 has not been completely characterized. Historical information indicates that organic liquids and PCBs were stored on site and that radioactive materials were not stored at IHSS 203. Discussions with RFP personnel indicate that spills larger than reportable volumes did not occur at IHSS 203.

Potential soil contamination in areas where spray irrigation occurred consists of metals, radionuclides, and major inorganic analytes detected in the East Landfill Pond. Volatile and semivolatile compounds are not expected in these soils because these analytes are not present in East Landfill Pond water sprayed over these areas. Additionally, these analytes are not expected because they would volatilize during spraying.

### 2.4.3 Release Mechanisms

Contaminants in the landfill may have impacted the soil and bedrock beneath the landfill and the groundwater within and downgradient of the landfill. Groundwater within the landfill has migrated into the East Landfill Pond and potentially into the drainage downstream of it, thereby affecting the quality of surface water and sediment.

The potential generation and/or migration of gases in the landfill could impact air quality. Previous soil-gas surveys detected only low concentrations of methane and organic compounds, which were not identified. However, the usability of these data is limited because documentation of sampling techniques was inadequate. Organic vapors were detected by air quality monitoring equipment while drilling and installing boreholes; therefore, gas generation is likely, and volatilization of gases may represent a release mechanism.

The primary mechanism for release of contaminants from the Present Landfill into the affected media is infiltration of water through the wastes and then out of the landfill. Groundwater occurs within the landfill as a result of infiltration of precipitation and also possibly from infiltration of groundwater through or beneath the perimeter groundwater diversion system. Groundwater flow exiting the wastes can then distribute contamination vertically downward and laterally downgradient. Secondary release mechanisms include the runoff of precipitation, migration of landfill gases either laterally or to the ground surface, and percolation of water through contaminated soils. The primary mechanism for release of contaminants from IHSS 203 is likely to be wind dispersal of gases or soil particles contaminated with sorbed metals, PCBs, and possibly radionuclides (although not expected). An additional release mechanism at IHSS 203 consists of infiltration of precipitation through potentially contaminated soils. Because spills were intermittent and low in volume, enhanced migration in groundwater due to cosolvation with organic compounds is not expected. Metals, PCBs, and radionuclides (if present) are likely sorbed to clayey material in shallow soils. The primary mechanism for release of contaminants from the spray areas is likely to be wind dispersal of contaminated soil particles. An additional release mechanism consists of infiltration of precipitation through potentially contaminated soils in the areas where spray evaporation occurred.

### 2.4.4 Contaminant Migration Pathways

The two primary potential pathways of migration for contaminants related to the primary release mechanisms described above are alluvial and bedrock groundwater flow. The primary exposure pathways to a receptor are, therefore, either by seepage (where groundwater flow intersects the ground surface) or by water supply wells tapping the affected groundwater downgradient of the landfill. Exposure pathways for IHSS 203 and the spray fields include (1) wind dispersal of contaminated surface soils or soil gas and (2) surface water runoff and sediment transport.

### 2.4.5 Receptors and Exposure Routes

Receptors are the populations exposed to contaminants at potential points of contact with a contaminated medium. Human receptors include primarily plant workers, and secondarily residents living near RFP, who may be exposed to windblown contaminated soil, landfill gases, or contaminated groundwater and surface water. There are three potential exposure routes to a receptor: ingestion, inhalation, and dermal contact.

The elements of the site conceptual model for OU7 described above are shown in Figure 2-26, which depicts sources of contamination, mechanisms of contaminant release, potential contamiant migration pathways, and receptors. The model as pictured is based on an initial evaluation of preliminary data. As additional information is obtained, the overall model and specific portions of the model (for example, the landfill leachate flow regime) may be refined or expanded to address the issues of concern.

This is a

CONTROLLED DOCUMENT

ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203

Manual No.: 21100-WP-OU 07.01
Section No.: 3.0, R0

RISKID — ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT DEPARTMENT

Organization: Environmental Management

This is a RED Stamp

Title: Applicable or Relevant and Appropriate Requirements (ARARS)

Approved by:

12/6/91
Effective Date

J. P. O'Rourke
Manager

6/23/92
Date

# 3.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section provides a preliminary identification of potential chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for surface water and groundwater at OU7. The summary of potential sitewide ARARs presented is based on current federal and state health and environmental statutes and regulations. The ARARs presented are not specific to OU7 because insufficient validated data exist to justify inclusion or exclusion of specific constituents. The preliminary identification and examination of potential ARARs will provide for the use of appropriate analytical detection limits during the RFI/RI. As data become available during the Phase I RFI/RI, specific ARARs will be proposed for OU7. Location-specific ARARs will be addressed in the RFI/RI report. The Corrective Measures Study (CMS)/Feasibility Study (FS) report will further address chemical-specific ARARs as well as action- and location-specific ARARs in the development and evaluation of remedial alternatives.

## 3.1 THE ARAR BASIS

Section 121 (d) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires that Superfund-financed, enforcement, and federal facility remedial actions comply with federal ARARs or more stringent promulgated state requirements. CDH Water Quality Control Commission (WQCC) groundwater standards (Regulation 3.12.0 [5CCR 1002-8]) became effective on April 30, 1991, and are therefore considered in the process for developing potential sitewide ARARs for RFP.

## 3.2 THE ARAR PROCESS

A screening and analysis process will be used to determine which of the potential ARARs will be applied to OU7. The analysis will address compliance with chemical-, location-, and action-specific ARARs in accordance with the National Contingency Plan (NCP). The screening process will consider relevant and appropriate requirements in the same manner as applicable requirements. When more than one ARAR is identified, the more stringent of the applicable ARARs will be used.

The first step in identifying potential ARARs will occur after the initial scoping and site characterization and will involve analysis of the chemicals present at the site and any location-specific characteristics at the site. After the chemicals have been identified, the presence or absence of chemical-specific ARARs will be determined. Chemical-specific ARARs will be derived primarily from federal and state health and environmental statutes and regulations, including the following:

- Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) applicable to both surface water and groundwater

- Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC) potentially applicable to surface water and alluvial groundwater

- RCRA, Subpart F, Groundwater Concentration Limits (40 CFR 264.94) applicable to groundwater

- CDH surface water standards for Woman Creek and Walnut Creek (5 CCR 1002-8, Section 3.8.29, Final Rule Effective March 30, 1990) applicable to surface water

- CDH WQCC proposed statewide and classified groundwater area standards (5 CCR 1002-8, Section 3.11) effective April 30, 1991

A summary of chemical-specific standards or potential ARARs (based on the above regulations and contaminants that may be found potentially sitewide) is presented in Table 3-1, "Groundwater Quality Standards," Table 3-2, "Federal Surface Water Quality Standards," and Table 3-3, "State Surface Water Quality Standards." These potential chemical-specific ARARs and accompanying regulations will be screened to determine their jurisdictional requirements and applicability to OU7. If the requirements are not applicable, they will be further screened to determine whether they are relevant and appropriate to the particular site-specific conditions at OU7. Where ARARs do not exist for a particular chemical or where existing ARARs are not protective of human health and the environment, to-be-considered (TBC) criteria (such as guidance, proposed standards, and advisories developed by EPA, other federal agencies, or states) will be evaluated for use. Where ARARs or TBC criteria are not available or are less than laboratory practical quantitation limits (PQLs), PQLs will be used. For any parameters to be analyzed in groundwater, surface water, or soil and for which no ARARs or TBCs were found, use of the methods that achieve the detection limits provided in the General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G, 1991j), which are CLP contract-required quantitation limits, should enable meaningful interpretation of sample results. In addition, whenever a potential standard is below the GRRASP-derived detection limit, the detection limit will be used as the standard. Risk-based concentrations taken from the baseline risk assessment will be used in establishing the remediation goals for the parameters for which no potential ARARs could be identified, thus ensuring environmental protectiveness.

### 3.2.1 ARARs

"Applicable requirements," as defined in 40 CFR 300.5, are "those 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 circumstances 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, are "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." The most stringent promulgated standards are applied as ARARs (Preamble to NCP, 55 FR 8741). According to the NCP (40 FR 300.400(g)(4)), the term "promulgated" means that standards are of general applicability and are legally enforceable.

### 3.2.2 TBCs

In addition to ARARs, advisories, criteria, or guidance may be identified as 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. Use of TBCs is discretionary rather than mandatory, as is the case with ARARs.

### 3.2.3 ARAR Categories

In general, there are three categories of ARARs:

1. Ambient or chemical-specific requirements

2. Location-specific requirements

3. Performance, design, or other action-specific requirements

ARARs are generally considered to be dynamic in nature in that they evolve from general to very specific in the CERCLA site cleanup process. Initially, during the RFI/RI work plan stage, probable chemical-specific ARARs may be identified, usually on the basis of limited data. Chemical-specific ARARs at this point have meaning only in that they can be used to ensure that appropriate detection limits have been established so that data collected in the RFI/RI will be amenable for comparison to ARAR standards. It is also appropriate to identify location-specific ARARs early in the RFI/RI process so that information can be gathered to determine whether restrictions can be placed on the concentrations of hazardous substances or on the conduct of an activity solely because it occurs in a special location. As discussed in the introductory paragraph of this section, detailed, location-specific ARARs will be proposed in the RFI/RI report. Identification of action-specific ARARs and remediation goals is part of the feasibility study process and will be addressed in the CMS/FS report. Chemical-specific ARARs may be deleted if they are found to be inappropriate at any time in the RFI/RI process. Deletion of chemical-specific ARARs will be based on analytical information obtained from sampling at OU7.

One medium for which chemical-specific ARARs do not currently exist is soils; however, some chemical-related, action-specific requirements do exist, such as Colorado's construction standard for plutonium in soils. Relative to chemical-specific ARARs, a risk assessment will be performed to determine acceptable contaminant concentrations in soils to ensure environmental "protectiveness." At this time, with respect to establishing analytical detection limits for soil, use of method detection limits provided in GRRASP (EG&G, 1991j), which are contract laboratory program (CLP) required quantitation limits, should enable meaningful interpretation of soil sample results.

For appropriate management of investigation-derived wastes, as required in the IAG, (Attachment 2, Statement of Work, Section IV) DOE has developed standard operating procedure (SOPs) for field investigation activities. All waste generated by the various investigations conducted at RFP will follow SOPs approved by EPA and CDH. The SOPs satisfy the IAG requirement to comply with ARARs as they relate to investigation activities. This approach is consistent with EPA policy as provided in the *Draft Guide to Management of Investigation-Derived Waste* (U.S. EPA, 1991a).

### 3.2.4 Remedial Action

CERCLA Section 121 specifically requires attainment of all ARARs. Moreover, as explained in the preamble to the NCP (55 FR 8741), in order to attain all ARARs, a remedial action must comply with the most stringent requirement, which then ensures attainment of all other ARARs. Furthermore, CERCLA requires that the remedies selected attain ARARs and be protective of human health and the environment. Remediation goals will be based on the baseline risk assessment to be conducted for protection of human health and the environment.

## TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## GROUNDWATER QUALITY STANDARDS (ug/l)

| | | | | FEDERAL STANDARDS | | | | | STATE STANDARDS (TBCs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CDH WQCC Groundwater Quality Standards (d) | | | | | | | |
| | | | | | | | | | Statewide | Site-Specific (g) | | | | | | |
| Parameter | Type (5) | PQL MDL | Method (9) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | RCRA Subpart F Concentration Limit (40CFR264.94) (c) | Tables A & B (d) | Table 1 Human Health | Table 2 Secondary Drinking | Table 3 Agriculture | Table 4 TDS | Table 5 Chronic | Table 6 Radionuclides Woman Creek | Table 6 Radionuclides Walnut Creek |
| Bicarbonate | A | 10 | E310.1 | | | | | | | | | | | | | |
| Carbonate | A | 10 | E310.1 | | | | | | | | | | | | | |
| Chloride | A | 5 | E325 | 250,000 • | | | | | | | 250,000 | | | | | |
| Fluoride | A | 5 | E340 | 4,000; 2,000• | | 4,000 | | | | 4,000 | | 2,000 | | | | |
| N as Nitrate | A | 5 | E353.1 | 10,000 | | | 10,000 | | | 10,000 | | | | | | |
| N as Nitrate+Nitrite | A | 5 | E353.1 | | 10,000 | | 10,000 | | | | | 100,000 | | | | |
| N as Nitrite | A | 5 | E354.1 | | 1,000 | | 1,000 | | | 1,000 | | 10,000 | | | | |
| Sulfate | A | 5 | E375.4 | 250,000• | | | | | | | 250,000 | | | | | |
| Sulfide | A | | | | | | | | | | | | | | | |
| Coliform (total) | B | 1 | SM9221C | 1/100 ml | | | | | | 1/100 ml | | | | | | |
| Ammonia as N | C | 5 | E350 | | | | | | | | | | | | | |
| Dioxin | D | | d | | | | | | 0.00000022 (7) | | | | | 0.000000013 | | |
| Sulfur | E | 100,000 | E600 | | | | | | | | | | | | | |
| Dissolved Oxygen | FP | 0.5 | SM4500 | | | | | | | | | | | | | |
| pH | FP | 0.1 | E150.1 | 6.5-8.5 • | | | | | | | 6.5-8.5 | 6.5-8.5 | | | | |
| Specific Conductance | FP | 1 | E120.1 | | | | | | | | | | | | | |
| Temperature | FP | | | | | | | | | | | | | | | |
| Boron | I | 5 | E6010 | | | | | | | | | 750 | | | | |
| Total Dissolved Solids | I | 10 | E160.1 | 500,000• | | | | | | | | | 400,000 (1) | | | |
| Aluminum | M | 200 | CT | | 50 to 200• | | | | | | | 5,000 | | | | |
| Antimony | M | 60 | CT | | | | | | | | | | | | | |
| Arsenic | M | 10 | CT | 50 | | | | 50 | | 50 | | 100 | | | | |
| Arsenic III | M | | | | | | | | | | | | | | | |
| Arsenic V | M | | | | | | | | | | | | | | | |
| Barium | M | 200 | CT | 1,000 | 2,000 (e) | | 2,000 (e) | 1,000 | | 1,000 | | | | | | |
| Beryllium | M | 5 | CT | | | | | | | | | 100 | | | | |

## TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## GROUNDWATER QUALITY STANDARDS (ug/l)

| | | | | FEDERAL STANDARDS | | | | | STATE STANDARDS (TBCs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CDH WQCC Groundwater Quality Standards (d) | | | | | | | |
| | | | | | | | | | Statewide | Site-Specific (g) | | | | | | |
| Parameter | Type (5) | PQL MDL | Method (6) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | RCRA Subpart F Concentration Limit (40CFR264.94) (c) | Tables A & B (d) | Table 1 Human Health | Table 2 Secondary Drinking | Table 3 Agriculture | Table 4 TDS | Table 5 Chronic | Table 6 Radionuclides Woman Creek | Table 6 Radionuclides Walnut Creek |
| Cadmium | M | 5 | CT | 10 | 5 | | 5 | 10 | | 10 | | 10 | | | | |
| Calcium | M | 5,000 | CT | | | | | | | | | | | | | |
| Cesium | M | 1,000 | NC | | | | | | | | | | | | | |
| Chromium | M | 10 | CT | 50 | 100 | | 100 | 50 | | 50 | | 100 | | | | |
| Chromium III | M | 5 | SW8467196 | | | | | | | | | | | | | |
| Chromium VI | M | 10 | E218.5 | | | | | | | | | | | | | |
| Cobalt | M | 50 | CT | | | | | | | | | 50 | | | | |
| Copper | M | 25 | CT | 1,000 • | | | 1300 (f) | | | | 1,000 | 200 | | | | |
| Cyanide | M | 10 | CT | | | | | | | 200 | | | | | | |
| Iron | M | 100 | CT | 300 • | | | | | | | 300 | 5,000 | | | | |
| Lead | M | 5 | CT | 50 | | | 0 (f) | 50 | | 50 | | 100 | | | | |
| Lithium | M | 100 | NC | | | | | | | | | 2,500 | | | | |
| Magnesium | M | 5000 | CT | | | | | | | | | | | | | |
| Manganese | M | 15 | CT | 50 • | | | | | | | 50 | 200 | | | | |
| Mercury | M | 0.2 | CT | 2 | 2 | | 2 | 2 | | 2 | | 10 | | | | |
| Molybdenum | M | 200 | NC | | | | | | | | | | | | | |
| Nickel | M | 40 | CT | | | | | | | | | 200 | | | | |
| Potassium | M | 5000 | CT | | | | | | | | | | | | | |
| Selenium | M | 5 | CT | 10 | 50 | | 50 | 10 | | 10 | | 20 | | | | |
| Silver | M | 10 | CT | 50 | 100 • | | | 50 | | 50 | | | | | | |
| Sodium | M | 5000 | CT | | | | | | | | | | | | | |
| Strontium | M | 200 | NC | | | | | | | | | | | | | |
| Thallium | M | 10 | CT | | | | | | | | | | | | | |
| Tin | M | 200 | NC | | | | | | | | | | | | | |
| Titanium | M | 10 | E6010 | | | | | | | | | | | | | |
| Tungsten | M | 10 | E6010 | | | | | | | | | | | | | |
| Vanadium | M | 50 | CT | | | | | | | | | 100 | | | | |
| Zinc | M | 20 | CT | 5,000 • | | | | | | | 5,000 | 2,000 | | | | |

# TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## GROUNDWATER QUALITY STANDARDS (ug/l)

| | | | | FEDERAL STANDARDS | | | | | STATE STANDARDS (TBCs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CDH WQCC Groundwater Quality Standards (d) | | | | | | | |
| | | | | | | | | | Statewide | Site-Specific (g) | | | | | | |
| Parameter | Type (5) | PQL MDL | Method (6) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | RCRA Subpart F Concentration Limit (40CFR264.94) (c) | Tables A & B (d) | Table 1 Human Health | Table 2 Secondary Drinking | Table 3 Agriculture | Table 4 TDS | Table 5 Chronic | Table 6 Radionuclides Woman Creek | Table 6 Radionuclides Walnut Creek |
| 2,4,5-TP Silvex | P | | d | 10 | 50 | | 50 | 10 | 10 | | | | | | | |
| 2,4-Dichlorophenoxyacetic acid (2,4-D) | P | | d | 100 | 70 | | 70 | 100 | 100 | | | | | | | |
| Aldicarb | P | | | | 3 (e) | | 1 (e) | | 10 | | | | | | | |
| Aldrin | P | 0.05 | CP | | | | | | 0.002 (7) | | | | | 0.0000784 | | |
| Bromacil | P | | | | | | | | | | | | | | | |
| Carbofuran | P | | d | | 40 | | 40 | | 36 | | | | | | | |
| Chloranil | P | | | | | | | | | | | | | | | |
| Chlordane (alpha) | P | 0.5 | CP | | 2 | | 0 | | 0.03 (7) | | | | | 0.00046 | | |
| Chlordane (gamma) | P | 0.5 | CP | | 2 | | 0 | | 0.03 (7) | | | | | 0.00046 | | |
| DDT | P | 0.1 | CP | | | | | | 0.1 (7) | | | | | 0.000024 | | |
| DDT metabolite (DDD) | P | 0.1 | CP | | | | | | | | | | | | | |
| DDT metabolite (DDE) | P | 0.1 | CP | | | | | | | | | | | | | |
| Demeton | P | | | | | | | | | | | | | | | |
| Diazinon | P | | | | | | | | | | | | | | | |
| Dieldrin | P | 0.1 | CP | | | | | | 0.002 (7) | | | | | 0.000071 | | |
| Endosulfan I | P | 0.05 | CP | | | | | | | | | | | | | |
| Endosulfan II | P | 0.1 | CP | | | | | | | | | | | | | |
| Endosulfan sulfate | P | 0.1 | CP | | | | | | | | | | | | | |
| Endrin | P | 0.1 | CP | 0.2 | | | | 0.2 | 0.2 | | | | | | | |
| Endrin Ketone | P | 0.1 | CP | | | | | | | | | | | | | |
| Guthion | P | | | | | | | | | | | | | | | |
| Heptachlor | P | 0.05 | CP | | 0.4 | | 0 | | 0.008 (7) | | | | | 0.00028 | | |
| Heptachlor Epoxide | P | 0.05 | CP | | 0.2 | | 0 | | 0.004 (7) | | | | | | | |
| Hexachlorocyclohexane, Alpha | P | 0.05 | CP | | | | | | | | | | | 0.0092 | | |
| Hexachlorocyclohexane, Beta | P | 0.05 | CP | | | | | | | | | | | 0.0163 | | |
| Hexachlorocyclohexane, Delta | P | 0.05 | CP | | | | | | | | | | | | | |
| Hexachlorocyclohexane, Technical | P | | f | | | | | | | | | | | 0.0123 | | |
| Hexachlorocyclohexane, Lindane | P | 0.05 | CP | 4 | 0.2 | | 0.2 | 4.0 | 4 | | | | | 0.0186 | | |

# TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## GROUNDWATER QUALITY STANDARDS (ug/l)

| | | | | FEDERAL STANDARDS | | | | | STATE STANDARDS (TBCs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CDH WQCC Groundwater Quality Standards (d) | | | | | | | |
| | | | | | | | | | Statewide | Site-Specific (g) | | | | | | |
| Parameter | Type (5) | PQL MDL | Method (6) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | RCRA Subpart F Concentration Limit (40CFR264.94) (c) | Tables A & B (d) | Table 1 Human Health | Table 2 Secondary Drinking | Table 3 Agriculture | Table 4 TDS | Table 5 Chronic | Table 6 Radionuclides Woman Creek | Table 6 Radionuclides Walnut Creek |
| Malathion | P | | | | | | | | | | | | | | | |
| Methoxychlor | P | 0.5 | CP | 100 | 40 | | 40 | 100 | 100 | 100 | | | | | | |
| Mirex | P | | | | | | | | | | | | | | | |
| Parathion | P | | | | | | | | | | | | | | | |
| PCBs | P | 0.5 | CP | | 0.5 | | 0 | | 0.005 (7) | | | | | 0.000079 | | |
| Simazine | P | | e | | | | | | | | | | | 4.0 | | |
| Toxaphene | P | 1 | CP | | 3 | | 0 | 5.0 | 5 | 5 | | | | | | |
| Vaponite 2 | P | | | | | | | | | | | | | | | |
| Aroclor 1016 | PP | 0.5 | CP | | | | | | | | | | | | | |
| Aroclor 1221 | PP | 0.5 | CP | | | | | | | | | | | | | |
| Aroclor 1232 | PP | 0.5 | CP | | | | | | | | | | | | | |
| Aroclor 1242 | PP | 0.5 | CP | | | | | | | | | | | | | |
| Aroclor 1248 | PP | 0.5 | CP | | | | | | | | | | | | | |
| Aroclor 1254 | PP | 1 | CP | | | | | | | | | | | | | |
| Aroclor 1260 | PP | 1 | CP | | | | | | | | | | | | | |
| Atrazine | PP | | e | | 3 | | 3 | | | | | | | 3.0 | | |
| Americium (pCi/l) | R | | | | | | | | | | | | | | 0.05 | 0.05 |
| Americium 241 (pCi/l) | R | 0.01 | | | | | | | | | | | | | | |
| Cesium 134 (pCi/l) | R | 1 | | | | | | | 80 (2) | | | | | | 80 | 80 |
| Cesium 137 (pCi/l) | R | 1 | | | | | | | | | | | | | | |
| Gross Alpha (pCi/l) | R | 2 | | 15 | | | | | | 15 | | | | | 7 | 11 |
| Gross Beta (pCi/l) | R | 4 | | 50 (4 mrem/yr) | | | | | | 4 mrem/yr | | | | | 5 | 19 |
| Plutonium 238+239+240 (pCi/l) | R | 0.01 | | | | | | | 15 (2) | | | | | | | |
| Plutonium (pCi/l) | R | | | | | | | | | | | | | | 0.05 | 0.05 |
| Radium 226+228 (pCi/l) | R | 0.5/0.1 (4) | | 5 | | | | | 5 (2) | | | | | | | |
| Strontium 89+90 (pCi/l) | R | 1 | | | | | | | | | | | | | | |
| Strontium 90 (pCi/l) | R | | | 8 (3) | | | | | 8 (2) | | | | | | 8 | 8 |
| Thorium 230+232 (pCi/l) | R | | | | | | | | 60 (2) | | | | | | | |

# TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## GROUNDWATER QUALITY STANDARDS (ug/l)

| | | | | FEDERAL STANDARDS | | | | | STATE STANDARDS (TBCs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CDH WQCC Groundwater Quality Standards (d) | | | | | | | |
| | | | | | | | | | Statewide | Site-Specific (g) | | | | | | |
| Parameter | Type (5) | PQL MDL | Method (6) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | RCRA Subpart F Concentration Limit (40CFR264.94) (c) | Tables A & B (d) | Table 1 Human Health | Table 2 Secondary Drinking | Table 3 Agriculture | Table 4 TDS | Table 5 Chronic | Table 6 Radionuclides | |
| | | | | | | | | | | | | | | | Woman Creek | Walnut Creek |
| Tritium (pCi/l) | R | | | 20,000 (3) | | | | | 20,000 (2) | | | | | | 500 | 500 |
| Uranium 233+234 (pCi/l) | R | | | | | | | | | | | | | | | |
| Uranium 235 (pCi/l) | R | 0.6 | | | | | | | | | | | | | | |
| Uranium 238 (pCi/l) | R | 0.6 | | | | | | | | | | | | | | |
| Uranium (total) (pCi/l) | R | | | | | | | | | | | | | | 5 | 10 |
| 1,2,4,5-Tetrachlorobenzene | SV | | b | | | | | | 2 (7) | | | | | | | |
| 1,2,4-Trichlorobenzene | SV | 10 | CS | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene (ortho) | SV | 10 | CS | | 600 | | 600 | | 620 | | | | | | | |
| 1,2-Diphenylhydrazine | SV | | b | | | | | | 0.05 (7) | | | | | | | |
| 1,3-Dichlorobenzene (meta) | SV | 10 | CS | | | | | | 620 | | | | | | | |
| 1,4-Dichlorobenzene (para) | SV | 10 | CS | 75 | | 75 | | | 75 | | | | | | | |
| 2,4,5-Trichlorophenol | SV | 50 | CS | | | | | | 700 | | | | | | | |
| 2,4,6-Trichlorophenol | SV | 10 | CS | | | | | | 2 (7) | | | | | 1.2 | | |
| 2,4-Dichlorophenol | SV | 10 | CS | | | | | | 21 | | | | | | | |
| 2,4-Dimethylphenol | SV | 10 | CS | | | | | | | | | | | | | |
| 2,4-Dinitrophenol | SV | 50 | CS | | | | | | | | | | | | | |
| 2,4-Dinitrotoluene | SV | 10 | CS | | | | | | | | | | | | | |
| 2-Chloronaphthalene | SV | 10 | CS | | | | | | | | | | | | | |
| 2-Chlorophenol | SV | 10 | CS | | | | | | | | | | | | | |
| 2-Methylnaphthalene | SV | 10 | CS | | | | | | | | | | | | | |
| 2-Methylphenol | SV | 10 | CS | | | | | | | | | | | | | |
| 2-Nitroaniline | SV | 50 | CS | | | | | | | | | | | | | |
| 2-Nitrophenol | SV | 10 | CS | | | | | | | | | | | | | |
| 3,3-Dichlorobenzidine | SV | 20 | CS | | | | | | | | | | | | | |
| 3-Nitroaniline | SV | 50 | CS | | | | | | | | | | | | | |
| 4,6-Dinitro-2-methylphenol | SV | 50 | CS | | | | | | | | | | | | | |
| 4-Bromophenyl Phenylether | SV | 10 | CS | | | | | | | | | | | | | |
| 4-Chloroaniline | SV | 10 | CS | | | | | | | | | | | | | |

# TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## GROUNDWATER QUALITY STANDARDS (ug/l)

| | | | | FEDERAL STANDARDS | | | | | STATE STANDARDS (TBCs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CDH WQCC Groundwater Quality Standards (d) | | | | | | | |
| | | | | | | | | | Statewide | Site-Specific (g) | | | | | | |
| Parameter | Type (5) | PQL MDL | Method (6) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | RCRA Subpart F Concentration Limit (40CFR264.94) (c) | Tables A & B (d) | Table 1 Human Health | Table 2 Secondary Drinking | Table 3 Agriculture | Table 4 TDS | Table 5 Chronic | Table 6 Radionuclides Woman Creek | Table 6 Radionuclides Walnut Creek |
| 4-Chlorophenyl Phenyl Ether | SV | 10 | CS | | | | | | | | | | | | | |
| 4-Chloro-3-methylphenol | SV | 10 | CS | | | | | | | | | | | | | |
| 4-Methylphenol | SV | 10 | CS | | | | | | | | | | | | | |
| 4-Nitroaniline | SV | 50 | CS | | | | | | | | | | | | | |
| 4-Nitrophenol | SV | 50 | CS | | | | | | | | | | | | | |
| Acenaphthene | SV | 10 | CS | | | | | | | | | | | | | |
| Anthracene | SV | 10 | CS | | | | | | | | | | | | | |
| Benzidine | SV | | d | | | | | | 0.0002 (7) | 0.1 | | | | 0.00012 | | |
| Benzoic Acid | SV | 50 | CS | | | | | | | | | | | | | |
| Benzo(a)anthracene | SV | 10 | CS | | | | | | | | | | | | | |
| Benzo(a)pyrene | SV | 10 | CS | | | | | | | | | | | | | |
| Benzo(b)fluoranthene | SV | 10 | CS | | | | | | | | | | | | | |
| Benzo(g,h,i)perylene | SV | 10 | CS | | | | | | | | | | | | | |
| Benzo(k)fluoranthene. | SV | 10 | CS | | | | | | | | | | | | | |
| Benzyl Alcohol | SV | 10 | CS | | | | | | | | | | | | | |
| bis(2-Chloroethoxy)methane | SV | 10 | CS | | | | | | | | | | | | | |
| bis(2-Chloroethyl)ether | SV | 10 | CS | | | | | | 0.03 (7) | | | | | 0.0000037 | | |
| bis(2-Chloroisopropyl)ether | SV | 10 | CS | | | | | | | | | | | | | |
| bis(2-Ethylhexyl)phthalate | SV | 10 | CS | | | | | | | | | | | | | |
| Butadiene | SV | | | | | | | | | | | | | | | |
| Butylbenzylphthalate | SV | 10 | CS | | | | | | | | | | | | | |
| Chlorinated Ethers | SV | | | | | | | | | | | | | | | |
| Chlorinated Napthalenes | SV | | | | | | | | | | | | | | | |
| Chloroalkylethers | SV | 10 | CS | | | | | | | | | | | | | |
| Chlorophenol | SV | | | | | | | | | 1 | | | | | | |
| Chrysene | SV | 10 | CS | | | | | | | | | | | | | |
| Dibenzofuran | SV | 10 | CS | | | | | | | | | | | | | |
| Dibenz(a,h)anthracene | SV | 10 | CS | | | | | | | | | | | | | |
| Dichlorobenzenes | SV | | | | | | | | | | | | | | | |

# TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## GROUNDWATER QUALITY STANDARDS (ug/l)

| | | | | FEDERAL STANDARDS | | | | | STATE STANDARDS (TBCs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CDH WQCC Groundwater Quality Standards (d) | | | | | | | |
| | | | | | | | | | Statewide | Site-Specific (g) | | | | | | |
| Parameter | Type (5) | PQL MDL | Method (6) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | RCRA Subpart F Concentration Limit (40CFR264.94) (c) | Tables A & B (d) | Table 1 Human Health | Table 2 Secondary Drinking | Table 3 Agriculture | Table 4 TDS | Table 5 Chronic | Table 6 Radionuclides Woman Creek | Table 6 Radionuclides Walnut Creek |
| Dichlorobenzidine | SV | 20 | CS | | | | | | | | | | | 0.01 | | |
| Diethylphthalate | SV | 10 | CS | | | | | | | | | | | | | |
| Dimethylphthalate | SV | 10 | CS | | | | | | | | | | | | | |
| Dinitrotoluene | SV | 10 | CS | | | | | | | | | | | | | |
| Di-n-butylphthalate | SV | 10 | CS | | | | | | | | | | | | | |
| Di-n-octylphthalate | SV | 10 | CS | | | | | | | | | | | | | |
| Ethylene glycol | SV | | d | | | | | | 7,000 | | | | | | | |
| Fluoranthene | SV | 10 | CS | | | | | | | | | | | | | |
| Fluorene | SV | 10 | CS | | | | | | | | | | | | | |
| Formaldehyde | SV | | | | | | | | | | | | | | | |
| Haloethers | SV | | | | | | | | | | | | | | | |
| Hexachlorobenzene | SV | 10 | CS | | | | | | 0.02 (7) | | | | | 0.00072 | | |
| Hexachlorobutadiene | SV | 10 | CS | | | | | | 14 | | | | | 0.45 | | |
| Hexachlorocyclopentadiene | SV | 10 | CS | | | | | | 49 | | | | | | | |
| Hexachloroethane | SV | 10 | CS | | | | | | | | | | | 1.9 | | |
| Hydrazine | SV | | | | | | | | | | | | | | | |
| Indeno(1,2,3-cd)pyrene | SV | 10 | CS | | | | | | | | | | | | | |
| Isophorone | SV | 10 | CS | | | | | | 1,050 | | | | | | | |
| Naphthalene | SV | 10 | CS | | | | | | | | | | | | | |
| Nitrobenzene | SV | 10 | CS | | | | | | 3.5 (7) | | | | | | | |
| Nitrophenols | SV | | | | | | | | | | | | | | | |
| Nitrosamines | SV | | | | | | | | | | | | | | | |
| Nitrosodibutylamine | SV | | b | | | | | | | | | | | 0.0064 | | |
| Nitrosodiethylamine | SV | | b | | | | | | | | | | | 0.0008 | | |
| Nitrosodimethylamine | SV | | b | | | | | | | | | | | 0.0014 | | |
| Nitrosopyrrolidine | SV | | b | | | | | | | | | | | 0.016 | | |
| N-Nitrosodiphenylamine | SV | 10 | CSb | | | | | | | | | | | 4.9 | | |
| N-Nitroso-di-n-dipropylamine | SV | 10 | CSb | | | | | | | | | | | | | |
| Pentachlorinated Ethanes | SV | | b | | | | | | | | | | | | | |

## TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## GROUNDWATER QUALITY STANDARDS (ug/l)

| | | | | FEDERAL STANDARDS | | | | | STATE STANDARDS (TBCs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CDH WQCC Groundwater Quality Standards (d) | | | | | | | |
| | | | | | | | | | Statewide | Site-Specific (g) | | | | | | |
| Parameter | Type (5) | PQL MDL | Method (6) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | RCRA Subpart F Concentration Limit (40CFR264.94) (c) | Tables A & B (d) | Table 1 Human Health | Table 2 Secondary Drinking | Table 3 Agriculture | Table 4 TDS | Table 5 Chronic | Table 6 Radionuclides | |
| | | | | | | | | | | | | | | | Woman Creek | Walnut Creek |
| Pentachlorobenzene | SV | | b | | | | | | 6 (7) | | | | | | | |
| Pentachlorophenol | SV | 50 | CS | | 1 (e) | | 0 (e) | | 200 | | | | | | | |
| Phenanthrene | SV | 10 | CS | | | | | | | | | | | | | |
| Phenol | SV | 10 | CS | | | | | | | 1 | | | | | | |
| Phthalate Esters | SV | | | | | | | | | | | | | | | |
| Polynuclear Aromatic Hydrocarbons | SV | | b | | | | | | | | | | | 0.0028 | | |
| Vinyl Chloride | SV | 10 | CV | 2 | | 0 | | | 2 | | | | | | | |
| 1,1,1-Trichloroethane | V | 5 | CV | 200 | | 200 | | | 200 | | | | | | | |
| 1,1,2,2-Tetrachloroethane | V | 5 | CV | | | | | | | | | | | 0.17 | | |
| 1,1,2-Trichloroethane | V | 5 | CV | | | | | | 28 | | | | | | | |
| 1,1-Dichloroethane | V | 5 | CV | | | | | | | | | | | 0.6 | | |
| 1,1-Dichloroethene | V | 5 | CV | 7 | | 7 | | | 7 | | | | | | | |
| 1,2-Dichloroethane | V | 5 | CV | 5 | | 0 | | | 5 | | | | | | | |
| 1,2-Dichloroethene (cis) | V | | a | | 70 | | 70 | | 70 | | | | | | | |
| 1,2-Dichloroethene (total) | V | 5 | CV | | | | | | | | | | | | | |
| 1,2-Dichloroethene (trans) | V | | a | | 100 | | 100 | | 70 | | | | | | | |
| 1,2-Dichloropropane | V | 5 | CV | | 5 | | 0 | | 0.56 (7) | | | | | | | |
| 1,3-Dichloropropene (cis) | V | 5 | CV | | | | | | | | | | | | | |
| 1,3-Dichloropropene (trans) | V | 5 | CV | | | | | | | | | | | | | |
| 2-Butanone | V | 10 | CV | | | | | | | | | | | | | |
| 2-Hexanone | V | 10 | CV | | | | | | | | | | | | | |
| 4-Methyl-2-pentanone | V | 10 | CV | | | | | | | | | | | | | |
| Acetone | V | 10 | CV | | | | | | | | | | | | | |
| Acrylonitrile | V | | c | | | | | | | | | | | 0.058 | | |
| Benzene | V | 5 | CV | 5 | | 0 | | | 5 | | | | | | | |
| Bromodichloromethane | V | 5 | CV | | | | | | | | | | | | | |
| Bromoform | V | 5 | CV | | | | | | | | | | | | | |
| Bromomethane | V | 10 | CV | | | | | | | | | | | | | |

# TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## GROUNDWATER QUALITY STANDARDS (ug/l)

| | | | | FEDERAL STANDARDS | | | | | STATE STANDARDS (TBCs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CDH WQCC Groundwater Quality Standards (d) | | | | | | | |
| | | | | | | | | | Statewide | Site-Specific (g) | | | | | | |
| Parameter | Type (5) | PQL MDL | Method (6) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | RCRA Subpart F Concentration Limit (40CFR264.94) (c) | Tables A & B (d) | Table 1 Human Health | Table 2 Secondary Drinking | Table 3 Agriculture | Table 4 TDS | Table 5 Chronic | Table 6 Radionuclides Woman Creek | Table 6 Radionuclides Walnut Creek |
| Carbon Disulfide | V | 5 | CV | | | | | | | | | | | | | |
| Carbon Tetrachloride | V | 5 | CV | 5 | | 0 | | | 5 | | | | | | | |
| Chlorinated Benzenes | V | 10 | CV/CS | | | | | | | | | | | | | |
| Chlorobenzene | V | 5 | CV/CS | | 100 | | 100 | | 300 | | | | | | | |
| Chloroethane | V | 10 | CV | | | | | | | | | | | | | |
| Chloroform | V | 5 | CV | Tot THM <100** | | | | | Tot THM <100** | | | | | 0.19 | | |
| Chloromethane | V | 10 | CV | | | | | | | | | | | | | |
| Dibromochloromethane | V | 5 | CV | | | | | | | | | | | | | |
| Dichloroethenes | V | | | | | | | | | | | | | | | |
| Ethyl Benzene | V | 5 | CV | | 700 | | 700 | | 680 | | | | | | | |
| Ethylene dibromide | V | | d | | 0.05 | | 0 | | 0.0004 | | | | | | | |
| Ethylene Oxide | V | | | | | | | | | | | | | | | |
| Halomethanes | V | | | 100 | | | | | 100 | | | | | 0.19 | | |
| Methylene Chloride | V | 5 | CV | | | | | | | | | | | | | |
| Pyrene | V | 10 | CS | | | | | | | | | | | | | |
| Styrene | V | 5 | CV | | 100 | | 100 | | | | | | | | | |
| Tetrachloroethanes | V | 5 | CV | | | | | | | | | | | | | |
| Tetrachloroethene | V | 5 | CV | | 5 | | 0 | | 10 | | | | | 0.8 | | |
| Toluene | V | 5 | CV | | 1,000 | | 1,000 | | 2,420 | | | | | | | |
| Trichloroethanes | V | 5 | CV | | | | | | | | | | | | | |
| Trichloroethene | V | 5 | CV | 5 | | 0 | | | 5 | | | | | | | |
| Vinyl Acetate | V | 10 | CV | | | | | | | | | | | | | |
| Xylenes (total) | V | 5 | CV | | 10,000 | | 10,000 | | | | | | | | | |

EXPLANATION OF TABLE

* = secondary maximum contaminant level; TBCs

** = total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane

CDH = Colorado Department of Health
CLP = Contract Laboratory Program
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Limit
RCRA = Resource Conservation and Recovery Act
SDWA = Safe Drinking Water Act
TAL = Target Analyte List
THM = Total Trihalomethanes
TIC = Tentatively Identified Compound
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis
WQCC = Water Quality Control Commission

(1) TDS standard – see Table 4 in (c); standard is 400 mg/l or 1.25 times the background level, whichever is least restrictive
(2) radionuclide standards – see sec. 3.11.5(c)2 in (d)
(3) If both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr.
(4) MDL for Radium 226 is 0.5; MDL for radium 228 is 1
(5) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P=pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(6) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TICs in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.
(7) Standard is below (more stringent than) PQL, therefore PQL is standard.

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of 5/1990)
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective July 30, 1992 (56 Federal Register 3526; 1/30/1991)
(c) NCP, 40 CFR 300; NCP Preamble 55 FR 8764; CERCLA Compliance with Other Laws Manual, EPA/540/G-89/006, August 1988
(d) CDH/Water Quality Control Commission, The Basic Standards for Ground Water, 3.11.0 (5 CCR 1002-8) 1/5/1987 amended 9/11/1990
(e) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective January 1, 1993 (56 FR 30266; 7/1/1991)
(f) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/91) effective 11/6/91.
(g) CDH/Water Quality Control Commission, Classifications and Water Quality Standards for Ground Water, 3.12.0 (3/5/1991).

## TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

| Parameter | Type (f) | PQL MDL | Method (f) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | CWA AWQC for Protection of Aquatic Life/TBCs (c) | | CWA AWQC for Protection of Human Health/TBCs (c) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Acute Value | Chronic Value | Water and Fish Ingestion | Fish Consumption Only |
| Bicarbonate | A | 10 | E310.1 | | | | | | | | |
| Carbonate | A | 10 | E310.1 | | | | | | | | |
| Chloride | A | 5 | E325 | 250,000* | | | | 860,000 | 230,000 | | |
| Flouride | A | 5 | E340 | 4,000; 2,000* | | 4,000 | | | | | 4,000 |
| N as Nitrate | A | 5 | E353.1 | 10,000 | | | 10,000 | | | 10,000 | |
| N as Nitrate+Nitrite | A | 5 | E353.1 | | 10,000 | | 10,000 | | | | |
| N as Nitrite | A | 5 | E354.1 | | 1,000 | | 1,000 | | | | |
| Sulfate | A | 5 | E375.4 | 250,000* | | | | | | | |
| Sulfide | A | | | | | | | | | | |
| Coliform (Fecal) | B | 1 | SM9221C | 1/100 ml | | | | | | | |
| Ammonia as N | C | 5 | E350 | | | | | Criteria are pH and temperature dependent - see criteria document | | | |
| Dioxin | D | | d | | | | | 0.01 | 0.00001 | 0.000000013 | 0.000000014 |
| Sulfur | E | 100,000 | E600 | | | | | | | | |
| Dissolved Oxygen | FP | 0.5 | SM4500 | | | | | 5,000 | | | |
| pH | FP | 0.1 | E150.1 | 6.5-8.5 * | | | | | 6.5-9 | | |
| Specific Conductance | FP | 1 | E120.1 | | | | | | | | |
| Temperature | FP | | | | | | | SS | SS | | |
| Boron | I | 5 | E6010 | | | | | | | | |
| Total Dissolved Solids | I | 10 | E160.1 | 500,000* | | | | SS | SS | 250,000 | |
| Aluminum | M | 200 | CT | | 50 to 200* | | | | | | |
| Antimony | M | 60 | CT | | | | | 9,000 | 1,600 | 146 | 45,000 |
| Arsenic | M | 10 | CT | 50 | | | | | | .0022 | .0175 |
| Arsenic III | M | | | | | | | 360 | 190 | | |
| Arsenic V | M | | | | | | | 850 | 48 | | |
| Barium | M | 200 | CT | 1,000 | 2,000 (f) | | 2,000 (f) | | | 1,000 | |
| Beryllium | M | 5 | CT | | | | | 130 | 5.3 | .0068** | .117** |
| Cadmium | M | 5 | CT | 10 | 5 | | 5 | 3.9 (3) | 1.1 (3) | 10 | |
| Calcium | M | 5,000 | CT | | | | | | | | |

## TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

| Parameter | Type (f) | PQL MDL | Method (g) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | CWA AWQC for Protection of Aquatic Life/TBCs (c) | | CWA AWQC for Protection of Human Health/TBCs (c) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Acute Value | Chronic Value | Water and Fish Ingestion | Fish Consumption Only |
| Cesium | M | 1,000 | NC | | | | | | | | |
| Chromium | M | 10 | CT | 50 | 100 | | 100 | | | | |
| *Chromium III* | M | 5 | *SW8467196* | | | | | 1,700 | 210 | 170,000 | 3,433,000 |
| Chromium VI | M | 10 | E218.5 | | | | | 16 | 11 | 50 | |
| Cobalt | M | 50 | CT | | | | | | | | |
| Copper | M | 25 | CT | 1,000• | | | 1,3000 (f) | 18 (3) | 12 (3) | | |
| Cyanide | M | 10 | CT | | | | | 22 | 5.2 | 200 | |
| Iron | M | 100 | CT | 300 • | | | | | 1,000 | 300 | |
| Lead | M | 5 | CT | 50 | | | 0 (g) | 82 (3) | 3.2 (3) | 50 | |
| Lithium | M | 100 | NC | | | | | | | | |
| Magnesium | M | 5000 | CT | | | | | | | | |
| Manganese | M | 15 | CT | 50 • | | | | | | 50 | 100 |
| Mercury | M | 0.2 | CT | 2 | 2 | | 2 | 2.4 | 0.012 | 0.144 | 0.146 |
| Molybdenum | M | 200 | NC | | | | | | | | |
| Nickel | M | 40 | CT | | | | | 1,400 (3) | 160 (3) | 13.4 | 100 |
| Potassium | M | 5000 | CT | | | | | | | | |
| Selenium | M | 5 | CT | 10 | 50 | | 50 | 20 (e) | 5 (e) | 10 | |
| Silver | M | 10 | CT | 50 | 100 • | | | 4.1 (3) | 0.12 | 50 | |
| Sodium | M | 5000 | CT | | | | | | | | |
| Strontium | M | 200 | NC | | | | | | | | |
| Thallium | M | 10 | CT | | | | | 1,400 (1) | 40 (1) | 13 | 48 |
| Tin | M | 200 | NC | | | | | | | | |
| Titanium | M | 10 | E6010 | | | | | | | | |
| Tungsten | M | 10 | E6010 | | | | | | | | |
| Vanadium | M | 50 | CT | | | | | | | | |
| Zinc | M | 20 | CT | 5,000 • | | | | 120 (3) | 110 (3) | | |
| 2,4,5-TP Silvex | P | | d | 10 | 50 | | 50 | | | | |
| 2,4-Dichlorophenoxyacetic acid (2,4-D) | P | | d | 100 | 70 | | 70 | | | | |
| Aldicarb | P | | | | 3 (f) | | 1 (f) | | | | |

## TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

| Parameter | Type (f) | PQL/ MDL | Method (g) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | CWA AWQC for Protection of Aquatic Life/TBCs (c) | | CWA AWQC for Protection of Human Health/TBCs (c) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Acute Value | Chronic Value | Water and Fish Ingestion | Fish Consumption Only |
| Aldrin | P | 0.05 | CP | | | | | 3.0 | | 0.000074 | 0.000079 |
| Bromacil | P | | | | | | | | | | |
| Carbofuran | P | | d | | 40 | | 40 | | | | |
| Chlordane (alpha) | P | 0.5 | CP | | 2 | | 0 | 2.4 | 0.0043 | 0.00046 | 0.00048 |
| Chlordane (gamma) | P | 0.5 | CP | | 2 | | 0 | 2.4 | 0.0043 | 0.00046 | 0.00048 |
| Cloranil | P | | | | | | | | | | |
| DDT | P | 0.1 | CP | | | | | 1.1 | 0.0011 | 0.000024 | 0.000024 |
| DDT metabolite (DDD) | P | 0.1 | CP | | | | | 0.06 | | | |
| DDT metabolite (DDE) | P | 0.1 | CP | | | | | 1,050 | | | |
| Demeton | P | | | | | | | | 0.1 | | |
| Diazinon | P | | | | | | | | | | |
| Dieldrin | P | 0.1 | CP | | | | | 2.5 | 0.0019 | 0.00007 | 0.000076 |
| Endosulfan I | P | 0.05 | CP | | | | | 0.22 | 0.056 | 74 | 159 |
| Endosulfan II | P | 0.1 | CP | | | | | | | | |
| Endosulfan Sulfate | P | 0.1 | CP | | | | | | | | |
| Endrin | P | 0.1 | CP | 0.2 | | | | 0.18 | 0.0023 | 1 | |
| Endrin Ketone | P | 0.1 | CP | | | | | | | | |
| Guthion | P | | | | | | | | 0.01 | | |
| Heptachlor | P | 0.05 | CP | | 0.4 | | 0 | 0.52 | 0.0038 | 0.00028 | 0.00029 |
| Heptachlor Epoxide | P | 0.05 | CP | | 0.2 | | 0 | | | | |
| Hexachlorocyclohexane, Alpha | P | 0.05 | CP | | | | | | | 0.0092 | 0.031 |
| Hexachlorocyclohexane, Beta | P | 0.05 | CP | | | | | | | 0.0163 | 0.0547 |
| Hexachlorocyclohexane, Delta | P | 0.05 | CP | | | | | | | | |
| Hexachlorocyclohexane, Technical | P | | f | | | | | | | 0.0123 | 0.0414 |
| Hexachlorocyclohexane, (Lindane) Gama | P | 0.05 | CP | 4 | 0.2 | | 0.2 | 2.0 | 0.08 | | |
| Malathion | P | | | | | | | | 0.01 | | |
| Methoxychlor | P | 0.5 | CP | 100 | 40 | | 40 | | 0.03 | 100 | |
| Mirex | P | | | | | | | | 0.001 | | |
| Parathion | P | | | | | | | 0.065 | 0.013 | | |
| PCBs | P | 0.5 | CP | | 0.5 | | 0 | 2.0 | 0.014 | 0.000079 | 0.000079 |

## TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

| Parameter | Type (7) | PQL MDL | Method (8) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | CWA AWQC for Protection of Aquatic Life/TBCs (c) | | CWA AWQC for Protection of Human Health/TBCs (c) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Acute Value | Chronic Value | Water and Fish Ingestion | Fish Consumption Only |
| Simazine | P | | e | | | | | | | | |
| Toxaphene | P | 1 | CP | | 3 | | 0 | 0.73 | 0.0002 | 0.0071 | 0.00073 |
| Vaponite 2 | P | | | | | | | | | | |
| Aroclor 1016 | PP | 0.5 | CP | | | | | | | | |
| Aroclor 1221 | PP | 0.5 | CP | | | | | | | | |
| Aroclor 1232 | PP | 0.5 | CP | | | | | | | | |
| Aroclor 1242 | PP | 0.5 | CP | | | | | | | | |
| Aroclor 1248 | PP | 0.5 | CP | | | | | | | | |
| Aroclor 1254 | PP | 1 | CP | | | | | | | | |
| Aroclor 1260 | PP | 1 | CP | | | | | | | | |
| Atrazine | PP | | e | | 3 | | 3 | | | | |
| | | | | | | | | | | | |
| Americium (pCi/l) | R | | | | | | | | | | |
| Americium 241 (pCi/l) | R | 0.01 | | | | | | | | | |
| Cesium 134 (pCi/l) | R | 1 | | | | | | | | | |
| Cesium 137 (pCi/l) | R | 1 | | | | | | | | | |
| Gross Alpha (pCI/l) | R | 2 | | 15 | | | | | | | 15 |
| Gross Beta (pCi/l) | R | 4 | | 50 (4 mrem/yr) | | | | | | | |
| Plutonium (pCi/l) | R | | | | | | | | | | |
| Plutonium 238+239+240 (pCi/l) | R | 0.01 | | | | | | | | | |
| Radium 226+228 (pCi/l) | R | 0.5/0.1 (4) | | 5 | | | | | | | 5 |
| Strontium 89+90 (pCi/l) | R | 1 | | | | | | | | | |
| Strontium 90 (pCi/l) | R | | | 8 (6) | | | | | | | 8 |
| Thorium 230+232 (pCi/l) | R | | | | | | | | | | |
| Tritium (pCi/l) | R | | | 20,000 (6) | | | | | | | |
| Uranium 233+234 (pCi/l) | R | | | | | | | | | | |
| Uranium 235 (pCi/l) | R | 0.6 | | | | | | | | | |
| Uranium 238 (pCi/l) | R | 0.6 | | | | | | | | | |
| Uranium (total) (pCi/l) | R | | | | | | | | | | |

## TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

| Parameter | Type (7) | PQL MDL | Method (8) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | CWA AWQC for Protection of Aquatic Life/TBCs (c) | | CWA AWQC for Protection of Human Health/TBCs (c) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Acute Value | Chronic Value | Water and Fish Ingestion | Fish Consumption Only |
| 1,2,4,5-Tetrachlorobenzene | SV | | b | | | | | | | 38 | 48 |
| 1,2,4-Trichlorobenzene | SV | 10 | CS | | | | | | | | |
| 1,2-Dichlorobenzene (ortho) | SV | 10 | CS | | 600 | | 600 | | | | |
| 1,2-Diphenylhydrazine | SV | | b | | | | | 270 (1) | | | |
| 1,3-Dichlorobenzene (meta) | SV | 10 | CS | | | | | | | | |
| 1,4-Dichlorobenzene (para) | SV | 10 | CS | 75 | | 75 | | | | | |
| 2,4,5-Trichlorophenol | SV | 50 | CS | | | | | | | 2,800 | |
| 2,4,6-Trichlorophenol | SV | 10 | CS | | | | | | 970 (1) | 1.2 ** | 3.6 ** |
| 2,4-Dichlorophenol | SV | 10 | CS | | | | | 2,020 (1) | 365 (1) | 3,090 | |
| 2,4-Dimethylphenol | SV | 10 | CS | | | | | 2,120 (1) | | | |
| 2,4-Dinitrophenol | SV | 50 | CS | | | | | | | | |
| 2,4-Dinitrotoluene | SV | 10 | CS | | | | | | | 0.11 ** | 9.1 ** |
| 2-Chloronaphthalene | SV | 10 | CS | | | | | | | | |
| 2-Chlorophenol | SV | 10 | CS | | | | | 4,360 (1) | 2,000 (1) | | |
| 2-Methylnaphthalene | SV | 10 | CS | | | | | | | | |
| 2-Methylphenol | SV | 10 | CS | | | | | | | | |
| 2-Nitroaniline | SV | 50 | CS | | | | | | | | |
| 2-Nitrophenol | SV | 10 | CS | | | | | | | | |
| 3,3-Dichlorobenzidine | SV | 20 | CS | | | | | | | 0.01 | 0.02 |
| 3-Nitroaniline | SV | 50 | CS | | | | | | | | |
| 4,6-Dinitro-2-methylphenol | SV | 50 | CS | | | | | | | | |
| 4-Bromophenyl Phenylether | SV | 10 | CS | | | | | | | | |
| 4-Chloroaniline | SV | 10 | CS | | | | | | | | |
| 4-Chlorophenyl Phenyl Ether | SV | 10 | CS | | | | | | | | |
| 4-Chloro-3-methylphenol | SV | 10 | CS | | | | | 30 (1) | | | |
| 4-Methylphenol | SV | 10 | CS | | | | | | | | |
| 4-Nitroaniline | SV | 50 | CS | | | | | | | | |
| 4-Nitrophenol | SV | 50 | CS | | | | | 230 (1) | 150 (1) | | |
| Acenaphthene | SV | 10 | CS | | | | | 1,700 (1) | 520 (1) | | |
| Anthracene | SV | 10 | CS | | | | | | | | |

## TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

| Parameter | Type (7) | PQL MDL | Method (8) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value | CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value | CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion | CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzidine | SV | | d | | | | | 2,500 | | 0.00012 | 0.00053 |
| Benzoic Acid | SV | 50 | CS | | | | | | | | |
| Benzo(a)anthracene | SV | 10 | CS | | | | | | | | |
| Benzo(a)pyrene | SV | 10 | CS | | | | | | | | |
| Benzo(b)fluoranthene | SV | 10 | CS | | | | | | | | |
| Benzo(g,h,i)perylene | SV | 10 | CS | | | | | | | | |
| Benzo(k)fluoranthene | SV | 10 | CS | | | | | | | | |
| Benzyl Alcohol | SV | 10 | CS | | | | | | | | |
| bis(2-Chloroethoxy)methane | SV | 10 | CS | | | | | | | | |
| bis(2-Chloroethyl)ether | SV | 10 | CS | | | | | | | 0.03** | 1.36 ** |
| bis(2-Chloroisopropyl)ether | SV | 10 | CS | | | | | | | 34.7 | 4,360 |
| bis(2-Ethylhexyl)phthalate | SV | 10 | CS | | | | | | | 15,000 | 50,000 |
| Butadiene | SV | | | | | | | | | | |
| Butylbenzylphthalate | SV | 10 | CS | | | | | | | | |
| Chlorinated Ethers | SV | | | | | | | | | | |
| Chlorinated Napthalenes | SV | | | | | | | 1,600 (1) | | | |
| Chloroalkylethers | SV | 10 | CS | | | | | 238,000 (1) | | | |
| Chlorophenol | SV | | | | | | | | | | |
| Chrysene | SV | 10 | CS | | | | | | | | |
| Dibenzofuran | SV | 10 | CS | | | | | | | | |
| Dibenz(a,h)anthracene | SV | 10 | CS | | | | | | | | |
| Dichlorobenzenes | SV | | | | | | | 1,120 (1) | 763 (1) | 400 | 2,600 |
| Dichlorobenzidine | SV | 20 | CS | | | | | | | 0.01 | 0.02 |
| Diethylphthalate | SV | 10 | CS | | | | | | | 350,000 | 1,800,000 |
| Dimethylphthalate | SV | 10 | CS | | | | | | | 313,000 | 2,900,000 |
| Dinitrotoluene | SV | 10 | CS | | | | | 330 (1) | 230 (1) | 70 | 14,300 |
| Di-n-butylphthalate | SV | 10 | CS | | | | | | | | |
| Di-n-octylphthalate | SV | 10 | CS | | | | | | | | |
| Ethylene glycol | SV | | d | | | | | | | | |
| Fluoranthene | SV | 10 | CS | | | | | 3,980 (1) | | 42 | 54 |

## TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

| Parameter | Type (7) | PQL MDL | Method (8) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | CWA AWQC for Protection of Aquatic Life/TBCs (c) | | CWA AWQC for Protection of Human Health/TBCs (c) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Acute Value | Chronic Value | Water and Fish Ingestion | Fish Consumption Only |
| Fluorene | SV | 10 | CS | | | | | | | | |
| Formaldehyde | SV | | | | | | | | | | |
| Haloethers | SV | | | | | | | 380 (1) | 122 (1) | | |
| Hexachlorobenzene | SV | 10 | CS | | | | | | | 0.00072** | 0.00074** |
| Hexachlorobutadiene | SV | 10 | CS | | | | | 90 (1) | 9.3 (1) | 0.45** | 50 ** |
| Hexachlorocyclopentadiene | SV | 10 | CS | | | | | 7 (1) | 5.2 (1) | 206 | |
| Hexachloroethane | SV | 10 | CS | | | | | 980 (1) | 540 (1) | 1.9 | 8.74 |
| Hydrazine | SV | | | | | | | | | | |
| Indeno(1,2,3-cd)pyrene | SV | 10 | CS | | | | | | | | |
| Isophorone | SV | 10 | CS | | | | | 117,000 (1) | | 5,200 | 520,000 |
| Naphthalene | SV | 10 | CS | | | | | 2,300 (1) | 620 (1) | | |
| Nitrobenzene | SV | 10 | CS | | | | | 27,000 (1) | | 19,800 | |
| Nitrophenols | SV | | | | | | | 230 (1) | 150 (1) | | |
| Nitrosamines | SV | | | | | | | 5,850 (1) | | | |
| Nitrosodibutylamine | SV | | b | | | | | | | 0.0064 | 0.587 |
| Nitrosodiethylamine | SV | | b | | | | | | | 0.0008 | 1.24 |
| Nitrosodimethylamine | SV | | b | | | | | | | 0.0014 | 16 |
| Nitrosopyrrolidine | SV | | b | | | | | | | 0.016 | 91.9 |
| N-Nitrosodiphenylamine | SV | 10 | b | | | | | | | 4.9 ** | 16.1 ** |
| N-Nitroso-di-n-dipropylamine | SV | 10 | b | | | | | | | | |
| Pentachlorinated Ethanes | SV | | b | | | | | 7,240 (1) | 1,100 (1) | | |
| Pentachlorobenzene | SV | | b | | | | | | | 74 | 85 |
| Pentachlorophenol | SV | 50 | CS | | 1 (f) | | 0 (f) | 20 (4) | 13 (4) | 1,010 | |
| Phenanthrene | SV | 10 | CS | | | | | | | | |
| Phenol | SV | 10 | CS | | | | | 10,200 (1) | 2,560 (1) | 3,500 | |
| Phthalate Esters | SV | | e | | | | | 940 (1) | 3 (1) | | |
| Polynuclear Aromatic Hydrocarbons | SV | | b | | | | | | | 0.0028** | 0.0311** |
| Vinyl Chloride | SV | 10 | CV | 2 | | 0 | | | | 2 ** | 525 ** |
| 1,1,1-Trichloroethane | V | 5 | CV | 200 | | 200 | | | | 18,400 | 1,030,000 |

## TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

| Parameter | Type (7) | PQL MDL | Method (8) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value | CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value | CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion | CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | V | 5 | CV | | | | | | 2,400 | 0.17** | 10.7 ** |
| 1,1,2-Trichloroethane | V | 5 | CV | | | | | | 9,400 | 0.6** | 41.8 ** |
| 1,1-Dichloroethane | V | 5 | CV | | | | | | | | |
| 1,1-Dichloroethene | V | 5 | CV | 7 | | 7 | | | | | |
| 1,2-Dichloroethane | V | 5 | CV | 5 | | 0 | | 118,000 | 20,000 | 0.94** | 243 ** |
| 1,2-Dichloroethene (cis) | V | | a | | 70 | | 70 | | | | |
| 1,2-Dichloroethene (total) | V | 5 | CV | | | | | | | | |
| 1,2-Dichloroethene (trans) | V | | a | | 100 | | 100 | | | | |
| 1,2-Dichloropropane | V | 5 | CV | | 5 | | 0 | 23,000 | 5,700 | | |
| 1,3-Dichloropropene (cis) | V | 5 | CV | | | | | 6,060 | 244 (1) | 87 | 14,100 |
| 1,3-Dichloropropene (trans) | V | 5 | CV | | | | | 6,060 | 244 (1) | 87 | 14,100 |
| 2-Butanone | V | 10 | CV | | | | | | | | |
| 2-Hexanone | V | 10 | CV | | | | | | | | |
| 4-Methyl-2-pentanone | V | 10 | CV | | | | | | | | |
| Acetone | V | 10 | CV | | | | | | | | |
| Acrylonitrile | V | | c | | | | | 7,500 | 6,000 | 0.058 | 0.65 |
| Benzene | V | 5 | CV | 5 | | 0 | | 5,300 | | 0.66** | 40 ** |
| Bromodichloromethane | V | 5 | CV | | | | | | | | |
| Bromoform | V | 5 | CV | | | | | | | | |
| Bromomethane | V | 10 | CV | | | | | | | | |
| Carbon Disulfide | V | 5 | CV | | | | | | | | |
| Carbon Tetrachloride | V | 5 | CV | 5 | | 0 | | 35,200 (1) | | 0.4** | 6.94 ** |
| Chlorinated Benzenes | V | 10 | CV/CS | | | | | 250 (1) | 50 (1) | | |
| Chlorobenzene | V | 5 | CV/CS | | 100 | | 100 | | | | |
| Chloroethane | V | 10 | CV | | | | | | | | |
| Chloroform | V | 5 | CV | Tot THM<100 (2) | | | | 28,900 (1) | 1,240 (4) | 0.19 ** | 15.7 ** |
| Chloromethane | V | 10 | CV | | | | | | | | |
| Dibromochloromethane | V | 5 | CV | | | | | | | | |
| Dichloroethenes | V | | | | | | | 11,600 (1) | | 0.033** | 1.85 ** |
| Ethyl benzene | V | 5 | CV | | 700 | | 700 | 32,000 (1) | | 1,400 | 3,280 |

## TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

| Parameter | Type (7) | PQL MDL | Method (8) | SDWA Maximum Contaminant Level (a) | SDWA Maximum Contaminant Level TBCs (b) | SDWA Maximum Contaminant Level Goal (a) | SDWA Maximum Contaminant Level Goal TBCs (b) | CWA AWQC for Protection of Aquatic Life/TBCs (c) | | CWA AWQC for Protection of Human Health/TBCs (c) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Acute Value | Chronic Value | Water and Fish Ingestion | Fish Consumption Only |
| Ethylene dibromide | V | | d | | 0.05 | | 0 | | | | |
| Ethylene oxide | V | | | | | | | | | | |
| Halomethanes | V | | | 100 | | | | 11,000 (1) | | 0.19** | 15.7 ** |
| Methylene Chloride | V | 5 | CV | | | | | | | | |
| Pyrene | V | 10 | CS | | | | | | | | |
| Styrene | V | 5 | CV | | 100 | | 100 | | | | |
| Tetrachloroethanes | V | 5 | CV | | | | | 9,320 (1) | | | |
| Tetrachloroethene | V | 5 | CV | | 5 | | 0 | 5,280 (1) | 840 (1) | 0.80** | 8.85 ** |
| Toluene | V | 5 | CV | | 1,000 | | 1,000 | 17,500 (1) | | 14,300 | 424,000 |
| Trichloroethanes | V | 5 | CV | | | | | 18,000 (1) | | | |
| Trichloroethene | V | 5 | CV | 5 | | 0 | | 45,000 (1) | 21,900 (1) | 2.7 ** | 80.7 ** |
| Vinyl Acetate | V | 10 | CV | | | | | | | | |
| Xylenes (total) | V | 5 | CV | | 10,000 | | 10,000 | | | | |

EXPLANATION OF TABLE

♦ = secondary maximum contaminant level, TBCs

♦♦ = Human health criteria for carcinogens reported for three risk levels. Value presented is the 10-5 risk level.

AWQC = Ambient Water Quality Criteria
CLP = Contract Laboratory Program
CWA = Clean Water Act
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Level
SDWA = Safe Drinking Water Act
SS = Species Specific
TAL = Target Analyte List
THM = Total Trihalomethanes

TIC = Tentatively Identified Compound
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis

(1) criteria not developed; value presented is lowest observed effects level (LOEL)
(2) total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(3) hardness dependent criteria
(4) pH dependent criteria (7.8 pH used)
(5) standard is not adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium.
(6) if both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr.
(7) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P=Pesticide; PP=Pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(8) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TIC in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990)
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142 and 143, Final Rule, effective July 30, 1992
(c) EPA, Quality Criteria for Protection of Aquatic Life, 1986
(d) EPA, National Ambient Water Quality Criteria for Selenium - 1987
(e) EPA, National Ambient Water Quality Criteria for Chloride - 1988
(f) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, and 143, Final Rule (56 FR 30266; 7/1/1991) effective 1/1/1993.
(g) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/1991) effective 11/6/1991.

# TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
# STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

| | | | | Statewide Standards (a) | | | | | | | Basin Standards (b) | | Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tables A,B | Table C | | Tables I,II,III (1) | | | | Organics (12) | | Tables A,B | Table C | Table D | Stream Segment Table (8) | | Table 2 Radionuclides | |
| | | | | Carcinogens/ | Aquatic Life | | Aquatic Life | | | | | | | | | | | | |
| Parameter | Type (10) | PQL MDL | Method (11) | Noncarcin-ogens (2) | Acute Value | Chronic Value | Acute Value (2) | Chronic Value (2) | Agricul-tural Standard (3) | Domestic Water Supply (9) | Aquatic Life | Water Supply | (2) | Fish & Water Ingestion | Radio-nuclide | Acute Value | Chronic Value | Woman Creek | Walnut Creek |
| Bicarbonate | A | 10 | E310.1 | | | | | | | | | | | | | | | | |
| Carbonate | A | 10 | E310.1 | | | | | | | | | | | | | | | | |
| Chloride | A | 5 | E325 | | | | | | | 250,000 | | | | | | 3 | 3 | | |
| Fluoride | A | 5 | E340 | | | | | | | 2,000 | | | | | | | | | |
| N as Nitrate | A | 5 | E353.1 | | | | | | 100,000 | 10,000 | | | | | | 10,000 | 10,000 | | |
| N as Nitrate+Nitrite | A | 5 | E353.1 | | | | | | 100,000 | 10,000 | | | | | | | | | |
| N as Nitrite | A | 5 | E354.1 | | | | SS | SS | 10,000 | 1,000 | | | | | | 1,000 | 1,000 | | |
| Sulfate | A | 5 | E375.4 | | | | | | | 250,000 | | | | | | 250,000 | 250,000 | | |
| Sulfide | A | | | | | | | 2 | | 50 | | | | | | | | | |
| Coliform (Fecal) | B | 1 | SM9221C | | | | | | | 2000/100 ml | | | | | | | | | |
| Ammonia as N | C | 5 | E350 | | | | 620 | 60 | | 5,000 | | | | | | 620 | 60 | | |
| Dioxin | D | | d | 0.00000022 (13) | 0.01 | 0.00001 | | | | | | | 0.00000022 (13) | 0.000000013 | | | 0.000000013 | | |
| Sulfur | E | 100,000 | E600 | | | | | | | | | | | | | 2.0 | 2.0 | | |
| Dissolved Oxygen | FP | 0.5 | SM4500 | | | | 5,000 | 5,000 | 3,000 | 3,000 | | | | | | 5,000 | 5,000 | | |
| pH | FP | 0.1 | E150.1 | | | | 6.5-9.0 | 6.5-9.0 | | 5.0-9.0 | | | | | | 6.5-9 | 6.5-9 | | |
| Specific Conductance | FP | 1 | E120.1 | | | | | | | | | | | | | | | | |
| Temperature | FP | | | | | | 30 degrees | 30 degrees | | | | | | | | | | | |
| Boron | I | 5 | E6010 | | | | | | 750 | | | | | | | 750 | 750 | | |
| Total Dissolved Solids | I | 10 | E160.1 | | | | | | | | | | | | | | | | |
| Aluminum | M | 200 | CT | | | | 950 | 150 | | | | | | | | | | | |
| Antimony | M | 60 | CT | | | | | | | | | | | | | | | | |
| Arsenic | M | 10 | CT | | | | 360 | 150 | 100 | 50 | | | | | | 50 | | | |
| Arsenic III | M | | | | | | | | | | | | | | | | | | |
| Arsenic V | M | | | | | | | | | | | | | | | | | | |
| Barium | M | 200 | CT | | | | | | | 1,000 | | | | | | | | | |
| Beryllium | M | 5 | CT | | | | | | 100 | | | | | | | | | | |
| Cadmium | M | 5 | CT | | | | TVS | TVS | 10 | 10 | | | | | | TVS | TVS | | |

# TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
# STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

| | | | | Statewide Standards (a) | | | | | | | Basin Standards (b) | | Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tables A,B | Table C | | Tables I,II,III (1) | | | | Organics (12) | | Tables | Table C | Table D | Stream Segment Table (8) | | Table 2 | |
| | | | | | Aquatic Life | | Aquatic Life | | | | | | | | | | | Radionuclides | |
| Parameter | Type (10) | PQL MDL | Method (11) | Carcinogens/ Noncarcinogens (2) | Acute Value | Chronic Value | Acute Value (2) | Chronic Value (2) | Agricultural Standard (3) | Domestic Water Supply (6) | Aquatic Life | Water Supply | A,B (2) | Fish & Water Ingestion | Radionuclide | Acute Value | Chronic Value | Woman Creek | Walnut Creek |
| Calcium | M | 5,000 | CT | | | | | | | | | | | | | | | | |
| Cesium | M | 1,000 | NC | | | | | | | | | | | | | | | | |
| Chromium | M | 10 | CT | | | | | | | | | | | | | | | | |
| Chromium III | M | 5 | SW8467196 | | | | TVS | TVS | 100 | 50 | | | | | | 50 | | | |
| Chromium VI | M | 10 | E218.5 | | | | 16 | 11 | 100 | 50 | | | | | | TVS | TVS | | |
| Cobalt | M | 50 | CT | | | | | | | | | | | | | | | | |
| Copper | M | 25 | CT | | | | TVS | TVS | 200 | | | | | | | TVS | TVS | | |
| Cyanide | M | 10 | CT | | | | 5 | 5 | 200 | 1,000 | | | | | | 5 | 5 | | |
| Iron | M | 100 | CT | | | | | 1,000 | | 300 (dis) | | | | | | | 300 (5) | | |
| Lead | M | 5 | CT | | | | TVS | TVS | 100 | 50 | | | | | | TVS | TVS | | |
| Lithium | M | 100 | NC | | | | | | | | | | | | | | | | |
| Magnesium | M | 5000 | CT | | | | | | | | | | | | | | | | |
| Manganese | M | 15 | CT | | | | | 1,000 | 200 | 50 (dis) | | | | | | | 50 (5) | | |
| Mercury | M | 0.2 | CT | | | | 2.4 | 0.1 | | 2.0 | | | | | | | 0.01 | | |
| Molybdenum | M | 200 | NC | | | | | | | | | | | | | | | | |
| Nickel | M | 40 | CT | | | | TVS | TVS | 200 | | | | | | | TVS | TVS | | |
| Potassium | M | 5000 | CT | | | | | | | | | | | | | | | | |
| Selenium | M | 5 | CT | | | | 135 | 17 | 20 | 10 | | | | | | 10 | | | |
| Silver | M | 10 | CT | | | | TVS | TVS | | 50 | | | | | | TVS | TVS | | |
| Sodium | M | 5000 | CT | | | | | | | | | | | | | | | | |
| Strontium | M | 200 | NC | | | | | | | | | | | | | | | | |
| Thallium | M | 10 | CT | | | | | 15 | | | | | | | | | | | |
| Tin | M | 200 | NC | | | | | | | | | | | | | | | | |
| Titanium | M | 10 | E6010 | | | | | | | | | | | | | | | | |
| Tungsten | M | 10 | E6010 | | | | | | | | | | | | | | | | |
| Vanadium | M | 50 | CT | | | | | | | | | | | | | | | | |
| Zinc | M | 20 | CT | | | | TVS | TVS | 2,000 | 5,000 | | | | | | TVS | TVS | | |
| 2,4,5-TP Silvex | P | | d | 10 | | | | | | | | | 10 | | | | | | |
| 2,4-D | P | | d | 100 | | | | | | | | 100 | 100 | | | | | | |

# TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
# STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

| | | | | Statewide Standards (a) | | | | | | | Basin Standards (b) | | Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tables A,B Carcinogens/ Noncarcin- | Table C Aquatic Life | | Tables I,II,III (1) Aquatic Life | | | | Organics (12) | | Tables A,B | Table C Fish & | Table D Radio- | Stream Segment Table (8) | | Table 2 Radionuclides | |
| Parameter | Type (10) | PQL MDL | Method (11) | ogens (2) | Acute Value | Chronic Value | Acute Value (2) | Chronic Value (2) | Agricul- tural Standard (3) | Domestic Water Supply (6) | Aquatic Life | Water Supply | (2) | Water Ingestion | nuclide | Acute Value | Chronic Value | Woman Creek | Walnut Creek |
| Aldicarb | P | | | 10 | | | | | | | | | 10 | | | | | | |
| Aldrin | P | 0.05 | CP | 0.002 (13) | 3 | | | | | | 0.003 | | 0.002 (13) | 0.000074 | | | 0.000074 | | |
| Bromacil | P | | | | | | | | | | | | | | | | | | |
| Carbofuran | P | | d | 36 | | | | | | | | | 36 | | | | | | |
| Chloranil | P | | | | | | | | | | | | | | | | | | |
| Chlordane (alpha) | P | 0.5 | CP | 0.03 (13) | 2.4 | 0.0043 | | | | | | | 0.03 (13) | 0.00046 | | | 0.00046 | | |
| Chlordane (gamma) | P | 0.5 | CP | 0.03 (13) | 2.4 | 0.0043 | | | | | | | 0.03 (13) | 0.00046 | | | 0.00046 | | |
| DDT | P | 0.1 | CP | 0.1 (13) | 1.1 | 0.001 | | | | | 0.001 | | 0.1 (13) | 0.000024 | | | 0.000024 | | |
| DDT metabolite (DDD) | P | 0.1 | CP | | 0.6 | | | | | | 0.001 | | | | | | | | |
| DDT metabolite (DDE) | P | 0.1 | CP | | 1,050 | | | | | | 0.001 | | | | | | | | |
| Demeton | P | | | | | 0.1 | | | | | 0.1 | | | | | | | | |
| Diazinon | P | | | | | | | | | | | | | | | | | | |
| Dieldrin | P | 0.1 | CP | 0.002 (13) | 2.5 | 0.0019 | | | | | 0.003 | | 0.002 (13) | 0.000071 | | | 0.000071 | | |
| Endosulfan I | P | 0.05 | CP | | 0.22 | 0.056 | | | | | 0.003 | | | | | | | | |
| Endosulfan II | P | 0.1 | CP | | | | | | | | | | | | | | | | |
| Endosulfan Sulfate | P | 0.1 | CP | | | | | | | | | | | | | | | | |
| Endrin | P | 0.1 | CP | 0.2 | 0.18 | 0.0023 | | | | | 0.004 | | 0.2 | | | | | | |
| Endrin Ketone | P | 0.1 | CP | | | | | | | | | | | | | | | | |
| Guthion | P | | | | | 0.01 | | | | | 0.01 | | | | | | | | |
| Heptachlor | P | 0.05 | CP | 0.008 (13) | 0.52 | 0.0038 | | | | | 0.001 | 0.2 | 0.008 (13) | 0.00028 | | | 0.00028 | | |
| Heptachlor epoxide | P | 0.05 | CP | 0.004 (13) | | | | | | | | | 0.004 (13) | | | | | | |
| Hexachlorocyclohexane, Alpha | P | 0.05 | CP | | | | | | | | | | | 0.0092 | | | 0.0092 | | |
| Hexachlorocyclohexane, Beta | P | 0.05 | CP | | | | | | | | | | | 0.0163 | | | 0.0163 | | |
| Hexachlorocyclohexane, Delta | P | 0.05 | CP | | | | | | | | | | | | | | | | |
| Hexachlorocyclohexane, Tech. | P | | f | | | | | | | | | | | 0.0123 | | | 0.0123 | | |
| Hexachlorocyclohexane, Lindane | P | 0.05 | CP | 4 | 2.0 | 0.08 | | | | | 0.01 | 4.0 | 4 | 0.0186 | | | 0.0186 | | |
| Malathion | P | | | | | 0.1 | | | | | 0.1 | | | | | | | | |
| Methoxychlor | P | 0.5 | CP | 100 | | 0.03 | | | | | 0.03 | 100 | 100 | | | | | | |
| Mirex | P | | | | | 620 | | | | | 0.001 | | | | | | | | |
| Parathion | P | | | | | 0.013 | | | | | 0.04 | | | | | | | | |

# TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
# STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

| | | | | Statewide Standards (a) | | | | | | | Basin Standards (b) | | Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tables A,B | Table C Aquatic Life | | Tables I,II,III (1) Aquatic Life | | | | Organics (12) | | Tables A,B | Table C | Table D | Stream Segment Table (8) | | Table 2 Radionuclides | |
| Parameter | Type (10) | PQL MDL | Method (11) | Carcinogens/ Noncarcin-ogens (2) | Acute Value | Chronic Value | Acute Value (2) | Chronic Value (2) | Agricul-tural Standard (3) | Domestic Water Supply (6) | Aquatic Life | Water Supply | (2) | Fish & Water Ingestion | Radio-nuclide | Acute Value | Chronic Value | Woman Creek | Walnut Creek |
| PCBs | P | 0.5 | CP | 0.005 (13) | 2.0 | 0.014 | | | | | 0.001 | | 0.005 (13) | 0.000079 | | | 0.000079 | | |
| Simazine | P | | e | | | | | | | | | | | 4 | | | 4 | | |
| Toxaphene | P | 1 | CP | 5 | 0.73 | 0.0002 | | | | | 0.005 | 5.0 | 5 | | | | | | |
| Vaponite 2 | P | | | | | | | | | | | | | | | | | | |
| Aroclor 1016 | PP | 0.5 | CP | | | | | | | | | | | | | | | | |
| Aroclor 1221 | PP | 0.5 | CP | | | | | | | | | | | | | | | | |
| Aroclor 1232 | PP | 0.5 | CP | | | | | | | | | | | | | | | | |
| Aroclor 1242 | PP | 0.5 | CP | | | | | | | | | | | | | | | | |
| Aroclor 1248 | PP | 0.5 | CP | | | | | | | | | | | | | | | | |
| Aroclor 1254 | PP | 1 | CP | | | | | | | | | | | | | | | | |
| Aroclor 1260 | PP | 1 | CP | | | | | | | | | | | | | | | | |
| Atrazine | PP | | e | | | | | | | | | | | 3 | | | 3 | | |
| Americium (pCi/l) | R | | | | | | | | | | | | | | | | | 0.05 | 0.05 |
| Americium 241 (pCi/l) | R | 0.01 | | | | | | | | | | | | | 30 | | | | |
| Cesium 134 (pCi/l) | R | 1 | | 80 (6) | | | | | | | | | 80 | | 80 | | | 80 | 80 |
| Cesium 137 (pCi/l) | R | 1 | | | | | | | | | | | | | | | | | |
| Gross Alpha (pCi/l) | R | 2 | | | | | | | | | | | | | | | | 7 | 11 |
| Gross Beta (pCi/l) | R | 4 | | | | | | | | | | | | | | | | 5 | 19 |
| Plutonium (pCi/l) | R | | | | | | | | | | | | | | | | | 0.05 | 0.05 |
| Plutonium 238+239+240 (pCi/l) | R | 0.01 | | 15 (6) | | | | | | | | | | | 15 | | | | |
| Radium 226+228 (pCi/l) | R | 0.5/0.1 (4) | | 5 (6) | | | | | | | | | | | 5 | | | | |
| Strontium 89+90 (pCi/l) | R | 1 | | | | | | | | | | | | | | | | | |
| Strontium 90 (pCi/l) | R | | | 8 (6) | | | | | | | | | | | 8 | | | 8 | 8 |
| Thorium 230+232 (pCi/l) | R | | | 60 (6) | | | | | | | | | | | 60 | | | | |
| Tritium (pCi/l) | R | | | 20,000 (6) | | | | | | | | | | | 20,000 | | | 500 | 500 |
| Uranium 233+234 (pCi/l) | R | | | | | | | | | | | | | | | | | | |
| Uranium 235 (pCi/l) | R | 0.6 | | | | | | | | | | | | | | | | | |
| Uranium 238 (pCi/l) | R | 0.6 | | | | | | | | | | | | | | | | | |
| Uranium (total) (pCi/l) | R | | | | | | TVS | TVS | | | | | | | 40 | | | 5 | 10 |

# TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
# STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

| | | | | Statewide Standards (a) | | | | | | | Basin Standards (b) | | Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tables A,B | Table C | | Tables I,II,III (1) | | | | Organics (12) | | Tables | Table C | Table D | Stream Segment Table (8) | | Table 2 | |
| | | | | Carcinogens/ | Aquatic Life | | Aquatic Life | | | | | | A,B | Fish & | Radio- | | | Radionuclides | |
| Parameter | Type (10) | PQL MDL | Method (11) | Noncarcin-ogens (2) | Acute Value | Chronic Value | Acute Value (2) | Chronic Value (2) | Agricul-tural Standard (3) | Domestic Water Supply (6) | Aquatic Life | Water Supply | (2) | Water Ingestion | nuclide | Acute Value | Chronic Value | Woman Creek | Walnut Creek |
| 1,2,4,5-Tetrachlorobenzene | SV | | b | 2 (13) | | | | | | | | | 2 | | | | | | |
| 1,2,4-Trichlorobenzene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene (ortho) | SV | 10 | CS | 620 | | | | | | | | | 620 | | | | | | |
| 1,2-Diphenylhydrazine | SV | | b | 0.05 (13) | | | | | | | | | 0.05 (13) | | | | | | |
| 1,3-Dichlorobenzene (meta) | SV | 10 | CS | 620 | | | | | | | | | 620 | | | | | | |
| 1,4-Dichlorobenzene (para) | SV | 10 | CS | 75 | | | | | | | | | 75 | | | | | | |
| 2,4,5-Trichlorophenol | SV | 50 | CS | 700 | | | | | | | | | 700 | | | | | | |
| 2,4,6-Trichlorophenol | SV | 10 | CS | 2.0 (13) | | 970 | | | | | | | 2.0 (13) | 1.2 | | | 1.2 | | |
| 2,4-Dichlorophenol | SV | 10 | CS | 21 | 2,020 | 365 | | | | | | | 21 | | | | | | |
| 2,4-Dimethylphenol | SV | 10 | CS | | 2,120 | | | | | | | | | | | | | | |
| 2,4-Dinitrophenol | SV | 50 | CS | | | | | | | | | | | | | | | | |
| 2,4-Dinitrotoluene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| 2-Chloronaphthalene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| 2-Chlorophenol | SV | 10 | CS | | 4,380 | 2,000 | | | | | | | | | | | | | |
| 2-Methylnaphthalene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| 2-Methylphenol | SV | 10 | CS | | | | | | | | | | | | | | | | |
| 2-Nitroaniline | SV | 50 | CS | | | | | | | | | | | | | | | | |
| 2-Nitrophenol | SV | 10 | CS | | | | | | | | | | | | | | | | |
| 3,3-Dichlorobenzidine | SV | 20 | CS | | | | | | | | | | | 0.01 | | | 0.01 | | |
| 3-Nitroaniline | SV | 50 | CS | | | | | | | | | | | | | | | | |
| 4,6-Dinitro-2-methylphenol | SV | 50 | CS | | | | | | | | | | | | | | | | |
| 4-Bromophenyl Phenylether | SV | 10 | CS | | | | | | | | | | | | | | | | |
| 4-Chloroaniline | SV | 10 | CS | | | | | | | | | | | | | | | | |
| 4-Chlorophenyl Phenyl Ether | SV | 10 | CS | | | | | | | | | | | | | | | | |
| 4-Chloro-3-methylphenol | SV | 10 | CS | | 30 | | | | | | | | | | | | | | |
| 4-Methylphenol | SV | 10 | CS | | | | | | | | | | | | | | | | |
| 4-Nitroaniline | SV | 50 | CS | | | | | | | | | | | | | | | | |
| 4-Nitrophenol | SV | 50 | CS | | | | | | | | | | | | | | | | |
| Acenaphthene | SV | 10 | CS | | 1,700 | 520 | | | | | | | | | | | | | |

# TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
# STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

| | | | | Statewide Standards (a) | | | | | | | Basin Standards (b) | | Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tables A,B Carcinogens/ Noncarcin-ogens (2) | Table C Aquatic Life | | Tables I,II,III (1) Aquatic Life | | | | Organics (12) | | Tables A,B (2) | Table C Fish & Water Ingestion | Table D Radio-nuclide | Stream Segment Table (8) | | Table 2 Radionuclides | |
| Parameter | Type (10) | PQL MDL | Method (11) | | Acute Value | Chronic Value | Acute Value (2) | Chronic Value (2) | Agricul-tural Standard (3) | Domestic Water Supply (6) | Aquatic Life | Water Supply | | | | Acute Value | Chronic Value | Woman Creek | Walnut Creek |
| Anthracene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Benzidine | SV | | d | 0.0002 (13) | 2,500 | | | | | | 0.1 | 0.01 | 0.0002 (13) | 0.00012 | | | 0.00012 | | |
| Benzoic Acid | SV | 50 | CS | | | | | | | | | | | | | | | | |
| Benzo(a)anthracene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Benzo(a)pyrene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Benzo(b)fluoranthene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Benzo(g,h,i)perylene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Benzo(k)fluoranthene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Benzyl Alcohol | SV | 10 | CS | | | | | | | | | | | | | | | | |
| bis(2-Chloroethoxy)methane | SV | 10 | CS | | | | | | | | | | | | | | | | |
| bis(2-Chloroethyl)ether | SV | 10 | CS | 0.03 (13) | | | | | | | | | 0.03 (13) | 0.0000037 | | | 0.0000037 | | |
| bis(2-Chloroisopropyl)ether | SV | 10 | CS | | | | | | | | | | | | | | | | |
| bis(2-Ethylhexyl)phthalate | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Butadiene | SV | | | | | | | | | | | | | | | | | | |
| Butyl Benzylphthalate | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Chlorinated Ethers | SV | | | | | | | | | | | | | | | | | | |
| Chlorinated Napthalenes | SV | | | | | | | | | | | | | | | | | | |
| Chloroalkylethers | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Chlorophenol | SV | | | | | | | | | | 1.0 | 1.0 | | | | | | | |
| Chrysene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Dibenzofuran | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Dibenz(a,h)anthracene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Dichlorobenzenes | SV | | | | | | | | | | | | | | | | | | |
| Dichlorobenzidine | SV | 20 | CS | | | | | | | | | | | 0.01 | | | 0.01 | | |
| Diethylphthalate | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Dimethylphthalate | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Dinitrotoluene | SV | 10 | CS | | 330 | 230 | | | | | | | | | | | | | |
| Di-n-butylphthalate | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Di-n-octylphthalate | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Ethylene glycol | SV | | d | | | | | | | | | | | | | | | | |

# TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
# STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

| | | | | Statewide Standards (a) | | | | | | | Basin Standards (b) | | Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tables A,B Carcinogens/ Noncarcin-ogens (2) | Table C Aquatic Life | | Tables I,II,III (1) Aquatic Life | | | | Organics (12) | | Tables A,B (2) | Table C Fish & Water Ingestion | Table D Radio-nuclide | Stream Segment Table (8) | | Table 2 Radionuclides | |
| Parameter | Type (10) | PQL MDL | Method (11) | | Acute Value | Chronic Value | Acute Value (2) | Chronic Value (2) | Agricul-tural Standard (3) | Domestic Water Supply (6) | Aquatic Life | Water Supply | | | | Acute Value | Chronic Value | Woman Creek | Walnut Creek |
| Fluoranthene | SV | 10 | CS | | 3,980 | | | | | | | | | | | | | | |
| Fluorene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Formaldehyde | SV | | | | | | | | | | | | | | | | | | |
| Haloethers | SV | | | | | | | | | | | | | | | | | | |
| Hexachlorobenzene | SV | 10 | CS | 0.02 (13) | | | | | | | | | 0.02 (13) | 0.00072 | | | 0.00072 | | |
| Hexachlorobutadiene | SV | 10 | CS | 14 | 90 | 9.3 | | | | | | | 14 | 0.45 | | | 0.45 | | |
| Hexachlorocyclopentadiene | SV | 10 | CS | 49 | 7 | 5.2 | | | | | | | 49 | | | | | | |
| Hexachloroethane | SV | 10 | CS | | 980 | 540 | | | | | | | | 1.9 | | | 1.9 | | |
| Hydrazine | SV | | | | | | | | | | | | | | | | | | |
| Indeno(1,2,3-cd)pyrene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Isophorone | SV | 10 | CS | 1,050 | 117,000 | | | | | | | | 1,050 | | | | | | |
| Naphthalene | SV | 10 | CS | | 2,300 | 620 | | | | | | | | | | | | | |
| Nitrobenzene | SV | 10 | CS | 3.5 (13) | 27,000 | | | | | | | | 3.5 (13) | | | | | | |
| Nitrophenols | SV | | | | | | | | | | | | | | | | | | |
| Nitrosamines | SV | | | | | | | | | | | | | | | | | | |
| Nitrosodibutylamine | SV | | b | | | | | | | | | | | 0.0064 | | | 0.0064 | | |
| Nitrosodiethylamine | SV | | b | | | | | | | | | | | 0.0008 | | | 0.0008 | | |
| Nitrosodimethylamine | SV | | b | | | | | | | | | | | *0.0014* | | | *0.0014* | | |
| Nitrosopyrrolidine | SV | | b | | | | | | | | | | | 0.016 | | | 0.016 | | |
| N-Nitrosodiphenylamine | SV | 10 | CSb | | | | | | | | | | | 4.9 | | | 4.9 | | |
| N-Nitroso-di-n-dipropylamine | SV | 10 | CSb | | | | | | | | | | | | | | | | |
| Pentachlorinated Ethanes | SV | | b | | | | | | | | | | | | | | | | |
| Pentachlorobenzene | SV | | b | 6 (13) | | | | | | | | | 6 (13) | | | | | | |
| Pentachlorophenol | SV | 50 | CS | 200 | 9 | 5.7 | | | | | | | 200 | | | | | | |
| Phenanthrene | SV | 10 | CS | | | | | | | | | | | | | | | | |
| Phenol | SV | 10 | CS | | 10,200 | 2,560 | | | | | 500 | 1.0 | | | | | | | |
| Phthalate Esters | SV | | c | | | | | | | | | | | | | | | | |
| Polynuclear Aromatic Hydrocarbons | SV | | b | | | | | | | | | | | 0.0028 | | | 0.0028 | | |
| Vinyl Chloride | SV | 10 | CV | 2 | | | | | | | | | 2 | | | | | | |

# TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
# STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

| | | | | Statewide Standards (a) | | | | | | | Basin Standards (b) | | Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tables A,B | Table C | | Tables I,II,III (1) | | | | | | | | | | | | |
| | | | | Carcinogens/ | Aquatic Life | | Aquatic Life | | | | Organics (12) | | Tables | Table C | Table D | Stream Segment Table (8) | | Table 2 Radionuclides | |
| Parameter | Type (10) | PQL MDL | Method (11) | Noncarcin-ogens (2) | Acute Value | Chronic Value | Acute Value (2) | Chronic Value (2) | Agricul-tural Standard (3) | Domestic Water Supply (6) | Aquatic Life | Water Supply | A,B (2) | Fish & Water Ingestion | Radio-nuclide | Acute Value | Chronic Value | Woman Creek | Walnut Creek |
| 1,1,1-Trichloroethane | V | 5 | CV | 200 | | | | | | | | | 200 | | | | | | |
| 1,1,2,2-Tetrachloroethane | V | 5 | CV | | | 2,400 | | | | | | | | 0.17 | | | 0.17 | | |
| 1,1,2-Trichloroethane | V | 5 | CV | 28 | | 9,400 | | | | | | | 28 | 0.60 | | | 0.60 | | |
| 1,1-Dichloroethane | V | 5 | CV | | | | | | | | | | | | | | | | |
| 1,1-Dichloroethene | V | 5 | CV | 7 | | | | | | | | | 7 | | | | | | |
| 1,2-Dichloroethane | V | 5 | CV | 5 | 118,000 | 20,000 | | | | | | | 5 | | | | | | |
| 1,2-Dichloroethene (cis) | V | | a | 70 | | | | | | | | | 70 | | | | | | |
| 1,2-Dichloroethene (total) | V | 5 | CV | | | | | | | | | | | | | | | | |
| 1,2-Dichloroethene (trans) | V | | a | 70 | | | | | | | | | 70 | | | | | | |
| 1,2-Dichloropropane | V | 5 | CV | 0.56 (13) | 23,000 | 5,700 | | | | | | | 0.56 (13) | | | | | | |
| 1,3-Dichloropropene (cis) | V | 5 | CV | | 6,060 | 244 | | | | | | | | | | | | | |
| 1,3-Dichloropropene (trans) | V | 5 | CV | | 6,060 | 244 | | | | | | | | | | | | | |
| 2-Butanone | V | 10 | CV | | | | | | | | | | | | | | | | |
| 2-Hexanone | V | 10 | CV | | | | | | | | | | | | | | | | |
| 4-Methyl-2-pentanone | V | 10 | CV | | | | | | | | | | | | | | | | |
| Acetone | V | 10 | CV | | | | | | | | | | | | | | | | |
| Acrylonitrile | V | | c | | 7,550 | 2,600 | | | | | | | | 0.058 | | | 0.058 | | |
| Benzene | V | 5 | CV | 5 | 5,300 | | | | | | | | 5 | | | | | | |
| Bromodichloromethane | V | 5 | CV | | | | | | | | | | | | | | | | |
| Bromoform | V | 5 | CV | | | | | | | | | | | | | | | | |
| Bromomethane | V | 10 | CV | | | | | | | | | | | | | | | | |
| Carbon Disulfide | V | 5 | CV | | | | | | | | | | | | | | | | |
| Carbon Tetrachloride | V | 5 | CV | 5 | 35,200 | | | | | | | | 5 | | | | | | |
| Chlorinated Benzenes | V | 10 | CV/CS | | | | | | | | | | | | | | | | |
| Chlorobenzene | V | 5 | CV/CVS | 300 | | | | | | | | | 300 | | | | | | |
| Chloroethane | V | 10 | CV | | | | | | | | | | | | | | | | |
| Chloroform | V | 5 | CV | Tot THM <100 (4) | 28,900 | 1,240 | | | | | | | Tot THM <100 (4) | 0.19 | | | 0.19 | | |
| Chloromethane | V | 10 | CV | | | | | | | | | | | | | | | | |
| Dibromochloromethane | V | 5 | CV | | | | | | | | | | | | | | | | |

## TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
## STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

| | | | | Statewide Standards (a) | | | | | | | Basin Standards (b) | | Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tables A,B | Table C | | Tables I,II,III (1) | | | | | | Tables | Table C | Table D | Stream Segment Table | | Table 2 | |
| | | | | Carcinogens/ | Aquatic Life | | Aquatic Life | | | | Organics | | A,B | Fish & | Radio- | (8) | | Radionuclides | |
| | | | | Noncarcin- | Acute | Chronic | Acute | Chronic | Agricul- | Domestic | (12) | | (2) | Water | nuclide | Acute | Chronic | Woman | Walnut |
| Parameter | Type (10) | PQL MDL | Method (11) | ogens (2) | Value | Value | Value (2) | Value (2) | tural Standard (3) | Water Supply (6) | Aquatic Life | Water Supply | | Ingestion | | Value | Value | Creek | Creek |
| Dichloroethenes | V | | | | | | | | | | | | | | | | | | |
| Ethyl benzene | V | 5 | CV | 680 | 32,000 | | | | | | | | 680 | | | | | | |
| Ethylene dibromide | V | | d | | | | | | | | | | | | | | | | |
| Ethylene oxide | V | | | | | | | | | | | | | | | | | | |
| Halomethanes | V | | | 100 | | | | | | | | | 100 | 0.19 | | | 0.19 | | |
| Methylene Chloride | V | 5 | CV | | | | | | | | | | | | | | | | |
| Pyrene | V | 10 | CS | | | | | | | | | | | | | | | | |
| Styrene | V | 5 | CV | | | | | | | | | | | | | | | | |
| Tetrachloroethanes | V | 5 | CV | | | | | | | | | | | 0.8 | | | 0.8 | | |
| Tetrachloroethene | V | 5 | CV | 10 | 5,280 | 840 | | | | | | | 10 | | | | | | |
| Toluene | V | 5 | CV | 2,420 | 17,500 | | | | | | | | 2,420 | | | | | | |
| Trichloroethanes | V | 5 | CV | | | | | | | | | | | | | | | | |
| Trichloroethene | V | 5 | CV | 5 | 45,000 | 21,900 | | | | | | | 5 | | | | | | |
| Vinyl Acetate | V | 10 | CV | | | | | | | | | | | | | | | | |
| Xylenes (Total) | V | 5 | CV | | | | | | | | | | | | | | | | |

EXPLANATION OF TABLE

CLP = Contract Laboratory Program
CDH = Colorado Department of Health
dis = dissolved
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Level
SS = species specific
TAL = Target Analyte List
THM = Total Trihalomethanes
TIC = Tentatively Identified Compound
TVS = Table Value Standard (hardness dependent), see Table III in (a)

MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis
WQCC = Water Quality Control Commission

(1) Table I = physical and biological parameters
Table II = inorganic parameters
Table III = metal parameters
Values in Tables I, II, and III for recreational uses, cold water biota and domestic water supply are not included.
(2) In the absence of specific, numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/WQCC or EPA
(3) All are 30-day standards except for nitrate+nitrite
(4) Total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(5) Lowest value given: dissolved or total recoverable
(6) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30-day standards, all others are 1-day standards
(7) Segment 4 standards for inorganics and metals are ARARs, organics and radionuclides are TBC and Segment 5 standards are goals (TBCs)
(8) Includes Table I: Additional Organic Chemical Standards (chronic only)
(9) See section 3.1.11 (f)(2) in (a)
(10) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P= pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(11) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TICs in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.
(12) See Section 3.8.5 (2)(a) in (b)
(13) Standard is below (more stringent than) PQL, therefore PQL is standard.

(a) CDH/WQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974; amended 9/30/1989
(Envrionmental Reporter 726:1001-1020:6/1990)
(b) CDH/WQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990

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ENVIRONMENTAL MANAGEMENT DEPARTMENT

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ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203

Manual No.: 21100-WP-OU 07.01
Section No.: 4.0, R0
Organization: Environmental Management

Title: Data Needs and Data Quality Objectives

Approved by:

12/6/91
Effective Date

Manager

6/23/92
Date

# 4.0 DATA NEEDS AND DATA QUALITY OBJECTIVES

The primary objective of an RFI/RI is collection of data necessary to determine the nature, distribution, and migration pathways of contaminants and to quantify any risks to human health and the environment. These assessments determine the need for remediation and are used to evaluate remedial alternatives, if necessary. The five general goals of an RFI/RI (U.S. EPA, 1988a) are as follows:

1. Characterize site physical features
2. Define contaminant sources
3. Determine the nature and extent of contamination
4. Describe contaminant fate and transport
5. Provide a baseline risk assessment

However, in accordance with the IAG, the RFI/RI for OU7 has been divided into two phases. Phase I of the RFI/RI will address characterization of the site physical features and definition of contaminant sources. Phase II of the RFI/RI will address determination of the nature and extent of contamination and evaluation of the fate and transport of contaminants at OU7.

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality and quantity of data required to support the objectives of the RFI/RI (U.S. EPA, 1987). The DQO process is divided into three stages:

Stage 1 - Identify decision types

Stage 2 - Identify data uses/needs

Stage 3 - Design data collection program

Through application of the DQO process, site-specific goals were established for the Phase I RFI/RI and data needs were identified for achieving those goals. This section of the RFI/RI Work Plan proceeds through the DQO process specific to the Phase I RFI/RI for OU7.

Data collected during previous investigations have been useful in developing and focusing the DQOs. Previous data collection activities focused on site characterization rather than performing a quantitative risk assessment or environmental evaluation. The historical data, along with the OU7 conceptual model, were summarized in Section 2.0 of this work plan. This section presents the rationale used in identifying OU7 data needs.

## 4.1 STAGE 1 - IDENTIFY DECISION TYPES

Stage 1 of the DQO process was to identify decision makers, data users, and the types of decisions that will be made as part of the Phase I RFI/RI. The general decision types were identified early in Stage 1 to determine data types sufficient to support decisions.

### 4.1.1 Identify and Involve Data Users

Data users are divided into three groups: decision makers, primary data users, and secondary data users. The decision makers for OU7 are personnel from EG&G, DOE, EPA, and CDH who are responsible for decisions related to management, regulation, investigation, and remediation of OU7. The decision makers are involved through the review and approval process specified in the IAG. Primary data users are individuals involved in ongoing Phase I RFI/RI activities for OU7. These individuals are the technical staff of CDH, EPA, EG&G, and EG&G subcontractors, including geoscientists, statisticians, risk assessors, engineers, and health and safety personnel. They will be involved in collection and analysis of data and in preparation of the Phase I RFI/RI report, including

the Baseline Human Health Risk Assessment and the Environmental Evaluation. Secondary data users are those users who rely on RFI/RI outputs to support their activities. Secondary data users of the Phase I RFI/RI information may include personnel from EPA, CDH, EG&G, and EG&G subcontractors working in areas such as data base management, quality assurance, records control, and laboratory management.

### 4.1.2 Evaluate Available Data

The historical and current conditions of the IHSSs and associated areas within OU7 are described in Section 2.0 of this work plan. The following is a brief summary of site conditions and a discussion of the completeness and usability of existing information, based on the data presented in Section 2.0.

#### 4.1.2.1 Quality and Usability of Analytical Data

Analytical data used in characterizing contamination at OU7 are in the process of being validated in accordance with EM Program QA procedures. As of early 1991, only a small fraction of the data has been validated. At present much of the analytical data for radionuclides have been rejected. Data were rejected because (1) sampling/analytical protocol did not conform to significant aspects of the QA/QC Plan (Rockwell International, 1989a) or (2) there is insufficient documentation to demonstrate conformance with these procedures. These data, at best, can be considered only qualitative measures of the analyte concentrations.

The analytical data have been used qualitatively to scope the Phase I RFI/RI activities at OU7 as presented in this work plan. Valid data are needed to accurately evaluate contamination at OU7. Additionally, data obtained periodically are needed to perform statistical evaluations of groundwater quality and to assess temporal trends.

Presently, groundwater quality at OU7 is compared to sitewide definitions of background groundwater quality to evaluate contamination. The methods used to establish background chemical quality at the RFP are presented in an EG&G report (1991f) and were discussed briefly in Section 2.3.3. In accordance with RCRA guidance, groundwater quality immediately upgradient of the site must be evaluated to accurately assess potential contamination related to OU7 and to differentiate contamination from other potential sources located upgradient of the site (U.S. EPA, 1988a). Therefore, site-specific statistical definitions of background chemical quality from wells located immediately upgradient of the landfill are needed.

#### 4.1.2.2 Physical Setting

Several investigations have provided information for characterizing the geology (Section 2.2.3) and hydrogeology (Section 2.2.5) at OU7. Drilling investigations have identified surficial materials overlying weathered and unweathered claystone and siltstone units of the Arapahoe formation. Subcropping sandstones within the Arapahoe have been identified; however, the occurrence and lateral continuity of these sandstones have not been fully characterized. Site-specific flow directions and gradients for surficial materials and weathered bedrock units have been determined on the basis of at least two years of quarterly water level data from 28 wells. Flow directions and gradients in unweathered bedrock units are expected to be similar to those in weathered bedrock. Limited testing has been performed to determine the hydraulic conductivity of surficial materials and the Arapahoe formation, including weathered and unweathered units. In general, existing information is not sufficient for adequately evaluating the geology of the site as it relates to characterization of the source and soils. In addition, hydrogeologic information (such as monthly water level measurements) is needed regarding the impact of the groundwater barriers (including the groundwater intercept system and the slurry walls) on groundwater/leachate movement, the groundwater/surface water interactions for the East

Landfill Pond, and infiltration of precipitation through the soil material used to cover the waste.

The effectiveness of the intercept system to control the movement of groundwater/leachate has been evaluated on the basis of quarterly water level and water quality data (Section 2.2.5). Water level elevations in well pairs located on either side of the groundwater intercept system indicate that the system may be functioning effectively. At three locations, groundwater levels outside the system are higher than water levels within the system. However, no data are available to evaluate two locations shown on the as-built drawings where the clay component of the interceptor trench was not keyed into bedrock. Because groundwater may flow beneath the system into the landfill at these locations, data are needed to evaluate the impact of the system on groundwater movement at these locations.

Water level elevations in the well pair located on either side of the southern slurry wall indicate that the slurry wall may be operating effectively. However, data from the well pair for the northern slurry wall indicate that (1) the slurry wall is not operating effectively in this area, (2) the slurry wall does not extend this far to the east, or (3) the monitoring wells are not located on either side of the slurry wall. Therefore, additional information is needed to evaluate the impact of the northern slurry wall on the groundwater system.

Precipitation has been observed to pond on the irregular landfill surface. Water levels within the groundwater intercept system show seasonal fluctuations similar to water level fluctuations outside of the system. Because the intercept system appears to be functioning effectively, water level fluctuations within the system are probably due to infiltration of surface water through the soil cover into the waste materials. To evaluate infiltration and generation of leachate, data are needed to establish the correlation between precipitation and water level fluctuations at the site.

The interactions between surface water and groundwater beneath the East Landfill Pond have not been determined.

#### 4.1.2.3 Characterization of Contamination at IHSS 114

Previous investigations have identified and characterized the waste streams historically disposed in the landfill (Section 2.3.1). Although the landfill was used primarily for disposal of nonhazardous solid wastes, hazardous solid wastes were occasionally included; therefore, the landfill is considered a RCRA-regulated unit. Prior to 1974, radioactive wastes may have been placed in the landfill. An investigation in 1973 identified the location of a source of tritium in a section of the landfill used during 1970. Further characterization of the landfill contents may not be necessary because containment of landfill contents, which is often the most practicable remedial technology, does not require such information (U.S. EPA, 1991b). The total volume of landfilled material as of 1988 was estimated to be 405,000 cubic yards. Twenty-five percent of the total volume is estimated to be soil cover material. The areal extent of the waste was approximated in 1988, and it was noted at that time that wastes had been landfilled beyond the extent of the groundwater intercept system. The present areal extent of the landfill wastes with respect to the groundwater intercept system is not currently known.

Little information exists to characterize the presence, nature, and migration pathways of landfill-generated gases (Section 2.2.2). Methane and unidentified VOCs were detected during a previous soil-gas survey; however, data collected during this investigation are not reliable. Therefore, the occurrence and composition of landfill gases is not known.

The nature of contamination in geological materials is based on a comparison of chemical data from borehole samples obtained from four locations at OU7 (Section 2.3.2). VOCs were detected in fill material but not in Rocky Flats Alluvium or the Arapahoe formation.

Radionuclides were not detected at concentrations exceeding sitewide background values. Concentrations of total metals in surficial materials and weathered bedrock exceeded sitewide background values. To determine whether these elevated metals concentrations represent contamination by the landfill, site-specific background concentrations in geologic materials should be established using analytical data from borehole samples located immediately upgradient of OU7 and procedures outlined in EG&G (1991f). Although the existing data do not indicate organic or radionuclide contamination in alluvial materials or the Arapahoe formation, additional data should be obtained from other areas within the landfill to verify this. Additionally, the extent of leachate-contaminated soils and sediments in the West Landfill Pond beneath the landfill has not been characterized. Data are needed to characterize the leachate-contaminated materials beneath the landfill.

The nature of leachate/groundwater contamination is based on a comparison of the available 1990 groundwater quality data for OU7 to sitewide background values. Analytes identified in samples from monitoring wells screened in surficial materials include VOCs, dissolved metals, dissolved radionuclides, and inorganic analytes (Section 2.3.3). Analytes primarily include TCE, 1,1,1-TCA, 1,2-DCE, calcium, barium, copper, iron, magnesium, manganese, nickel, sodium, zinc, americium-241, uranium-233,234, cesium-137, nitrate/nitrite, bicarbonate, chloride, sulfate, and TDS. As mentioned above, the identification of analytes as contamination is based on a comparison of chemical data with sitewide background values. Additionally, most data for radionuclides have been rejected. The spatial distribution of analytes in leachate/groundwater needs to be determined; therefore, additional analytical data are needed.

Two wells (Wells 6387 and 6487) monitor leachate/groundwater heads within surficial materials within the main portion of the landfill. Therefore, the volume of leachate/groundwater within IHSS 114 is not known. Additionally, the occurrence of leachate perched in materials above the water table is not known. Therefore, data are needed to determine the volume/extent of leachate.

#### 4.1.2.4 Characterization of Contamination at IHSS 203

Historical information for IHSS 203 indicates that the 150-foot by 100-foot site was used from 1986 to 1987 for storage of both solid and liquid hazardous nonradioactive wastes, including organic solvents and PCBs (Section 2.2.1). Institutional controls, built to regulatory standards, likely prevented spills of liquid wastes. Solid hazardous wastes were stored in 55-gallon drums placed on the ground surface. Spills of less than reportable quantities may have occurred from these drums. Based on the environmental fate and transport characteristics of the constituents potentially stored at the site, contamination is likely limited to (1) metals, PCBs, and radionuclides (if present) sorbed to surficial soils and (2) volatile and semivolatile compounds present at shallow depths in surficial materials. The presence or absence of metals, organic, radionuclide, and PCB contamination at IHSS 203 is not presently known. The spatial distribution of sorbed contaminants due to wind dispersion of soil particles is not presently known. Additionally, the vertical distribution of organic contaminants in shallow soils beneath the IHSS is unknown.

#### 4.1.2.5 Characterization of Contamination in the East Landfill Pond

The composition of water in the East Landfill Pond has been characterized on the basis of chemical analysis of samples obtained quarterly during 1989. Contaminants include selected radionuclides, metals, and inorganic analytes. Although chemical data for sediments in the pond are not available, the nature of contamination may be evaluated with regard to differences in the quality of leachate draining into the pond and the quality of the pond water. Sediments are expected to contain metals, radionuclide, and organic constituents; however, the presence or absence of contamination in sediments has not been confirmed. The extent (thickness) of contaminated sediments is not presently known.

#### 4.1.2.6 Characterization of Contamination in Spray Evaporation Areas

Little direct information is available for characterizing contamination in soils in areas where spray evaporation operations occurred. However, chemical data for the East Landfill Pond are available to characterize the quality of water that was spray evaporated. Contaminants in surface water include radionuclides, metals, and inorganic analytes. The presence or absence of these analytes in soil adjacent to the pond is not presently known. Additionally, the extent of wind-dispersed contaminants sorbed to soil particles has not been evaluated.

### 4.1.3 Develop Conceptual Model

A conceptual model for OU7 has been developed in Section 2.4 and is illustrated in Figure 2-26. This model includes a description of potential sources, release mechanisms, contaminant migration pathways, receptors, and exposure routes. Because few previous studies have provided valid data, the model is a basic Phase I model. The site-specific conceptual model for OU7 is discussed briefly below.

The primary source of contamination at the Present Landfill (IHSS 114) is landfilled wastes. At the Inactive Hazardous Waste Storage Area (IHSS 203), the primary source of contamination is potentially contaminated soil near the ground surface. Secondary sources of contamination include soils beneath the landfill that have been contaminated by leachate, contaminated leachate/groundwater within the wastes, potentially contaminated sediments, contaminated surface water, and potentially contaminated surface soils as a result of spray evaporation operations.

The individual IHSSs and areas within OU7 have been characterized to various degrees. Characterization of IHSS 114 preliminarily identified elevated concentrations of VOCs, dissolved metals, dissolved radionuclides, and inorganic analytes in groundwater. In addition to these analyte groups, semivolatile compounds were identified in leachate draining into the East Landfill Pond. Generation of gas by landfilled wastes has not been characterized.

Sediments in the pond are likely to contain contaminants with sorptive properties. Soil contamination at IHSS 203 is not well characterized but may include VOCs and PCBs and possibly semivolatiles and radionuclides. The presence or absence of contamination at IHSS 203 and areas adjacent to the pond has not been characterized.

The primary release mechanisms for contaminants from IHSS 114 are likely to be volatilization of landfill-generated gases and infiltration of water through landfilled wastes and sediments, producing contaminated groundwater and surface water. Wind dispersion of contaminated surficial soil and gases is the primary release mechanism at IHSS 203 and areas where spray evaporation occurred. The exposure pathways for contaminants from the landfill consist of receptors exposed via ingestion, inhalation, or dermal contact to windblown contaminated soil, volatilized landfill-generated gases, or contaminated groundwater and surface water. The receptors are the populations exposed to contaminants at the exposure points. Human receptors include primarily present and future RFP workers and secondarily residents living downwind and/or downgradient of OU7 RFP. Ecological receptors include terrestrial wildlife, aquatic wildlife, and terrestrial and aquatic vegetation in and around OU7.

### 4.1.4 Specify Phase I RFI/RI Objectives and Data Needs

Based on the existing site information (Section 2.2), the nature of contamination (Section 2.3), the site-specific conceptual model for OU7 (Section 2.4), and an evaluation of the quality and usability of the existing data (Section 4.1.2), site-specific Phase I RFI/RI objectives/data needs associated with identifying contaminant sources and characterizing contamination have been developed. These are summarized in Table 4-1 and are discussed below.

In accordance with the IAG, the specific objectives of the Phase I RFI/RI field investigation for OU7 are as follows:

Characterize Site Physical Features

1. Determine representative site-specific background concentrations of analytes in groundwater and subsurface materials

2. Characterize the flow regime within and around OU7 to evaluate the effects of the groundwater intercept system and slurry walls on groundwater/leachate movement

3. Characterize surface water/groundwater interactions

4. Evaluate infiltration of precipitation through the existing soil cover material

Define Contaminant Sources

1. Determine the presence or absence of soil contamination at IHSS 203

2. Determine the presence or absence of contamination in soils where spray evaporation occurred

3. Identify and further characterize waste streams disposed in the landfill, and evaluate the environmental fate and transport characteristics of chemicals associated with the waste streams

4. Determine the area and volume of landfill material

5. Determine the volume and character of leachate

6. Determine the character and volumes (gas production) of landfill-generated gases

7. Characterize leachate-contaminated materials (including soils, bedrock, and West Landfill Pond sediments) beneath the landfill

8. Characterize contamination in surface water and sediments in the East Landfill Pond

Determine Nature and Extent of Contamination

This will be addressed in the Phase II RFI/RI Work Plan.

Describe Contaminant Fate and Transport

This will be addressed during Phase II RFI/RI Work Plan.

Provide a Baseline Risk Assessment

The objectives of the Baseline Risk Assessment are discussed in Sections 8.0 and 9.0.

## 4.2 STAGE 2 - IDENTIFY DATA USES/NEEDS

The data needed to meet each of the site-specific Phase I RFI/RI objectives developed for OU7 are listed in Table 4-1. The associated sampling and analysis activities are also identified in Table 4-1. Specific plans for obtaining the needed data are presented in Section 7.0 (Field Sampling Plan). The following sections discuss the uses, general types, quality, and quantity of the data needed for the OU7 Phase I RFI/RI.

### 4.2.1 Identify Data Uses

RFI/CMS data can be categorized according to use for the following general purposes:

- Site characterization
- Health and safety
- Risk assessment
- Evaluation of alternatives
- Engineering design of alternatives
- Monitoring during remedial action
- Determination of potentially responsible parties (PRPs)

# Table 4-1: Phase I RFI/RI Data Quality Objectives



| Objective (Data Need) | Data Type | Sampling/Analysis Activity | Analytical Level | Data Use |
|---|---|---|---|---|
| <u>Characterize Site Physical Features</u> | | | | |
| 1) Determine representative (site-specific) background analyte concentrations in groundwater, soils, and subsurface geologic materials | Upgradient groundwater and soil chemical data for each geologic unit | • Drill and install upgradient monitoring wells in each of the geologic units (alluvium, weathered bedrock, unweathered bedrock). | I | • Site Characterization<br>• Baseline Risk Assessment |
| | | • Collect and analyze surface soil borehole and groundwater samples for TAL metals, TCL volatiles and semivolatiles, radionuclides, and inorganic analytes. | IV (V for radiological analyses) | • Environmental Evaluation |
| 2) Characterize the flow regime within and around OU7 to evaluate the effect of the groundwater intercept system and slurry walls on the movement of groundwater/leachate | Water level data.<br>Chemical data | • Obtain monthly water level measurements in existing and newly installed monitoring wells and/or piezometers. | I | • Site Characterization<br>• Baseline Risk Assessment |
| | | • Drill borings and install monitoring wells. Include locations where groundwater may flow beneath the intercept system. | I | • Environmental Evaluation |
| | | • Collect water samples from existing and newly installed monitoring wells and from existing surface water stations; analyze samples for TAL metals, TCL volatiles and semivolatiles, radionuclides, and inorganic analytes. | I, IV (V for radiological analyses) | • Evaluation of Remedial Alternatives |
| 3) Characterize surface water/groundwater interactions | Groundwater and surface water elevations | • Monthly measurements of pond surface elevation at a surveyed staff gage and concurrently measured groundwater elevations in alluvial and bedrock wells adjacent to the pond. | I | • Site Characterization |

| Objective (Data Need) | Data Type | Sampling/Analysis Activity | Analytical Level | Data Use |
|---|---|---|---|---|
| 4) Evaluate infiltration of precipitation through soil cover materials | RFP precipitation data. Groundwater level data. Flow volumes from the landfill seep. | • Obtain RFP precipitation data. Measure groundwater elevations in existing and newly installed monitoring wells on a monthly bases. Concurrently measure flow volumes from landfill seep. | I | • Site Characterization<br>• Evaluation of Remedial Alternatives |
| <u>Define Contaminant Sources</u> | | | | |
| 1) Characterize presence or absence of soil contamination at IHSS 203 | Data from surficial soils within and upwind of IHSS 203. | • Conduct radiological (FIDLER) survey.<br>• Conduct soil gas survey; analyze vapor samples for VOCs.<br>• Collect surficial soil scrapes; analyze for PCBs, TAL metals, radionuclides, and TCL volatiles and semivolatiles.<br>• Collect soil core samples along depth profiles; analyze samples for PCBs, TAL metals, radionuclides, and TCL volatiles and semivolatiles. | II<br>II (field GC)<br>IV (V for radiological analyses)<br>IV (V for radiological analyses) | • Site Characterization<br>• Baseline Risk Assessment<br>• Environmental Evaluation<br>• Evaluation of Remedial Alternatives |
| 2) Characterize presence or absence of contamination of soils in areas where spray evaporation occurred | Data from surficial soils. | • Conduct radiological (FIDLER) survey. Collect surficial soil scrapes; analyze samples for TAL metals, radionuclides, and inorganic parameters. | II<br>IV (V for radiological analytes) | • Site Characterization<br>• Baseline Risk Assessment<br>• Environmental Evaluation<br>• Evaluation of Remedial Alternatives |

| Objective (Data Need) | Data Type | Sampling/Analysis Activity | Analytical Level | Data Use |
|---|---|---|---|---|
| 3) Identify and characterize the waste streams disposed in the landfill; evaluate environmental fate and transport characteristics | Information from the Waste Stream and Residue Identification and Characterization program. | Obtain published information on fate and transport characteristics | Not Applicable | • Site Characterization<br>• Baseline Risk Assessment<br>• Environmental Evaluation<br>• Evaluation of Remedial Alternatives |
| 4) Determine area and volume of landfilled material | Thickness and areal extent of material. | • Perform Core Penetrometer Tests (CPT) at 38 locations. | II | • Site Characterization<br>• Evaluation of Remedial Alternatives |
| 5) Determine volume and character of landfill leachate | Fluid levels and chemical data. | • Collect insitu leachate/groundwater samples at the 38 CPT locations using BAT sampling system. Screen samples for VOCs. | II | • Site Characterization<br>• Baseline Risk Assessment |
| | | • Obtain water level measurements and samples from existing and newly installed monitoring wells. Analyze samples for TAL metals, TCL volatiles, radionuclides, and inorganic analytes. | I<br>IV (V for radiological analyses) | • Environmental Evaluation<br>• Evaluation of Remedial Alternatives |
| | | • Obtain sample of landfill leachate. Analyze for TAL metals, TCL volatiles and semivolatiles, radionuclides, and inorganic analytes. | IV (V for radiological analyses) | |

| Objective (Data Need) | Data Type | Sampling/Analysis Activity | Analytical Level | Data Use |
|---|---|---|---|---|
| 6) Determine the character and volume (gas production) of landfill-generated gases | Chemical composition of gases. | • Conduct soil gas survey using BAT sampling system; analyte vapor samples for methane, hydrogen sulfide, and selected VOCs. | II (field GC) | • Site Characterization<br>• Baseline Risk Assessment<br>• Environmental Evaluation<br>• Evaluation of Remedial Alternatives |
| 7) Characterize leachate contaminated materials (including soil, bedrock, and West Landfill Pond sediments) beneath the landfill | Chemical data from subsurface samples. | • Collect soil and bedrock samples form six borings. Analyze samples for TAL metals, TCL volatiles and semivolatiles, radionuclides, and inorganic analytes. | IV (V for radiological analyses) | • Site Characterization<br>• Baseline Risk Assessment<br>• Environmental Evaluation<br>• Evaluation of Remedial Alternatives |
| 8) Characterize contamination in surface water and sediment in East Landfill Pond | Information on types of contaminants present in each media and thickness of sediments. | • Logging of sediment samples at 3 locations. Measurement of water depth.<br>• Monthly measurements of pond surface elevation.<br>• Measure field parameters in sediments.<br>• Collection and analysis of sediments and pond water. Analyze for TAL metals, TCL volatiles and semivolatiles, radionuclides, and inorganic analytes. | I<br>I<br>I<br>IV (V for radiological analyses) | • Site Characterization<br>• Baseline Risk Assessment<br>• Environmental Evaluation<br>• Evaluation of Remedial Alternatives |

| Objective (Data Need) | Data Type | Sampling/Analysis Activity | Analytical Level | Data Use |
|---|---|---|---|---|
| Determine Nature and Extent of Contamination | | | | |
| | Phase II RFI/RI Work Plan | | | |
| Describe Contaminant Fate and Transport | | | | |
| | Phase II RFI/RI Work Plan | | | |
| Support a Baseline Risk Assessment | | | | |
| | Sections 8.0 and 9.0 of this work plan | | | |

Because this work plan describes a Phase I RFI/RI, data uses such as engineering design and monitoring during remediation (both remedial action activities) will not be considered. The data use for PRP determination is also not appropriate to this work plan. The remaining four data uses will be important in meeting the objectives identified in Section 4.1.4. Data uses for specific sampling and analysis activities for the Phase I investigation at OU7 are listed in Table 4-1.

### 4.2.2 Identify Data Types

Data types can be initially divided into broad groups and again divided into more specific components. For the Phase I investigation, soil, sediment, leachate, and soil-gas samples will be collected. Additionally, radiation surveys will be conducted over IHSS 203. These data types will provide Phase I information to characterize physical features and contamination at OU7. Selection of chemical analyses has been based on the objectives of the Phase I program and on the past activities at the units. Data types are listed in Table 4-1.

### 4.2.3 Identify Data Quality Needs

EPA defines five levels of analytical data, listed as follows (U.S. EPA, 1987):

- Level I - Field screening or analysis using portable instruments. Results are often not compound-specific and not quantitative, but results are available in real time. It is the least costly of the analytical options.

- Level II - Field analysis using more sophisticated portable analytical instruments; in some cases, the instruments may be set up in a portable laboratory onsite. There is a wide range in the quality of the data that can

be generated. The quality depends on the use of suitable calibration standards, reference materials, and sample preparation equipment and on the training of the operator. Results are available in real time or several hours.

- Level III - All analysis performed in an offsite laboratory. Level III analyses may or may not be performed according to CLP procedures, but the validation or documentation procedures required of CLP Level IV analysis are not usually utilized. The laboratory may or may not be a CLP laboratory.

- Level IV - CLP routine analytical services (RAS). All analyses are performed in an offsite CLP analytical laboratory following CLP protocols. Level IV is characterized by rigorous QA/QC protocols and documentation.

- Level V - Analysis by non-standard methods. All analyses are performed in an offsite analytical laboratory that may or may not be a CLP laboratory. Method development or method modification may be required for specific constituents or detection limits. CLP special analytical services (SAS) are Level V.

All five levels of data quality will be necessary for performing Phase I field activities. The levels appropriate to the data need and data use have been specified in Table 4-1.

Data quality for the Phase I RFI/RI will be achieved by meeting the requirements for Level I through V data outlined in GRRASP (EG&G, 1991j) and by adhering to the data collection protocols provided in agency-approved Standard Operating Procedures (SOPs) and Procedure Change Notices (PCNs).

### 4.2.4 Identify Data Quantity Needs

Data quantity needs are based primarily on an evaluation of the information available for characterizing the site physical features and contamination at OU7. This is consistent with guidance provided in Data Quality Objectives for Remedial Response Activities (U.S. EPA, 1987) and Guidance for Data Useability in Risk Assessments (U.S. EPA, 1990). Additionally, data quantity needs are designed to be consistent with similar data collection activities performed for the Phase I RFI/RI for OU6. The rationale for sampling quantities is described in the FSP presented in Section 7.0 of this work plan.

To ensure that a sufficient amount of valid data are generated, the FSP was designed to include (1) a rationale for all field activities based on an evaluation of the existing information, (2) a phased approached using screening-level techniques to identify and/or locate critical sampling sites, and (3) contingency plans for obtaining data from critical locations. These components of the FSP are discussed further in Section 7.0.

### 4.2.5 Evaluate Sampling/Analysis Options

To ensure that sufficient and adequate data are collected, the Phase I RFI/RI for OU7 is based on a stepped, or phased, approach in which field screening techniques (e.g., Level I and II data types) are used to direct data collection activities designed to obtain Level III through V data. This stepped program has been designed to be consistent with the IAG schedule.

This approach maximizes collection of useful data because field screening techniques are used to properly locate and minimize intrusive data collection activities such as borehole drilling. Additionally, this approach minimizes the volume of hazardous waste material

generated that requires special management, the potential exposure of field personnel to hazardous waste material, and the overall time to perform the field activities.

Three types of activities will be performed during the Phase I field investigation: (1) screening activities, (2) sampling activities, and (3) monitoring well installation. Screening activities (Levels I and II) include visual inspection, radiological surveys, cone penetrometer testing (CPT), soil-gas surveys, and leachate screening for VOCs using the BAT® sampling system. Analysis of surficial soils, subsurface materials from test borings, sediments, leachate/groundwater, and surface water will provide Level III through IV data. Monitoring wells will provide Level I type data.

Sampling options for the Phase I RFI/RI were selected on the basis of their ability to (1) obtain data consistent with the DQOs in the least intrusive manner, (2) obtain multiple types of data at each sampling location, and (3) reduce the number of "leave-behind" sampling locations requiring long-term maintenance and care.

The CPT and BAT® systems were selected for sampling because these techniques provide continuous testing of soil and groundwater conditions using discrete point samples. This results in a more accurate characterization of the site and, consequently, more well-defined remediation.

Data from the CPT can delineate the distribution and thickness of the landfill waste and fill material and their position with respect to the groundwater intercept system, provide detailed lithologic descriptions of the soil within the waste cells and beneath the landfill, and indicate the presence and depth of groundwater/leachate within the landfill. This information can then be used to select appropriate depths for obtaining in-situ gas/liquid samples from both the saturated and unsaturated zones using the BAT® sampling system. Samples from the BAT® can be analyzed in real time using a portable photoionizing

detector gas chromatography (GC) unit. Onsite testing of soil gas and leachate samples for VOCs will indicate the lateral and vertical distribution of these compounds in the landfill materials and underlying soils.

To determine the presence or absence of potential metals, PCB, and radionuclide contamination in soils at IHSS 203, a surface soil sampling program will be initiated. Data obtained from this analysis will be used to determine the extent of contamination and to assist in determining the level of more detailed vertical and horizontal sampling.

Analytical options were selected to obtain data meeting the DQOs and the PARCC parameters (precision, accuracy, representativeness, completeness, and comparability) discussed below.

### 4.2.6 Review of PARCC Parameter Information

PARCC parameters are indicators of data quality. Precision, accuracy, and completeness goals are established for this work plan according to the analyses being performed and the analytical levels. PARCC goals are specified in the Quality Assurance Addendum (QAA) discussed in Section 10.0 of this work plan.

The analytical program requirements for OU7 are discussed in Section 7.3 of this work plan. GRRASP (EG&G, 1991j) provides a listing of the CLP analytes and detection/quantification limits for Target Compound List (TCL) volatile organics, TCL semivolatile organics, Target Analyte List (TAL) metals, radionuclides, pesticides/PCBs, and inorganic parameters. These analytical methods are appropriate for meeting the data quality requirements for analytical Levels I through V during the Phase I RFI/RI. The precision, accuracy, and completeness parameters for analytical Levels I through V are discussed below, along with the completeness and representativeness for all analytical levels.

Precision measures the reproducibility of measurements under a given set of conditions. Accuracy measures the bias or source of error in a group of measurements. Precision and accuracy objectives for the analytical data collected for the Phase I RFI/RI at OU7 will be evaluated according to the control limits specified in the referenced analytical method and/or in data validation guidelines. For the radionuclide analyses, the accuracy objectives specified in GRRASP will be followed. The specified criteria for precision and accuracy are described in the QAA. Precision and accuracy for non-analytical data will be achieved through protocols outlined in agency-approved SOPs and PCNs.

Completeness is defined as the percentage of measurements made that are judged to be valid. The target completeness objective for the OU7 field and analytical data is 100 percent, although 90 percent will be the minimum acceptable level. Again, to ensure that a sufficient amount of valid data are generated, the FSP was designed to include (1) a rationale for all field activities based on an evaluation of the existing information, (2) a phased approached using screening level techniques to identify and/or locate critical sampling sites, and (3) contingency plans for obtaining data from critical locations. These components of the FSP are discussed further in Section 7.0.

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. In order to achieve comparability, work will be performed at OU7 in accordance with approved sampling and analysis plans, standard analytical protocols, and approved SOPs for data collection. Consistent units of measurement will be used for data reporting.

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a particular site or condition. Representativeness is a qualitative parameter related to the design of the sampling and analysis components of the investigative program. The FSP described in Section 7.0 of this work plan and the



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referenced SOPs describe the rationale for the sampling program to provide for representative samples.

## 4.3 STAGE 3 - DESIGN DATA COLLECTION PROGRAM

The purpose of Stage 3 of the DQO process is to design the specific data collection program for the Phase I RFI/RI for OU7. To accomplish this, the elements identified in Stages 1 and 2 were assembled and the Sampling and Analysis Plan (SAP) was prepared. The SAP consists of (1) a Quality Assurance Project Plan (QAPjP) that describes the policy, organization, functional activities, and QA/QC protocols necessary to achieve the DQOs dictated by the intended use of the data and (2) an FSP that provides guidance for all fieldwork by defining in detail the sampling and data collection methods to be used in the Phase I RFI/RI for OU7. These two components are presented in Sections 7.0 and 10.0 of this work plan. A detailed discussion of all samples to be obtained is presented in Section 7.3 for each media and includes sample type, number of samples, sample location, analytical methods, and QA/QC samples.

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EG&G — ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT DEPARTMENT

ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203

Manual No.: 21100-WP-OU 07.01
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Approved by:

12/6/91
Effective Date

Manager

6/23/92
Date

# 5.0 RCRA FACILITY INVESTIGATION/REMEDIAL INVESTIGATION TASKS

## 5.1 TASK 1 - PROJECT PLANNING

The project planning task includes all efforts required to initiate the Phase I RFI/RI for OU7. Activities undertaken for this project have included review of previous site investigation results, preliminary site characterization, and scoping of the Phase I RFI/RI. Results of these activities are presented in Sections 2.0, 3.0, and 4.0.

Prior to performing field investigations for OU7, it will be necessary to review new information and data that become available after preparation of this work plan, integrate field activities proposed for OU7 with ongoing waste operations at the landfill, and integrate field activities proposed for OU7 with ongoing or proposed field activities for the Phase I RFI/RI for OU6. New information to be evaluated prior to initiation of field activities for OU7 may include data from sitewide surface water and groundwater monitoring programs and recent information from the WSRIC program. Proposed field investigations at OU7 will be integrated with ongoing waste operations at the landfill to ensure that quality data are obtained, field activities are performed in accordance with the IAG schedule, and appropriate sampling points are preserved and maintained for future use. Proposed field activities for OU7 will be coordinated with ongoing or proposed field activities for OU6 to minimize redundant sampling.

Two project planning documents, including this work plan, have been prepared for the OU7 Phase I RFI/RI as required by the IAG. A Field Sampling Plan (FSP) included in this document presents the locations, media, and frequency of sampling efforts. The second document required by the IAG is a Sampling and Analysis Plan (SAP), which includes a QAPjP and SOPs for all field activities. The QAPjP and SOPs are being revised in accordance with the IAG.

## 5.2 TASK 2 - COMMUNITY RELATIONS

In accordance with the IAG, the RFP is developing a Community Relations Plan (CRP) to inform and actively involve the public in decision-making as it relates to environmental restoration activities. The CRP will address the needs and concerns of the surrounding communities as identified through approximately 80 interviews with federal, state, and local elected officials; businesses; medical professionals; educational representatives; interest groups; media; and residents adjacent to the RFP.

A Draft CRP was issued for public comments in January 1991. The Draft CRP was revised to reflect public comment, and following EPA and CDH approval, a final CRP is scheduled to be released in August 1991. Accordingly, a site-specific CRP is not required for OU7.

Current community relations activities concerning environmental restoration include participation by plant representatives in informational workshops; presentations at meetings of the Rocky Flats Environmental Monitoring Council; briefings for citizens, businesses, and surrounding communities on environmental restoration and monitoring activities; and public comment oportunities on various EM Program plans and actions. RFP personnel involve several special interest groups in decisions that pertain to environmental restoration activities, including the Rocky Flats Cleanup Commission, the recipient of the EPA Technical Assistant Grant.

In addition, a Speakers' Bureau program provides plant speakers to civic groups and educational organizations, and a public tours program allows the public to visit the RFP. The RFP also produces fact sheets and periodic updates on environmental restoration activities for public information and responds to numerous public inquiries regarding the RFP.

## 5.3 TASK 3 - FIELD INVESTIGATION

The Phase I RFI/RI field investigation is designed to meet the objectives outlined in Section 4.0 of this work plan. Additionally, the data will be used to support the Phase I Environmental Evaluation and the Phase I Baseline Human Health Risk Assessment.

Three types of activities will be performed during the Phase I field investigation: screening activities, sampling activities, and monitoring well installation. Screening activities include visual inspections, radiological surveys, cone penetrometer testing (CPT), soil-gas surveys, and leachate screening for VOCs. Technical details regarding the CPT are discussed in Section 7.0. Sampling activities include surface soil sampling, subsurface sampling using test borings, sediment sampling, leachate sampling, surface water sampling, and groundwater sampling. Monitoring wells will be installed at specified locations and will be sampled after completion and development. The activities described below will be performed as part of the field investigation, as described in detail in Section 7.0.

### 5.3.1 IHSS 114

1. New data will be reviewed.

2. A visual inspection of the Present Landfill will be performed.

3. CPT investigations will be conducted at 38 locations to delineate the extent of landfill wastes and obtain detailed profiles of subsurface materials.

4. In-situ landfill liquid and vapor samples from the 38 CPT locations will be collected and analyzed to define the volume of leachate and the nature and occurrence of landfill gases.

5. Boreholes will be drilled at 11 locations and sampled to evaluate the extent of leachate-contaminated materials. Six of these holes will penetrate land filled materials. Three holes will be drilled upgradient from the landfill and 2 downgradient of the pond.

6. Monitoring wells will be installed at six locations within the landfill area to obtain water level and chemical data for evaluating contamination and the effect of the groundwater and surface water barriers on leachate/groundwater movement. Nine monitoring wells will be installed upgradient of the site to establish site-specific background concentrations.

7. Groundwater samples will be collected from existing and newly installed wells, and samples will be analyzed for TCL volatile and semivolatile compounds, dissolved and total TAL metals, dissolved and total radionuclides, and inorganic analytes.

8. Water samples will be collected from four existing surface water stations and will be analyzed for TCL volatile and semivolatile compounds, TAL metals, TCL PCBs, radionuclides, and inorganic analytes.

9. Sediment samples from the East Landfill Pond will be collected and analyzed for TCL volatile and semivolatile compounds, TAL metals, TCL PCBs, radionuclides, and inorganic analytes.

10. The status of the valves for the groundwater intercept system will be determined, and samples of discharge from the intercept system will be obtained for analysis.

11. Locations of all sampling points and wells will be surveyed using standard surveying techniques.

### 5.3.2 IHSS 203

1. New data will be reviewed.

2. A visual inspection to delineate areas of possible spills will be performed.

3. A radiological (FIDLER) survey will be performed to determine the presence or absence of radioisotopes.

4. Surficial soils will be collected and analyzed for metals, radionuclides, TCL PCBs, and inorganic analytes. Subsurface samples will be collected and screened for TCL volatile and semivolatile compounds.

5. Locations of all sampling points will be surveyed using standard land surveying techniques.

### 5.3.3 Other OU7 Areas

1. New data will be reviewed.

2. A visual inspection to delineate areas impacted by spray evaporation will be performed.

3. A radiological (FIDLER) survey will be performed to determine the presence or absence of radioisotopes.

4. Surficial soil samples from spray evaporation areas adjacent to and downwind of the East Landfill Pond will be analyzed for TAL metals, radionuclides, and inorganic analytes.

5. Locations of all sampling points will be surveyed using standard land surveying techniques.

Sampling locations, frequency, and analyses are discussed in the FSP (Section 7.0). All field activities will be performed in accordance with RFP EM Program SOP unless otherwise noted in the FSP.

## 5.4 TASK 4 - SAMPLE ANALYSIS AND DATA VALIDATION

Analytical procedures will be completed in accordance with the ER Program QAPjP (EG&G, 1991k). Analytical detection limits, sample container and volume requirements, preservation requirements, and sample holding times are discussed in Section 7.3 of the FSP.

Results of data review and validation activities will be documented in data validation reports. EPA data validation functional guidelines will be used for validating organic and inorganic (metals) data (U.S. EPA, 1988c). Data validation methods for radiochemistry and major ions data have not been published by EPA, but data and documentation requirements

have been developed by EM Program QA staff. Data validation methods for these data are derived from these requirements. Details of the data validation process are described in the QAPjP (EG&G, 1991k).

Phase I data will be reviewed and validated according to data validation guidelines in the QAPjP and the Data Validation Functional Guidelines (EG&G, 1990b). These documents state that the results of data review and validation activities will be documented in data validation reports.

## 5.5 TASK 5 - DATA EVALUATION

Data collected during the Phase I RFI/RI, as well as previously collected data, will be incorporated into the existing RFEDS data base and will be used to better characterize contaminant sources and soil. These results also will be used in delineating the requirements for the Phase II RFI/RI plans for determining the impact of OU7 on surface water, groundwater, air, the environment, and biota, as well as the potential contaminant migration pathways at OU7. Additionally, data will be used to support the evaluation of proposed remedial alternatives and the Baseline Risk Assessment.

### 5.5.1 Site Characterization

The additional physical data collected during Phase I will be incorporated into the existing site characterization. Subsurface data will be used to describe the fill structure/profile and geotechnical engineering properties (such as penetration resistence and coefficient of friction) of geologic materials within OU7. The site geologic map and geologic cross sections will be revised on the basis of new information. Water-level data will be used to characterize the alluvial groundwater flow regime, including leachate flow within the wastes and the influence of the groundwater diversion system on groundwater flow. The response

of water levels to precipitation events will be evaluated for both historical and new data. Well hydrographs will be prepared for all wells, and the data will be summarized graphically for wells along the longitudinal and transverse sections through the landfill. Groundwater potentiometric surface maps will also be prepared for low water elevations and high water elevations time periods. Maps will be completed for both saturated surficial materials and weathered bedrock.

### 5.5.2 Source Characterization

Analytical data from boreholes, landfill liquid and gas samples, and soil samples will be used to:

- Characterize the nature of source contaminants
- Characterize the lateral and vertical extent of source contaminants;
- Evaluate onsite contaminant concentrations
- Better quantify the volume of source material and leachate

Analytical data obtained from samples of soil, sediment, landfill liquid and gas, surface water, and groundwater will be used to characterize the sources of contamination. Data from downgradient wells in the vicinity of the landfill will be compared to information obtained from the newly installed upgradient monitoring wells. Groundwater quality data from the newly installed upgradient monitoring wells will be used to establish site-specific statistical background values for evaluating contamination at OU7. Four quarters of validated chemical data will be used to develop statistical definitions of site-specific

background values for analytes in groundwater. Analytical data from borehole samples from the upgradient wells will be used to establish background values for subsurface materials. Data will be summarized graphically and/or in tabular form to assist interpretation. If appropriate, contaminant isopleth maps will be prepared to summarize the spatial distribution of source and soil contaminants.

The criteria for the identification of contamination will be analyte-specific. For all analytes (including radionuclides), only those concentrations that exceed the site-specific background concentrations will be considered likely evidence of contamination. The statistical techniques that will be used to calculate site-specific background concentrations of inorganic compounds collected at OU7 as part of the Phase I RFI/RI are documented in the Background Geochemical Characterization Report (EG&G, 1991f) and discussed briefly in Section 2.3.3. Essential to the implementation of these statistical techniques for groundwater and borehole samples is the correlation of each analytical datum to an appropriate geologic unit (such as the Rocky Flats Alluvium, colluvium, or artificial fill [waste]). Analytical data from surficial soil samples and vertical soil profiles will be evaluated to characterize the areal and vertical distribution of contaminants in remedial investigation areas where spray evaporation occurred and at IHSS 203. Analytical data from surface water and sediment samples from the East Landfill Pond will be used to assess contamination in that area. These data will be compared to sitewide background values provides in the Background Geochemical Characterization Report (EG&G, 1991f).

## 5.6 TASK 6 - PHASE I BASELINE RISK ASSESSMENT

As required by the IAG, a Baseline Risk Assessment will be performed as part of the Phase I RFI/RI report. This task includes a Baseline Human Health Risk Assessment and Environmental Evaluation for OU7. The purpose of the Baseline Human Health Risk Assessment and Environmental Evaluation are to assess the potential human health and

environmental risks associated with the site and to provide a basis for determining whether remedial actions are necessary. The Baseline Human Health Risk Assessment will address potential public health risks, and the Environmental Evaluation will address environmental impacts. In accordance with the IAG Statement of Work (Section I.B. 11.b, Page 13), the Baseline Risk Assessment for the Phase I investigation of OU7 will be limited to providing "the information necessary to determine the risk associated with the source of contamination...". Determination of risk associated with transported contaminants will be performed during the Phase II RFI/RI investigation.

Existing data and data collected during the Phase I RFI/RI will be used to support the quantitative Baseline Human Health Risk Assessment and Environmental Evaluation. The sampling program will be designed to generate data that meet the requirements set forth in Guidance for Data Useability in Risk Assessment (U.S. EPA, 1990).

These assessments will aid in the preliminary screening of site remedies based on the contaminants of concern and the environmental media associated with potential risks to public health and the environment. The risk assessment process will be accomplished in five general steps:

1. Identification of chemicals of concern
2. Exposure assessment
3. Toxicity assessment
4. Risk characterization
5. Qualitative and quantitative uncertainty analysis

As stated in the IAG, a risk characterization of the following scenarios will be developed:

1. Current site conditions (No Action Alternative)

2. Worker and public exposure during remedial action

3. Past remedy risk

If the Baseline Human Health Risk Assessment and Environmental Evaluation determine that risks posed by contamination at OU7 must be remediated, Tasks 7 and 8 will be conducted.

The objectives and the description of work for the Baseline Human Health Risk Assessment are described in detail in Section 8.0 of this work plan. The Environmental Evaluation work plan is presented in Section 9.0.

## 5.7 TASK 7 - DEVELOPMENT, SCREENING, AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

### 5.7.1 Remedial Alternatives Development and Screening

This section identifies potential technologies applicable to remediation of contaminated soils, wastes, surface water, sediments, and groundwater at OU7. The identified technologies are based on the preliminary site characterization developed in Section 2.0 and summarized in Section 2.4. Identification and screening of technologies, assembling an initial screening of alternatives, and identification of interim response actions will be conducted while the RFI/RI is being conducted. However, investigation of this operable unit is in its early stages; thus, remedial alternatives are only briefly reviewed in this section.

A more detailed evaluation of the remedial alternatives for OU7 will be performed as more data are collected.

The process employed to develop and evaluate alternatives for OU7 will follow guidelines provided in the National Contingency Plan (NCP). Although RCRA regulations will direct remedial investigations at OU7, the CERCLA process will also be considered for guidance because it specifies in greatest detail the steps that should be followed for selection of remedial alternatives. In addition, the IAG requires general compliance with both RCRA and CERCLA guidance.

The steps followed to develop remedial alternatives for the Present Landfill (IHSS 114), the Inactive Hazardous Waste Storage Area (IHSS 203), the East Landfill Pond, and spray areas are as follows:

1. Develop a list of general types of actions appropriate for the IHSS area constituting OU7 (such as containment, treatment, and/or removal) that may be implemented to satisfy the objectives defined in the previous step. These general types or classes of actions are generally referred to as "general response actions" in EPA guidance.

2. Identify and screen technology groups for each general response action. Screening will eliminate groups that are not technically feasible at the site.

3. Identify and evaluate process options for each technology group to select a process option representing each technology group under consideration. Although specific process options are selected to represent a technology group for alternative development and evaluation, these processes are intended to represent the broader range of options within a general technology group.

4. Assemble the selected representative technologies into site closure and corrective action alternatives for the IHSS areas of OU7 that represent a range of treatment and containment combinations, as appropriate.

5. Screen the assembled alternatives in terms of the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Because the purpose of the screening evaluation is to reduce the number of alternatives that will undergo thorough and extensive analysis, alternatives will be evaluated in less detail than subsequent evaluations.

6. Develop preliminary risk-based remedial action goals for affected media. Preliminary remedial action goals will be applied as performance objectives for evaluating the effectiveness of specific technology processes identified as candidate components of viable remedial action alternatives. Consistent with the NCP, preliminary remediation goals will be established at a $1 \times 10^{-6}$ excess cancer risk point of departure and at other intervals within the $1 \times 10^{-4}$ to $1 \times 10^{-6}$ decision range. As the CMS/FS evolves, preliminary remediation goals may be revised to a different risk level on the basis of consideration of appropriate factors that include, but are not limited to, exposure, uncertainty, and technical issues.

For the Phase I RFI/RI Work Plan, the appropriate level of alternatives analysis is the listing of general response actions most applicable to the type of site under investigation. General response actions are defined as those broad classes of actions that may satisfy the objectives for remediation defined for OU7. Table 5-1 provides a list and description of general response actions and typical technologies associated with remediating soils, wastes, groundwater, sediments, and surface water. Table 5-1 also includes a general statement regarding the applicability of the general response action to potential exposure pathways.

## Table 5-1: General Response Actions, Typical Associated Remedial Technologies, and Evaluation

| General Response Action | Description | Typical General Response Technologies | Action to Potential Pathways |
|---|---|---|---|
| No Action | No remedial action taken at site | Some monitoring and analyses may be performed. | National Contingency Plan requires consideration of no action as an alternative. Would not address potential pathways, although existing access restriction would continue to control onsite contact. |
| Access and use restrictions | Permanent prevention of entry into contaminated area of site. Control of land use. | Site security; fencing; deed use restrictions; warming signs. | Could control onsite exposure and reduce potential for offsite exposure. Site security fence and some signs are in place. Additional short-term or long-term access restrictions would likely be part of most remedial actions. |
| Containment | In-place actions taken to prevent migration of contaminants. | Capping; groundwater containment barriers; soil stabilization; enhanced vegetation. | If applied to source, could be used to control all pathways. If applied to transport media, could be used to mitigate past releases (except air). |
| Pumping | Transfer of accumulated subsurface or surface contaminated water, usually to treatment and disposal. | Groundwater pumping; leachate collection; liquid removal from surface impoundments. | Applicable to leachate removal prior to in situ treatment or waste removal. Applicable removal of contaminated groundwater and bulk liquids (for example, from buried drums). |
| Removal | Excavation and transport of primarily nonaqueous contaminated material from area of concern to treatment or disposal area. | Excavation and transfer of drums, soils, sediments, wastes, contaminated structures. | If applied to source, could be used to control all pathways. If applied to transport medial, will control corresponding pathway. Must be used with treatment or disposal response actions to be effective. |

| General Response Action | Description | Typical General Response Technologies | Action to Potential Pathways |
|---|---|---|---|
| Treatment | Application of technology to change the physical or chemical characteristics of the contaminated material. Applied to material that has been removed. | Solidification; biological, chemical, and physical treatment. | Applied to removed source material; could be used to control all pathways. Applied to removed transport medial, could control air, surface water, groundwater, and sediment pathways. |
| In Situ Treatment | Application of technologies in situ to change the in-place physical or chemical characteristics of contaminated material. | In situ vitrification; bioremediation. | Applied to source, could be used to control all pathways. Applied to transport medial, could be used to control corresponding pathways. |
| Storage | Temporary stockpiling of removed material in a storage area or facility prior to treatment or disposal. | Temporary storage structures. | May be useful as a means to implement removal actions, but definition would not be considered a final action for pathways. |
| Disposal | Final placement of removed contaminated material or treatment residue in a permanent storage facility. | Permitted landfill; repositories. | With source removal, could be used to control all pathways. With removal of contaminated transport medial, could be used to control corresponding pathway (except air). |
| Monitoring | Short- and/or long-term monitoring is implemented to assess site conditions and contamination levels. | Sediment, soil, surface water, and groundwater sampling and analysis. | RCRA requires post-closure monitoring to assess performance of closure and corrective action implementation. |

Not all of the alternative response actions and typical technologies listed may be appropriate for the IHSS areas of OU7. Some will be discarded during the screening of alternatives.

The response actions outlined in Table 5-1 must be applied to the potential exposure pathways that will be identified for OU7. The response actions can be capable of providing control over all or some of the potential pathways. Partially effective response actions can be combined to form complementary sets of response actions that provide control over all pathways.

In general terms, potential human exposure can be avoided by prevention of contaminant release, transport, and/or contact. Thus, application of the response actions may be considered at three different points in each potential exposure pathway: (1) at the point where the contaminant could be released from the source, (2) in the transport medium, and (3) at the point where the contact could occur with the released contaminant.

The existing data do not adequately characterize the source, release mechanisms, and migration pathways for contamination at OU7. Therefore, the existing data are not sufficient for implementing the screening of alternatives. Phase I will generate data (Table 5-2) necessary to characterize the source and soils (as defined in Section 1.0). Phase II of the RFI/RI will evaluate the impact of OU7 on surface water, groundwater, air, the environment, and biota in addition to characterizing potential contaminant migration pathways. Data obtained from these investigations will:

- Describe the physical characteristics of the site

- Define sources of contamination

## Table 5-2: Response Actions, Remedial Technologies, and Data Requirements



| General Response Actions | Associated Remedial Technologies | Data Purpose | Data Need |
|---|---|---|---|
| Complete or Partial Removal and Treatment of Contaminated Soils | • Disposal (Off-Site) | Evaluate RCRA Land Ban and Radioactivity Restrictions | - 40 CFR 268 Table CCWE and Appendix III Analyses<br>- Full Suite of Radionuclide Analyses |
| | | Cost Analysis | - Vertical and Horizontal Extent of Contamination |
| In-Situ Contaminated Soils Treatment | • Immobilization | Determine Viscosity of Grout Material | - Soil Grain Size Distribution (sieve analysis) |
| | | Effectiveness | - Full Suite of Organic and Inorganic Analyses |
| | • Soil Flushing | Effectiveness | - Full Suite of Organic and Inorganic Analyses<br>- Soil Organic Matter Content<br>- Soil Classification<br>- Soil Permeability<br>- Treatability Study |
| | • Vapor Extraction | Effectiveness | - Full Suite of Organic and Inorganic Analyses<br>- Subsurface Geological Characteristics<br>- Depth to Ground Water<br>- Soil Permeability<br>- Treatability |

| General Response Actions | Associated Remedial Technologies | Data Purpose | Data Need |
|---|---|---|---|
| | • Vitrification | Cost Effectiveness | - Full Suite of Organic and Inorganic Analyses<br>- Treatability Study |
| Groundwater Collection | • Well Array/Subsurface Drains | Storativity (transient flow) | - Aquifer tests |
| Infiltration and Groundwater Containment Controls | • Capping/Subsurface Barriers | Suitability of Off-Site Soil for Use | - Gradation (Sieve Analysis)<br>- Atterberg Limits (Plasticity Tests)<br>- % Moisture<br>- Compaction (Proctor)<br>- Permeability (Triaxial Permeability)<br>- Strength (Triaxial or Direct Shear) |
| | | Effectiveness | - Location of Subcroping Sandstones<br>- Hydraulic Conductivity of Bedrock Materials |
| | | Construction Feasibility | - Grade<br>- Depth to Bedrock |
| In-Situ Groundwater Treatment/Immobilization | • Immobilization | Determine Viscosity of Grout Material | - Soil Grain Size Distribution (sieve analysis) |
| | | Effectiveness | - Full Suite of Organic and Inorganic Analyses |

| General Response Actions | Associated Remedial Technologies | Data Purpose | Data Need |
|---|---|---|---|
| | • Aeration | Effectiveness | - Full Suite of Organic and Inorganic Analyses<br>- Subsurface Geological Characteristics<br>- Depth to Ground Water<br>- Soil Permeability<br>- Treatability Study |
| Groundwater/Surface Water Treatment | • UV/Peroxide or UV/Ozone | Process control | - Iron and Manganese |
| | | Effectiveness | - Full Suite of Organic and Inorganic Analyses<br>- Treatability Study |
| | • Air Stripping | Process Control | - Hardness |
| | | Effectiveness | - Full Suite of Organic and Inorganic Analyses<br>- Treatability Study |
| | • Other Water Treatment Technologies (carbon adsorption, ion exchange, electrodialysis, and reverse osmosis) | Process Control | - Full Suite of Organic and Inorganic Analyses |
| | | Effectiveness | |

• See Table 2-14

- Determine the nature and extent of contamination in soil, groundwater, surface water, sediments, and air

- Describe contaminant fate and transport

- Describe receptors

These data will provide information for the preliminary screening of alternatives and a thorough, comparative evaluation of the technologies with respect to implementability, effectiveness, and cost. This information will allow for informed decisions to be made with respect to the selection of preferred technologies. The FSP (Section 7.0) describes the methodology that will be followed to obtain the required information for the Phase I RFI/RI characterization.

### 5.7.2 Detailed Analysis of Remedial Alternatives

Sufficient data may not be generated during the Phase I investigation to allow for a detailed analysis of alternatives; however, this is not a requirement of the Phase I RFI/RI. The detailed analysis of each alternative will be performed when sufficient data are generated during Phase II. The detailed analysis and selection of alternatives is not a decision-making process; rather, it is the process of analyzing and comparing relevant information in order to select a preferred remedial action. In accordance with the NCP, containment technologies will generally be appropriate remedies for wastes that pose a relatively low-level threat or where treatment is impracticable (U.S. EPA, 1991b). Each appropriate alternative will be assessed in terms of nine evaluation criteria, and the assessments will be compared to identify the key attributes among the alternatives. Assessment in terms of nine evaluation criteria is necessary for the CMS and the subsequent Corrective Action

Decision (CAD)/Record of Decision (ROD). The nine specific evaluation criteria are as follows:

1. Overall protection of human health and the environment

2. ARARs

3. Long-term effectiveness and permanence

4. Reduction of toxicity, mobility, or volume

5. Short-term effectiveness

6. Implementability

7. Cost

8. State acceptance

9. Community acceptance

These criteria are described in recently revised guidelines provided in the NCP. The first two criteria are considered threshold criteria because they must be evaluated before further consideration of the remaining criteria. The next five criteria are considered the balancing criteria on which the analysis is based. The final two criteria are addressed during the final decision-making process after completion of the CMS/FS.

## 5.8 TASK 8 - TREATABILITY STUDIES/PILOT TESTING

The primary purposes of a treatability study are to provide sufficient technology performance information and to reduce cost and performance uncertainties to acceptable levels so that treatment alternatives can be fully developed and evaluated during detailed analysis. The task includes efforts to evaluate whether treatability studies are necessary and, if so, to prepare for and conduct treatbility studies. If remedial alternatives are developed, the data collected as part of the field investigation will be reviewed in terms of whether the alternatives can be evaluated. If additional data are required, treatability studies or field investigations will occur.

If it is determined that a treatability study is necessary, a treatability work plan will also be prepared. The plan will identify treatability tests that need to be conducted as well as the test materials and equipment needed.

The treatability work plan will discuss the following

- The scale of the treatability study
- Key parameters to be varied and evaluated, and criteria to be used to evaluate the tests
- Specifications for test samples, and the means for obtaining these samples
- Test equipment and materials, and procedures to be used in the treatability test

- Identification of where and by whom the tests and any analytical services will be conducted, as well as any special procedures and permits required to transport samples and residues and conduct the test

- Methods required for residue management and disposal

- Any special QA/QC needed for the tests

## 5.9 TASK 9 - PHASE I RFI/RI REPORT

An RFI/RI report will be prepared to consolidate and summarize the data obtained during the Phase I fieldwork as well as data collected from previous and ongoing investigations. This report will:

- Describe the field activities that serve as a basis for the Phase I RFI/RI report. This will include any deviations from the work plan that occurred during implementation of the field investigation.

- Discuss site physical conditions based on existing data and data derived during the Phase I RFI/RI. This discussion will include surface features, climate, surface water hydrology, surficial geology, stratigraphy, groundwater hydrology, demography and land use, and ecology.

- Present site characterization results from all Phase I RFI/RI activities to characterize the site physical features and contamination at OU7. The media to be addressed will be limited to contaminant source and soils (including leachate/groundwater within the landfill source).

- Discuss contaminant fate and transport based on existing information. This discussion will include a preliminary identification of potential contaminant migration routes, and a discussion of contaminant persistence, chemical attenuation processes, and potential receptors.

- Present a Phase I Baseline Risk Assessment. The risk assessment will include human health and environmental evaluations.

- Present a summary of findings and conclusions.

- Identify data needs for Phase II of the RFI/RI, if necessary.

Before submittal of the Phase I RFI/RI report, a Preliminary Site Characterization Summary will be submitted to EPA and CDH for review. This summary will provide an early description of the initial site characterization effort, including a preliminary presentation of analytical data and a listing of chemical and radiological contaminants, the affected media, and potential sitewide chemical-specific ARARs. In addition to the characterization summary, technical memoranda will be prepared with the completion of each field sampling task to provide preliminary results of field investigations.

This is a
CONTROLLED DOCUMENT

ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT DEPARTMENT

ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203
Title: Schedule

Manual No.: 21100-WP-OU 07.01
Section No.: 6.0, R0
Organization: Environmental Management

This is a RED Stamp

Approved by:

12/6/91
Effective Date

L. P. O'Rourke
Manager

6/23/92
Date

## 6.0 SCHEDULE

The schedule for conducting the Phase I RFI/RI is summarized in Figure 6-1. Dates shown are from the IAG, dated January 22, 1991. According to the schedule, approximately three years will elapse from the time this work plan is finalized until the Phase I RFI/RI report is issued.

The schedule indicates field activities continuing until September 1993. This will allow collection of four quarters of surface water and groundwater samples for chemical analyses. This schedule also allows for additional data collection activities that may be required based on the results of the sampling proposed in the FSP.

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

OPERABLE UNIT 7
PRESENT LANDFILL

| ACTIVITY | START | FINISH |
|---|---|---|
| PROJECT MANAGEMENT | 02Jan90 | 15Apr94 |
| TASK 1 - PROJECT PLANNING | 02Jan90 | 07Sep92 |
| TASK 2 - COMMUNITY RELATIONS | 02Jan90 | 15Apr94 |
| TASK 3 - FIELD INVESTIGATION | 05Aug92 | 30Sep93 |
| TASK 4 - SAMPLE ANALYSIS & DATA VALIDATION | 19Aug92 | 14May93 |
| TASK 5 - DATA EVALUATION | 19Apr93 | 12Aug93 |
| TASK 6 - BASELINE RISK ASSESSMENT | 01Jun93 | 27May94 |
| TASK 7 - DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES | 10Nov93 | 21Jun94 |
| TASK 8 - TREATABILITY STUDIES | 13Oct93 | 06Jul94 |
| TASK 9 - PHASE I RFI/RI REPORT | 19Apr93 | 15Apr94 |

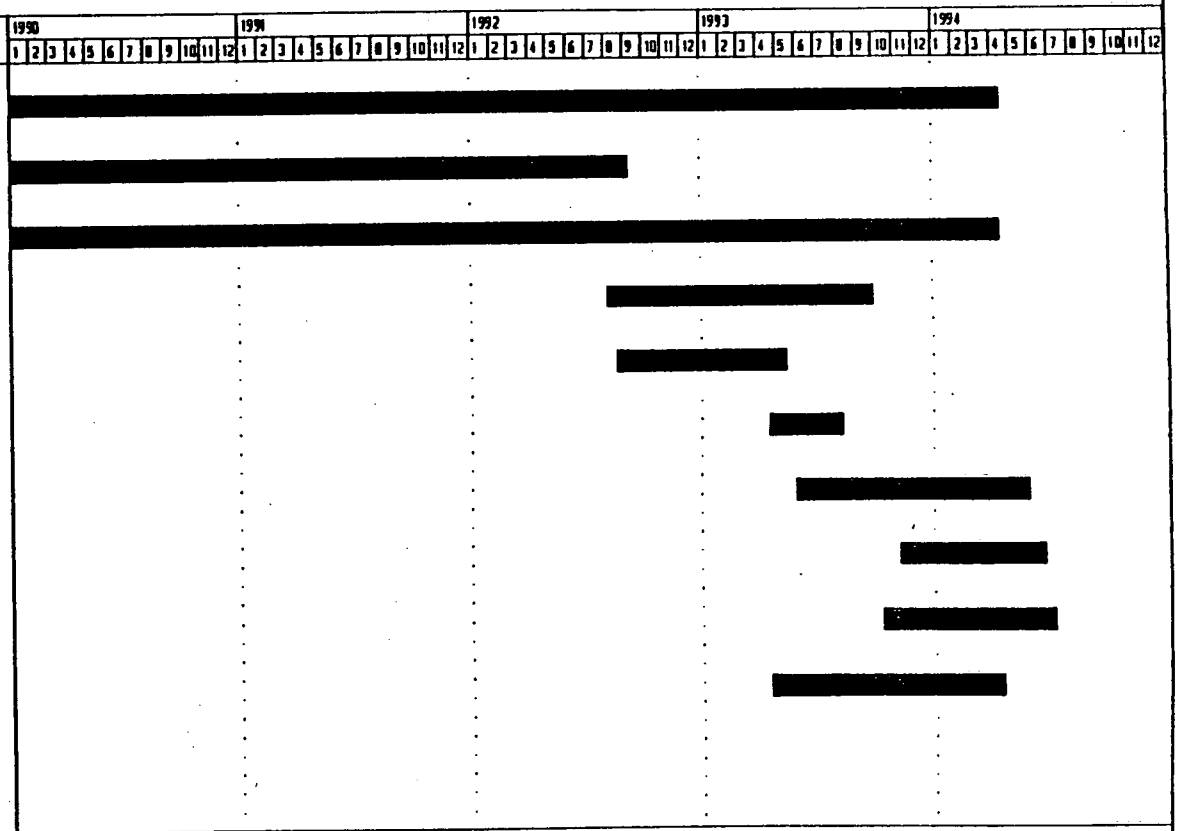



FIGURE 6-1 JULY 1991

This is a
CONTROLLED DOCUMENT

ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203

Manual No.: 21100-WP-OU 07.01
Section No.: 7.0, R0
Organization: Environmental Management

ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT DEPARTMENT

This is a RED Stamp

Title: Field Sampling Plan

Approved by:

12/6/91
Effective Date

L. P. O'Rourke
Manager

6/23/92
Date

## 7.0 FIELD SAMPLING PLAN

The purpose of this section of the work plan is to provide a Field Sampling Plan (FSP) that will generate sufficient and adequate data to satisfy the Phase I RFI/RI objectives developed in Section 4.0. These site-specific objectives are presented in Section 7.1. Current site conditions and a discussion of the rationale for the sampling and analysis activities needed to obtain the necessary data to meet the Phase I objectives are summarized in Section 7.2.

Following the discussion of sampling activities (design, location, and frequency) proposed to meet the Phase I RFI/RI objectives (Section 7.3), the analytical program (sample designations, analytical requirements and rationale, sample containers and preservations, sample labeling and documentation, and data reporting requirements) and field quality control procedures are discussed in Section 7.4.

Phase II of the RFI/RI will determine the nature and extent of contamination, describe contaminant fate and transport, and evaluate the impact of OU7 on surface water, groundwater, air, the environment, and biota.

### 7.1 OU7 PHASE I RFI/RI OBJECTIVES

The specific objectives of the Phase I RFI/RI field investigation for OU7 are as follows:

Characterize Site Physical Features

1. Determine representative site-specific background concentrations of analytes in groundwater and subsurface materials

2. Characterize the flow regime within and around OU7 to evaluate the effects of the groundwater intercept system and slurry walls on groundwater/leachate movement

3. Characterize surface water/groundwater interactions

4. Evaluate infiltration of precipitation through the existing soil cover material.

Define Contaminant Sources

1. Determine the presence or absence of soil contamination at IHSS 203

2. Determine the presence or absence of contamination in soils where spray evaporation occurred

3. Further characterize the waste streams disposed in the landfill and evaluate the environmental fate and trasnport of the chemicals associated with the identified waste streams

4. Determine the area and volume of landfill material

5. Determine the volume and character of leachate

6. Determine the character and volumes (gas production) of landfill-generated gases

7. Characterize leachate-contaminated materials (including soils, bedrock, and West Landfill Pond sediments) beneath the landfill

8. Characterize contamination in surface water and sediments in the East Landfill Pond

Determine Nature and Extent of Contamination

This will be addressed in the Phase II RFI/RI Work Plan.

Describe Contaminant Fate and Transport

This will be addressed in the Phase II RFI/RI Work Plan.

Provide a Baseline Risk Assessment

The objectives of the Baseline Risk Assessment are discussed in Sections 8.0 and 9.0.

Data collected to satisfy the Phase I objectives will support the Baseline Risk Assessment.

## 7.2 BACKGROUND AND FSP RATIONALE

Previous investigations performed at OU7 and other pertinent information are described in Section 2.0 of this work plan. To summarize, numerous investigations have been performed previously to characterize the physical setting (Section 2.2) and contamination (Section 2.3) at OU7. Available information includes IHSS site histories, stratigraphic logs, geotechnical studies, geophysical information, soil-gas data, groundwater level measurements, results of pump-in borehole packer tests, and analytical data for groundwater, surface water, and borehole samples collected within and near OU7.

Only a small portion of the data for OU7 are reliable or have been validated. Most of the analytical data for radionuclides have been rejected. Presently, groundwater quality at OU7 is compared to sitewide statistical definitions of groundwater quality to evaluate the nature and extent of contamination. Site-specific statistical definitions of background groundwater quality are needed from wells located immediately upgradient of the landfill to (1)

accurately assess contamination within sources at OU7, (2) differentiate contamination from other sources, and (3) comply with RCRA guidance.

Drilling investigations have identified surficial materials overlying weathered and unweathered claystones and siltstones of the Arapahoe formation. Based on at least two years of quarterly water level data, site-specific flow directions and gradients have been determined for surficial materials and weathered bedrock units. Limited hydraulic testing has been performed to estimate the hydraulic conductivity of the surficial materials and the weathered and unweathered bedrock. However, additional geologic and hydrogeologic information is needed to characterize the extent of the landfill material and the flow regime of leachate/groundwater within the landfill materials. Additional information is needed to adequately assess infiltration of water through the soil cover overlying landfill wastes and the impacts of the groundwater barriers. In addition, groundwater/surface water interactions have not been characterized during previous investigations at OU7.

The nature and extent of contamination at OU7 has only been preliminarily characterized by previous investigations. The Phase II RFI/RI will address the nature and extent of contamination at OU 7. Available IHSS site histories and analytical data for groundwater, surface water, soil-gas, and borehole samples have been examined in preparation of this work plan. Previous investigations have focused primarily on IHSS 114. IHSS 203, sediments in the East Landfill Pond, and the area around the East Landfill Pond where spray evaporation occurred have not been characterized during previous investigations. Therefore, the types of sampling and analysis activities for the various sites within OU7 differ, based on the amount and reliability of available data.

Analytical Rationale

The analytical suites for each area in OU7 were developed according to the type of waste suspected to be present at each site. The rationale for the analytical suites is based on historical information (types of contamination and waste management practices), available

chemical data, and an interpretation of the environmental fate and transport characteristics of the individual contaminants within the physical setting at OU7. The specific analytes and detection/quantitation limits that will be used for the Phase I RFI/RI are presented in Tables 7-1 and 7-2. The detection/quantitation limits shown in Table 7-1 are CLP quantitation limits for soil, sediment, and water analyses specified in GRRASP (EG&G, 1991j). The analytical suite listed in Table 7-1 should address the bulk of chemicals and compounds that were landfilled, handled, or suspected to be present at OU7 and enable detection of soil, sediment, surface water, and groundwater contamination, if present. The analytical suite listed in Table 7-2 should address the primary landfill-generated gases. However, to evaluate the possibility of additional hazardous constituents as a result of undocumented disposal at OU7, samples from selected locations and media will be analyzed for a complete RCRA Appendix IX analytical suite. The location and media to be sampled and analyzed for RCRA Appendix IX analytes have been selected to provide a representative "worst-case" sample from appropriate areas within OU7. The locations and media to be analyzed for the Appendix IX analtyes are described in detail in Sections 7.3.1 and 7.3.2. The rationales for the analytical suites appropriate for the various samples obtained from the different areas within OU7 are discussed below. In Section 7.4.2, target analytes within the analytical suites are discussed.

Based on previous investigations of groundwater quality (Section 2.0), IHSS 114 may contribute VOCs, semivolatiles, metals, inorganic analytes, and radionuclides to groundwater. PCBs are not expected in the groundwater at OU7 because of the low solubility coefficient of these compounds. Because no reliable data exist to characterize potential gases generated by the landfill material, the analytical suite for the soil-gas survey will consist of common gases frequently found in landfills and selected VOCs identified in leachate/groundwater within IHSS 114.

Based on historical records, the primary contaminants of concern at IHSS 203 are likely to be VOCs, semivolatiles, and PCBs. Because of limited information regarding the types of wastes stored at IHSS 203, radiochemical analyses will be performed to determine the

# Table 7-1: Phase I Soil, Sediment, and Water Sampling Parameters and Detection/Quantitation Limits



| Target Analyte List - Metals | Detection Limits* Water (µg/l) | Soil/Sediment (mg/kg) |
|---|---|---|
| Aluminum | 200 | 40 |
| Antimony | 60 | 12 |
| Arsenic | 10 | 2 |
| Barium | 200 | 40 |
| Beryllium | 5 | 1.0 |
| Cadmium | 5 | 1.0 |
| Calcium | 5000 | 2000 |
| Cesium | 1000 | 200 |
| Chromium | 10 | 2.0 |
| Cobalt | 50 | 10 |
| Copper | 25 | 5.0 |
| Cyanide | 10 | 10 |
| Iron | 100 | 20 |
| Lead | 5 | 1.0 |
| Lithium | 100 | 20 |
| Magnesium | 5000 | 2000 |
| Manganese | 15 | 3.0 |
| Mercury | 0.2 | 0.2 |
| Molybdenum | 200 | 40 |
| Nickel | 40 | 8.0 |
| Potassium | 5000 | 2000 |
| Selenium | 5 | 1.0 |
| Silver | 10 | 2.0 |
| Sodium | 5000 | 2000 |
| Strontium | 200 | 40 |
| Thallium | 10 | 2.0 |
| Tin | 200 | 40 |
| Vanadium | 50 | 10.0 |
| Zinc | 20 | 4.0 |

| Target Compounds List - Volatiles | Quantitaion Limits* Water (µg/l) | Soil/Sediment (µg/kg) |
|---|---|---|
| Chloromethane | 10 | 10 |
| Bromomethane | 10 | 10 |
| Vinyl Chloride | 10** | 10 |
| Chloroethane | 10 | 10 |
| Methylene Chloride | 5 | 5 |
| Acetone | 10 | 10 |
| Carbon Disulfide | 5 | 5 |
| 1,1-Dichloroethene | 5 | 5 |
| 1,1-Dichloroethane | 5 | 5 |
| trans 1,2-Dichloroethene | 5 | 5 |
| Chloroform | 5 | 5 |
| 1,2-Dichloroethane | 5 | 5 |
| 2-Butanone | 10 | 10 |
| 1,1,1-Trichloroethane | 5 | 5 |
| Carbon Tetrachloride | 5 | 5 |
| Vinyl Acetate | 10 | 10 |
| Bromodichloromethane | 5 | 5 |
| 1,1,2,2,-Tetrachloroethane | 5 | 5 |
| 1,2-Dichloropropane | 5 | 5 |
| trans-1,3-Dichloropropene | 5 | 5 |
| Trichloroethene | 5 | 5 |
| Dibromochloromethane | 5 | 5 |
| 1,1,2-Trichloroethane | 5 | 5 |
| Benzene | 5 | 5 |
| cis-1,3-Dichloropropene | 5 | 5 |
| Bromoform | 5 | 5 |
| 2-Hexanone | 10 | 10 |
| 4-Methyl-2-pentanone | 10 | 10 |

| | | |
|---|---|---|
| Tetrachloroethene | 5 | 5 |
| Toluene | 5 | 5 |
| Chlorobenzene | 5 | 5 |
| Ethyl Benzene | 5 | 5 |
| Styrene | 5 | 5 |
| Total Xylenes | 5 | 5 |

| | Quantitation Limits* | |
|---|---|---|
| **Semivolatiles** | Water µg/ℓ | Soil/Sediment µg/Kg |
| Phenol | 10** | 330 |
| bis(2-Chloroethyl)ether | 10** | 330 |
| 2-Chlorophenol | 10** | 330 |
| 1,3-Dichlorobenzene | 10 | 330 |
| 1,4-Dichlorobenzene | 10 | 330 |
| Benzyl alcohol | 10 | 330 |
| 1,2-Dichlorobenzene | 10 | 330 |
| 2-Methylphenol | 10 | 330 |
| bis(2-Chloroisopropyl)ether | 10 | 330 |
| 4-Methylphenol | 10 | 330 |
| N-Nitroso-di-n-propylamine | 10 | 330 |
| Hexachloroethane | 10 | 330 |
| Nitrobenzene | 10** | 330 |
| Isophorone | 10 | 330 |
| 2-Nitrophenol | 10 | 330 |
| 2,4-Dimethylphenol | 10 | 330 |
| Benzoic acid | 50 | 1600 |
| bis(2-Chloroethoxy)methane | 10 | 330 |
| 2,4-Dichlorophenol | 10 | 330 |
| 1,2,4-Trichlorobenzene | 10 | 330 |
| Naphthalene | 10 | 330 |
| 4-Chloroaniline | 10 | 330 |
| Hexachlorobutadiene | 10 | 330 |

| | | |
|---|---|---|
| 4-Chloro-3-methylphenol (para-chloro-meta-cresol) | 10 | 330 |
| 2-Methylnaphthalene | 10 | 330 |
| Hexachlorocyclopentadiene | 10 | 330 |
| 2,4,6-Trichlorophenol | 10 | 330 |
| 2,4,5-Trichlorophenol | 50 | 1600 |
| 2-Chloronapthalene | 10 | 330 |
| 2-Nitroaniline | 50 | 1600 |
| Dimethylphthalate | 10 | 330 |
| Acenaphthylene | 10 | 330 |
| 2,6-Dinitrotoluene | 10 | 330 |
| 3-Nitroaniline | 50 | 1600 |
| Acenaphthene | 10 | 330 |
| 2,4-Dinitrophenol | 50 | 1600 |
| 4-Nitrophenol | 50 | 1600 |
| Dibenzofuran | 10 | 330 |
| 2,4-Dinitrotoluene | 10 | 330 |
| Diethylphthalate | 10 | 330 |
| 4-Chlorophenyl-phenyl ether | 10 | 330 |
| Fluorene | 10 | 330 |
| 4-Nitroaniline | 50 | 1600 |
| 4,6-Dinitro-2-methylphenol | 50 | 1600 |
| N-nitrosodiphenylamine | 10 | 330 |
| 4,-Bromophenyl-phenylether | 10 | 330 |
| Hexachlorobenzene | 10** | 330 |
| Pentachlorophenol | 50 | 1600 |
| Phenanthrene | 10 | 330 |
| Anthracene | 10 | 330 |
| Di-n-butylphthalate | 10 | 330 |
| Fluoranthene | 10 | 330 |
| Pyrene | 10 | 330 |
| Butylbenzylphthalate | 10 | 330 |

| | | |
|---|---|---|
| 3,3'-Dichlorobenzidine | 20** | 660 |
| Benzo(a)anthacene | 10 | 330 |
| Chrysene | 10 | 330 |
| bis(2-Ethylhexyl)phthalate | 10 | 330 |
| Di-n-octylphthalate | 10 | 330 |
| Benzo(b)fluoranthene | 10 | 330 |
| Benzo(k)fluoranthene | 10 | 330 |
| Benzo(a)pyrene | 10 | 330 |
| Indeno(1,2,3-cd)pyrene | 10 | 330 |
| Dibenz(a,h)anthracene | 10 | 330 |
| Benzo(g,h,i)perylene | 10 | 330 |

Quantitation Limits*

| Target Compound List - Pesticides/PCBs | Water (µg/l) | Soil/Sediment (µg/kg) |
|---|---|---|
| alpha-BCH | 0.05 | 8.0 |
| beta-BCH | 0.05 | 8.0 |
| delta-BCH | 0.05 | 8.0 |
| gamma-BCH (Lindane) | 0.05 | 8.0 |
| Heptachlor | 0.05** | 8.0 |
| Aldrin | 0.05** | 8.0 |
| Heptachlor epoxide | 0.05** | 8.0 |
| Endosulfan I | 0.05 | 8.0 |
| Dieldrin | 0.10 | 16.0 |
| 4,4'-DDD | 0.10 | 16.0 |
| Endrin | 0.10 | 16.0 |
| Endosulfan II | 0.10 | 16.0 |
| 4,4'-DDE | 0.10 | 16.0 |
| Endosulfan sulfate | 0.10 | 16.0 |
| 4,4'-DDT | 0.10 | 16.0 |
| Methoxychlor | 0.5 | 80.0 |
| Endrin ketone | 0.10 | 16.0 |

| | | |
|---|---|---|
| alpha-Chlordane | 0.5** | 80.0 |
| gamma-Chlordane | 0.5** | 80.0 |
| Toxaphene | 1.0 | 160.0 |
| Arochlor-1016 | 0.5** | 80.0 |
| Arochlor-1221 | 0.5** | 80.0 |
| Arochlor-1232 | 0.5** | 80.0 |
| Arochlor-1242 | 0.5** | 80.0 |
| Arochlor-1248 | 0.5** | 80.0 |
| Arochlor-1254 | 1.0** | 160.0 |
| Arochlor-1260 | 1.0** | 160.0 |

Required Detection Limits*

| **Radionuclides** | Water (pCi/ℓ) | Soil/Sediment (pCi/g) |
|---|---|---|
| Gross Alpha | 2 | 4 dry |
| Gross Beta | 4 | 10 dry |
| Uranium 233+234, 235, and 238 (each species) | 0.6 | 0.3 dry |
| Americium 241 | 0.01 | 0.02 dry |
| Plutonium 239+240 | 0.01 | 0.03 dry |
| Tritium | 400 | 400 (pCi/ml) |
| Cesium 137 | 1 | 0.1 dry |
| Strontium 89+90 | 1 | 1 dry |

Detection Limits*

| Parameters Exclusively for Groundwater Samples | Water (mg/ℓ) |
|---|---|
| **Anions** | 10 |
| Carbonate | 10 |
| Bicarbonate | 5 |
| Chloride | 5 |
| Sulfate | 5 |
| Nitrate as N | |

| | |
|---|---|
| **Field Parameters** | |
| pH | 0.1 pH unit |
| Specific Conductance | 1 |
| Temperature | |
| Dissolved Oxygen | 0.5 |
| Barometric Pressure | |
| **Indicators** | |
| Total Dissolved Solids | 5 |

*Detection and quantitaion limits are highly matrix dependent. The limits listed here are the minimum achievable under ideal conditions. Actual limits may be higher.

**The laboratory Practical Quantification Limits (PQLs) for these analytes exceed ARARs.

## Table 7-2: Phase I Investigation Soil Gas Parameters and Proposed Detection Limits

| Sample Type | Detection Limit |
|---|---|
| acetone | 1 µg/ℓ |
| hydrogen sulfide | 1 µg/ℓ |
| methylene chloride | 1 µg/ℓ |
| methane | 1 µg/ℓ |
| TCE | 1 µg/ℓ |
| toluene | 1 µg/ℓ |
| xylenes (total) | 1 µg/ℓ |
| 1,1,1-TCA | 1 µg/ℓ |
| 1,2-DCE | 1 µg/ℓ |
| 2-butanone | 1 µg/ℓ |

Note: Detection limits are a function of the detector type and injection volume. Thus, the detection limit may vary.

presence or absence of radionuclides. Facilitated transportation of PCBs dissolved in organic liquids (cosolvation) is not expected because spills were low in volume, intermittent, and subject to rapid volatilization. Contamination of surficial soils by organic compounds is not expected becuase these contaminants would volatilize. However, residual organic compounds may be present in shallow soils where volatilization is limited by overlying soil. Metals and radionuclides are expected to be sorbed to the clayey materials in shallow soils.

The contaminants of concern in leachate draining into the East Landfill Pond include VOCs, semivolatiles, metals, radionuclides, and inorganic analytes. Contaminants detected in surface water samples obtained from the East Landfill Pond include metals, radionuclides, and inorganic analytes. Concentrations of these analytes in samples from the East Landfill Pond are consistently lower than concentrations in the leachate entering the East Landfill Pond. Therefore, sediments in the East Landfill Pond are likely to have sorbed some of these analytes. PCBs have not been detected in pond samples, nor are they expected, as any surface drainage from IHSS 203 would be diverted around the East Landfill Pond.

The primary potential contaminants of concern at the East Landfill Pond spray areas are metals and radionuclides. VOCs and semivolatiles would not be present, as these compounds would be expected to volatilize during spray evaporation.

Sampling Rationale

The rationale for the Phase I sampling activities is based on an iterative process involving the use of Level I and II data types to direct subsequent field activities requiring more intrusive sampling techniques designed to obtain samples for Level III through V analyses. For example, information from the CPT will be used to select target intervals for in-situ gas/liquid sampling, select borehole locations, and design the monitoring wells.

This section describes the Phase I investigation rationale for the IHSSs within OU7. For each IHSS, the tasks listed are generally divided into the following four separate steps:

- Step 1 consists of a review of new data. Although review and evaluation of existing data relative to OU7 have been performed during preparation of this Phase I work plan, data obtained from ongoing or other operable unit investigations that have become available since preparation of this Phase I work plan will also be compiled, reviewed, and evaluated. These data will be validated as appropriate for incorporation into the characterization of OU7.

- Step 2 involves field screening activities, including visual inspections, cone penetrometer testing (CPT), a soil-gas survey, and leachate screening for VOCs with an in-situ sampling system at IHSS 114, and a surface radiation survey and a shallow soil-gas survey at IHSS 203. Visual inspections will be performed to assess site conditions, including ongoing waste operations that may affect field activities or the quality of data collected. Data from CPTs will show detailed lithologies, indicate the distribution and thickness of both landfill waste and fill material, and indicate the presence and depth of leachate/groundwater within the landfill. This information will be used to design the groundwater monitoring wells. In-situ testing of soil gas and leachate screening for VOCs will indicate the lateral and vertical distribution of these compounds in the landfilled material. A schematic diagram that illustrates the CPT rig, the CPT profiles, the general BAT® gas/liquid sampling locations, and general monitoring well construction details is presented as Figure 7-1. The radiation and soil-gas surveys are designed to provide Phase I screening-level data regarding the presence or absence of surface radiological or shallow subsurface volatile contamination at IHSS 203.

- Step 3 consists of Phase I sampling activities for soil, sediment, and surface water. Soil borings will be completed at IHSS 114 to collect samples at depth. Some of the sampling locations may be selected to investigate anomalies identified in the Step 2 soil-gas and radiation surveys. This step will aid in

Phase I geologic/hydrogeologic and source and soils characterization of the site as well as provide confirmation of the Phase I screening data. Surface water and sediment samples will be collected from the East Landfill Pond. Leachate draining from the landfill into the East Pond will also be sampled. Shallow soils will be obtained at IHSS 203 and the area around the landfill pond to assess the presence or absence of contamination.

- Step 4 involves installation and sampling of monitoring wells. The exact locations of the proposed monitoring well locations will be re-evaluated on the basis of Step 2 screening and Step 3 characterization and sampling. Groundwater monitoring wells will be installed to monitor alluvial groundwater quality and conditions (levels) within and/or downgradient of the landfill. All wells will be sampled after completion and development. Groundwater monitoring wells will also be installed upgradient of OU7. These wells will monitor alluvial, weathered bedrock, and unweathered bedrock groundwater quality. Data obtained from these wells will be used to determine site-specific background concentrations of analytes.

As part of the field sampling program, data from the sitewide monitoring program will be used as appropriate to add to the data collected during the Phase I investigation. These data include the results of quarterly sampling of existing monitor wells and monthly sampling of surface water monitoring stations. The Phase I investigation programs for each area are summarized below. A number of SOPs will be used during the investigation; SOPs are cited in this section and discussed further in Section 11.0.

## 7.3 SAMPLING DESIGN, LOCATION, AND FREQUENCY

The sampling activities to be performed at each IHSS and the area around the East Landfill Pond are outlined below and discussed in detail in Sections 7.3.1 through 7.3.3. Sampling activities are also summarized in Table 7-3.

# Table 7-3: Summary of Activities Phase I Investigation OU7



| Activity | Purpose | Location | Number of Locations | Method | Analysis | Frequency of Sampling per site |
|---|---|---|---|---|---|---|
| **IHSS 114 - Present Landfill** | | | | | | |
| Review new data | Evaluate/incorporate new data | NA | NA | NA | NA | 1 |
| Visual inspection | Evaluate impacts of waste operators on field activities | Site | NA | Visual | NA | 1 |
| Cone Penetrometer Testing | • Characterize lithologies<br>• Determine extent of landfill<br>• Determine volume of landfill<br>• Determine depth to leachate/groundwater | Within IHSS 114 | 38 | CPT | Electronics to measure tip and side resistance; pore pressure probe to measure depth and thickness of leachate/ groundwater | 1 |
| In-situ Sampling gas/leachate/ groundwater | • Characterize landfill gas<br>• Characterize leachate/ groundwater | Within IHSS 114 | 38 | BAT in-situ sampler. Head space analysis in field; SOP 3.9 | Methane, hydrogen sulfide, TCE, 1,2-DCE, 1,1,1-TCA, acetone, 2-butanone, methylene chloride, toluene, total xylenes | 2 intervals in vadose zone<br>3 intervals in staturated zone |

| Activity | Purpose | Location | Number of Locations | Method | Analysis | Frequency of Sampling per site |
|---|---|---|---|---|---|---|
| Drill and sample borings | • Characterize lithologies<br>• Characterize geologic material within, upgradient, and downgradient of IHSS 114<br>• Determine depth to water | Within and downgradient of IHSS 114 | 11 | Hollow-stem auger/NX coring; SOPs 3.1, 3.2, 3.3, and 3.4. Handling of investigation derived wastes SOPs 1.5 and 1.8 | TAL metals, inorganics, TCL VOCs, TCL semivolatiles, TCL PCBs, radionuclides | 1; continous sampling in borings |
| Pump-in borehole packer tests | Obtain hydraulic properties of bedrock | Within and downgradient of IHSS 114 | 8 | Pump-in SOP 2.3 | NA | 1 |
| Monitoring well installation/sampling | • Obtain leachate/groundwater level data<br>• Characterize groundwater quality within IHSS 114<br>• Characterize alluvial and bedrock groundwater quality upgradient of IHSS 114<br>• Determine if groundwater intercept system is functioning<br>• Handling of drilling fluids, cuttings, purge/development water | Within IHSS 114 | 15 | SOPs 3.6, 2.1, 2.2, 2.5, and 2.6 | Field parameters, indicators, dissolved and total TAL metals, dissolved and total radionuclides, TCL VOCs, TCL semivolatiles | Quarterly sampling; monthly water level measurements |

| Activity | Purpose | Location | Number of Locations | Method | Analysis | Frequency of Sampling per site |
|---|---|---|---|---|---|---|
| Sediment sampling of East Pond | • Characterize chemistry of pond sediments<br>• Determine thickness of pond sediments | East Landfill Pond | 3 | Continuous sampling | TAL metals, inorganics, TCL VOCs, TCL semivolatiles, radionuclides | 1 |
| Leachate/surface water sampling at East Pond | • Characterize chemistry of landfill leachate and pond water<br>• Obtain discharge measurement from leachate seep | East Landfill Pond | 2 | SOPs 4.3, 4.4 | Field parameters, indicators, dissolved and total TAL metals, TCL VOCs, TCL semivolatiles, inorganics, dissolved and total radionuclides | monthly |
| Effluent sampling from groundwater diversion system discharge | • Characterize chemistry of intercepted groundwater<br>• Obtain discharge flow rate | SW099<br>SW100 | 2 | SOPs 4.3, 4.4 | Field parameters, indicators, dissoved and total TAL metals, TCL VOCs, TCL semivolatiles, inorganics, dissolved and total radionuclides | monthly |
| Location survey | Accurately determine sampled locations | All 62 sampled points | 62 | Standard land surveying techniques | Horizontal accuracy ±0.5 foot<br>Vertical accuracy ±0.1 foot | 1 |
| **IHSS 203 - Inactive Hazardous Waste Storage Area** | | | | | | |
| Visual inspection | Identify areas that may have been impacted by spills | Within IHSS 203 | NA | Visual | NA | 1 |

| Activity | Purpose | Location | Number of Locations | Method | Analysis | Frequency of Sampling per site |
|---|---|---|---|---|---|---|
| Soil-gas | Determine presence/absence of soil-gas 10-12 inches | Twenty-five-foot grid within IHSS 203. | 35 | Core soil sampler and head space analysis in field; SOP 3.9 | Methane, hydrogen sulfide, TCE, toluene, 1,1,1-TCA, 1,2-DCE, xylene, methylene chloride, acetone | 1 |
| Surficial Soil sampling | Characterize surficial soil contamination | Twenty-five-foot grid within IHSS 203 | 35 | SOPs 3.2 and 3.8 | TAL metals, inorganics, TCL PCBs, radionuclides | 1 |
| Subsurface Soil sampling when analytical results of surficial sampling indicate concentrations above background | Characterize vertical extent of soil contamination. | Twenty-five-foot grid within IHSS 203. | 35 | Hand Auger; SOPs 3.2 and 3.8 | TAL metals, inorganics, TCL PCBs. Radionuclides if FIDLER and soil-gas surveys indicate hotspots. | 1 |
| Location Surveying | Accurately determine sampled locations | All sampled points | 35 | Standard land surveying techniques | Horizontal accuracy ±0.5 foot for borings<br>Vertical accuracy ±0.1 foot for borings<br>Horizontal accuracy ±0.1 foot for wells<br>Vertical accuracy ±0.01 foot for wells | 1 |

| Activity | Purpose | Location | Number of Locations | Method | Analysis | Frequency of Sampling per site |
|---|---|---|---|---|---|---|
| **Areas Around East Landfill Pond** | | | | | | |
| Visual inspection | Delineate areas impacted by spray evaporation. | Area around Landfill Pond | NA | Visual | NA | 1 |
| Radiation field screening | Identify areas of radionuclide contamination. | Area around Landfill Pond | 96 | FIDLER; SOP 1.16 | NA | 1 |
| Surficial soil sampling | Characterize surficial soil contamination. | Fifty-foot grid around Landfill Pond, 100-foot grid downwind of East Landfill Pond | 122 | SOP 3.8 | TAL metals, inorganics, radionuclides. | 1 |
| Subsurface soil sampling when analytical results of surficial soil sampling indicate concentrations above background | Characterize vertical extent of soil concentration | Fifty-foot grid around Landfill Pond, 100-foot grid downwind of East Landfill Pond | | Hand auger; SOPs 3.2 and 3.8 | TAL metals, inorganics, radionuclide analytes from samples from hotspots identified by FIDLER. | |
| Location surveying | Accurately determine sampled locations. | All sample points | 122 | Standard land surveying techniques | Horizontal accuracy ±0.5 foot Vertical accuracy ±0.1 foot | 1 |

IHSS 114 - Present Landfill Sampling Activities

- Review of new data and information
- Visual inspection
- Cone penetrometer testing in area of artificial fill
- In-situ sampling of gas/leachate/groundwater within landfill materials
- Drilling and sampling of borings
- Pump-in borehole packer tests
- Installation and sampling of monitoring wells
- Sediment sampling at east landfill pond
- Leachate sampling at seep of landfill and surface water sampling of East Landfill Pond
- Evaluation of the status of the groundwater intercept system valves and sampling of groundwater diversion system discharge
- Location surveying of sampled points

IHSS 203 - Inactive Hazardous Waste Storage Area Sampling Activities

- Review of new data

- Visual inspection
- Radiological field screening
- Soil-gas survey/soil sampling
- Location surveying of sampled points

Areas Around the East Landfill Pond

- Review of new data
- Visual inspection
- Radiological field screening
- Soil sampling
- Location surveying of sampled points

### 7.3.1 IHSS 114 - Present Landfill

Review of New Data

Data obtained since preparation of this work plan will be reviewed and evaluated, as appropriate, for characterization of OU7. This may include additional waste stream identification and characterization information, data from the sitewide programs, and data obtained from OU6 investigations. Chemicals identified by the WSRIC program as being disposed in the landfill will be evaluated with respect to their environmental fate and

transport characteristics. Evaluation of new data may result in modifications to the sampling activities and/or analytical suites for the Phase I RFI/RI.

Visual Inspection

A visual survey will be performed at IHSS 114 prior to any other site work. The survey will consist of inspecting the area to look for any hazards that would prohibit use of the proposed sampling equipment. Hazards include any exposed metal, pipe, concrete, and areas in which access would be prohibited because of slope or other ground conditions. Additionally, visual inspections of ongoing waste operations will be performed to evaluate potential impacts on the proposed field activities and the quality of data collected.

Cone Penetrometer Testing in Area of Artificial Fill

CPT will be used to determine physical soil properties and to detail stratigraphy at the Present Landfill in the areas of fill material overlying Rocky Flats Alluvium and/or bedrock.

The CPT probe is a 1.5-inch-diameter rod with a conical point that is pushed into the ground at a constant rate. Electronic sensors at the tip and sides of the probe measure penetration resistance and side friction of the soils, respectively. Measurements are obtained every 2 inches in depth. Penetration resistance and side friction are typically different for granular soils and clayey soils, making the CPT a particularly useful tool for defining the occurrence of sands and gravels versus clays and silts (Robertson and Campanella, 1986). A pore pressure probe will be coupled with the tip to detect the presence and thickness of leachate/groundwater.

CPTs are performed using a special test rig equipped with hydraulics to push the cone and a computer-automated data collection, analysis, and display system. The CPT profile will provide valuable information regarding material type and depth of leachate/groundwater (Figure 7-1).

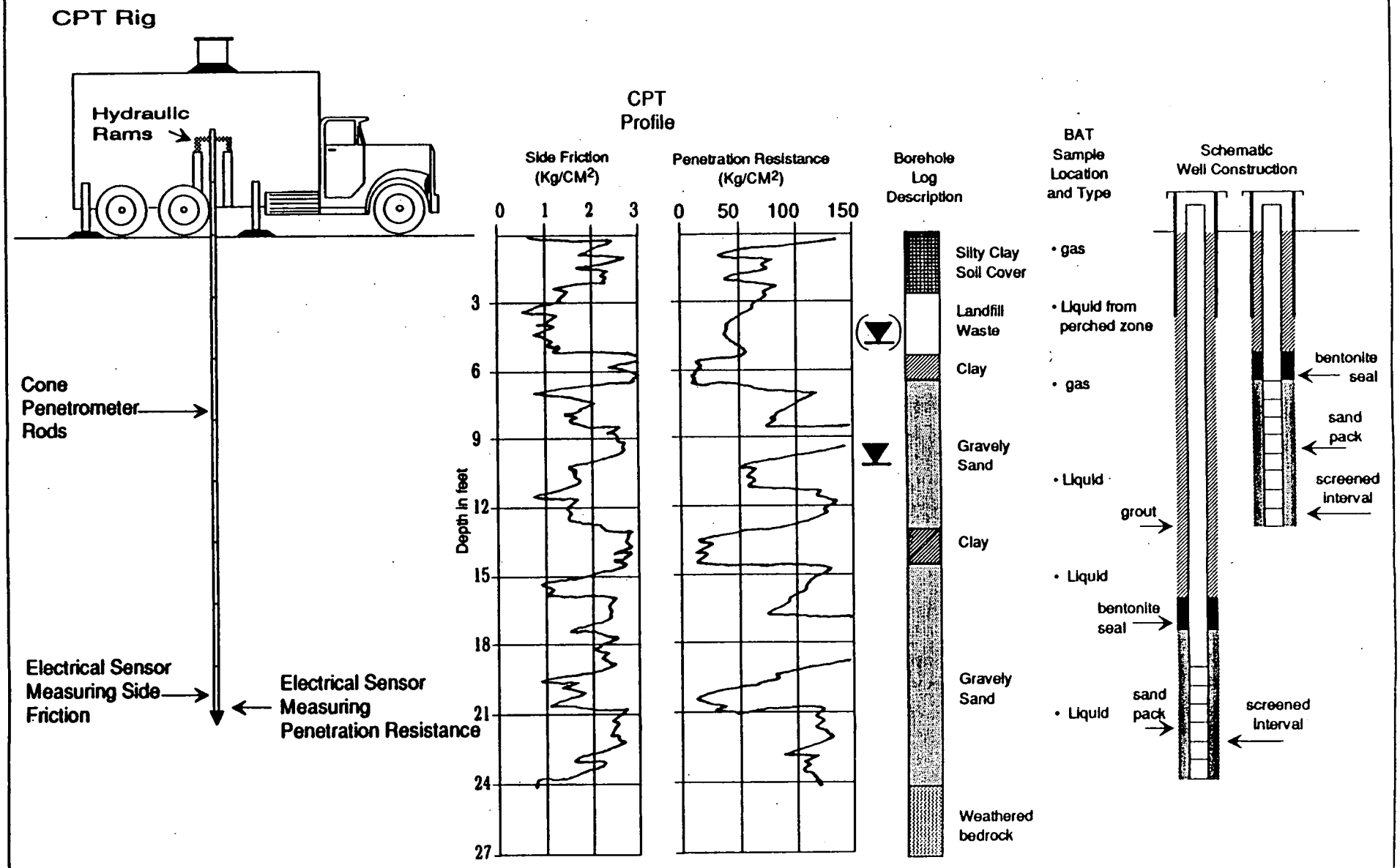
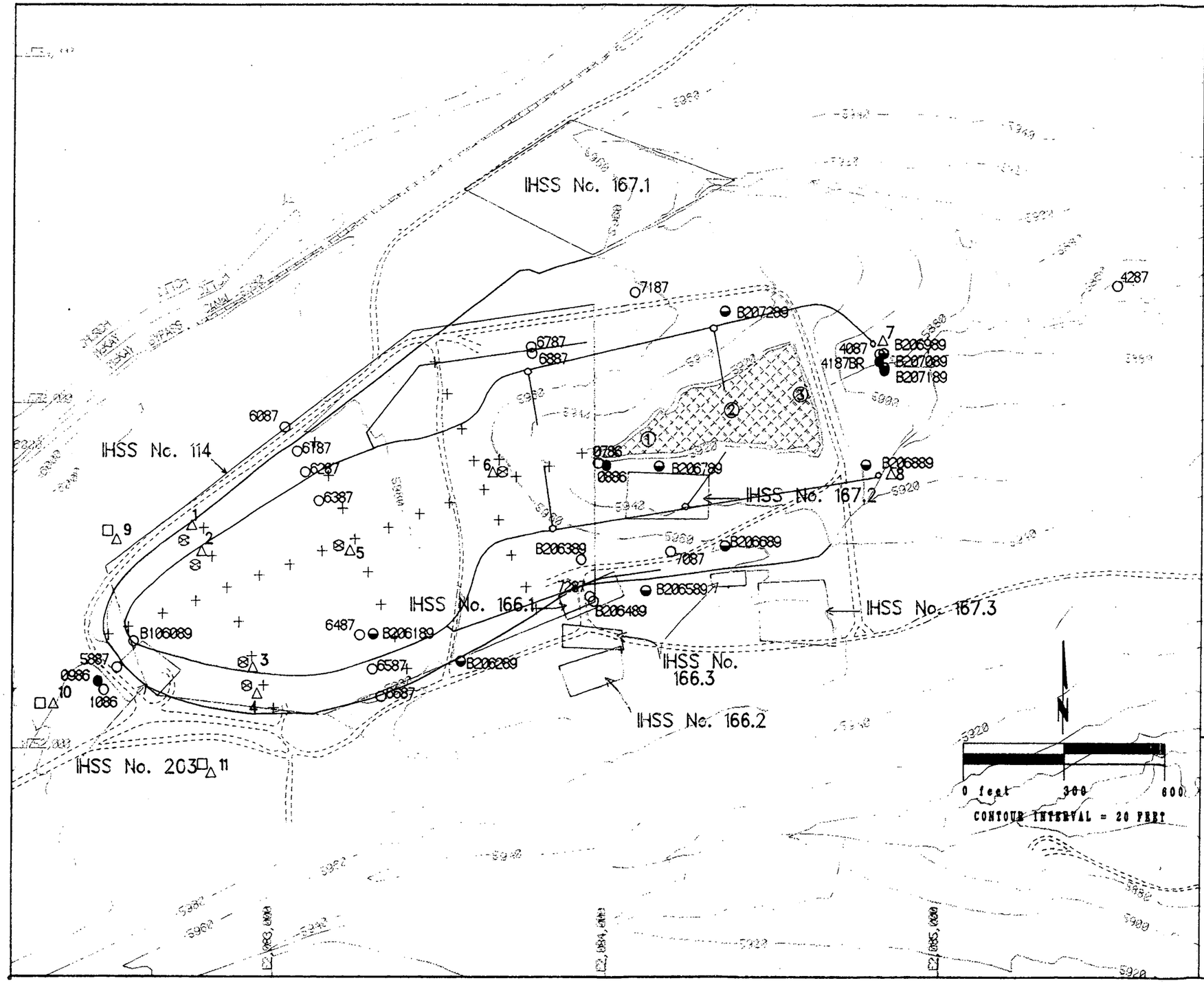



Figure 7-1 Schematic Diagram Illustrating CPT Rig, CPT Profile, BAT Gas/Liquid Sample Locations, and Monitoring Wells

Thirty-eight CPTs will be performed. The CPTs will profile subsurface material from ground surface to bedrock, or tip refusal, at each location. The proposed locations are plotted in Figure 7-2. CPT profiles will be obtained at 100-foot intervals along four transects. The east-west transect will provide profiles along the center line of the landfill where waste material is expected to be thickest. This information is neccessary to provide an accurate estimate of the volume and type of the landfilled materials. The western north-south transect will provide profiles of the western portion of the landfill where the groundwater intercept system may not be completely keyed into bedrock. Data obtained from this transect will be used to characterize the volume and type of landfilled materials along this transect and to design the monitoring wells that will be installed to evaluate the groundwater diversion system. The middle north-south transect will provide profiles along the center of the landfill and will allow the CPT profiles to be compared to existing borehole logs as a calibration technique as well as providing data that will be used to design a monitoring well proposed for this area. The eastern north-south transect will provide profiles of the eastern portion of the landfill and will be used to characterize the type and volume of landfilled material present in this area. The buried West Landfill Pond is considered to be a critical sampling area. CPTs performed in this area will verify the location and provide a subsurface profile of the buried West Landfill Pond sediments. CPT profiles and in-situ gas/liquid samples will be used to select the location of the borehole and monitoring well to be installed in this area.

Historical records listing surveyed locations of monitoring wells installed during previous investigations have been compared to the locations of proposed CPT holes, borings, and monitoring wells. None of the proposed locations will penetrate existing or abandoned borings or wells.

After each hole is profiled, the CPT rods will be removed and the hole will be backfilled with pH-buffered bentonite-cement grout. If the hole remains open, a 1-inch-diameter polyvinyl chloride (PVC) pipe will be inserted to the bottom of the hole, and grout will be pumped into the hole. If the hole has collapsed, a stainless-steel sacrificial (dummy) tip will




## EXPLANATION

- △ 8 PROPOSED BORING TO BE SAMPLED AND GROUTED AFTER COMPLETION
- ⊗ PROPOSED MONITORING WELL LOCATIONS
- \+ PROPOSED CPT LOCATIONS
- □ PROPOSED CLUSTER MONITORING WELL LOCATIONS
- ⓘ PROPOSED SEDIMENT SAMPLING LOCATIONS
- ○ EXISTING ALLUVIAL WELL
- ◒ EXISTING WEATHERED BEDROCK WELL
- ● EXISTING UNWEATHERED BEDROCK WELL
- DIRT ROADS
- STREAMS, DITCHES, DRAINAGE FEATURES
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- LANDFILL STRUCTURES
- SURFACE WATER IMPOUNDMENTS

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**Rocky Flats Plant, Golden, Colorado**

Proposed Locations of CPTs, Borings, and Monitoring Wells Phase I RFI/RI

Figure 7-2

be pushed to the total depth with hollow CPT rods, and grout will then be pumped through the rods.

In the event that tip refusal occurs in landfilled material at any of the proposed locations, the CPT rods will be removed, the original hole will be offset by 5 feet, and the CPT will be attempted again. A maximum of three attempts will be made at each location in an effort to complete the CPT through the landfilled material. If a complete CPT profile cannot be obtained after three attempts, the location will be grouted and abandoned.

All procedures will follow guidance outlined in an SOP that is currently being developed for the operation and interpretation of CPTs.

In-Situ Landfill Material Gas/Leachate/Groundwater Sampling

A BAT® in-situ soil-gas/groundwater sampling system will be used to obtain gas/leachate/groundwater samples within the landfilled material. The system utilizes a sealed filter tip attached to the extension pipe and an evacuated glass sample container to obtain samples. Filter sizes range from 20 microns to 60 microns. The filter tip is attached to an extension pipe, which is advanced to the target interval with the CPT rig. The evacuated container is mounted in a portable sampling probe together with a double-ended hypodermic needle. When lowered into the extension pipe, the probe connects to the cap of the filter tip. A temporary, leak-proof hydraulic connection is achieved by penetration of the double-ended hypodermic needle through the Teflon septa in the tip and the sample container. With negative pressure in the evacuated container, gas and/or groundwater is drawn via the filter tip into the container. When the sample container is disconnected from the filter tip, the septa in both the filter tip and the container automatically reseal resulting in a hermetically isolated gas and/or liquid sample. The septa in the filter tip and the sample containers can be pierced hundreds of times without loss of the self-sealing capability. Because the sealed

filter tip is in direct contact with the formation fluid, only a small amount of fluid needs to be purged before each sample is obtained. The time needed to fill the sample container varies with the permeability of the formation.

In-situ soil/landfilled material gas samples will be obtained within the unsaturated zone of the landfilled materials from the first encountered landfilled materials beneath the cover and within 3 feet of the saturated zone at all of the CPT locations.

The original CPT hole will be offset upgradient by 5 feet, and a 2-inch-diameter rod will be equipped with a BAT® filter tip. The tip will be pushed to a depth of 2 inches above the target depth, and a low-pressure gauge will be threaded onto the top of the 2-inch-diameter rod. A positive reading on the low-pressure gauge will indicate that landfill gases are being generated, the generated gases are under pressure, and off-gassing is not occurring through the landfill cover. Three 1-minute interval readings of the gas flow rate will be obtained at each sampling location in the vadose zone. After the pressure reading has been obtained, the gauge will be removed and the tip will be pushed to the target interval, where an in-situ gas sample will be obtained. The sample will be extracted with a glass syringe. The headspace sample will be injected into a Photovac portable photoionizing detector (PID) GC unit and analyzed for hydrogen sulfide, VOCs detected frequently in groundwater samples (TCE, 1,2-DCE, and 1,1,1,-TCA), and VOCs detected in borehole samples (acetone, 2-butanone, methylene chloride, toluene, and total xylenes). Because methane cannot be detected with a PID, a portion of the gas sample will be analyzed for methane using a Foxboro OVA 128 flame ionizing detector (FID) equipped with a carbon prefilter. The FID detects methane, and the carbon prefilter will screen out other VOCs associated with the sample.

In-situ soil/landfilled material liquid samples will be obtained from up to three intervals within the saturated zone of the landfilled materials at all of the locations that underwent CPT. The headspace of the liquid samples will be extracted and analyzed. The specific

locations and depth intervals will be selected after the CPT profiles have been examined (Figure 7-1). A decision-tree diagram that depicts the decision process to be used to obtain gas/liquid samples using the CPT/BAT® system is presented in Figure 7-3. If a profile indicates the presence of isolated zones of saturated material above the water table, a sample will be obtained for analyses at those depths. If the profile indicates that no perched water is present, samples will be obtained from the top, middle, and bottom of the saturated zone. The liquid sample will be obtained by following the same procedures described for the gas samples, and the headspace of the liquid sample will be extracted with a glass syringe. The headspace of the liquid sample will be injected into a Photovac portable PID GC unit and will be analyzed for hydrogen sulfide, TCE, 1,2-DCE, 1,1,1,-TCA, acetone, 2-butanone, methylene chloride, toluene, and xylene (total). Methane concentrations will be measured by screening a portion of the gas sample with a Foxboro OVA 128 FID equipped with a carbon prefilter.

Ten percent of the gas/liquid samples will be sent offsite to an analytical laboratory to confirm the results of the portable GC. All procedures will follow guidance outlined in an SOP that is currently being developed for operation of the BAT® system. Headspace analysis procedures will follow guidelines described in SOP 3.9. A discussion of the analytical program for these samples is provided in Section 7.4.

After the hole has been sampled, the 2-inch-diameter extension rods will be removed and decontaminated. The hole will be backfilled with pH-buffered bentonite-cement grout. If the hole remains open, a 1-inch-diameter PVC pipe will be inserted to the bottom of the hole, and the grout will be pumped into the hole. If the hole has collapsed, a stainless-steel sacrificial (dummy) tip will be pushed to the total depth with hollow CPT rods and grout will be pumped through the rods.

In the event that the BAT® system is unable to obtain samples of gas/liquid for headspace analyses, conventional soil-gas investigative methods performed with smaller diameter tubing

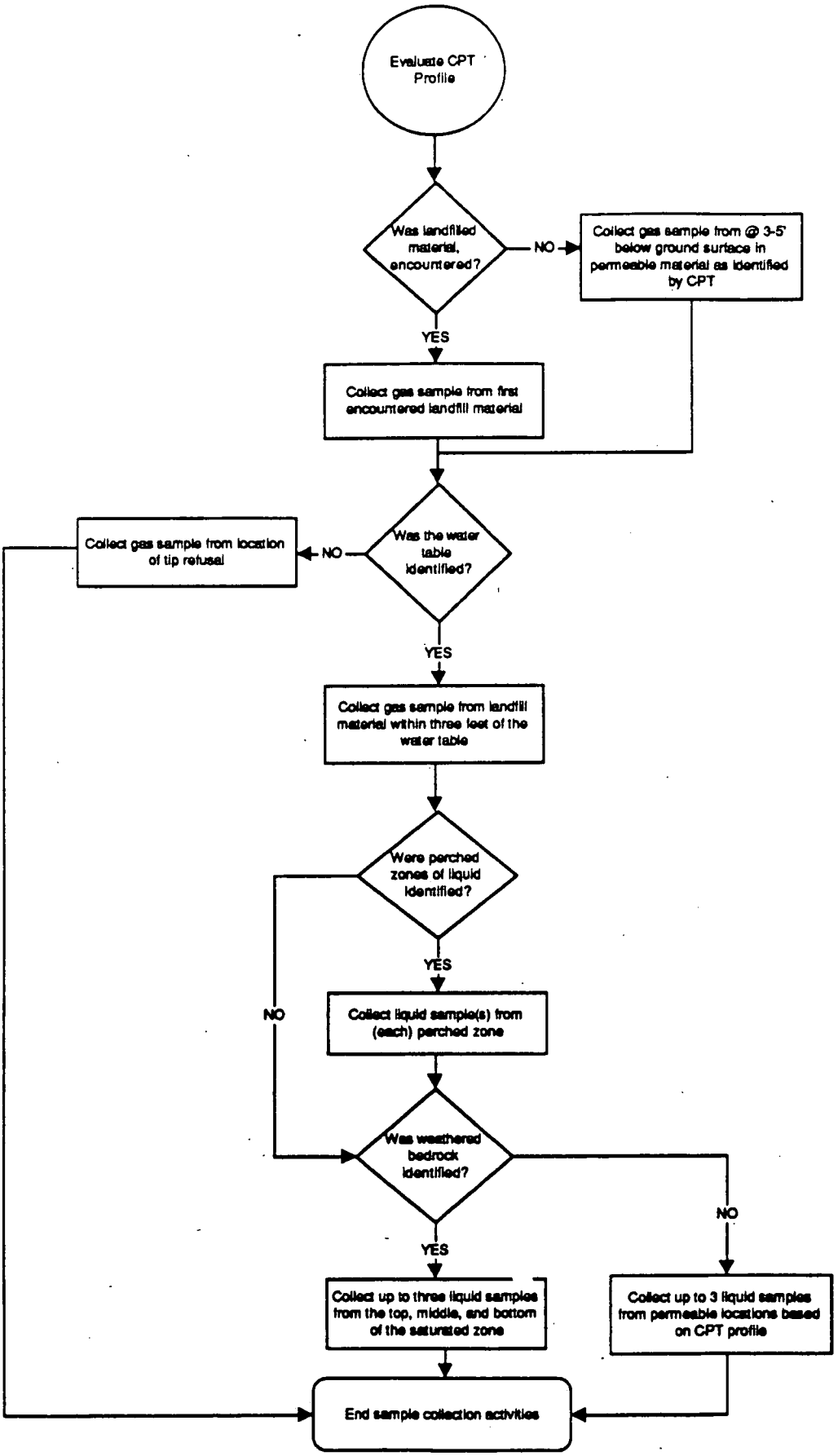



**Figure 7-3**

**Decision Tree Diagram for Obtaining Gas/Liquid Samples Using CPT/BAT System**

coupled with a vacuum pump will be employed. These methods are described in SOP 3.9. If additional soil-gas methods are required, the activities will be performed within the IAG schedule, as indicated in Figure 6-1.

Drilling and Sampling Borings

Boreholes will be drilled at six locations within IHSS 114 (borings #1, 2, 3, 4, 5, and 6), at two locations downgradient (east) of IHSS 114 (borings #7 and 8), and three locations upgradient (west) of IHSS 114 (borings #9, 10, and 11). The proposed boring locations are shown on Figure 7-2. All borings drilled within and downgradient of IHSS 114 will penetrate the soils and weathered bedrock to the surface of the unweathered bedrock. The three borings drilled upgradient of IHSS 114 will be drilled to the bottom of the first unweathered sandstone unit encountered. The purpose of the borings is to provide information on type of material, depth to water, and chemistry of soils within and below the landfilled material. Physical data obtained from these borings will provide data that will be used to design the monitoring wells that will be installed at these locations.

Drilling through the landfilled materials will be performed using hollow-stem augers coupled with continuous sampling techniques. A 5-foot-long continuous sampler will be used. Near the bottom of the landfilled materials (as determined by the CPT logs), drilling will be performed using 2-foot lifts to minimize the potential for penetrating the top of the soil/bedrock interface. After drilling to the bottom of the landfilled material/top of bedrock, a 6- to 8-inch-diameter surface conductor casing will be inserted in the hole and pressure grouted.

Rock coring/sampling techniques using carbide or diamond bits will be used when drilling through bedrock. Potable water from an analytically tested and agency-approved source will be used as the drilling fluid. A pump-in borehole permeability test (packer test) will be conducted in the rock-cored section of each boring. Investigation-derived wastes such as drilling fluids, cuttings, and residual samples, will be handled according to guidelines

outlined in SOP 1.8. All soil and bedrock samples will be visually classified following procedures outlined in SOP 3.1. Hollow-stem drilling and sampling procedures will follow guidelines outlined in SOP 3.2. Pressure grouting procedures will follow guidelines outlined in SOP 3.3. Rock coring will follow guidance presented in SOP 3.4. Pump-in borehole packer tests will follow procedures outlined in SOP 2.3.

During drilling, all cuttings and soil samples will be screened with field instruments for radiological contamination and VOCs following procedures outlined in SOP 1.15. From the continuous soil and weathered rock samples, discrete samples will be submitted for laboratory chemical analysis at 2-foot increments in soil and 4-foot increments in rock. Additional samples will be obtained if visual observation or screening indicates the presence of contamination. Investigation-derived wastes such as drilling fluids, cuttings, and residual samples will be handled according to guidelines outlined in SOP 1.8.

Soil/bedrock samples will be analyzed for TAL metals, inorganics, TCL volatiles, TCL semivolatiles, TCL PCBs, and radionuclides. Soil samples obtained from the borehole drilled at location #6 (the now-buried West Landfill Pond) will be analyzed for Appendix IX analytes. A discussion of the analytical program for the soil/bedrock samples is provided in Section 7.4.

All of the borings will be grouted and abandoned immediately after drilling in accordance with procedures outlined in SOP 3.5. Procedures specified in this SOP are designed to prevent vertical migration of contaminants after abandonment.

Installing and Sampling Groundwater Monitoring Wells

Two-inch-diameter groundwater monitoring wells will be constructed adjacent to and upgradient of borings #1, 2, 3, 4, 5, and 6 (Figure 7-2). These wells will be constructed for the purpose of sampling leachate/groundwater and to obtain water level measurements for evaluating the effectiveness of the intercept system. Two-inch-diameter wells will be

installed to reduce the volume of contaminated cuttings and development/purge water generated during drilling and sampling. Well construction techniques will follow procedures outlined in SOP 3.6. Investigation-derived wastes such as drilling fluids, cuttings, and residual samples will be handled in accordance with guidelines outlined in SOP 1.8.

Information obtained from the CPT tests proximal to these locations and the boring logs will be used to design the wells. If waste is present above the saturated zone, the waste layer will be cased from the surface and pressure grouted. The grout will then be drilled out, and the boring will be advanced to the target depth. The well will then be installed.

In areas where the saturated thickness of the landfilled materials is 10 feet or less, the well will be screened from the bottom to 3 feet above the saturated material. In areas where the saturated material is greater than 10 feet thick, well pairs will be completed. For each pair, one well will be screened in the bottom 5 feet of the saturated material and the other well will be screened from approximately 7 feet below the liquid level to 3 feet above the liquid level. The well that screens the upper portion of the aquifer will be installed at least 5 feet upgradient from the well that screens the bottom portion of the aquifer.

Wells located adjacent to borings #1 and #2 will be used to evaluate the north intercept system. Wells located adjacent to borings #3 and #4 will be used to evaluate the south intercept system. The well located adjacent to boring #5 will be used to generate additional data regarding stratigraphy, fluid quality, and waste thickness along the centerline of the landfill. The well located adjacent to boring #6 will be used to evaluate the effect of potentially contaminated sediments in the buried pond on groundwater quality. A decision-tree diagram that depicts the decision process to be used as a reference to install monitoring wells at boring locations #1, 2, 3, 4, 5, and 6 is presented as Figure 7-4.

Cluster wells will be installed adjacent to and upgradient of borings #9, 10, and 11 (Figure 7-2). At each location, one alluvial monitoring well, one weathered bedrock monitoring well, and one unweathered bedrock monitoring well will be installed. Screened intervals will

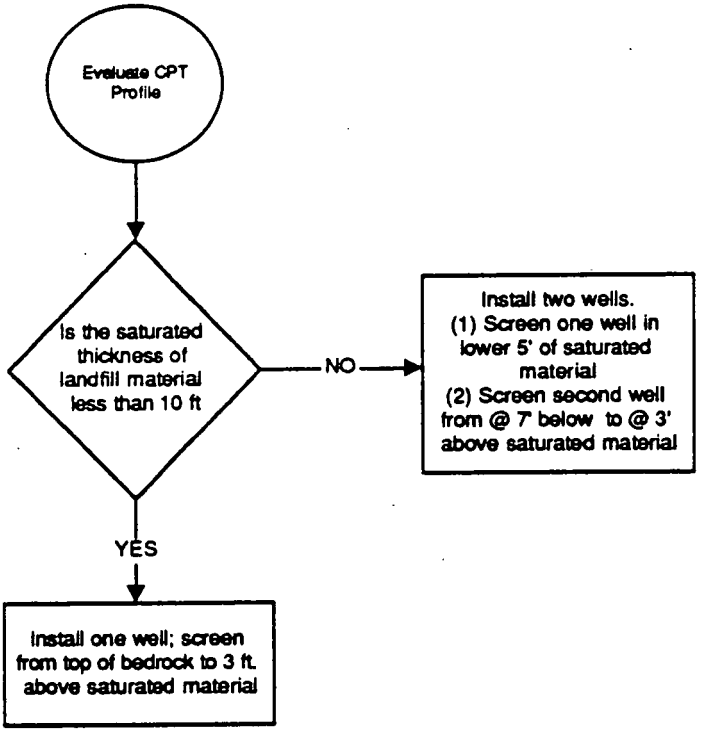



**Figure 7-4**

**Decision Tree Diagram for Completion of Monitoring Wells at Boring Locations #1,2,3,4,5, and 6.**

be selected on the basis of data obtained from borings #9, 10, and 11. It is anticipated that the deepest wells will screen the unweathered sandstone unit monitored by Well 0986. These wells will be used to determine the quality of the groundwater upgradient of OU7. The bedrock wells will be isolated from the overlying units with surface casing that has been pressure grouted.

Well construction techniques for all monitorings wells will follow procedures outlined in SOP 3.6. Monitoring wells will be protected from landfill operations equipment by placement of steel posts around the monitoring wells, as described in SOP 3.6. Pressure grouting procedures will follow guidelines outlined in SOP 3.3. It is possible that continued waste operations at the Present Landfill may result in the mounding of landfilled materials over the aboveground casing of the monitoring wells. If this occurs, the aboveground casing of the monitoring wells will need to be extended with additional solid casing and additional protective casing before the fill approaches the top of the existing protective casing. Open lines of communication between RFP Waste Operations and the contractor reasponsible for monitoring well maintenance will have to be maintained to ensure that the new and existing monitoring wells will be modified as discussed above.

Four quarters of groundwater samples will be collected during the Phase I RFI/RI. Monthly water level measurements will also be taken. Groundwater sampling will be performed by the the RFI/RI field investigation team to ensure that samples are obtained within the same month of a given quarter. The RFI/RI field investigation team will also perform the monthly water level measurements. The first sampling event will occur two weeks after the wells have been developed. The wells are scheduled to be installed between August and December 1992; thus, the wells will be sampled during the fourth quarter of 1992 and quarterly thereafter. Well development, groundwater sampling, and water level measurement will follow procedures outlined in SOP 2.1, 2.2, 2.5, and 2.6. All development and purge water will be handled in accordance with guidelines outlined in SOP 1.8.

Groundwater samples will be analyzed for field parameters, indicators, dissolved and total TAL metals, anions, TCL volatiles, TCL semivolatiles, and dissolved and total radionuclides. Groundwater samples obtained from the monitoring well installed at location #6 (the buried pond) will be analyzed for Appendix IX analytes. A discussion of the analytical program for groundwater samples is provided in Section 7.4.

Sediment Sampling at East Landfill Pond

Samples of sediment will be obtained from three locations along the centerline of the East Landfill Pond. These sampling locations were selected to provide a longitudinal profile in the center of the pond, where sediments are expected to be thickest. Sampling location #1 is located at the west end of the East Landfill Pond, directly downgradient of the landfill and the seep. Given the proximity to the landfill, it is expected that sediments at this location will contain the greatest concentration of any contaminants that may be present. Sampling location #2 is located at the midpoint of the East Landfill Pond, approximately where the groundwater diversion system discharges into the East Pond. It is expected that sediments at this location may be impacted by discharge from the groundwater intercept system. Sampling location #3 is located at the east end of the East Landfill Pond. It is expected that sediments at this location will have been impacted to a lesser extent by the landfill and will contain the lowest concentrations of contaminants that may be present. Sampling locations are plotted on Figure 7-5. At each of these locations, a sediment core will be obtained with hand-operated equipment from a floating platform to obtain a continuous sample of the entire thickness of the sediments. The thickness of the sediments is anticipated to be between 3 and 6 feet. The boring will be terminated when refusal is encountered at the base of the sediments. The sampler will be lined with polybutyrate tubes cut to 10-inch lengths. Discrete samples from 10-inch intervals will be submitted for laboratory analysis, with the first sample at the sediment surface. Sampling procedures will follow those outlined in an addendum to SOP 4.6 (Section 11.0). Sediment materials will be described according to SOP 3.1.

Sediment samples will be analyzed for TAL metals, inorganics, TCL volatiles and semivolatiles, and radionuclides. The samples obtained from site #1 will be analyzed for Appendix IX analytes. A discussion of the analytical program for sediment samples is presented in Section 7.4.

Leachate Sampling at Seep of Landfill and Surface Water Sampling at East Landfill Pond

Samples of leachate seeping from the landfill at surface water station SW097 will be collected. At the time of sampling, discharge measurements will be recorded. Sampling will be performed during a dry period when no surface runoff is occurring at the east face of the landfill. Pond water samples will be collected from surface water station SW098. Samples will be collected at the same time that the sediment samples are collected; additional samples will be collected on a monthly basis under the RFP Surface Water Monitoring Program. Sampling locations are plotted on Figure 7-5. Field parameters will be measured following procedures outlined in SOP 4.2. Samples will be collected according to procedures specified in SOP 4.3. Discharge measurements from SW097 will be obtained following procedures outlined in SOP 4.4.

Leachate and pond water samples will be analyzed for field parameters, indicators, dissolved and total TAL metals, TCL volatiles and semivolatiles, dissolved and total radionuclides, and inorganic analytes. The leachate samples obtained from SW097 will be analyzed for Appendix IX analytes. A discussion of the analytical program for these samples is provided in Section 7.4.

Evaluation of the Status of the Groundwater Intercept System Valves and Sampling from Groundwater Diversion System Discharge Points

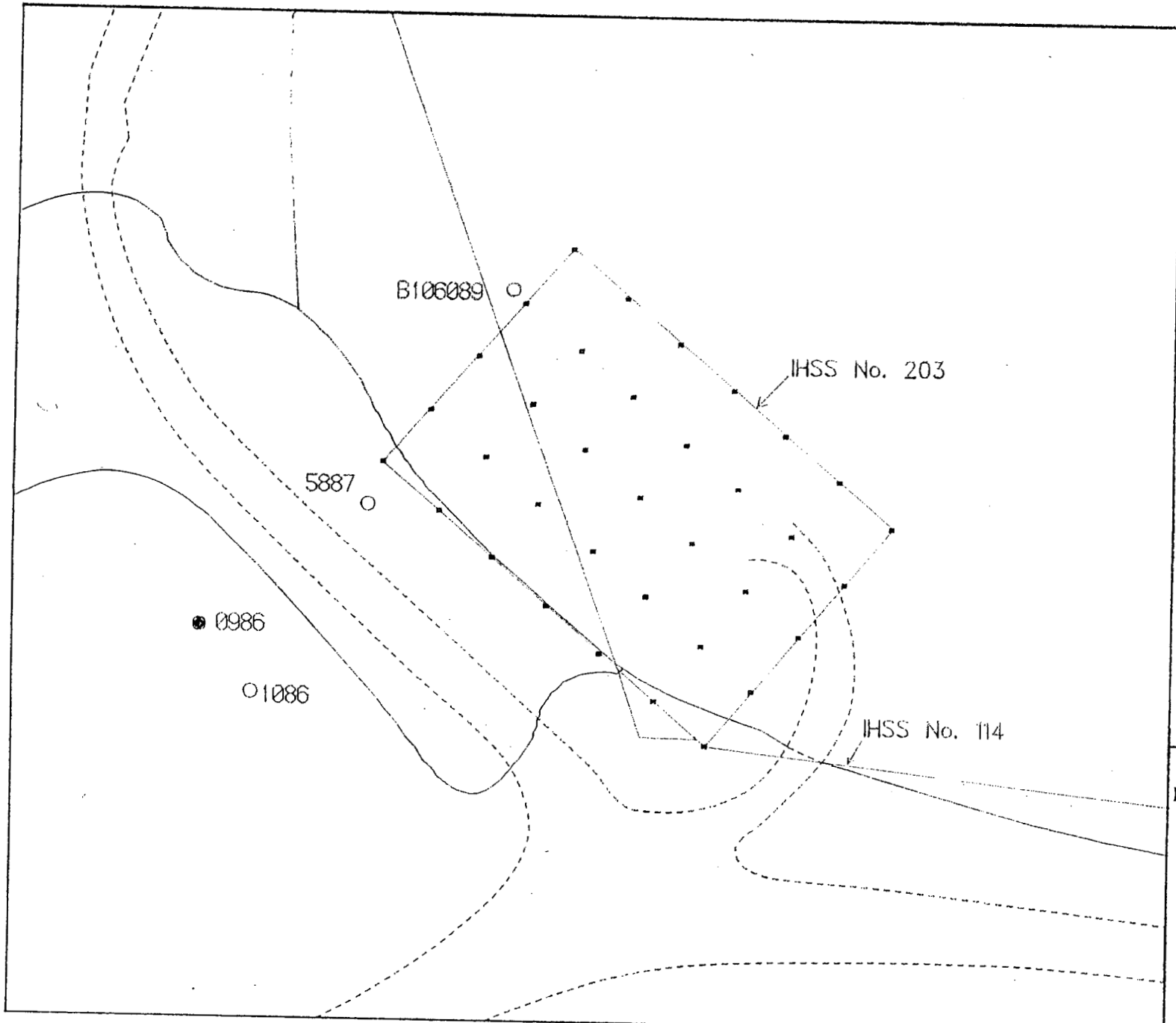
Samples of discharge from the groundwater intercept system will be collected. Available data do not indicate whether the groundwater intercept system is discharging to the East Landfill Pond or downgradient of the East Landfill Pond at surface water monitoring

stations SW099 and SW100. Prior to sample collection, the status of the valve components of the groundwater intercept system will be assessed by site visits and personal communications with EG&G RFP Waste Operations to determine the discharge points. When the location where the groundwater intercept system discharges has been determined, samples will be collected. Potential sampling locations are plotted on Figure 7-5. At the time of sample collection, discharge measurements will be recorded. Sample collection will follow procedures specified in SOP 4.3. Discharge measurements will be obtained according to procedures outlined in SOP 4.4.

Samples will be analyzed for field parameters, indicators, dissolved and total TAL metals, TCL volatiles and semivolatiles, dissolved and total radionuclides, and inorganic analytes. A discussion of the analytical program for these samples is provided in Section 7.4.

Location Surveying

Locations of all borings and surface sampling points will be surveyed using standard land surveying techniques prior to sampling or drilling. Field team members will coordinate with Waste Operations personnel to ensure that stakes and/or flagging used to identify sampling locations and leave-behind sampling points (such as wells) are not moved or damaged by ongoing waste operations. Provisions for long-term protection of monitoring wells are discussed in Section 11.2. After sampling, drilling, or well installation, locations will again be surveyed using standard land surveying techniques. Horizontal accuracy will be ±0.5 foot for borings and ±0.1 foot for wells. Vertical accuracy will be ±0.1 foot for borings and ±0.01 foot for wells. Three elevations will be determined for each well: ground surface, top of well casing, and top of surface casing.




EXPLANATION

- PROPOSED SAMPLE LOCATIONS WITHIN IHSS203
- INDIVIDUAL HAZARDOUS SUBSTANCE SITE BOUNDARIES
- DIRT ROADS
- STREAMS, DITCHES, DRAINAGE FEATURES
- ALLUVIAL WELL
- UNWEATHERED BEDROCK WELL

0 feet 25 50

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Proposed Field Sampling Locations
IHSS203
Phase I RFI/RI

Figure 7-6

### 7.3.2 IHSS 203 - Inactive Hazardous Waste Storage Area

Review of New Data

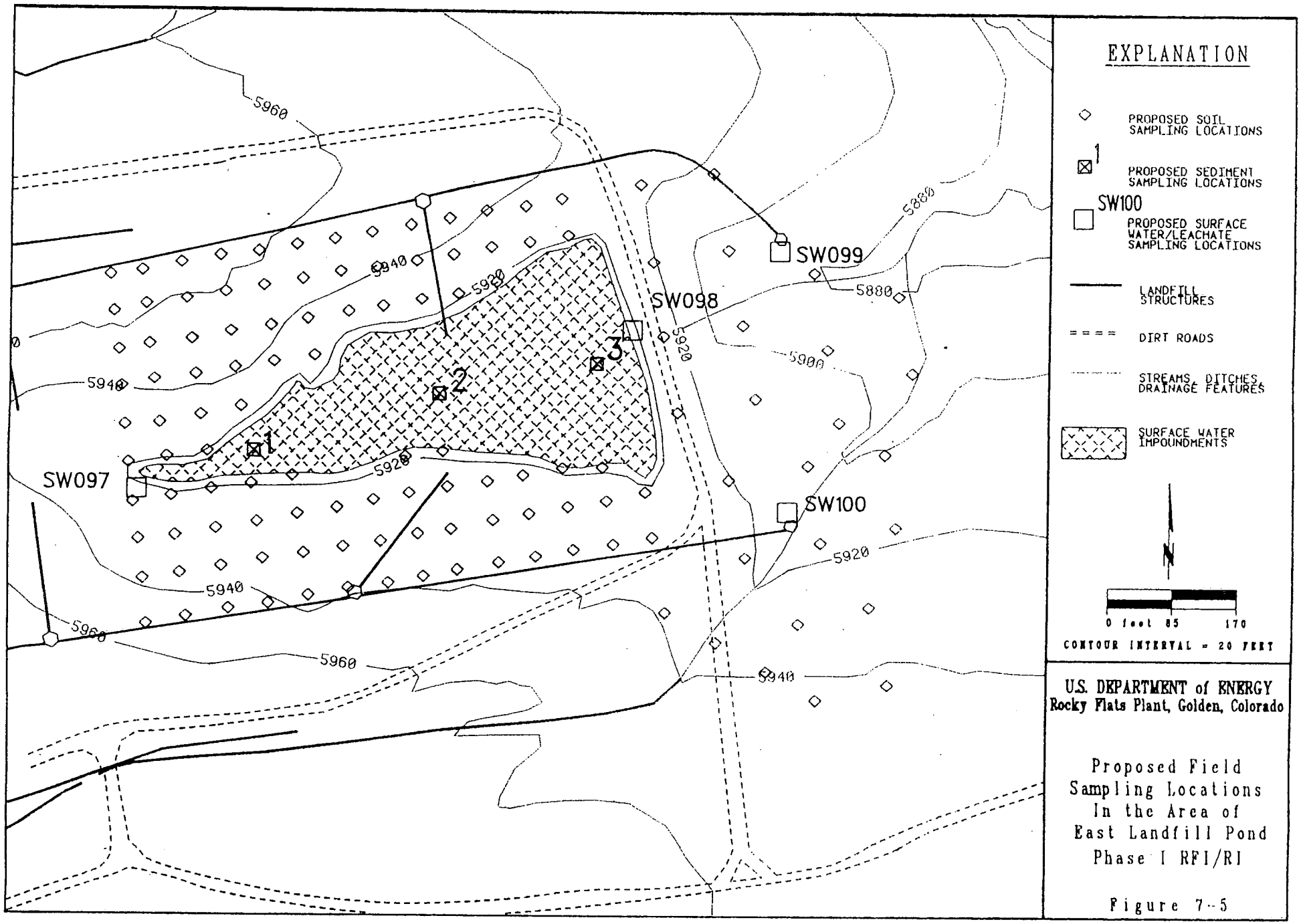
Data obtained since preparation of this work plan will be reviewed and evaluated, as appropriate, for characterization of OU7. This information may include additional waste stream identification and characterization data, data from the sitewide programs, and data obtained from OU6 investigations. Evaluation of new data may result in modifications to the sampling activities and/or analytical suites for the Phase I RFI/RI.

Visual Inspection

A visual survey will be performed at IHSS 203 prior to any other site work. The survey will consist of inspecting the area for any soil staining or stressed vegetation that could indicate a spill. Areas with such indication will be sampled according to procedures described in the surface/soil-gas sampling section below.

Radiation Survey

A radiation survey will be performed over the surface of the ground areas affected by operations at IHSS 203. Sampling locations are plotted on Figure 7-6. The radiation readings will be taken on a 25-foot grid according to the procedure described in SOP 1.16 (Field Radiological Measurements). If readings above natural background are detected, the size of the grid will be refined to 5-foot centers around the "hot spot" to further define the area of radioactive contamination. If readings above background are detected near the existing boundary of IHSS 203, the grid will be expanded past the existing boundary. The results of the survey will be plotted and contoured on a map. The Phase I survey will be conducted using a side-shielded FIDLER and a shielded Geiger-Mueller (G-M) pancake-type detector.

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Proposed Field Sampling Locations In the Area of East Landfill Pond Phase I RFI/RI

Figure 7-5

Soil/Soil-Gas Sampling

Surface soil samples will be collected on the same grid as the radiation survey. (Sampling locations are plotted on Figure 7-6.) These samples will be obtained according to procedures specified in SOP 3.8 and will be analyzed for TAL metals, TCL PCB's, inorganics, and radionuclides. Subsurface soil samples will be collected with a hand auger to depths of 10 inches. These samples will be obtained on the same grid as the radiation survey at sites where the analytical results from the surficial soils sampling indicate contaminant levels above background (Figure 7-6). Each sample will be mixed in a stainless-steel pan and split into separate sample containers for appropriate analyses. Procedures will follow an addendum to SOP 3.2, Drilling and Sampling Using Hollow-Stem Auger Techniques, which specifies hand-auger sampling techniques. Subsurface soil samples will be analyzed for TAL metals, TCL PCBs, radionuclides, and inorganic analytes. One of the samples will also be analyzed for Appendix IX analytes; this sample will be selected in the field from the area that is most likely (based on the results of the visual inspection and the radiation survey) to be contaminated. A discussion of the analytical program for soil samples is provided in Section 7.4.

At each location from which soil samples were obtained, samples for headspace screening will be obtained. A 2-inch by 2-inch sample will be obtained from 10 to 12 inches in depth with a soil core barrel lined with a 4-inch-long stainless-steel tube driven by a slide hammer. The ends of the sample sleeve will be covered with aluminum foil and capped. A headspace sample will be extracted with a glass syringe.

The headspace sample will be injected into a Photovac portable PID GC unit and will be analyzed for hydrogen sulfide, TCE, 1,2-DCE, 1,1,1,-TCA, acetone, methylene chloride, toluene, and xylene (total). Methane concentrations will be measured by screening a portion of the gas sample with a Foxboro OVA 128 equipped with a carbon prefilter. Headspace analysis procedures will follow guidelines described in SOP 3.9. A discussion of the analytical program for the soil gas samples is provided in Section 7.4.

Location Surveying

Locations of all sampling points will be paced and/or taped off prior to sampling. After sampling, locations will be surveyed using standard land surveying techniques. Field team members will coordinate with Waste Operations personnel to ensure that stakes and/or flagging used to identify sampling locations are not moved or damaged by ongoing waste operations prior to surveying. Horizontal accuracy will be ±0.5 foot. Vertical accuracy will be ±0.1 foot.

### 7.3.3 Area Around the East Landfill Pond

Review of New Data

Data obtained since preparation of this work plan will be reviewed and evaluated, as appropriate, for characterization of OU7. This information may include additional waste stream identification and characterization data, data from the sitewide programs, and data obtained from OU6 investigations. Evaluation of new data may result in modifications to the sampling activities and/or analytical suites for the Phase I RFI/RI.

Visual Inspection

A visual survey will be performed at the area around the East Landfill Pond prior to any other site work. The survey will consist of inspecting the area for any indication of spray evaporation, such as spray evaporation pipes and abundant vegetation. Areas with such indication will be sampled.

Radiation Survey

A ground-surface radiation survey will be performed over locations affected by spray evaporation operations, including downwind areas. Sampling locations are plotted on Figure

7-5. The radiation readings will be taken on a 25-foot grid according to the procedure described in SOP 1.16 (Field Radiological Measurements). If readings above natural background are detected, the size of the grid will be refined to 5-foot centers around the "hot spot" to further define the area of radioactive contamination. The results of the survey will be plotted and contoured on a map. The Phase I survey will be conducted using a side-shielded FIDLER and a shielded G-M pancake-type detector.

Soil Sampling

Surficial soil samples will be obtained according to procedures specified in SOP 3.8. These samples will be collected on a 50-foot grid over the areas affected by spray evaporation. The area to be sampled also includes areas east of the spray evaporation operations to evaluate the presence or absence of wind-dispersed contaminants. This area will be sampled on a 100-foot grid. Sampling locations are plotted on Figure 7-5. Subsurface soils will be sampled to depths of 10 inches at grid locations where analytical results from surficial sampling indicate contaminant concentrations above background. Each sample will be mixed in a stainless-steel pan and split into separate sample containers for appropriate analyses. Procedures will follow an addendum to SOP 3.2, Drilling and Sampling Using Hollow-Stem Auger Techniques, which specifies hand-auger sampling techniques. Surface soil samples will also be collected from "hot spots" located during the radiation survey. These samples will be obtained according to procedures specified in SOP 3.8, Surface Soil Sampling.

Soil samples will be analyzed for TAL metals, radionuclides, and inorganic analytes. A discussion of the analytical program for these samples is provided in Section 7.4.

Location Surveying of Sampled Points

Locations of all sampling points will be paced and/or taped off prior to sampling. After sampling, locations will be surveyed using standard land surveying techniques. Field team

members will coordinate with Waste Operations personnel to ensure that stakes and/or flagging used to identify sampling locations are not moved or damaged by ongoing waste operations prior to surveying. Horizontal accuracy will be ±0.5 foot. Vertical accuracy will be ±0.1 foot.

## 7.4 SAMPLE ANALYSIS

This section describes the sample handling procedures and analytical program for samples collected during the Phase I investigation. This section also includes discussions of sample designations, analytical requirements, sample containers and preservation, and sample handling and documentation.

### 7.4.1 Sample Designation

All sample designations generated for the RFI/RI will conform to the input requirements of RFEDS. Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media samples (e.g., "SB" for soil borings, "SS" for surface soils), a unique five-digit number, and a two-letter suffix identifying the contractor. One sample number will be required for each sample generated, including QC samples. In this manner, 99,999 unique sample numbers are available for each sample media for each contractor that contributes sample data to the database. Boring numbers will be developed independently of the sample number for a given boring. These sample numbering procedures are consistent with the RFP sitewide QAPjP.

### 7.4.2 Analytical Requirements

Generally, samples from the Phase I RFI/RI will be analyzed for some or all of the following chemical and radionuclide parameters:

- Nitrate

- TAL metals
- Uranium 233/234, 235, 236, and 238
- Transuranic elements (plutonium and americium)
- Cesium 137 and strontium 89/90
- Gross alpha and gross beta
- Tritium
- Total dissolved solids
- TCL volatile organics
- TCL semivolatile organics
- TCL PCBs
- Inorganics
- Anions (water only)
- Field parameters (water only)

The analytical suites for each area in OU7 were developed according to the type of waste suspected to be present at each site. Specific analytes in the above groups and their CLP detection/quantitation limits are listed in Table 7-1. These analytes and limits should address the bulk of chemical or compounds that were landfilled, handled, or suspected to

be present at OU7 and enable detection of soil, sediment, surface water, and groundwater contamination, if present. Nitrates are included because low-level radioactive wastes with high nitrate concentrations may be present. Sludges containing metals were landfilled at IHSS 114; therefore, all of the TAL metals have been selected for Phase I analysis. Both filtered and unfiltered samples as well as surface water and groundwater samples will be analyzed at each location.

Uranium is not documented to have been a constituent of the wastes at OU7 but may be present. The isotopes U-233, U-234, U-235, U-236, and U-238 have been selected for analysis in Phase I. Plutonium is the only transuranic element that is used on the site. However, americium is a daughter product of plutonium and has been detected in groundwater at OU7 at concentrations exceeding sitewide background values. Therefore, plutonium and americium have been selected as Phase I radionuclide parameters. Gross alpha and gross beta are included as screening parameters because they are useful indicators of radionuclides. Tritium and strontium are included in the analytical program because of the historical occurrence of these analytes in OU7.

Volatile and semivolatile organics have been detected at low concentrations in landfill leachate at surface water station SW097 and in samples from monitoring wells. Therefore, all of the TCL volatile and semivolatile organics will be included in the Phase I analyses. TCL PCBs have been included to provide data for the environmental evaluation and for characterization of IHSS 203, where PCB wastes were stored.

The analytical parameters for the soil-gas surveys at OU7 are methane, hydrogen sulfide, TCE, 1,2-DCE, 1,1,1,-TCA, methylene chloride, toluene, 2-butanone, acetone, and xylene (total). Detection limits proposed for these parameters during the soil-gas survey are listed in Table 7-2.

# Table 7-4: Sample Containers, Sample Preservation, and Sample Holding Times for Water Samples



| Parameter | Container | Preservative | Holding Time |
|---|---|---|---|
| Liquid - Low to Medium Concentration Samples | | | |
| **Organic Compounds:** | | | |
| Purgeable Organics (VOCs) | 2 x 40-mℓ VOA vials with teflon-lined septum lids | Cool, 4°C[a] with HCL to pH<2 | 7 days<br>14 days |
| Extractable Organics (BNAs), Pesticides and PCBs | 1 x 4-ℓ amber[b] glass bottle | Cool, 4°C | 7 days until extraction,<br>40 days after extraction |
| **Inorganic Compounds:** | | | |
| Metals (TAL) | 1 x 1-ℓ polyethylene bottle | Nitric acid pH<2;<br>Cool, 4°C | 180 days[c] |
| Cyanide | 1 x 1-ℓ polyethylene bottle | Sodium hydroxide[d] pH>12;<br>Cool, 4°C | 14 days |
| Anions | 1 x 1-ℓ polyethylene bottle | Cool, 4°C | 14 days |
| Sulfide | 1 x 1-ℓ polyethylene bottle | 1 mℓ-zinc acetate sodium hydroxide to pH>9;<br>Cool, 4°C | 7 days |
| Nitrate | 1 x 1-ℓ polyethylene bottle | Cool, 4°C | 48 hours |
| Total Dissolved Solids (TDS) | 1 x 1-ℓ polyethylene bottle | Cool, 4°C | 48 hours |
| Radionuclides | 1 x 1-ℓ polyethylene bottle | Nitric acid pH<2; | 180 days |

[a]Add 0.008% sodium thiosulfate ($Na_2S_2O_3$) in the presence of residual chlorine.

[b]Container requirement is for any or all of the parameters given.

[c]Holding time for mercury is 28 days.

[d]Use ascorbic acid only if the sample contains residual chlorine. Test a drip of sample with potassium iodine-starch test paper; a blue color indicates need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add an additional 0.6g of ascorbic acid for each liter of sample volume.

# Table 7-5: Sample Containers, Sample Preservation, and Sample Holding Times for Soil Samples



| Parameter | Container | Preservative | Holding Time |
|---|---|---|---|
| Soil or Sediment Samples - Low to Medium Concentration | | | |
| **Organic Compounds:** | | | |
| Purgeable Organics (VOCs) | 1 x 4-oz wide-mouth teflon-lined glass vials | Cool, 4°C | 7 days<br>14 days |
| Extractable Organics (BNAs), Pesticides and PCBs | 1 x 8-oz wide-mouth teflon-lined glass vials | Cool, 4°C | 7 days until extraction,<br>40 days after extraction |
| **Inorganic Compounds:** | | | |
| Metals (TAL) | 1 x 8-oz wide-mouth glass jar | Cool, 4°C | 180 days[1] |
| Cyanide | 1 x 8-oz wide-mouth glass jar | Cool, 4°C | 14 days |
| Sulfide | 1 x 8-oz wide-mouth glass jar | Cool, 4°C | 28 days |
| Nitrate | 1 x 8-oz wide-mouth glass jar | Cool, 4°C | 48 hours |
| Radionuclides | 1 x 1-ℓ wide-mouth glass jar | None | 45 days |

[1]Holding time for mercury is 28 days.

### 7.4.3 Sample Containers and Preservation

Sample volume requirements, preservation techniques, holding times, and container material requirements are dictated by the media being sampled and by the analyses to be performed. The soil matrices to be analyzed will include soils and sediments, and the water matrices for analysis will include surface water and groundwater. Analytical parameters of interest in OU7 for water and soil matrices, along with the associated container size, preservatives (chemical and/or temperature), and holding times are listed in Tables 7-4 and 7-5. Additional specific guidance on the appropriate use of containers and preservatives is provided in SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Waste Samples.

### 7.4.4 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance defining the necessary sample control, identification, and chain-of-custody documentation is discussed in SOP 1.13.

## 7.5 DATA MANAGEMENT AND REPORTING REQUIREMENTS

Field data will be input to the RFEDS using a remote data entry module supplied by EG&G. Data will be entered on a timely basis, and a 3.5-inch computer diskette will be delivered to EG&G. A hardcopy report will be generated from the module for contractor use. The data will undergo a prescribed QC process based on SOP 1.14.

A sample tracking spreadsheet will be maintained by the contractor for use in tracking sample collection and shipment. EG&G will supply the spreadsheet format and will stipulate timely reporting of information. These data will also be delivered to EG&G on

3.5-inch computer diskettes. Computer hardware and software requirements for contractors using government-supplied equipment will be supplied by EG&G. Computer and data security measures will also follow acceptable procedures outlined by EG&G.

## 7.6 FIELD QC PROCEDURES

Sample duplicates, field preservation blanks, and equipment rinsate blanks will be prepared. Trip blanks will be obtained from the laboratory. The analytical results obtained for these samples will be used by the ER project manager to assess the quality of the field sampling effort. The types of field QC samples to be collected and their application are discussed below. The frequency with which QC samples will be collected and analyzed is provided in Table 7-6.

Duplicate samples will be collected by the sampling team for use as a relative measure of the precision of the sample collection process. These samples will be collected at the same time, using the same procedures and equipment, and in the same types of containers as required for the samples. They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field preservation blanks of distilled water, preserved according to the preservation requirements (Section 7.4.3), will be prepared by the sampling team and will be used to provide an indication of any contamination introduced during field sample preparation. As indicated in Table 7-6, these QC samples are applicable only to samples requiring chemical preservation.

Equipment (rinsate) blanks will be collected from final decontamination rinsate to evaluate the success of the field sampling team's decontamination efforts on non-dedicated sampling equipment. Equipment blanks are obtained by rinsing cleaned equipment with distilled water prior to sample collection. The rinsate is collected and placed in the appropriate sample containers. Equipment rinsate blanks are applicable to all analyses for water and

# Table 7-6: Field QC Sample Frequency



| Sample Type | Type of Analysis | Media | |
|---|---|---|---|
| | | Solids | Liquids |
| Duplicates | Organics | 1/10 | 1/10 |
| | Inorganics | 1/10 | 1/10 |
| | Radionuclides | 1/10 | 1/10 |
| Field Preservation Blanks | Organics | NA | NA |
| | Inorganics | NA | 1/20 |
| | Radionuclides | NA | 1/20 |
| Equipment Blanks | Organics | 1/20 | 1/20 |
| | Inorganics | 1/20 | 1/20 |
| | Radionuclides | 1/20 | 1/20 |
| Trip Blanks | Organics | NR | 1/20 |
| | Inorganics | NR | NR |
| | Radionuclides | NR | NR |

NA = Not Applicable
NR = Not Required
1/10 = one QC sample per ten samples collected

soil samples, as indicated in Table 7-6.

Trip blanks consisting of distilled water will be prepared by the laboratory technician and will accompany each shipment of water samples for volatile organic analysis. Trip blanks will be stored with the group of samples with which they are associated. Analysis of the trip blank will indicate migration of volatile organics or any problems associated with sample shipment, handling, or storage. Information from the trip blanks will be used in conjunction with air monitoring data and other information to assess the influence of ongoing waste operations on the quality of data collected.

Procedures for monitoring field QC are provided in the sitewide QAPjP.

## 7.7 AIR MONITORING PROCEDURES

Air monitoring will be performed during field activities to ensure that quality data are obtained during sampling and that all sampling activities comply with the Interim Plan for Prevention of Contaminant Dispersion (IPPCD) (EG&G, 1991l). Air quality monitoring will be performed in accordance with SOPs presently being developed by EG&G.

Air quality monitoring requirements for activities such as borehole drilling where there is a significant potential for producing appreciable quantities of suspended particulates include the following:

- Site perimeter and community Radiological Ambient Air Monitoring Program (RAAMP) monitoring

- Local monitoring of Respirable Suspended Particulates (RSP) at individual activity work sites shall be conducted using a TSI "Piezobalance" Model 3500 Respirable Aerosol Mass Monitor, a real-time instrument. Local RSP measurements will be used to guide the project manager's evaluation of the

potential hazards associated with activity-related emissions. The threshold RSP concentration for curtailing intrusive activities will be 6.0 milligrams/cubic meter ($mg/m^3$)

- Additional worker health and safety monitoring as required by the Site-Specific Health and Safety Plan (SSH&SP)

This is a
CONTROLLED DOCUMENT

EG&G — ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT DEPARTMENT

ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203

Manual No.: 21100-WP-OU 07.01
Section No.: 8.0, R0

This is a RED Stamp

Organization: Environmental Management

Title: Baseline Human Health Risk Assessment Plan

Approved by:

12/6/91
Effective Date

T. P. O'Rourke
Manager

6/23/92
Date

# 8.0 BASELINE HUMAN HEALTH RISK ASSESSMENT PLAN

## 8.1 OVERVIEW

In accordance with the IAG, a Baseline Risk Assessment will be prepared for OU7 as part of the Phase I RFI/RI report. Both a Baseline Human Health Risk Assessment and an Environmental Evaluation will be performed. This section describes the Baseline Human Health Risk Assessment. The Environmental Evaluation is described in Section 9.0 of this work plan.

As described in Section 300.430(d) of the NCP, the purpose of a Baseline Risk Assessment is to provide an estimate of current or potential risks to human health and the environment that may result from releases of hazardous substances from a site in the absence of any remedial action. Results of a Baseline Risk Assessment are also used to determine whether remedial actions are warranted and, if so, the associated cleanup levels necessary to protect human health.

The Baseline Human Health Risk Assessment for OU7 will be accomplished in five general steps:

1. Identification of contaminants of concern

2. Exposure assessment

3. Toxicity assessment

4. Risk characterization

5. Uncertainty analysis

Several objectives will be accomplished under the Baseline Human Health Risk Assessment task, including identification and characterization of the following:

- Toxicity and levels of hazardous substances present in relevant media (e.g., air, groundwater, soil, surface water, sediment, and biota)

- Environmental fate and transport mechanisms within specific environmental media, and inter-media fate and transport where appropriate

- Potential human and environmental receptors

- Potential exposure routes and extent of actual or expected exposure

- Extent of expected impact or threat, and the likelihood of such impact or threat occurring (e.g., risk characterization)

- Level(s) of uncertainty associated with the above

The Baseline Human Health Risk Assessment for OU7 will be performed in general accordance with EPA and other guidance documents listed in Table 8-1. The documents listed in Table 8-1 constitute the most recent EPA guidance in public health risk assessment. It must be emphasized that EPA manuals are guidelines only and that EPA states that considerable professional judgment must be used in their application. The focus of the risk assessment for OU7 will be to produce a realistic analysis of exposure and health risk.

## Table 8-1: EPA Guidance Documents Which May Be Used in the Risk Assessment Task



- EPA's Integrated Risk Information System (IRIS) -- Office of Research and Development (continuously updated). Agency's primary source of chemical-specific toxicity and risk assessment information. Includes narrative discussion of toxicity data base quality and explains derivation of Reference Doses, cancer potency factors, and other key dose response parameters. IRIS presents information that updates data originally presented in Exhibits A-4 and A-6 of the SPHEM (see below). Further information: IRIS Users Support, 513-569-7254 (U.S. EPA, 1987b).

- Health Effects Assessment Summary Tables (HEAST) -- Office of Research and Development/Office of Emergency and Remedial Response (updated quarterly). Because the IRIS chemical universe (while growing) is currently incomplete, the HEAST has been produced to serve as a "pointer" system to identify current literature and toxicity information on important non-IRIS chemicals. While HEAST data in some cases may be "Agency-verified", the information is considered valuable for Superfund risk assessment purposes. Available from Superfund docket, 202-382-3046 (U.S. EPA, updated quarterly).

- Risk Assessment Guidance for Superfund, Human Health Evaluation Manual Part A, Interim Final -- Office of Emergency and Remedial Response. This volume provides updated risk assessment procedures and policies, specific equations and variable values for estimating exposure, and a hierarchy of toxicity data sources. There is an expanded chapter on risk characterization to help summarize information for the decision makers and detailed descriptions of uncertainties in risk assessment (U.S. EPA, 1989b).

- OSWER Directive on Soil Ingestion Rates -- Office of Solid Waste and Emergency Response (January 1989), OSWER Directive #9850.4. Recommends soil investigation rates for use in risk assessment when site-specific information is not available. Available from Darlene Williams, 202-475-9810 (U.S. EPA, 1989b).

- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference -- Office of Solid Waste and Emergency Response EPA 600-3/89/013. This report is a field and laboratory reference document that provide guidance on designing, implementing, and interpreting ecological assessments of hazardous waste sites. It includes sections on ecological endpoints, field sampling design, quality assurance, aquatic and terrestrial toxicity and field survey methods, recommended biomarkers, and data analysis (U.S. EPA, 1989d).

- Risk Assessment Guidance for Superfund -- Environmental Evaluation Manual, Interim Final (RAGS-EEM) -- Office of Emergency and Remedial Response (March 1989), EPA/540/1-89/001A. Provides program guidance to help remedial project managers and on-scene coordinators manage ecological assessment at Superfund sites (U.S. EPA, 1989e).

- Exposure Factors Handbook -- Office of Research and Development (March 1989), EPA/600/8-89/043. Provides statistical data on the various factors used in assessing exposure; recommends specific default values to be used when site-specific data are not available for certain exposure scenarios. Further information: Exposure Methods Branch, 202-382-5988 (U.S. EPA, 1989c).

- Superfund Public Health Evaluation Manual (SPHEM) -- Office of Emergency and Remedial Response. The current program risk assessment guidance manual. Explains how to conduct a baseline site risk assessment, set preliminary goals, and evaluate risks of remedial alternatives. (U.S. EPA, 1986a).

- Superfund Risk Assessment Information Directory (RAID) -- Office of Emergency and Remedial Response (November 1986b), EPA/540/1-86/061. Describes sources of information useful in conducting risk assessments. Currently under revision.*

- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA -- Office of Emergency and Remedial Response EPA/540/g-89/004. This guidance document is a revision of the U.S. EPA's 1985 guidance. It describes general procedures for conducting an RI/FS (U.S. EPA, 1988a).

- Superfund Exposure Assessment Manual (SEAM) -- Office of Emergency and Remedial Response (April 1988), EPA/540/1-88/001. Provides a framework for the assessment of exposure to contaminants at or migrating from hazardous waste sites. Discusses modeling and monitoring* (U.S. EPA, 1988d).

- CERCLA Compliance With Other Laws Manual -- Office of Emergency and Remedial Response. The guidance is intended to assist in the selection of onsite remedial actions that meet the applicable or relevant and appropriate requirements (ARARs) of the Resource Conservation and Recovery Act (RCRA), Clean Water Act (CWA), Safe Drinking Water Act (SDWA), Clean Air Act (CAA), and other federal and state environmental laws as required by CERCLA, Section 121 (U.S. EPA, 1988b).

- Guidance for Data Useability in Risk Assessment -- Interim Final 1990. EPA/540/G-90/008.

## 8.2 IDENTIFICATION OF CONTAMINANTS OF CONCERN

This section outlines the process that will be used to identify source-related contaminants present at OU7 at concentrations that could be of concern to human health. This process includes a summary of historical and RFI/RI related data collected at OU7, an evaluation of historical and RFI/RI data relevant to performing the Baseline Human Health Risk Assessment, and use of this information to identify contaminants of concern (COCs). COCs include chemicals and other constituents, such as metals or radionuclides, that are identified at the unit and evaluated in the Baseline Human Health Risk Assessment.

The first step in the process is a summary of all data available for use in the Baseline Human Health Risk Assessment. This step identifies the historical data relevant to performing the Baseline Human Health Risk Assessment, assembles Phase I RFI/RI data as they become available, and establishes data formats to facilitate data evaluation. Data attributes important to this step include the following information:

- Site description
- Sample design with sampling locations
- Analytical method and detection limit
- Results for each sample, including qualifiers
- Sample quantitation limits and/or detection limits for nondetects
- Field conditions

- Sample documentation (for example, chain-of-custody and SOPs)

Data lacking any of the above information will be considered for qualitative use in the Baseline Human Health Risk Assessment. Data associated with all of these attributes will be carried forward for further detailed evaluation and summary.

Historical data and Phase I RFI/RI data will be further evaluated according to EPA guidelines issued in *Guidance for Data Usability in Risk Assessment* (U.S. EPA, 1990). EPA identified the following data usability criteria:

- Assess data documentation for completeness
- Assess data sources for appropriateness and completeness
- Assess analytical methods and detection limits for appropriateness
- Assess data validation review
- Assess sampling data quality indicators (i.e., PARCC parameters)
- Assess analytical data quality indicators (such as recoveries, duplicates, and blanks) for PARCC parameters

Following completion of Phase I RFI/RI data collection, analysis, and validation, new data will be evaluated to determine whether they support historical trends. Where new data and

historical data appear compatible, the historical data will be re-evaluated to identify those that could be used quantitatively in conjunction with new data.

Based on the outcome of this evaluation, the data set containing historical and Phase I RFI/RI data that can be used to support a quantitative Baseline Human Health Risk Assessment will be identified. Part of this evaluation will include the most appropriate summary process and format, which will involve identifying statistical summary techniques that consider spatial and temporal data distributions, determining whether arithmetic or geometric means are appropriate, and determining the appropriate method for dealing with nondetect values and qualified data. The data summary will include (1) the frequency of detection (number of positive detects per number of analyses) for each compound and sample location, and (2) the minimum and maximum reported concentrations for each compound at each sample location.

Tentatively identified compounds (TICs) reported in the Phase I RFI/RI data will be evaluated relative to their usefulness in the Baseline Human Health Risk Assessment. If only a few TICs are reported relative to other contaminants, or if they are unrelated to RFP, they will be excluded from the Baseline Human Health Risk Assessment. If numerous TICs are reported and they appear related to the RFP, they will be carried through the Baseline Human Health Risk Assessment only to the extent that they aid in characterizing human health risk as needed for site decisions. It is unlikely that risks resulting from exposure to TICs cannot be characterized at this time because of the absence of specific contaminant identity and available toxicological information.

From the list of valid data suitable for use in the risk assessment, potential site-specific COCs may be selected on the basis of the following considerations:

- The chemical is identified as a site-specific, waste activity related compound released from an identified source at the IHSS.

- The concentration of the chemical exceeds the chemical-specific ARARs.

- The chemical is detected at a frequency greater than 5 percent of the time in an individual media (e.g., surface soil, subsurface soil, alluvial groundwater, etc.).

- The concentration of the chemical exceeds the 95 percent Upper Tolerance Limit of the background concentration estimate.

- The chemical is a potential carcinogenic compound classified as: Group A - sufficient evidence of carcinogenicity in humans, Group B1 - limited evidence of carcinogenicity in humans, and Group B2 - sufficient evidence in animals with inadequate evidence in humans.

- The occurrence of a non-carcinogenic compound in media at a concentration 0.1 times the derived media concentration (DMC). (The DMC equals the exposure dose divided by the reference dose.)

- The chemical's inter-media transport, persistence, and biometabolic characteristics.

- The chemical's role as a nutrient.

Potential COCs will be evaluated in terms of all considerations in an iterative process. Thus, a chemical may be eliminated as a COC on the basis of one criterion, but it may subsequently be identified as a COC on the basis of another criterion (and vice-versa). Adequate documentation will be prepared to justify including or excluding specific contaminants.

## 8.3 EXPOSURE ASSESSMENT

The objectives of the exposure assessment are to (1) identify actual or potential pathways, (2) characterize potentially exposed populations, and (3) determine the extent of exposure.

Exposure is defined as the contact of an organism with a contaminant or physical agent. The magnitude of exposure is determined by measuring or estimating the amount of a contaminant available at the exchange boundaries (i.e., lungs, intestines, and skin). When contaminants migrate from the site to an exposure point (a location where receptors can come into contact with contaminants) or when a receptor directly contacts the contaminated media, exposure can occur.

The exposure assessment process will:

- Analyze the probable fate and transport of compounds for both present and future uses

- Identify the human populations in the area, typical activities that would influence exposure, and sensitive population subgroups

- Identify potential exposure pathways under current and future use conditions

- Develop exposure scenarios for each identified pathway and select plausible scenarios

- Identify exposure pathways based on contaminant source and release, exposure point, and exposure route

- Identify the exposure parameters (such as estimated intakes, reference doses, and cancer slope factors) to be used in assessing the risk for all scenarios

- Develop an estimate of the expected exposure levels from the potential release of contaminants

### 8.3.1 Site Conceptual Model

The site conceptual model for OU7 (Figures 2-25 and 2-26) will be used to evaluate primary and secondary contaminant sources, release mechanisms, contaminant migration pathways, potential receptors, and associated exposures. The model helps to characterize the exposure setting relative to contaminant fate and transport mechanisms through exposed receptors. The site conceptual model for OU7 may be revised on the basis of Phase I RFI/RI data. Although not explicitly described in the OU7 site conceptual model, residential and occupational pathways through ingestion, inhalation, or dermal contact with site-related contaminants will be considered for evaluation in the risk characterization if the revised conceptual model suggests that they may be complete exposure pathways. An exposure pathway consists of five elements:

1. Source of contaminants

2. Mechanism of chemical release to the environment

3. Environmental transport medium (e.g., air, groundwater) for the released constituent

4. Point of potential contact of human or biota with the affected medium (the exposure point)

5. Exposure route (e.g., inhalation of contaminated dust) at the exposure point

Appropriate exposure scenarios will be identified for the site. Scenarios that could potentially be considered include residential, commercial/industrial, recreational, agricultural, and/or ecological research use. Factors to be examined in the pathway and receptor identification process will include the following:

- Location of contaminant source
- Local topography
- Local meteorological data
- Local hydrogeology/surface water hydrology
- Surrounding land use
- Local water use

- Prediction of contaminant fate and migration

- Persistence and mobility of migrating contaminants

Receptors will be identified and characterized for each migration pathway and for current and future conditions. Potential receptors will be defined by the appropriate exposure scenarios.

To assess the potential adverse health effects associated with access to the site, the potential level of human exposure to the selected chemicals must be determined. Intakes of exposed populations will be calculated separately for all appropriate pathways of exposure to chemicals. Then, for each population-at-risk, the total chronic intake by each route of exposure will be calculated by adding the intakes from each pathway. Total oral, inhalation, and dermal chronic exposures will be estimated separately. Exposure concentrations will be estimated for a variety of reasonable exposure conditions so that the risk assessor can evaluate the range of plausible exposure concentrations. At a minimum, the exposure assessment will consider the estimated minimum, expected, and reasonable maximum (RME) exposure concentrations. RME concentrations are represented by the 95th percent confidence limit on average or the maximum reported concentration, whichever is lower. Depending on the quality of the data and their appropriateness for grouping, data distribution will be used to determine the appropriateness of using geometric or arithmetic means to estimate RME concentrations.

### 8.3.2 Contaminant Fate and Transport

The site conceptual model helps identify potential contaminant fate and transport mechanisms, which could include wind dispersion of soil contamination and leaching of contaminants to groundwater and surface water. Contaminant-specific characteristics affect

fate and transport. Factors affecting the probability that a contaminant will migrate include, but are not limited to, solubility, partition coefficient, vapor pressure, Henry's Law constant, and bioconcentration factor. The evaluation of these factors will help determine whether contaminants can migrate from their sources to potential receptors (including receptors identified under current and future use scenarios).

### 8.3.3 Potential Receptors

The exposure scenarios that will be developed in the Baseline Human Health Risk Assessment may include exposure of onsite workers, exposure of potential future receptors to contaminated media within OU7, and exposure of offsite receptors to potentially contaminated groundwater, surface water, and airborne soil particulates. The exact exposure scenarios to be considered will be selected according to an assessment of future use (e.g., residential, recreational, restricted access) of the site that may be made prior to completion of the Baseline Human Health Risk Assessment.

### 8.3.4 Exposure Pathways

Identification of exposure pathways involves linking the source of chemical release, an environmental transport mechanism, a point of human exposure, and a mechanism of human uptake. Sources of chemical release will be sites within OU7 that contain COCs. Mechanisms of release can include leaching of chemicals from soils into groundwater or surface runoff, airborne transport of contaminated soil particulates, volatilization of organic compounds, or release of radioactive particles. Points of human exposure will be identified during the site characterization. These may include sites within the operable unit as well as offsite locations where contaminants may be transported. Examples of mechanisms of human uptake are dermal contact with contaminated media, inhalation of volatile organics or particulates, and ingestion of soils or water.

Only complete exposure pathways will be evaluated in the risk assessment. If any one of the elements of an exposure pathway (chemical source and release, environmental transport mechanism, exposure point, or uptake) is missing, the exposure pathway is considered incomplete and will not be quantified in the assessment.

### 8.3.5 Exposure Point Concentrations

Exposure point concentrations of COCs will be estimated on the basis of analytical results of the sampling program described in Section 7.0 of this work plan and available relevant historical data. Release and transport of contaminants in environmental media may be modeled using basic analytical models recommended by EPA or the best model available, as determined by a model performance evaluation. The models will be calibrated to improve performance using site-specific parameters.

Model outputs will be characterized by estimating variance through an uncertainty analysis to the extent required by the overall risk uncertainty analysis. Efforts will be made to reduce the variance of model output. The target model variance will be one that does not exceed the variance contributed by other major contributors of uncertainty, such as exposure factors and/or toxicology factors. Other major contributors to the overall risk assessment uncertainty include exposure factors used in the estimation of intake and the toxicity parameters (reference dose and cancer slope factors) used to evaluate the effect of an acquired dose.

Concentrations will also be estimated for minimum, expected, and reasonable maximum estimated exposure conditions (as a minimum). When feasible, a goodness-of-fit analysis will be conducted to correctly identify the distribution of the data and the most appropriate measure of central tendency. The reasonable maximum concentration will be the upper 95 percent confidence limit on the appropriate mean or maximum likelihood estimate. In

calculating the media concentrations, censored data (data sets with missing values, nondetects, etc.) will be treated by appropriate methods such as those described in *Statistical Methods for Environmental Pollution Monitoring* (Gilbert, 1987).

### 8.3.6 Estimation of Intake

In general, chemical intakes will be estimated using available, region-specific exposure parameters. Deviation from standard parameters will be documented and submitted to the regional EPA office for approval prior to preparation of the risk assessment.

Contaminant exposure (or intake) is normalized for time and body weight and is expressed as milligrams of contaminant per kilogram of body weight per day (mg/kg/day). Radionuclide intake is expressed as picocuries of radionuclide per kilogram of body weight per day (pCi/kg/day). Six basic factors are used to estimate intake: exposure frequency, exposure duration, contact rate, chemical concentrations, body weight, and average time. These factors are based on the types of exposure (e.g., residential or occupational, ingestion, or inhalation).

The RME and average exposure point concentrations are used in conjunction with receptor activity patterns to estimate contaminant intake for each exposure route as appropriate. EPA requires using 95th percentile rates, 90th or 95th percentile values for exposure duration, and average values for parameters such as body weight. For example, a residential land use scenario describes an adult, weighing 70 kilograms, who works at home and consumes 2 liters of water and breathes 20 cubic meters ($m^3$) of air per day. The individual stays at home 350 days per year and lives in the same residence for 30 years. Different parameters are used for children, adult workers, and recreational exposures based on information provided by EPA in the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance, "Standard Default Exposure*

*Factors"* (U.S. EPA, 1989b). Also, the averaging time for carcinogens and noncarcinogens differ.

Other standard intake rates established by EPA that will be used, if appropriate, include the following:

- Soil ingestion rates for children ages 1 through 6
- Soil ingestion rates for all others (workers and residents more than 6 years of age)
- Inhalation rates based on activity levels

Contaminant rates can also be estimated for dermal exposures. Of the three routes of exposure (ingestion, inhalation, and dermal), the greatest uncertainty is associated with dermal exposures. Part of this uncertainty results from the lack of chemical-specific permeability constants. For the Baseline Human Health Risk Assessments, limited effort will be directed toward quantification of dermal exposures because, relative to other contributors to risk, dermal risk is expected to be quite low. The Baseline Human Health Risk Assessment will calculate the estimated contaminant intake through dermal exposures and compare the intake values to those calculated for ingestion as the basis for demonstrating the insignificance of dermal exposures relative to other routes of exposure.

Human intake of COCs will be estimated using reasonable estimates of exposure parameters. EPA guidance, site-specific factors, and professional judgment will be applied in establishing exposure assumptions. Using reasonable values allows estimation of risks associated with the assumed exposure conditions without underestimating actual risk. The estimate of intake is the "intake factor," which may then be mathematically combined with the exposure point concentrations and the critical toxicity values to determine cancer risks and hazard indices.

## 8.4 TOXICITY ASSESSMENT

The objective of the toxicity assessment is to describe the contaminants considered in the Baseline Human Health Risk Assessment relative to their potential to cause harm. The toxicity assessment has two general steps. The first determines what adverse health impacts, if any, could result from exposure to a particular contaminant. These are typically classified as "carcinogenic" and "noncarcinogenic" health effects. The second step, dose-response evaluation, quantitatively examines the relationship between the level of exposure and the incidence of adverse health effects. From this evaluation, toxicity values (i.e., reference doses and slope factors) are derived.

To judge the degree and extent of risk to public health and the environment (including plants, animals, and ecosystems), the projected concentrations of COCs at exposure points will be compared with ARARs. Because ARARs do not exist for certain media (such as soils), nor are all ARARs necessarily health based, this comparison is not sufficient in itself to satisfy the requirements of the risk assessment process. Moreover, receptors may be exposed to contaminants in more than one medium so that their total doses might exceed risk reference doses (RfDs) and/or might result in an excess cancer risk greater than an acceptable target risk, as defined by EPA (e.g., $10^{-6}$ to $10^{-4}$). Nevertheless, the comparison with standards and criteria is useful in defining the exceedence of institutional requirements. Aside from the ARARs discussed in Section 3.0, the following criteria will be examined:

- Drinking-water health advisories
- Ambient water quality criteria for protection of human health
- Center for Disease Control and Agency for Toxic Substances and Disease Registry soil advisories

- National Ambient Air Quality Standards

Toxicity depends on the dose or concentration of the substance (dose-response relationship). Toxicity values are a quantitative expression of the dose-response relationship for a contaminant and take the form of RfDs and cancer slope factors, both of which are specific to exposure via different routes.

Two sources of toxicity values are currently available for chemicals and radionuclides. The primary source is EPA's Integrated Risk Information System (IRIS) data base. IRIS contains up-to-date health risk and regulatory information and only those RfDs and slope factors that have been verified by EPA. IRIS is considered by EPA to be the preferred source of toxicity information for chemicals.

Following IRIS, the most recently available Health Affects Summary Tables (HEAST), issued by the EPA's Office of Research and Development, will be consulted to identify interim RfDs and slope factors for radionuclides.

In addition to identifying appropriate toxicity values, this section of the Baseline Human Health Risk Assessment will provide brief toxicity profiles based on recent, published literature for each contaminant evaluated in the Baseline Human Health Risk Assessment. These profiles will describe the acute, chronic, and carcinogenic health effects associated with site-related contaminants identified at OU7. The quality of these studies and their usefulness in estimating human health risks will be described. A more detailed explanation of the toxic effects of target chemicals will be provided in appendices to the Baseline Human Health Risk Assessment and the Environmental Evaluation. Toxicity reference values will also be summarized. For the human health risk assessment, this will include a brief description of the studies upon which selected reference values were based, the uncertainty factors used to calculate RfDs, and the EPA weight-of-evidence classification

for carcinogens. For chemicals without EPA toxicity reference values, a literature search, including computer data bases, will be conducted for selected compounds. A toxicity value will then (if possible) be derived from this information.

## 8.5 RISK CHARACTERIZATION

This section presents the evaluation of potential risks to public health associated with exposure to contaminants at OU7. Potential carcinogenic and noncarcinogenic risks associated with complete exposure pathways will be estimated.

Risk characterization involves integrating exposure assumptions and toxicity information to quantitatively estimate the risk of adverse health effects. Risk characterization will be performed in accordance with EPA guidance (U.S. EPA, 1989b).

Noncarcinogenic risk will be evaluated by comparing the estimated daily intake of a contaminant at an exposure point to its RfD. This comparison measures the potential for noncarcinogenic health effects given the chemical intake factors used to estimate exposure. To assess the potential for non-cancer effects posed by multiple chemicals, EPA's hazard index approach will be used. This method assumes dose additivity. Hazard quotients (individual chemical intake divided by the chemical RfD) are summed to provide a hazard index, and if the index exceeds 1, a potential for health risk is suggested. If a hazard index exceeds 1, where possible, chemicals may be segregated by similar effect or target organ to determine the potential health risks. Separate hazard indices may be derived for each effect if sufficient information or target organ specificity is available.

The potential for carcinogenic effects will be quantified by calculating excess lifetime cancer risks from the lifetime average exposure and cancer slope factor. These will be upper-bound

estimates because methods used to estimate slope factors are regarded as upper bounds on potential cancer risks rather than accurate representations of true cancer risk.

Both cancer and non-cancer risks will be estimated by using RME and average contaminant intake values combined with exposure assumptions. This allows risk ranges to be considered (rather than a single value) and more closely considers the uncertainty associated with the estimates. In addition, risks may be added across exposure routes to assess the potential for additive affects.

Not all contaminants at OU7 will have toxicity values, thereby limiting the ability to develop quantitative estimates of risk. Where adequate toxicity values cannot be identified, potential risks associated with exposure to those constituents will be dealt with qualitatively.

The results of the Baseline Risk Assessment will be used to define and evaluate remedial alternatives during the CMS/FS.

## 8.6 UNCERTAINTY ANALYSIS

The numbers and kinds of uncertainties identified in the Baseline Human Health Risk Assessment directly impact the interpretation of estimated risks developed in the exposure scenarios. Quantitative risk estimates derived in risk assessments are conditional estimates that include numerous assumptions about exposures and toxicity. An uncertainty analysis will be performed to identify and evaluate non-site-specific and site-specific factors that may produce uncertainty in the risk assessment, such as assumptions inherent to development of toxicological endpoints (potency factors, reference doses) and assumptions considered in the exposure assessment (model input variability, population dynamics). Statistical sampling techniques (such as Monte-Carlo) may be employed for contaminants for which quantitative evaluation is not possible. The goal of this task will be to quantify, to the extent practicable,

the magnitude and extent of uncertainty propagated through the risk assessment process. The uncertainty analysis will present the spectrum of potential risks under specified scenarios such that the risk management decision maker can obtain an understanding of the level of confidence associated with all estimates of potential human health risk.

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ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203
Title: Environmental Evaluation

Manual No.: 21100-WP-OU 07.01
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This is a RED Stamp
Organization: Environmental Management

Approved by:

12/6/91
Effective Date

Manager

6/23/92
Date

# 9.0 Environmental Evaluation

## 9.1 Introduction

The purpose of this Environmental Evaluation Work Plan (EEWP) is to provide a framework for addressing and quantifying the ecological effects on the biotic environment (plants, animals, microorganisms) from exposure to contaminants resulting from IHSSs within OU7. This EEWP is based on an ecosystem approach to ecological risk assessment to ensure that effects of contamination at the ecosystem level of biological organization are considered (U.S. EPA, 1989c). The ecosystem approach is comprehensive in that it initially addresses all ecosystem components, then progressively focuses on aspects of the system potentially affected by contamination. The result is an evaluation of the nature and extent of contamination in biota, its relationship to abiotic sources, and the type and extent of adverse effects at the ecosystem, population, and individual levels of biological organization. The data are also used to support an assessment of risk to human health and the environment.

This plan conforms to the requirements of current applicable legislation, including CERCLA, as amended by SARA. Guidance is taken from the NCP and EPA documents for the conduct of RCRA RFI/RI activities. Specifically, guidance is taken from *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual* (U.S. EPA 1989c) and *Ecological Assessment of Hazardous Waste Sites* (U.S. EPA, 1989d). Although a formal Natural Resource Damage Assessment (NRDA) process has not been initiated at Rocky Flats, this work plan was also designed to be consistent with the NRDA process to the maximum extent possible.

Determination of the effects on biota will be performed in conjunction with the human health risk assessment for OU7. Where appropriate, criteria necessary for performing the Environmental Evaluation will be developed in conjunction with human health risk assessments and environmental evaluations for all Rocky Flats operable units. Information

from the environmental evaluations will assist in determining the form, feasibility, and extent of remediation necessary for the Present Landfill in accordance with RCRA.

Documents reviewed during preparation of this work plan include the Final Environmental Impact Statement (EIS), Rocky Flats Plant (U.S. DOE, 1980); Wetlands Assessment (EG&G, 1990c); Present Landfill Closure Plan (Rockwell, 1988a); Present Landfill Hydrogeologic Characterization Report (Rockwell, 1988c); Draft 1989 Surface Water and Sediment Geochemical Characterization Report (EG&G, 1991e); and Phase I RFI/RI Work Plan, Walnut Creek Priority Drainage OU6 (EG&G, 1991c). New data generated by the implementation of this Phase I work plan and other sitewide studies will be reviewed as they become available.

### 9.1.1 Approach

This plan presents a comprehensive approach to conducting the Environmental Evaluation of the Present Landfill. Guidance for development of this work plan was taken from EPA's *Environmental Evaluation Manual* (U.S. EPA, 1989c). This approach was designed to ensure that all procedures to be performed are appropriate, necessary, and sufficient to adequately characterize the nature and extent of environmental effects to biota under the "no action" scenario. The approach presented in this plan is adapted from the toxicity-based approach to the assessment of ecosystem effects (U.S. EPA, 1989c), which is based on standard risk assessment concepts whereby uncertainties with regard to potential ecosystem effects are explicitly recognized and, where possible, quantified. The planned approach is designed to provide evidence as to whether estimated damage is due to the contamination in question. Three types of information will be used (U.S EPA, 1989d):

- Chemical - Sampling and analyses to establish the presence, concentrations, and variability of distribution of specific toxic compounds (to be conducted under the RFI/RI abiotic sampling program)

- Ecological - Ecological surveys to characterize the condition of existing communities and establish whether any adverse effects have occurred

- Toxicological - Toxicological and ecotoxicological testing to establish the link between adverse ecological effects and known contamination

These three types of data are necessary to exclude factors other than contamination as the source of apparent ecological and toxicological impacts at the study site.

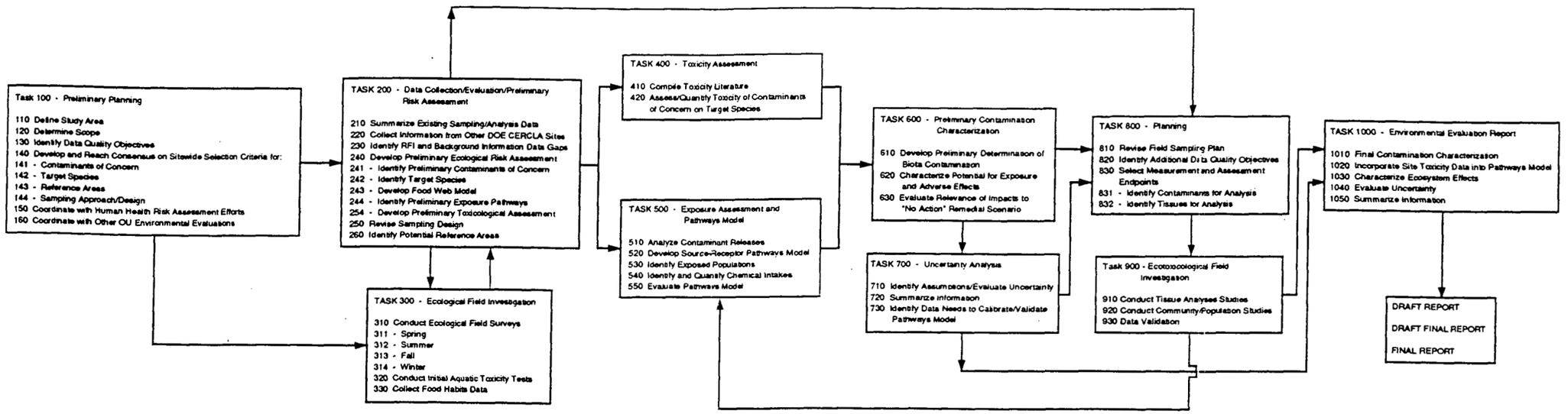
The ecological assessment scheme adopted for this project blends standard environmental and risk assessment methods with ecological and toxicological modeling to produce an integrated procedure for selecting COCs and indicator species and for conducting an investigation of ecosystem effects resulting from contamination. As recommended by EPA (U.S. EPA, 1989c), this Environmental Evaluation is not intended to be or develop into a research-oriented project. The plan presented herein is designed to provide for a focused investigation of the potential effects of contaminants on biota.

The tasks of this Environmental Evaluation will be coordinated with RFI/RI activities at other operable units at Rocky Flats. Coordination with OU6 activities will be especially important because IHSSs associated with OU6 are located within the OU7 boundary.

The Environmental Evaluation is divided into ten tasks. These tasks and their interrelationships are shown in Figure 9-1. Brief descriptions of each task and its associated goals are provided below. A more detailed description of task activities is presented in Section 9.2, Environmental Evaluation Tasks.

Task 1: Preliminary Planning

Task 1 will focus on planning and coordination of the OU7 Environmental Evaluation with other OU7 RFI/RI activities and with environmental evaluations for other operable units.




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

OPERABLE UNIT 7
PHASE I RFI/RI WORK PLAN

**FLOW DIAGRAM:**
**INTERRELATIONSHIPS BETWEEN TASKS IN ENVIRONMENTAL EVALUATION**

Figure 9-1 August 1991

Task 1 will include determination of the scope of work and definition of the study area. DQOs defined in the FSP will be refined in Task 1 according to EPA guidance (U.S. EPA, 1987), and procedures for monitoring and controlling data quality will be specified.

Task 2: Data Collection/Evaluation and Preliminary Risk Assessment

Task 2 will include review, evaluation, and summary of available chemical and ecological data and identification of data groups. Based on these data, a preliminary assessment of risks to the environment will be performed for use in refining the list of COCs presented in Section 9.1.3. As part of this preliminary risk assessment, a food web model will be developed and preliminary exposure pathways will be identified. Results of this task will be used to refine the ecological and ecotoxicological field investigation sampling designs.

Task 3: Ecological Field Investigations

Task 3 will include preliminary field surveys and an ecological field inventory to characterize OU7 biota and their trophic relationships and to note locations of obvious zones of chemical contamination. Brief field surveys of vegetation types in OU7 will be conducted to obtain information on the occurrence, distribution, variability, and general abundance of key plant and animal species. EPA's Rapid Bioassessment techniques will be employed in the qualitative aquatic surveys of this task (U.S. EPA, 1989e). Field inventories will be conducted in late spring and summer to obtain quantitative data on community composition in terrestrial and aquatic habitats. Samples collected as part of the activity may be preserved for tissue analyses, where COCs have been identified. Task 3 will also include aquatic toxicity tests of surface water and sediment using the cladoceran *Ceriodaphnia spp.*, the fathead minnow *Pimephales promelas*, and the isopod *Hyallela spp.* As part of these activities, all collected field data will be reduced, evaluated, compared with, and integrated into the existing data bank to update knowledge of site conditions.

Task 4: Toxicity Assessment

Task 4 will entail compilation of toxicity literature and toxicological assessment of potential adverse effects from COCs on key receptor species. This task will be performed in conjunction with Task 5.

Task 5: Exposure Assessment and Pathways Model

The objective of this task is to develop a site-specific pathways model(s) based on the ecological field investigation and inventory. This exposure-receptor pathways model will be used to evaluate the transport of OU7 contaminants to biological receptors. The pathways model is based on a conceptual pathways approach (Fordham and Reagan, 1991) and will provide an initial determination of the movements and distribution of contaminants, likely interactions among ecosystem components, and expected ecological effects. This effort will be coordinated with those of investigations in other operable units to avoid duplication of effort and to ensure consistent data collection techniques and consistent assessment of environmental risk.

Task 6: Preliminary Contamination Characterization

Task 6 will provide a characterization of the risk to ecological receptors posed by potential exposure to OU7 contaminants and a summary of risk-related data pertaining to the site. Determinations will be made as to the magnitude of the effects of contamination on OU7 biota. The actual or potential effects of contamination on ecological endpoints (e.g., species diversity, food web structure, productivity) will also be addressed. Depending on the DQOs and the quality of data collected, the contamination characterization will be expressed qualitatively, quantitatively, or as a combination of the two. If sufficient information is available, Task 6 may also include preliminary derivation of remediation criteria. Development of these criteria will include consideration of (1) federal and Colorado laws and regulations pertaining to preservation and protection of natural resources and (2) RCRA risk-based criteria (or other criteria; see Section 3.0) for concentrations of contaminants in environmental media.

Task 7: Uncertainty Analysis

Task 7 includes identification of assumptions and evaluation of uncertainty in the environmental risk assessment analysis. Task 7 will also include identification of data needs to calibrate and validate the pathways models developed in Task 5.

Task 8: Planning

Task 8 will include planning of field sampling activities and development of additional DQOs with respect to the conduct of the ecotoxicological field investigation. Task 8 will include collection of samples for tissue analysis and any additional ecotoxicological field investigations. Samples collected in Task 3 field studies will be used when possible (e.g., when contaminants of concern have been identified and sampling protocols are in place); new samples will be collected if necessary. The need for measuring additional population endpoints (such as reproductive success and enzyme inhibition) will be evaluated on the basis of the Task 3 preliminary ecological risk assessment. DQOs to be achieved by such sampling will be defined according to EPA guidance (U.S. EPA, 1987). Scoping and design of the Task 8 field studies will be based initially on the outcome of the Task 2 preliminary risk assessment and results of Task 3 field activities. Field sampling will be performed only where acceptance criteria for demonstrating injury to a biological resource will be satisfied in accordance with regulations under the NRDA (43 CFR Subtitle 1, Section 11.62 [f]).

Task 9: Ecotoxicological Field Investigations

Task 9 will include tissue analysis studies and any additional ecotoxicological field investigations. Samples collected in Task 3 field studies will be used when possible (e.g., when COCs have been identified and sampling protocols are in place); new samples will be collected if necessary.

Task 10: Environmental Evaluation Report

Results from Task 8 will provide a final characterization of contamination in biota at OU7 and will be used in the final evaluation of ecosystem effects. Information on site environmental characteristics and contaminants, characterization of effects, remediation criteria, conclusions, uncertainty analysis, and limitations of the assessment will be summarized in the Environmental Evaluation report.

Each of the preceding tasks is described in further detail in Section 9.2. The field sampling plan presented in Section 9.3 addresses both the Task 3 ecological investigation and the Task 8 ecotoxicological field investigations.

### 9.1.2 OU7 Contamination

A summary of the contamination that could impact ecological receptors is presented in this section; data pertaining to the nature of contamination at OU7 are presented in detail in Section 2.3. The data needed to fully characterize contamination at OU7 are lacking; therefore, the more extensive data that will be collected during the surface water and soil sampling programs in this RFI/RI will aid in assessment of contamination potentially harmful to biota. Additional soil sampling locations and procedures may be required to identify the availability of nutrients and other ecologically relevant soil conditions.

Review of the 1989 Surface Water and Sediment Geochemical Characterization Report (EG&G, 1991e) indicates that several metals exceeded Rocky Flats sitewide background concentrations in surface waters at OU7 (Table 9-1). The concentrations of beryllium, copper, selenium, strontium, and zinc also exceeded ARARs for surface water and may therefore be COCs. Copper, selenium, and zinc are of particular concern, given the capacity of these metals to bioaccumulate. The inorganic parameters cyanide, nitrate, and sulfate also exceeded sitewide background and ARARs (Table 9-1). Possible radionuclide contamination in OU7 surface waters is limited to uranium isotopes detected primarilty in water samples from the groundwater intercept system (Table 9-2). Several organic compounds were also detected primarily at SW097, a seep downgradient of the landfill

## Table 9-1: Summary of Potential Metal and Inorganic Contamination of Surface Water at OU7



| Parameters | Maximum[a] Value Reported (µg/l) | Location | Site-wide Background[b] (µg/l) | Federal Standards | | | State Standards[c] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | AWQC for Protection[c] of Aquatic Life (µg/l) | | | Biological Parameters for Aquatic Life (µg/l) | | Stream Segment Standard (µg/l) | |
| | | | | Acute | Chronic | MCL[d] | Acute | Chronic | Acute | Chronic |
| Total Metals | | | | | | | | | | |
| Aluminum | 56,600 | SW-100 | 60,423 | | | 0.05 | 950 | 150 | | |
| Arsenic | 20 | SW-100 | 1,030 | 360-III | 190-III | 0.05 | | | 50 | |
| Beryllium | 54 | SW-100 | 11 | 130 | 5.3 | | | | | |
| Calcium | 418,000 | SW-100 | 43,360 | | | | | | | |
| Chromium | 51 | SW-097 | 275 | 1700-III | 210-III | 0.05 | TVS-III | TVS-III | | |
| Cobalt | 41.4 | SW-100 | 489 | | | | | | | |
| Copper | 633 | SW-100 | 607 | 18 | 12 | | TVS | TVS | TVS | TVS |
| Iron | 71,300 | SW-097 | 87,147 | | 1,000 | 0.3 | | 1,000 | | 300 |
| Lead | 127 | SW-097 | 516 | 82 | 3.2 | 0.5 | TVS | TVS | TVS | TVS |
| Lithium | 74.7 | SW-100 | 100 | | | | | | | |
| Magnesium | 83,937 | SW-100 | 8,938 | | | | | | | |
| Manganese | 1,790 | SW-097 | 1,965 | | | 0.5 | | | | 50 |
| Mercury | 0.3 | SW-100 | 1.4 | 2.4 | 0.012 | 0.002 | | | 0.01 | |
| Nickel | 48 | SW-100 | 646 | 1400 | 160 | TVS | TVS | TVS | TVS | TVS |
| Potassium | 30,700 | SW-100 | 1,020 | | | | | | | |
| Selenium | 155 | SW-100 | 25 | 260 | 36 | 0.01 | 135 | 17 | 10 | |
| Sodium | 229,000 | SW-100 | 23,100 | | | | | | | |
| Strontium | 2,290 | SW-100 | 1,460 | | | | | | | |
| Tin | 181 | SW-100 | 969 | | | | | | | |
| Zinc | 4,620 | SW-097 | 376 | 120 | 110 | 5000 | TVS | TVS | TVS | TVS |

| Parameters | Maximum[a] Value Reported (µg/l) | Location | Site-Wide Background[b] (µg/l) | Federal Standards | | | State Standards[e] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | AWQC for Protection[c] of Aquatic Life (µg/l) | | MCL[d] | Biological Parameters for Aquatic Life (µg/l) | | Stream Segment Standard (µg/l) | |
| | | | | Acute | Chronic | | Acute | Chronic | Acute | Chronic |
| Inorganics/ Anions | | | | | | | | | | |
| Cyanide | 461 | SW-100 | 45.2 | 22 | 5.2 | | 5 | 5 | 5 | 5 |
| $NO_2 + NO_3$ | 24,000 | SW-100 | DL = 20,000 | | | 10,000 | | | | 250 mg/l |
| Sulfate | 1,250K | SW-100 | 36,967 | | | | | | | |

[a] Source: Values as reported in Table 2-11 of Phase I RFI/RI Work Plan for OU7.
[b] Source: EG&G 1991d.
[c] Source: EPA 1986.
[d] Source: EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990).
[e] Source: Colorado Department of Health/Water Quality Control Commission, Classifications and Numeric Standards for S. Platte River Basin, Laramie River.

TVS = Table Value Standard
DL = Detection Limit

## Table 9-2: Summary of Potential Radionuclide Contamination of Surface Water at OU7

| Analyte | Max Value Reported[a] (pCi/l) | Location | Background[b] (pCi/l) | Federal Standards | State Stream Classification Standards[d] | |
|---|---|---|---|---|---|---|
| | | | | SDWA Maximum Contaminant Level[c] | Basin Table D Radionuclide Standards | Table 2 - Radionuclide Standard for South Walnut Creek |
| Gross Alpha | 90.3 | SW-100 | 117.43 | 15 pCi/l | | 11 pCi/l |
| Gross Beta | 144 | SW-100 | 163.20 | 4 mrem/yr | | 19 pCi/l |
| Strontium-90 | 1.02 | SW-097 | 1.61 | | 8 pCi/l[e] | |
| Plutonium-239 | 0.026 | SW-097 | 1.46 | | 15 pCi/l | 0.05 pCi/l |
| Americium-241 | 0.11 | SW-100 | 0.18 | | 30 pCi/l | 0.05 pCi/l |
| Cesium-137 | 0.22 | SW-098 | 3.93 | | | |
| Tritium | 153.0 | SW-097 | 2,022.45 | | 20,000 pCi/l | 500 pCi/l |
| Radium-226 | 46 | SW-100 | 29.25 | 5 pCi/l[f] | 5 pCi/l[f] | |
| Uranium-233+234 | 14.7 | SW-100 | 1.10 | | | 10 pCi/l |
| Uranium-235 | 0.43 | SW-100 | 0.19 | | | 10 pCi/l |
| Uranium-238 | 11.9 | SW-100 | 0.19 | | | 10 pCi/l |

[a] Source: Values as reported in Table 2-11 of Phase I RFI/RI Work Plan for OU7.
[b] Source: EG&G 1991d.
[c] Source: EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990).
[d] Source: Colorado Department of Health/Water Quality Control Commission, Classifications and Numeric Standards for S. Platte River Basin, Laramie River.
[e] Standard for strontium-90.
[f] Standard for radium-226+228.

(Tables 2-12 and 9-3). Water from this seep eventually flows into the East Landfill Pond. Sediment and surface water sampling activities associated with the field activities of this Phase I RFI/RI will provide additional information for identification of contaminants of concern for the Environmental Evaluation.

Soil analytical data at OU7 are limited to data obtained from borehole samples collected during drilling of four monitoring wells. The analyses included total metals, VOCs, and selected inorganic parameters. Only samples from 0 to 20 feet in depth are considered in this investigation because deeper contaminants are not likely to affect plant roots and burrowing animals. The results, which are based on samples composited over various depth intervals to a maximum depth of 20 feet, are presented in detail in Section 2.3.2. Based on these analyses, arsenic, lead, zinc, mercury, and copper were detected above sitewide background concentrations (Table 9-4). The organic compounds acetone, 2-butanone, methylene chloride, toluene, and xylenes were also detected in borehole samples. No radionuclides or inorganic ions were detected in borehole samples at concentrations above background.

Soils contamination can be further characterized during soil sampling to be performed as part of the overall RFI/RI effort. Areas adjacent to the East Landfill Pond that were sprayed with water from the pond may be of particular concern, as spray evaporation could have resulted in deposition of metals and other contaminants in surficial soils in these areas.

Because so few data on soil contamination exist, information on groundwater contamination was also used to assess the Present Landfill as a source of subsurface contamination (see Section 2.3.3). Groundwater contamination could lead to contamination of surface waters and indicate soil contamination. Possible groundwater contaminants of ecological concern include nitrate/nitrite, chromium, copper, zinc, trichloroethene, 1,1,1-trichlorethane, and 1,2-dichloroethene. In addition, the radionuclides americium-241, cesium-137, and uranium-233+234 exceeded background concentrations in groundwater.

# Table 9-3: Summary of Potential Organic Contaminants of Surface Water at OU7



| Analyte | Max. Value[a] Reported | Location | Background[b] Limit | Federal Standards | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | CWA AWQC for Protection of Aquatic Life[c] | | SDWA MCL[d] | CWA Water Quality Criteria for Protection of Human Health[e] | |
| | | | | Acute | Chronic | | Water and Fish | Fish Consumption Only |
| Semivolatile Organics (µg/ℓ) | | | | | | | | |
| 2,4-Dimethylphenol | 3.5 | SW097 | DL | | | | | |
| 2,4-Methylnapthalene | 12 | SW097 | DL | | | | | |
| 4-Methylphenol | 16.5 | SW097 | DL | | | | | |
| Acenapthene | 1.5 | SW097 | DL | | | | | |
| Benzoic Acid | 15.5 | SW097 | DL | | | | | |
| Benzyl Alcohol | 3.5 | SW097 | DL | | | | | |
| Bis(2-ethylhexyl)phthalate | 3 | SW097 | DL | | | | | |
| Butyl benzyl phthalate | 3 | SW097 | DL | | | | | |
| Di-n-butyl phthalate | 4.5 | SW097 | DL | | | | | |
| Diethyl phthalate | 1 | SW097 | DL | | | | | |
| Fluorene | 1 | SW097 | DL | | | | | |
| Napthalene | 1 | SW097 | DL | | | | | |
| Phenanthrene | 1 | SW100 | DL | | | | | |
| Phenol | 0.5 | SW099 | DL | | | | | |
| Volatiles (µg/ℓ) | | | | | | | | |
| 1,1-Dichloroethane | 5.36 | SW097 | DL | | | 5 µg/ℓ | | |
| 1,1-Dichloroethene | 10.9 | SW097 | DL | | | 7 µg/ℓ | | |

| Analyte | Max. Value[a] Reported | Location | Background[b] Limit | Federal Standards | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | CWA AWQC for Protection of Aquatic Life[c] | | SDWA MCL[d] | CWA Water Quality Criteria for Protection of Human Health[e] | |
| | | | | Acute | Chronic | | Water and Fish | Fish Consumption Only |
| 1,2-Dichloroethene | 2.71 | SW097 | DL | | | | | |
| 2-Butanone | 8.29 | SW097 | DL | | | | | |
| 4-Methyl-2-Pentanone | 7.71 | SW097 | DL | | | | | |
| Acetone | 16.2 | SW097 | DL | | | 50 µg/ℓ | | |
| Benzene | 13.8 | SW097 | DL | | | 5 µg/ℓ | | |
| Chlorobenzene | 15.6 | SW097 | DL | | | | | |
| Chloroethane | 9.14 | SW097 | DL | | | | | |
| Chloroethene | 4.57 | SW097 | DL | | | | | |
| Ethyl Benzene | 7.64 | SW097 | DL | | | | | |
| Methylene Chloride | 6.83 | SW097 | DL | | | 5 µg/ℓ | | |
| Tetrachloroethene | 2.29 | SW097 | DL | 5.28mg/ℓ | 840 µg/ℓ | 5 µg/ℓ | 800 ng/ℓ | 8.85 µg/ℓ |
| Toluene | 34.3 | SW097 | DL | 17.5 mg/ℓ | | 1 mg/ℓ | 14.3 ng/ℓ | 424 mg/ℓ |
| Trichloroethene | 16.2 | SW097 | DL | 45mg/ℓ | 21.9 mg/ℓ | 5 µg/ℓ | 2.7 µg/ℓ | 80.7 µg/ℓ |
| Vinyl Chloride | 4.57 | SW097 | DL | | | 2 µg/ℓ | | |

a Source: Values as reported in Table 2-11 of Phase I RFI/RI Work Plan for OU7.
b Source: EG&G 1991d.
c Source: EPA 1986.
d Source: EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990).
e Source: Colorado Department of Health/Water Quality Control Commission, Classifications and Numeric Standards for S. Platte River Basin, Laramie River.

TVS = Table Value Standard
DL = Detection Limit

## Table 9-4: Summary of Potential Soils Contamination at OU7

| Analyte | Maximum Value Reported[a] | Depth | Background[b] | Action Criteria[c] |
|---|---|---|---|---|
| Metals | | | | |
| Arsenic | 14.1 | 17.5' - 21.5' | 4.3 | -- |
| Copper | 26.9 | 16' - 19.9' | 21.5 | 400 |
| Iron | 32,500 | 17.5' - 21.5' | 13,753 | -- |
| Mercury | 1.6 | 6' - 12' | 0.32 | -- |
| Lead | 29.4 | 0' - 3' | 17.2 | -- |
| Zinc | 104 | 6' - 12' | 39.7 | 20 - 4,000 |
| Organics | | | | |
| Acetone | 990 | 15.5' - 15.7' | N/A | 8,000 |
| 2-Butanone | 330 | 15.5' - 15.7' | N/A | -- |
| Methylene Chloride | 27 | 0' - 1.2' | N/A | -- |
| Toluene | 71 | 11.5' - 13' | N/A | -- |
| Xylenes (Total) | 6 | 3.4' - 4.8' | N/A | -- |

a Source: Tables 2-7 and 2-8 of Phase I RFI/RI Work Plan.
b Source: EG&G 1991d; Values for Alluvial Borehole Samples.
c Source: EPA 1989a; Values for Human-Health Criteria divided by 100 to protect most sensitive species.

### 9.1.3 Preliminary Identification of Contaminants of Concern

COCs are chemicals that are associated with activities at a hazardous waste site, are suspected to occur in environmental media as a result of activities at the site, and have the potential to damage natural populations or ecosystems. (In this context, "chemicals" include organic compounds, inorganic compounds, and elements.) The list of COCs is used to select target analytes for testing biota and/or environmental media for contamination.

A list of COCs was generated using the criteria presented below. These criteria were developed in concert with EG&G and are presently under review by EPA. The list should be considered preliminary because of the limited amount of data available at the time this work plan was prepared. The identification of COCs was based on criteria in three general categories: documentation of occurrence of the chemical in environmental media, ecotoxicity of the chemical, and extent of contamination at the site. These criteria are discussed in more detail below.

1. Occurrence - The known or suspected occurrence of a chemical in environmental media should be gleaned from:

    - Existing data from soil, water, or air analyses
    - Waste stream identification and disposal practices
    - Process analyses to identify potentially hazardous substances used in large quantities
    - Historical accounts of accidental releases

2. Ecotoxicity - For purposes of inclusion in COCs, the ecotoxicity of a chemical was determined from its documented adverse effects on biota or potentiation

of toxic effects of other chemicals. A chemical was considered for inclusion on the list of COCs if it is known to exhibit:

- Acute and chronic toxicity, including mortality and teratogenicity; or
- Sublethal toxicity, including reduced growth rates, reduced fecundity, and behavioral effects; or
- Toxicity resulting from biocaccumulation due to absorption of the chemical directly from environmental media or ingestion of contaminated food items.

The above information will be extracted from federal or state regulatory guidelines, chemical information data bases, or scientific literature.

3. Extent of Contamination - The extent of contamination should be such that it results in significant exposure of ecological receptors. A chemical was included on the list of COCs if:

- It is present above regulatory standards or ARARs; or
- It is present above natural background concentrations; or
- It is present above risk-based "acceptable levels"; and
- It is reported in greater than 5 percent of the samples analyzed for a given area; or
- It is widely distributed; or

- It occurs in ecologically sensitive areas; or

- It occurs in localized areas of high concentration ("hot spots").

The above criteria were applied to the potential contaminants presented in Section 9.1.2 and resulted in the following list of COCs for terrestrial and aquatic sampling in this Environmental Evaluation (Table 9-5). A comparison of potential contaminant data with the selection criteria is presented for terrestrial and aquatic habitats (Table 9-6).

Depending on physical properties, contaminants may become differentially distributed among environmental media or among components within a medium. The result may be differential exposure of species or populations to the contaminant. The factors affecting distribution in environmental media include:

- Persistence - The resistance to degradation by abiotic or biotic processes

- Volatility - The tendency to volatilize, thus reducing soil or water concentration

- Mobility - The degree to which a chemical tends to migrate within or between environmental media, thus placing further resources at risk

- Solubility - The solubility in aqueous solutions, which may affect mobility in surface water and groundwater

- Differential Accumulation - The tendency to segregate into different environmental media or components of a single medium

These factors will be considered when developing a target analyte list for analyses of specific organisms, tissues, or abiotic media.

Table 9-5: Preliminary List of Contaminants of Concern for OU7 Environmental Evaluation

| | |
|---|---|
| Metals: | aluminum, arsenic, beryllium, chromium, copper, lead, mercury, nickel, selenium, zinc |
| Organics: | 1,1-dichloroethane, 1,1-dichloroethene, 2-butanone, bis(2-ethylhexyl) phthalate, tetrachloroethene, toluene, trichloroethene, vinyl chloride, xylenes |
| Radionuclides: | gross alpha, gross beta, americium-241, plutonium-239, strontium-90, uranium-233 + 234, uranium-235, uranium-238 |
| Inorganics: | cyanide, sulfate, nitrate + nitrite |

**Table 9-6: OU7 Contaminants of Concern Selection Matrix**

| Analyte | Criterion 1 - Occurrence[1] | | | | | | | Criterion 2 - Ecotoxicity[2] | | | | | Criterion 3 - Extent of Contamination[3] | | | | | | | | | | | | Summary of Criteria | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | or | b | or | c | or | d | a | or | b | or | c | a | and | b | or | c | and | d | or | e | or | f | or | g | 1 | 2 | 3 | COC |
| METALS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Aluminum | X | | | | | | | X | | X | | | X | | X | | | | X | | | | | | | X | X | X | X |
| Arsenic | X | | | | | | | X | | | | X | X | | | | | | X | | | | | | | X | X | X | X |
| Berylium | X | | | | | | | X | | | | | X | | X | | | | X | | X | | | | | X | X | X | X |
| Calcium | X | | | | | | | | | | | | | | | | | | X | | X | | | | | X | | X | |
| Chromium | X | | | | | | | X | | | | | X | | X | | | | X | | | | | | | X | X | X | X |
| Cobalt | X | | | | | | | | | | | | X | | | | | | X | | X | | | | | X | | X | |
| Copper | X | | | | | | | X | | | | X | X | | X | | | | X | | X | | | | | X | X | X | X |
| Iron | X | | | | | | | | | | | | X | | X | | | | X | | | | | | | X | | X | |
| Lead | X | | | | | | | | | | | X | X | | X | | | | X | | X | | | | | X | X | X | X |
| Lithium | X | | X | | | | | | | | | | | | | | | | X | | | | | | | X | | X | |
| Magnesium | X | | | | | | | | | | | | X | | | | | | X | | X | | | | | X | | X | |
| Manganese | X | | | | | | | | | | | | X | | | | | | X | | | | | | | X | | X | |
| Mercury | X | | | | | | | X | | | | X | X | | X | | | | X | | X | | | | | X | X | X | X |
| Nickel | X | | | | | | | X | | | | | X | | X | | | | X | | X | | | | | X | X | X | X |
| Potassium | X | | | | | | | | | | | | X | | | | | | X | | X | | | | | X | | X | |
| Selenium | X | | | | | | | X | | | | X | X | | X | | | | X | | X | | | | | X | X | X | X |
| Sodium | X | | | | | | | | | | | | X | | | | | | X | | X | | | | | X | | X | |
| Strontium | X | | | | | | | | | | | | X | | | | | | X | | X | | | | | X | | X | |
| Tin | X | | | | | | | | | | | | X | | | | | | X | | | | | | | X | | X | |
| Zinc | X | | | | | | | X | | | | | X | | X | | | | X | | X | | | | | X | X | X | X |

| Analyte | Criterion 1 - Occurrence[1] | | | | | | | Criterion 2 - Ecotoxicity[2] | | | | | Criterion 3 - Extent of Contamination[3] | | | | | | | | | | | | Summary of Criteria | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | or b | or c | or d | | | | a | or b | or c | | | a | and b | or c | and d | or e | or f | or g | | | | | | 1 | 2 | 3 | COC |
| ORGANICS | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,1-Dichloroethane | X | | | | | | | X | | | | | n/a | | | | | | | | | | | | | X | X | X | X |
| 1,1-Dichloroethene | X | | | | | | | X | | | | | n/a | | | | | | | | | | | | | X | X | X | X |
| 1,2-Dichloroethene | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| 2-Butanone | X | | | | | | | X | | | | | n/a | | | | | | | | | | | | | X | X | X | X |
| 2-Methylphenol | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| 4-methyl-2-pentanol | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Acenaphthene | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Acetone | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Benzene | X | | | | | | | X | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Benzoic acid | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Benzyl Alcohol | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Bis(2-ethylhexyl) phthalate | X | | | | | | | | | X | | | n/a | | | | | | | | | | | | | X | X | X | X |
| Butyl benzyl phthalate | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Chlorobenzene | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Chloroethene | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Di-n-butyl phthalate | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Diethyl phthalate | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Ethylbeneze | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Fluorene | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Methylene chloride | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Naphthalene | X | | | | | | | X | | X | | | n/a | | | | | X | | | | | | | | X | | X | |
| Phenanthrene | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |

| Analyte | Criterion 1 - Occurrence[1] | | | | | | | Criterion 2 - Ecotoxicity[2] | | | | | Criterion 3 - Extent of Contamination[3] | | | | | | | | | | | | Summary of Criteria | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | or | b | or | c | or | d | a | or | b | or | c | a | and | b | or | c | and | d | or | e | or | f | or | g | 1 | 2 | 3 | COC |
| Phenol | X | | | | | | | | | | | | n/a | | | | | | | | | | | | | X | | X | |
| Tetrachloroethene | X | | | | | | | X | | X | | | n/a | | | | | | X | | | | | | | X | X | X | X |
| Toluene | X | | | | | | | X | | | | | n/a | | | | | | | | | | | | | X | X | X | X |
| Trichloroethene | X | | | | | | | X | | | | | n/a | | | | | | X | | | | | | | X | X | X | X |
| Vinyl chloride | X | | | | | | | X | | | | | n/a | | | | | | X | | | | | | | X | X | X | X |
| Xylenes (total) | X | | | | | | | X | | X | | | n/a | | | | | | X | | | | | | | X | X | X | X |
| RADIONUCLIDES | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gross Alpha | X | | X | | X | | X | | | X | | | X | | X | | | | X | | X | | | | | X | X | X | X |
| Gross Beta | X | | X | | X | | X | | | X | | | X | | X | | | | X | | X | | | | | X | X | X | X |
| Americium 241 | X | | X | | | | | | | X | | | X | | X | | | | X | | X | | | | | X | X | X | X |
| Cesium-137 | X | | | | | | | | | X | | | | | | | | | | | | | | | | | X | | |
| Plutonium-239 | X | | X | | X | | X | | | X | | X | X | | X | | | | X | | X | | | | | X | X | X | X |
| Radium-226 | X | | | | | | | | | | | | X | | | | | | X | | | | | | | X | | X | |
| Strontium-90 | X | | | | | | | | | X | | X | X | | | | | | X | | X | | | | | X | X | X | X |
| Tritium | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Uranium-233+234 | X | | | | | | | | | | | | X | | | | | | X | | X | | | | | X | X | X | X |
| Uranium-235 | X | | | | | | | | | | | | X | | | | | | X | | X | | | | | X | X | X | X |
| Uranium-238 | X | | | | | | | | | | | | X | | | | | | X | | X | | | | | X | X | X | X |
| INORGANICS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cyanide | X | | | | | | | X | | X | | | X | | X | | | | X | | | | | | | X | X | X | X |
| Sulfate(+sulfide) | X | | | | | | | X | | X | | | X | | | | | | X | | | | | | | X | X | X | X |
| $NO_3+NO_2$ | X | | | | | | | | | X | | | X | | X | | | | X | | | | | | | X | X | X | X |

| Analyte | Criterion 1 - Occurrence[1] | | | | | | | Criterion 2 - Ecotoxicity[2] | | | | | Criterion 3 - Extent of Contamination[3] | | | | | | | | | | | | Summary of Criteria | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | or | b | or | c | or | d | a | or | b | or | c | a | and | b | or | c | and | d | or | e | or | f | or | g | 1 | 2 | 3 | COC |

n/a - not applicable

[1] a. Existing data
b. Waste stream characterization
c. Process analysis
d. Historical data

[2] a. Acute or chronic toxicity
b. Sublethal toxicity
c. Bioaccumulates

[3] a. Above background concentation
b. Above pertinent ARAR
c. Above risk-based level
d. Occurs in >5% of samples
e. Widely distributed
f. Occurs in ecologically sensitive area
g. Occurs in "hot spots"

### 9.1.4 Wildlife, Vegetation, and Habitats

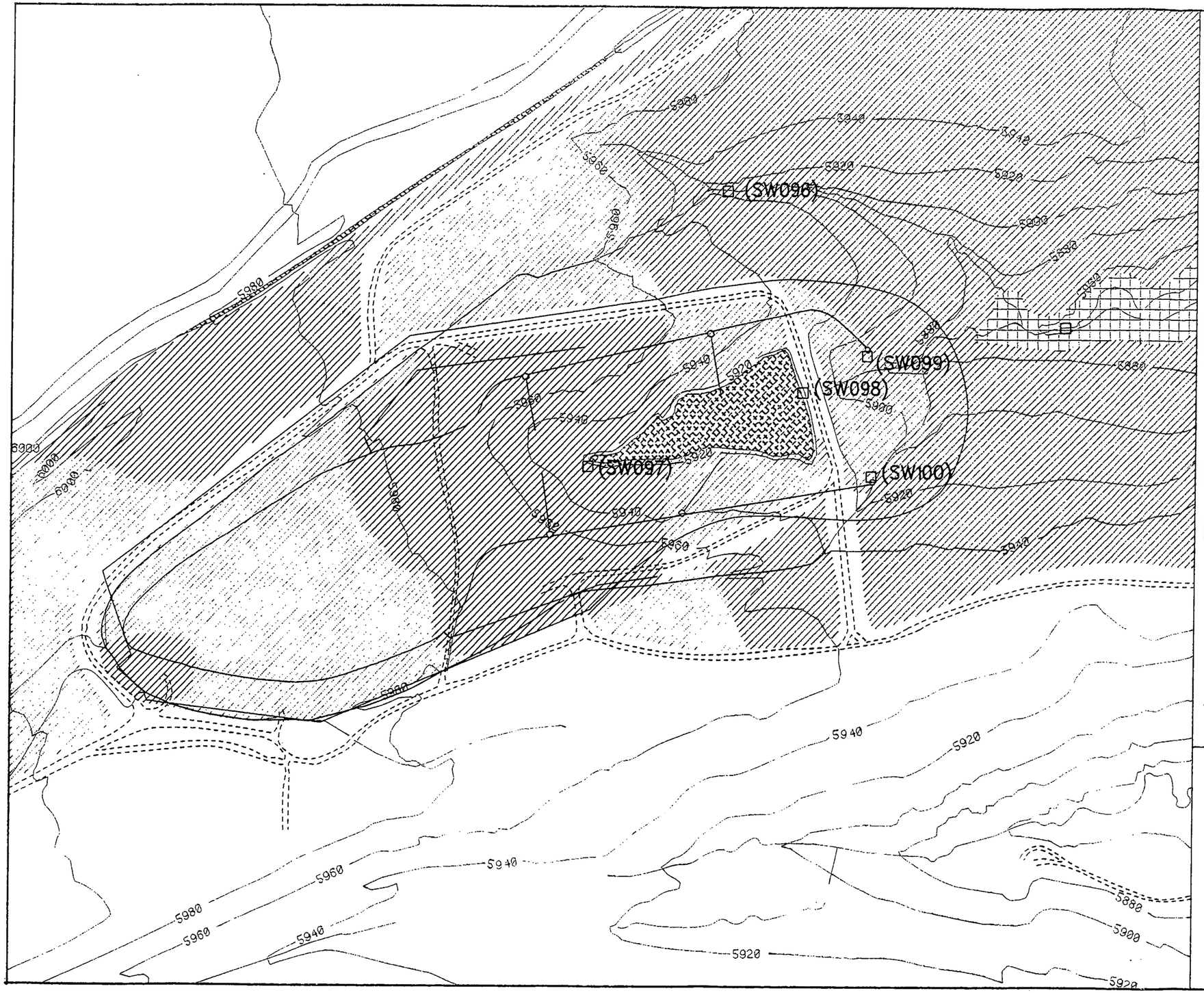
#### 9.1.4.1 OU7 Habitats

The Present Landfill is located at the upstream, eastern end of the unnamed tributary to Walnut Creek drainage. The confluence of this drainage with Walnut Creek lies approximately 2 kilometers (km) downstream. Habitats in the area were identified according to SOP 5.11 - Identifiction of Habitat Types (Figure 9-2). Habitats at OU7 include mixed upland grassland, bottomland meadow, riparian shrubland, cheatgrass/weedy forbs (disturbed areas), barren ground, and open water (landfill pond). The unnamed tributary to Walnut Creek provides intermittent stream habitat in spring and early summer. A preliminary assessment of vegetation cover and species richness was conducted in July 1991 using methods outlined in SOP 5.10 - Vegetation.

The mixed upland grassland is found on hillsides on either side of the stream bed. These habitats are dominated by Canada bluegrass and Kentucky bluegrass, with prairie junegrass, western wheatgrass, smooth brome, and needle-and-thread as minor grass components. Forbs include Louisiana sage, fringed sage, annual sunflower, purple prairie-clover, prairie cone-flower, wavyleaf thistle, musk thistle, western ragweed, crepis, alyssum, curlycup gumweed, yarrow, hedgehog cactus, prickly pear cactus, and ball cactus.

The bottomland meadow habitat type borders the intermittent stream bed. Inclusions of riparian shrubland are also located along the stream bed. These grassland habitats are dominated by western wheatgrass, Kentucky bluegrass, and prairie junegrass, with Japanese brome, Canada bluegrass, blue grama, and green needlegrass also present. Prominent forbs include Loisiana sage, yarrow, prairie goldenrod, slimflower scurfpea, and curlycup gumweed.

Areas immediately adjacent to the landfill have been highly disturbed and consist primarily of the cheatgrass/weedy forb dominated habitat type.




## EXPLANATION

- DIRT ROADS
- STREAMS, DITCHES, DRAINAGE FEATURES
- LANDFILL STRUCTURES
- OU7 REMEDIAL INVESTIGATION AREA
- BOTTOMLAND MEADOW
- MIXED UPLAND GRASSLAND
- CHEATGROSS/WEEDY FORBS
- DISTURBED AREA (BARREN GROUND)
- OPEN WATER

N

0 feet 300 600

CONTOUR INTERVAL = 20 FEET

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

# OU7 HABITATS

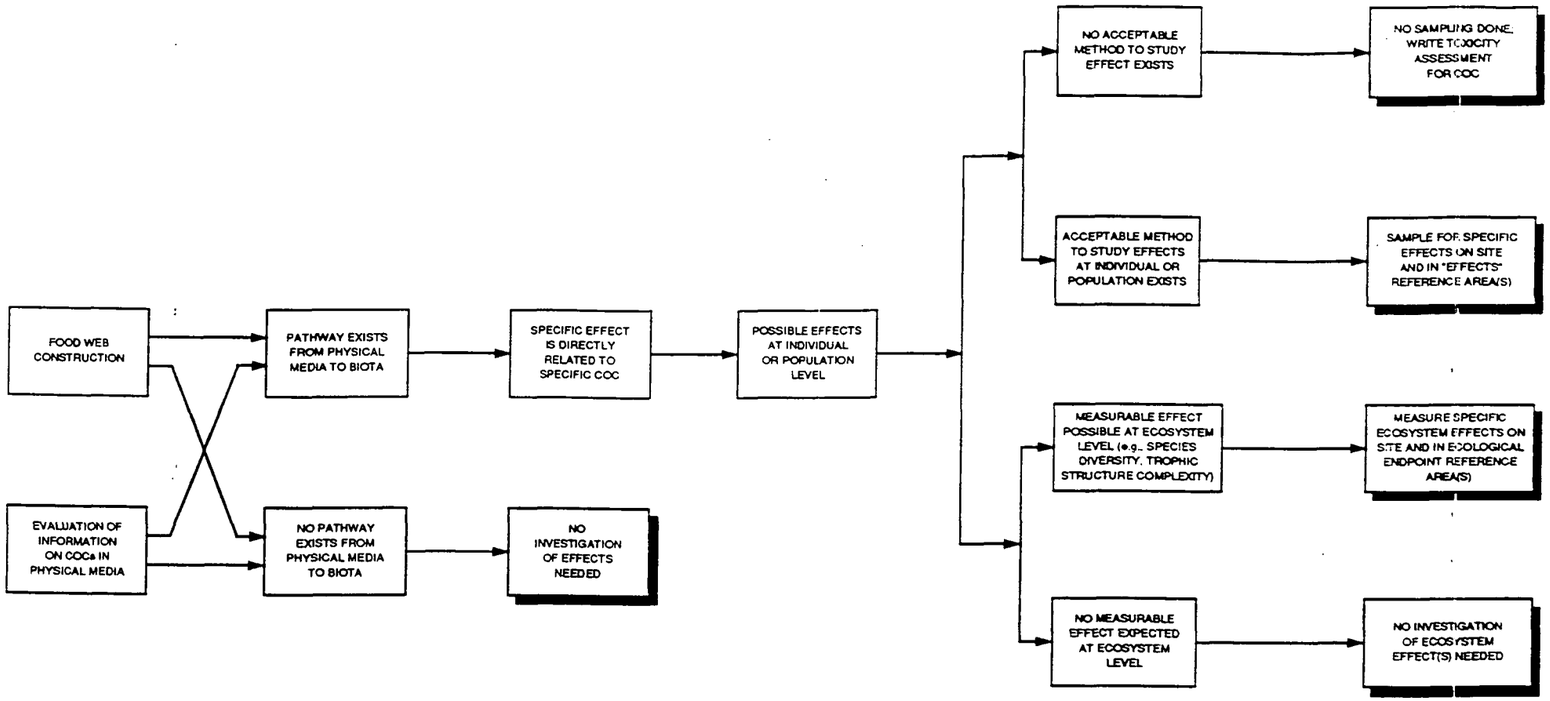
Figure 9-2

### 9.1.4.2 Protected Species and Habitats

Endangered species potentially of interest in the Rocky Flats area are the black-footed ferret, peregrine falcon, and bald eagle (EG&G, 1991m). Black-footed ferrets are not known to occur in the vicinity of RFP. Critical habitat for the black-footed ferrets consists primarily of colonies of its major food item, the prairie dog. Prairie dog colonies do not exist in the area of the Present Landfill. Bald eagles occur occasionally in the RFP area, primarily as irregular visitors during the winter or migration seasons. No roost areas or nest sites exist at RFP. Peregrine falcons may occur as migrants, and a pair has reportedly nested approximately 10 km to the northwest in 1991. It is possible that the hunting territory of the nesting peregrines will include Rocky Flats, although suitable habitat occurs closer to the nest area.

Other wildlife species of higher federal interest that are potentially present at RFP include the white-faced ibis, mountain plover, long-billed curlew, Preble's meadow jumping mouse, and swift fox (EG&G, 1991m). To-date, these species have not been documented to occur at RFP. An additional species, the ferruginous hawk, is known to occur near RFP and is likely to visit the site as a migrant or winter vagrant. Ferruginous hawks may also breed in the RFP vicinity; if so, their hunting territory could include RFP. Potential nesting sites include scattered trees and rocky ridge tops.

Four species of special concern that are potentially present include one species proposed for listing as a threatened species (Diluvium lady's tresses), one species of high federal interest (Colorado butterfly plant), and two species of concern in Colorado (forktip three-awn and toothcup). None of these species were found at RFP during a recent survey, but the forktip three-awn was reported along Woman Creek in 1973 (EG&G, 1991m). The toothcup was reported in a temporary pool approximately 6 km east of Boulder, and the Diluvium lady's tresses was reported near Clear Creek to the south of RFP and near South Boulder Creek to the north of RFP (EG&G, 1991m). The Colorado butterfly plant has not been reported near RFP, but wetlands along major creeks represent suitable habitat.




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

OPERABLE UNIT 7
PHASE I RFI/RI WORK PLAN

**DECISION PROCESS FOR THE INVESTIGATION OF INDIVIDUAL, POPULATION, AND ECOSYSTEM LEVEL EFFECTS AND FOR THE USE OF REFERENCE AREAS FOR COC EFFECTS**

Figure 9-3 August 1991

Several wetlands identified at RFP are protected under state and federal laws (EG&G, 1990c). Wetlands at RFP were identified in conjunction with the National Wetlands Inventory (1979) and field checked by U.S. Army Corp of Engineers personnel to verify their jurisdictional status. Areas officially designated as wetlands at RFP include reaches of the unnamed tributary to Walnut Creek and the East Landfill Pond. These wetlands consist of emergent, intermittently flooded stream channels and artificial, semipermanent ponds (wetlands types PEMW and POWKF, respectively; see U.S. FWS, 1981). Wetlands around the East Landfill Pond and along Walnut Creek are dominated by a narrow band of cattails, with occasional cottonwoods, willows, and other shrubs.

## 9.2 Environmental Evaluation Tasks

This Environmental Evaluation will include qualitative and quantitative appraisal of actual and/or potential injury to biota, other than humans and domesticated species, due to contamination at OU7. The Environmental Evaluation is intended to reduce the uncertainty associated with understanding the environmental effects of contaminants and remedial actions.

The following plan for OU7 provides a framework for review of existing data, the conduct of subsequent field investigations, and preparation of the contamination assessment. Methodologies for the ecological and ecotoxicological field investigations (Tasks 3 and 8) are described in the FSP presented in Section 9.3.

### 9.2.1 Task 1: Preliminary Planning

This task includes definition of the study area, determination of the scope of the Environmental Evaluation, identification of DQOs, and a plan for selecting COCs, target species, reference area, and the field sampling approach/design.

#### 9.2.1.1 Selection Criteria for Contaminants of Concern

The COCs used in this Environmental Evaluation will be selected from the larger list of suspected contaminants attributed to OU7. The preliminary list of COCs presented in Section 9.1.3 was based on criteria currently being developed by EG&G for the selection of COCs for environmental evaluations. These criteria include physical properties of the chemical, such as solubility in water, resistance to chemical or biological degradation, and tendency to bioaccumulate. Criteria also include regulatory status of the chemical and factors relating to the nature and extent of contamination. The list of COCs and target analytes may be revised pending results of soil and sediment sampling in and around the East Landfill Pond. These sampling programs are described in Section 7.0 of this work plan. The final list of COCs may include metals, organic compounds, and radionuclides. Analytes for specific tasks will be selected from the list of COCs.

The lists of COCs and target species will provide the basis for the contamination assessment (Tasks 4 through 7). In the contamination assessment, food webs and contaminant exposure pathways will be developed for OU7. Information on these food webs will be used to (1) relate quantitative data on contaminants in the abiotic environment to adverse effects on biota and (2) evaluate potential impacts on biota due to contaminant exposure.

#### 9.2.1.2 Reference Areas

Reference areas may be used to assess the impact of OU7 contaminants when available data are insufficient to do so and when appropriate reference areas are available. The decision to use reference areas and the criteria for selecting reference areas will ultimately depend on the the ecological endpoint to be measured. The decision process for using reference areas is presented in Figure 9-3. Reference areas will be selected according to criteria in SOP 5.13 - Development of Field Sampling Plans. Reference areas for terrestrial sites will be selected on the basis of habitat type (see SOP 5.11 - Identification of Habitat Types), soil series, topography, and aspect. Reference areas for aquatic sites will be selected on the basis of substrate type, flow regime, depth, current, and bank characteristics. Reference

areas for tissue sampling will be located upgradient or upwind of potential contaminant sources at RFP.

9.2.1.3 Data Quality Objectives

Preliminary DQOs for Task 3 activities were developed according to the process prescribed by EPA (U.S. EPA, 1987). DQOs for Task 9 field activities will also be developed using this process. The DQO development process as recommended by EPA includes three stages:

- Stage 1 - Identify decision types.
  The decisions for which the data will be used are defined. Available data and a conceptual model for the study area will be developed so that specific objectives can be formulated.

- Stage 2 - Identify data uses and needs.
  The specific uses and types of data needed to meet specific objectives are defined. The quality and quantity of the required data, including resolution and sample size, are estimated.

- Stage 3 - Design data collection program.
  The methods by which data are to be collected should be outlined and documented. QA/QC methods should be developed and documented.

Existing environmental data and the site conceptual model presented in Section 2.0 were used to assess potential exposure points and pathways, and general objectives of the sampling program were identified. Based on the types of data needed to address the objectives, sampling locations and methods were preliminarily identified. Final details of the the field program defined in the FSP (Section 9.3) will be defined during prior to the

beginning of fieldwork. At that time, the contractor will verify that sampling locations and methods are appropriate for existing conditions.

#### 9.2.1.4 Field Sampling Approach/Design

The FSP (presented in Section 9.3) helps to ensure that data and sample collection is consistent with the information objectives and DQOs developed for the Environmental Evaluation. The FSP is designed to be flexible so that preliminary data and information can be used to modify and refine subsequent sampling efforts. Data and sample collection methods will be consistent with the Ecology SOPs (Volume V), and overall sample design will be consistent among tasks. Therefore, results from preliminary sampling in Task 3 will be compatible with results from subsequent sampling in Task 9.

### 9.2.2 Task 2: Data Collection/Evaluation and Preliminary Risk Assessment

Task 2 of the Environmental Evaluation will focus on accumulating and analyzing pertinent information in three major areas:

1. Species, populations, and food web interrelationships

2. Types, distribution, and concentrations of contaminants in the abiotic environment (e.g., soil, surface water, groundwater, and air)

3. Preliminary determination of potential exposure pathways and potential contaminant effects on OU7 biota, based on literature review

The principal subtasks in Task 2 include literature review and site characterization. These subtasks will be performed in conjunction with the Task 3 ecological field investigation. Information that will be developed from these tasks includes the following:

- COCs - Existing information regarding the nature and extent of contamination at OU7 will be reviewed and used to develop a preliminary list of COCs. Selection of COCs will follow criteria established by EG&G.

- Surface Water and Sediment Toxicity - OU7 surface water and sediments will be tested for toxicity using approved standard tests and test organisms. At least two species will be used to test surface water toxicity, and one species will be used to test sediment toxicity.

- Descriptive Field Surveys - Inventory of OU7 biota and locations of obvious zones of chemical contamination, ecological effects, and human disturbance.

- Species Inventory - Plant and animal species known to occur within OU7 or to potentially contact contaminants at OU7 and their trophic relationships.

- Population Characteristics - General information on the composition of ecologically functional groups and the abundance of key species in those groups.

- Food Habit Studies - Available information from literature sources to supplement field observations and possible gut content analysis on key species.

#### 9.2.2.1 Literature Review

An essential component of Task 2 is the review of available documents, aerial photographs, and relevant data. This review will allow compilation of a data base from which to determine data gaps and will provide the basis for developing the field sampling program. Studies conducted by DOE and RFP operating contractors will be reviewed and evaluated. Information to be reviewed will include the following:

- Project files maintained by Rockwell International and EG&G
- Project reports and documents on file at Front Range Community College Library and the Colorado Department of Health
- DOE documents and DOE orders
- Phase I data base
- Rocky Flats EIS data base
- Data from ongoing environmental monitoring, environmental evaluations from other operable units, baseline vegetation and wildlife studies, and NPDES programs
- Studies conducted at Rocky Flats on radionuclide uptake, retention, and effects on plant and animal populations
- Scientific literature, including ecological and risk assessment reports from other DOE facilities (Oak Ridge, Los Alamos, Hanford, Savannah River, and Fernald national laboratories)

If available and applicable, historical data will be used. Where the same methods are not used in collection of new data, use of historical data will depend on the demonstrated comparability of the data collection methods.

#### 9.2.2.2 Site Characterization

Environmental resources at the site will be characterized on the basis of reviews of existing literature and reports, including results from the Phase I RFI/RI, other operable unit

RFI/RIs, and the Task 3 ecological field investigation. The description of the site will be presented in terms of the following distinct resource areas:

- Meteorology/Air Quality
- Soils
- Geology
- Surface and Groundwater Hydrology
- Terrestrial Ecology
- Aquatic Ecology
- Protected/Sensitive Species and Habitats

The purpose of the site characterization is to describe resource conditions as they exist without remediation. The narrative with supporting data will include descriptions of each resource, with appropriate tables and figures to clearly and concisely depict site conditions, particularly as they influence contaminant fate and transport and the likelihood that the contaminants will adversely affect the ecosystem.

Included in this task is development of a preliminary community food web model to describe the trophic relationships among organisms at RFP. Food web construction begins with gathering information to evaluate the food habits of species (e.g., grasshoppers) found or potentially occurring at the site. Standard computer searches will be augmented with searches in local university libraries to locate any regionally pertinent studies on food habits. Experts from local universities and other institutions will also be consulted where appropriate. The preliminary list of important species, compiled from background

information, will be completed on the basis of observations of the presence and abundance of species during ecological site surveys and on trophic-level data obtained from the food web model. Based on the model, a modified list of species will be compiled using toxicological information (toxicity assessment) to determine which species or species groups might be most affected by or most sensitive to the contaminant(s) of concern.

Data from past studies and preliminary data from current environmental studies will be used to better define the present distribution of contaminants from the abiotic environment and to develop an initial food web model. The food web model will be used in conjunction with a preliminary pathways analysis to identify likely or presumed exposure pathways or combinations of pathways and receptor species at risk. Based on this preliminary information, the Task 3 and Task 9 field investigation sampling approach/designs may be revised.

### 9.2.3 Task 3: Ecological Field Investigation

The Phase I field investigation for OU7 consists of the following separate programs: (1) the air program, which will entail emissions estimation and modeling; (2) the soils, surface water, and groundwater programs, which will be conducted as part of the Phase I RFI/RI activities; and (3) the terrestrial and aquatic biota sampling program, which will be conducted as part of this Environmental Evaluation.

#### 9.2.3.1 Air Quality

A sitewide air quality monitoring program is being conducted at Rocky Flats, and the data may be used to model airborne transport of contaminants to potential receptors. Where the inhalation pathway is considered to be significant in the case of OU7 biota, a detailed pathways analysis and assessment of potential adverse effects using these transport model data will be performed.

9.2.3.2 Soils

Few data exist on contaminants present in surficial materials at OU7. Groundwater monitoring wells have been installed at several location within the IHSSs. Soil samples from various depths in these wells were analyzed, but the samples were collected from depths other than those relevant for ecological purposes.

The purpose of the Phase I RFI/RI sampling and analysis program is to provide data for characterizing the IHSSs and for confirming the presence or absence of contamination. The Phase I RFI/RI Work Plan proposes collection of soil samples from each of the IHSSs in the Present Landfill. The soil sampling and analysis program is presented in Section 7.0 of this work plan. In addition, soil analyses will be conducted in the field and laboratory to confirm and clarify Soil Conservation Service descriptions and classifications and available nutrient status. This information will be used to evaluate the suitability of the soils for plant growth and to assist in the selection of suitable reference areas.

Surficial soil samples will be of prime importance for determining source contaminants for biota. This uppermost layer is a major source of nutrients and contaminant uptake for the vegetation under study and is also a potential source of contaminant ingestion to wildlife. Soil samples from all depths are related to surface water and groundwater regimes. Fluids moving through the soils can leach contaminants, transport them through available flow paths, and deposit them in downgradient environments. Contamination in soil and groundwater at a depth of greater that 20 feet (maximum depth of burrowing animals and plant root penetration) will not be considered to affect biota. Contamination at these depths may be considered if other RFI/RI studies (e.g., groundwater studies) suggest that the contaminants may reach the surface.

The sampling and analysis programs under the Phase I RFI/RI field investigations will be reviewed and modified as necessary to ensure that sampling intervals and methods are appropriate for collection of surficial soil samples in the required locations. Data from the

Phase I OU6 RFI/RI program will also be evaluated for use in characterizing the nature and areal extent of surface soil contamination in the vicinity of OU7. The information will be used to help identify exposure pathways for the contamination assessment.

#### 9.2.3.3 Surface Water and Sediments

Surface water and sediment samples are collected on a regular basis as part of ongoing sitewide investigations. These investigations will continue. This Phase I RFI/RI Work Plan proposes additional sampling in the East Landfill Pond, the unnamed tributary to Walnut Creek, and the groundwater intercept system. In addition, samples will be collected upstream of RFP to provide background data. Samples will be analyzed for metals, radionuclides, inorganics, and organics. Total organic carbon will also be determined in the sediment analyses.

#### 9.2.3.4 Groundwater

Groundwater leachate from the landfill flows into the East Landfill Pond. Zinc and several organic compounds have been detected in this leachate at SW097 (see Table 2-12). Groundwater from 32 existing groundwater monitoring wells and 15 wells to be installed in the course of this RFI/RI will be sampled quarterly (see Section 7.0 for well locations).

#### 9.2.3.5 Terrestrial and Aquatic Biota

Terrestrial and aquatic species in the RFP area have been described by several researchers (Quick, 1964; Weber et al., 1974; Winsor, 1975; Clark, 1977; Clark et al., 1980; CDOW, 1981; CDOW, 1982a, 1982b); most of these reports are summarized in the Final EIS (U.S. DOE, 1980). In addition, terrestrial and aquatic radioecology studies conducted by Colorado State University and DOE (Johnson et al., 1974; Little, 1976; Hiatt, 1977; Paine, 1980; Rockwell International, 1986) along with annual monitoring programs at RFP have provided information on plants and animals in the area and their relative distribution. More

recent data on species distribution and abundance can be obtained from the Baseline Vegetation and Wildlife studies and environmental evaluations under way at OUs 1, 2, and 5. These studies are scheduled for completion in FY92 and FY93.

Field surveys will be conducted during Task 3 to characterize current biological site conditions in terms of species composition, habitat characteristics, and/or community organization. Methods identified and described in the Ecology SOPs (Volume V) (EG&G, 1991m) will be used in collecting biological data and samples. The emphasis will be to describe the structure of the biological communities at OU7 in order to identify potential contaminant pathways, biotic receptors, and target species.

Initial toxicity tests using *Ceriodaphnia spp.*, fathead minnows, and *Hyallela spp.* will be conducted for OU7 surface water and sediments under Task 3. Standardized EPA acute and chronic test methods will be followed in accordance with NPDES toxicity testing procedures currently in use at Rocky Flats.

Vegetation

The objectives of the vegetation sampling program are to provide data for (1) description of site vegetation characteristics, (2) determination of impacts to plant communities, (3) identification of potential exposure pathways from contaminant releases to higher trophic-level receptors, (4) selection of key species for contaminant analysis to determine background conditions for OU7, and (5) identification of any protected vegetation species or habitats.

Wetlands Vegetation

Wetlands have been identified around the East Landfill Pond, along Walnut Creek, and along the unnamed tributary to Walnut Creek (EG&G, 1990c). These occur mostly as linear wetlands that support hydrophytic vegetation species, including sandbar willow (*Salix*

*exigua*), american watercress (*Barbarea orthoceras*), plains cottonwood (*Populus sargentii*), broad-leaf cattail (*Typha latifolia*), baltic rush (*Juncus articus*), cordgrass (*Spartina pectinata*), silver sedge (*Carex pregracilis*), and various bulrushes (*Scirpus spp.*). Transects will be established in wetlands vegetation habitats along the wetlands areas for collection of phytosociological data on density and species composition.

Periphyton

Periphyton is a group of small aquatic organisms that adheres to submerged surfaces, forming mat-like communities on rocks or other objects. Periphyton is composed of algae, bacteria, fungi, protozoans, and other micro- and macroscopic organisms. Because of their high turnover rate, periphyton communities are sensitive to changes in the aquatic habitat, such as introduction of contaminants. Further, it is known that the tolerance for different kinds of contaminants varies among components of the periphyton community. Therefore, absence or abundance of some species or divisions may be indicative of contamination.

The structure of the periphyton community will be assessed through analysis of composition and relative abundance of species present. Samples for these analyses will be obtained from natural and artificial substrates. Production in the community will be assessed by determining algal density and chlorophyll *a* content (standing crop) from measured areas on artificial substrates. Periphyton will be collected from the East Landfill Pond, Walnut Creek and its unnamed tributary, and, if available, appropriate reference areas.

Benthic Macroinvertebrates

The benthic macroinvertebrate community includes macroscopic aquatic animals that live on or near the stream or pond bottom. This group includes relatively stationary organisms that occupy several trophic levels and exhibit many different feeding mechanisms. The structure of this community can be a good indicator of overall stream health and distribution of contaminants within a stream. Benthic macroinvertebrates will be sampled for

community structure and tissue analysis in Walnut Creek and its unnamed tributary and from the East Landfill Pond.

Fish

Fish can be important components of ecological assessments because they are relatively long-lived, occupy upper trophic levels of aquatic ecosystems, and may spend their entire lives in relatively small areas. OU7 surface waters will be inventoried for fish species composition, and fish will be collected for tissue analysis.

Terrestrial Wildlife

A field survey will be conducted to collect data on terrestrial wildlife in OU7 and potentially affected areas. The objectives of this survey are to (1) describe the existing wildlife habitats in the OU7 area; (2) develop food web models, including contribution from vegetation; (3) identify potential contaminant pathways through trophic levels; (4) identify target species for collection and tissue analysis; and (5) identify protected species.

The field survey will document the presence of terrestrial species and allow for a general description of the community. Some species (e.g., songbirds, larger mammals, reptiles, and raptors) may use the area daily, seasonally, or sporadically. The field survey will consider the use of OU7 habitats by these species.

### 9.2.4 Contamination Assessment (Tasks 4 through 7)

The contamination assessment includes Tasks 4 through 7. The two primary objectives of the contamination assessment are to (1) obtain quantitative information on the types, concentration, and distribution of contaminants in selected species and (2) evaluate the effects of contamination in the abiotic environment on ecological systems.

Contamination assessment requires an evaluation of chemical and radiological exposures and the actual or potential toxicological effects on target species. Specifically, the assessment should identify exposure points, contaminant concentrations at those points, and potential impacts or injury.

The contamination assessment for OU7 will be based on existing environmental criteria, published toxicological literature, and existing site-specific data. The program design will be integrated with other ongoing RFI/RI studies so that concentrations of contaminants in abiotic media can be related to biota exposures. Task 2 will include a preliminary contamination assessment based on the site characterization and identification of COCs. The preliminary Task 2 assessment will be used to revise the Task 9 ecotoxicological field investigation sampling design. The contamination assessment process described in the following tasks will include development of a site-specific pathways model to assess the potential for contaminant exposure to and adverse effects on biota. The objectives and description of work for each of the contamination assessments tasks are presented below.

### 9.2.5 Task 4: Toxicity Assessment

This assessment will include a summary of potential adverse effects on biota associated with exposure to OU7 contaminants, comparison of estimated exposure concentrations relative to published RfDs or concentrations at which toxic effects are known, and an uncertainty analysis of the above for this site. Potential health effects on ecological receptors will then be characterized using EPA critical toxicity values (when available) in addition to selected literature pertaining to site- and receptor-specific parameters. The toxicity assessment will include brief toxicological profiles for COCs. The profiles will cover the major health effects information available for each COC. Data pertaining to wildlife species will be emphasized, and information on domestic or laboratory animals will be used when wildlife data are unavailable.

### 9.2.6 Task 5: Exposure Assessment and Pathways Model

The objective of this task is to assess the physical and biological exposure pathways of the contaminants. Each pathway will be described in terms of the chemical(s), media, and potential receptors involved. The exposure assessment process will include the following three subtasks: (1) identification of exposure pathways, (2) determination of exposure points and concentrations, and (3) estimation of chemical intake for receptors. Each of these subtasks is described below.

### 9.2.6.1 Exposure Pathways

The purpose of this subtask is to qualitatively identify the actual or potential pathways by which various biological receptors at or near OU7 might be exposed to site-related chemicals or radionuclides. The exposure pathways analysis will address the following five elements:

1. Chemical/radionuclide source

2. Mechanism of release to the environment

3. Environmental transport medium (e.g., soil, water, air) for the released chemical/radionuclide

4. Point of potential biological contact (exposure point) with the contaminated medium

5. Biological uptake mechanism at the point of exposure

All five elements must be present for an exposure pathway to be complete. Exposure pathways will be modeled, and the models will be evaluated using toxicity tests and actual contaminant concentrations. These results will be used to evaluate the need for additional ecotoxicological investigations in Task 8.

### 9.2.6.2 Determination of Exposure Points and Concentrations

Exposure points are locations where receptor species may contact COCs. Preliminary identification of exposure points will result from the pathways modeling described above. Fate and transport modeling will then be used to assess exposures for target species. A preliminary characterization of the nature and extent of contamination in abiotic media (air, soils, surface water, and groundwater) is presented in Section 2.0 of this work plan. Phase I data, where available, will be summarized and used in characterizing source areas and release characteristics at the site. The exact exposure points can be expected to vary, depending on both the contaminant and the target species under consideration. The exposure assessment will provide information on the following:

- Major routes of exposure
- Organisms that are actually or potentially exposed to contaminants from OU7
- Concentrations of each contaminant to which organisms are actually or potentially exposed
- Frequency and duration of exposure
- Seasonal and climatic variations in conditions that may affect exposure
- Site-specific geophysical, physical, and chemical conditions that may affect exposure

This approach can provide the potential maximum concentrations of chemicals at the exposure points and allow evaluation of the "worst-case" scenario.

### 9.2.6.3 Estimation of Chemical Intake by Target Species

This step includes evaluation of the routes of contaminant uptake by target species. Potential mechanisms of uptake include direct routes (such as inhalation, ingestion of contaminated media, or dermal contact) and indirect routes (such as ingestion of prey species that have been contaminated). The metabolic fate of a contaminant is also important in determining ultimate exposures. Contaminants that tend to bioaccumulate can result in exposure concentrations greater than those from the environmental media alone. Exposures will be evaluated according to published bioconcentration factors (BCFs) and site-specific data when available. The amounts of chemical and radiological uptake will be estimated using site-specific analytical data and forthcoming guidance from EPA's *Wildlife Exposure Factors Handbook* (to be published in 1991). A pathways model will be used to establish relationships between contaminant concentrations in different media and concentrations known to cause adverse effects.

Direct measurement of contaminant loads will then be conducted in tissue analysis activities in Task 8. These data will be used to assess uncertainty in the pathways model and thus aid in the interpretation of the overall study.

### 9.2.7 Task 6: Contamination Characterization

Contamination characterization entails integration of exposure concentrations and reasonable worst-case assumptions with the information developed during the exposure and toxicity assessments to characterize current and potential adverse biological effects (e.g., death, diminished reproductive success, reduced population levels) posed by OU7 contaminants. The potential impacts from all exposure routes (inhalation, ingestion, and dermal contact) and all media (air, soil, groundwater, and surface water/sediment) will be included in this evaluation, as appropriate, according to EPA guidance (U.S. EPA, 1989f).

Characterization of adverse effects on receptor species and populations is generally more qualitative than characterizaton of human health risks because the toxic effects of most chemicals, and their environmental fates and interactions, have not been well characterized.

Criteria that are suitable and applicable for evaluation of ecological effects are generally limited. EPA Ambient Water Quality Criteria (AWQC) and Maximum Allowable Tissue Concentrations (MATC) are the most readily available criteria. Criteria set forth in federal and Colorado state laws and regulations pertaining to preservation and protection of natural resources can also be used where available. Criteria may also be derived from information developed for use under other environmental statutes, such as the Toxic Substances Control Act or the Federal Insecticide, Fungicide, and Rodenticide Act. In accordance with EPA guidance (1989d, 1989e), priority will be placed on the adverse effects of chemicals at the ecosystem, habitat, and population levels rather than effects on individual organsims. Where specific information is available in published literature, a more quantitative evaluation of effects will be made using the site-specific pathways model. This approach is in agreement with EPA guidance (U.S. EPA, 1989c).

### 9.2.8 Task 7: Uncertainty Analysis

The process of assessing ecological effects is one of estimation under conditions of uncertainty. To address uncertainties, the OU7 Environmental Evaluation present each conclusion, along with the issues that support and fail to support the conclusion, and the uncertainty accompanying the conclusion. Factors that limit or prevent development of definitive conclusions will also be discussed. In summarizing the assessment data, the following sources of uncertainty and limitations will be specified:

- Variance estimates for all statistics
- Assumptions and the range of conditions underlying use of statistics and models
- Narrative explanations of other sources of potential error

Validation and calibration of the pathways model will also be used where practicable.

### 9.2.9 Task 8: Planning

Task 8 will include planning for tissue analysis studies and any additional ecotoxicological studies needed to assess the adverse effects of COCs on receptor species. Initial planning for the Task 8 field investigations will begin after COCs and target species have been selected in Task 2. Planning in Task 8 will consider new data generated during other activities of this Phase I RFI/RI. Such data may reveal previously unknown contaminants or the need for additional soil or sediment sampling to complement sampling performed in association with other RFI/RI activities. For example, additional sampling may be required to determine levels of a target analyte in soils at reference areas in which vegetation is to be sampled for tissue analysis. Methods for any additional sampling will be consistent with those used in other Phase I RFI/RI activities.

The need for measuring additional ecotoxicological endpoints in Task 8 will be evaluated on the basis of the pathways analyses and published information on direct toxic effects. Data from Task 3 and abiotic sampling programs may also reveal the need for further ecological testing. For example, results of the surficial soil sampling in and around the East Landfill Pond may indicate the need for assessment of soil microbial function in areas of depauperate vegetation.

Selection of field methodologies will be based on a review of available scientific literature providing quantitative data for the species of concern or similar test species. Analysis of population, habitat, or ecosystem changes will be based on species or habitats that represent broad components of the ecosystem or that are especially sensitive to the contaminant(s). In order to select methodologies for the ecotoxicological field sampling program, the biological response under consideration and the proposed methodology should satisfy program DQOs as well as the following more specific criteria:

- The methodology and measurement endpoint must be appropriate to the exposure pathway.

- The endpoint response to the contaminant is well defined, easily identifiable, and predictable.

- The contaminant is known to cause the biological response in laboratory experiments or experiments with free-ranging organisms.

- The available sample size is large enough to make the measurement useful.

Tissue analyses will be conducted for selected aquatic and terrestrial species from OU7 and reference areas. Acute and chronic aquatic toxicity tests using fathead minnows, *Ceriodaphnia spp.*, and *Hyallela spp.* are proposed for Task 3 (see Section 9.3.5). These screening tests will provide preliminary assessment of OU7 surface waters. If toxicity is observed in either the acute or chronic tests at any one station, subsequent toxicity testing may be designed to determine the cause of the toxicity and the source of the toxicant(s).

Prior to conducting Task 8 studies, the FSP will be refined to address the proposed methodologies. More specific DQOs will be formulated on the basis of the proposed methodologies and will address the following:

- Number and types of analyses
- Species, locations, and tissues to be sampled
- Number of samples collected
- Detection limits for contaminants
- Acceptable margin of error in analyzing results

The Task 9 ecotoxicological field investigation will consist primarily of collection of samples for tissue analysis. Analysis of tissue contaminant concentrations will provide data for evaluation of the relationship between environmental concentrations and contaminant loads predicted by pathway and food web models.

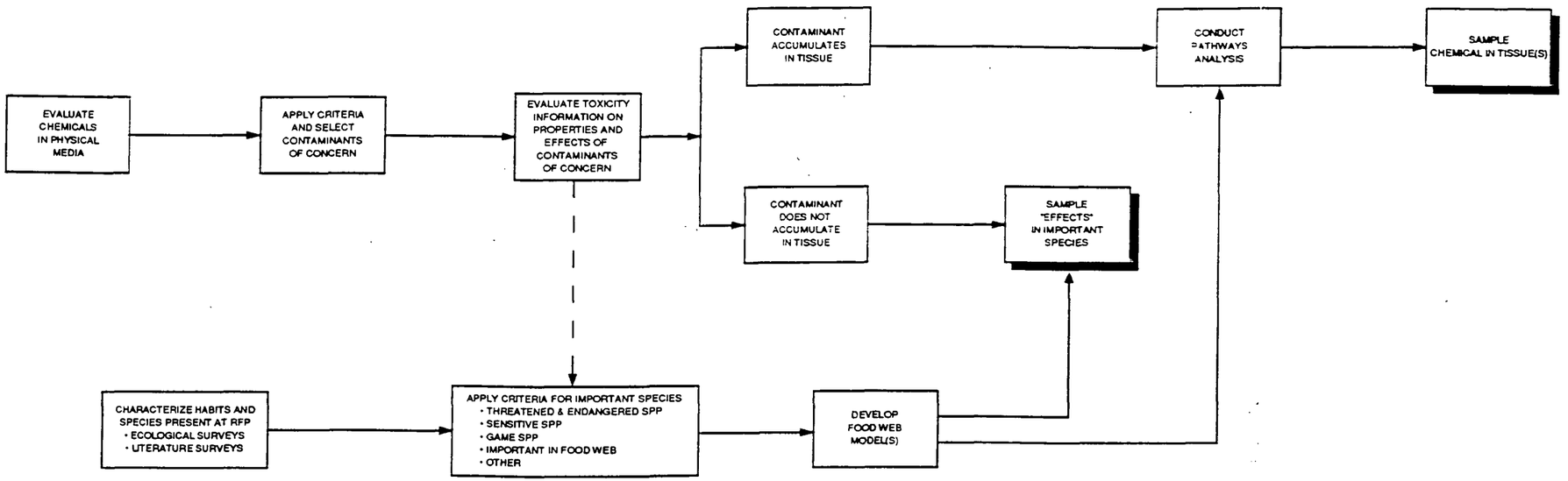
Selection of the species and specific tissues for analysis will be based on a preliminary evaluation of site-specific food webs, potential contaminant transport pathways, and the potential for accumulation in specific organs or tissues. The decision process for conducting tissue analyses is presented in Figure 9-4. Tissue sampling will be conducted for only the COCs that bioaccumulate. Whole-body burdens or individual tissues may be analyzed, depending on which portions are consumed by organisms in higher trophic levels. Suitability of a species for tissue sampling will depend on its position in the food web and its abundance at the site.

To the extent possible, tissue samples will be collected simultaneously with environmental media samples collected during other Phase I RFI/RI sampling activities. This will allow for determination of site-specific BCFs, which will then be incorporated into the exposure assessment for use in calibrating/validating the pathways model. Where BCFs cannot be determined, published or predicted BCF values will be used in the pathways model to assess potential impacts.

Where ARARs (i.e., acceptable levels in receptor species or prey species) are established, tissue sampling must be conducted only at the study area and not in reference areas. Where no pertinent ARARs exist, tissue sampling will include suitable reference areas. The decision process for the use of reference areas in tissue sampling is illustrated in Figure 9-5. Use of statistical tests will be consistent with DQOs and quality assurance provisions of the QAPjP.

Additional ecotoxicological studies indicated from results of Tasks 4 and 5 may include in-situ (in-field) toxicity testing and/or further laboratory toxicity testing. These tests can be used to isolate specific contaminants or sources. Selection of a particular methodology is generally based on the capability of the method to demonstrate a measurable biological response to the selected contaminant(s) of concern.

### 9.2.10 Task 9: Ecotoxicological Field Investigation

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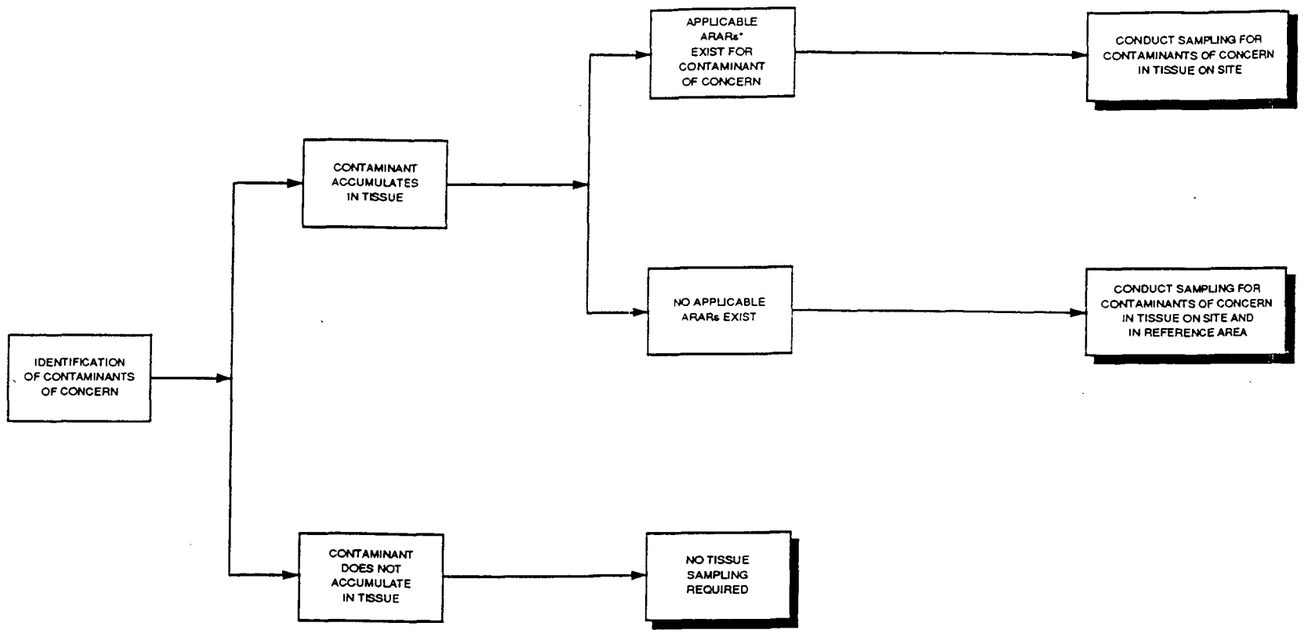
OPERABLE UNIT 7
PHASE I RFI/RI WORK PLAN

**DECISION PROCESS FOR CHEMICAL SAMPLING OF TISSUES**

Figure 9-4 August 1991




* ARARs MAY NOT BE APPLICABLE IF THEY ARE BASED ON SPECIES THAT DO NOT EXIST ON SITE (e.g., TROUT), ARE BASED ON BIOTA PATHWAYS TO HUMANS, OR IF THEY ARE BELOW BACKGROUND FOR THE REGION (e.g., SOME METALS).

**U.S. DEPARTMENT OF ENERGY**
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OPERABLE UNIT 7
PHASE I RFI/RI WORK PLAN

**DECISION PROCESS ON USE OF REFERENCE AREAS FOR CONTAMINANTS IN TISSUE**

Figure 9-5 August 1991

The revised FSP developed in Task 8 will be executed in Task 9. SOPs and analytical protocols will be closely adhered to. Reference areas will be sampled in parallel to study areas to help ensure comparability of data. Results of Task 9 activities may be used to revise contamination assessment and pathways models. Further sampling will be performed if necessary.

### 9.2.11 Task 10: Environmental Evaluation Report

Task 10 will include the summary of information and production of an environmental evaluation report as part of the RFI/RI report. The Environmental Evaluation Report will be prepared in a clear and concise manner to present study results and interpretation. All relevant data from the Environmental Evaluation, in addition to relevant Phase I RFI/RI data, will be integrated and evaluated in the characterization of potential environmental impacts. The following topics will be covered in the report:

- Objectives
- Scope of Investigation
- Site Description
- Contaminants of Concern and Target Species
- Contaminant Sources and Releases
- Exposure Characterization
- Impact Characterization
- Remediation Criteria

- Conclusions and Limitations

#### 9.2.11.1 Remediation Criteria

Remediation criteria protective of Rocky Flats biota will be developed in Task 9 on the basis of the results of the food web analyses, pathways model, and exposure assessments. Remediation criteria will be developed for contaminants for which a significant ecological impact is detected or for which that risk exists. Criteria will address remediation of the contaminant source so that remaining environmental concentrations do not pose a threat to key ecological receptors. "Acceptable" environmental concentrations will be estimated using exposure assessments to calculate contaminant concentrations in abiotic media below which the ecotoxicological effect does not occur. The acceptable (no effects) criteria levels will be used in conjunction with ARARs to evaluate potential adverse effects on biota as appropriate for the Environmental Evaluation portion of the Phase I RFI/RI. This approach will be integrated with the Baseline Human Health Risk Assessment process and will assist in development of potential remediation criteria.

## 9.3 Field Sampling Plan

Field sampling activities will be conducted in Task 3 and Task 8 of the Environmental Evaluation. Task 3 field sampling will include the following:

- Confirmation of habitats and vegetation mapping units involved at OU7
- Verification of reference area selections
- Characterization of biota present at OU7 (and reference areas, if appropriate)
- Initial aquatic toxicity testing

Planning for the Task 8 and 9 tissue analysis program will begin in Task 2 so that samples collected in the Task 3 field inventory can be used wherever possible (i.e., where COCs have been defined and field sampling protocols have been developed). Final determination of the need for additional ecotoxicological studies (e.g., reproductive success, population studies, or enzyme analyses) will be made after completion of the contamination assessment.

The following FSP is provisional and will be periodically revised as appropriate. The Task 3 sampling plan is largely complete but may be modified in order to better coordinate with the surface water and soil sampling programs for the OU7 RFI/RI or other operable units. The Task 8 FSP will be designed in greater detail after identification of COCs and target species, preliminary determination of food webs, and contamination source-receptor pathways. In addition, results of Task 8 planning may include plans for additional soil or sediment sampling in study or reference areas. Determination of this need will follow from results of the soil and sediment sampling described in Section 7.0. This FSP was prepared in accordance with SOP 5.13 - Development of Field Sampling Plans. All ecological data and sample collection should follow the procedures provided in the Ecology SOP (Volume V) (EG&G, 1991m).

Study Site Detail.

OU7 comprises IHSSs 114 and 203 as well as the surrounding areas. Preliminary data indicate that landfill operations may have led to contamination of soils and surface water around the landfill. Leachate from the landfill flows into the East Landfill Pond at SW097 and into the Walnut Creek drainage at SW099 and SW100. In addition, water from the pond was sprayed on the banks surrounding the pond. Surface water and leachate contains elevated levels of metals, organics, and radionuclides, and elevated metals and organics have been detected in soils. (See Sections 2.0 and 9.1.2 of this work plan for details.)

Habitats potentially affected by OU7 contamination are indicated in Figure 9-2. The habitat types include mixed upland grassland on hillsides and bottomland grassland near the bottom

of the small drainage east of the landfill. Reclaimed areas west of the landfill are weedy and typical of disturbed areas. Most of the active area of the landfill is barren ground. Seasonal stream and wetlands habitats are found in the unnamed tributary to Walnut Creek. The East Landfill Pond provides open water habitat and wetlands areas along its shores.

Reference areas.

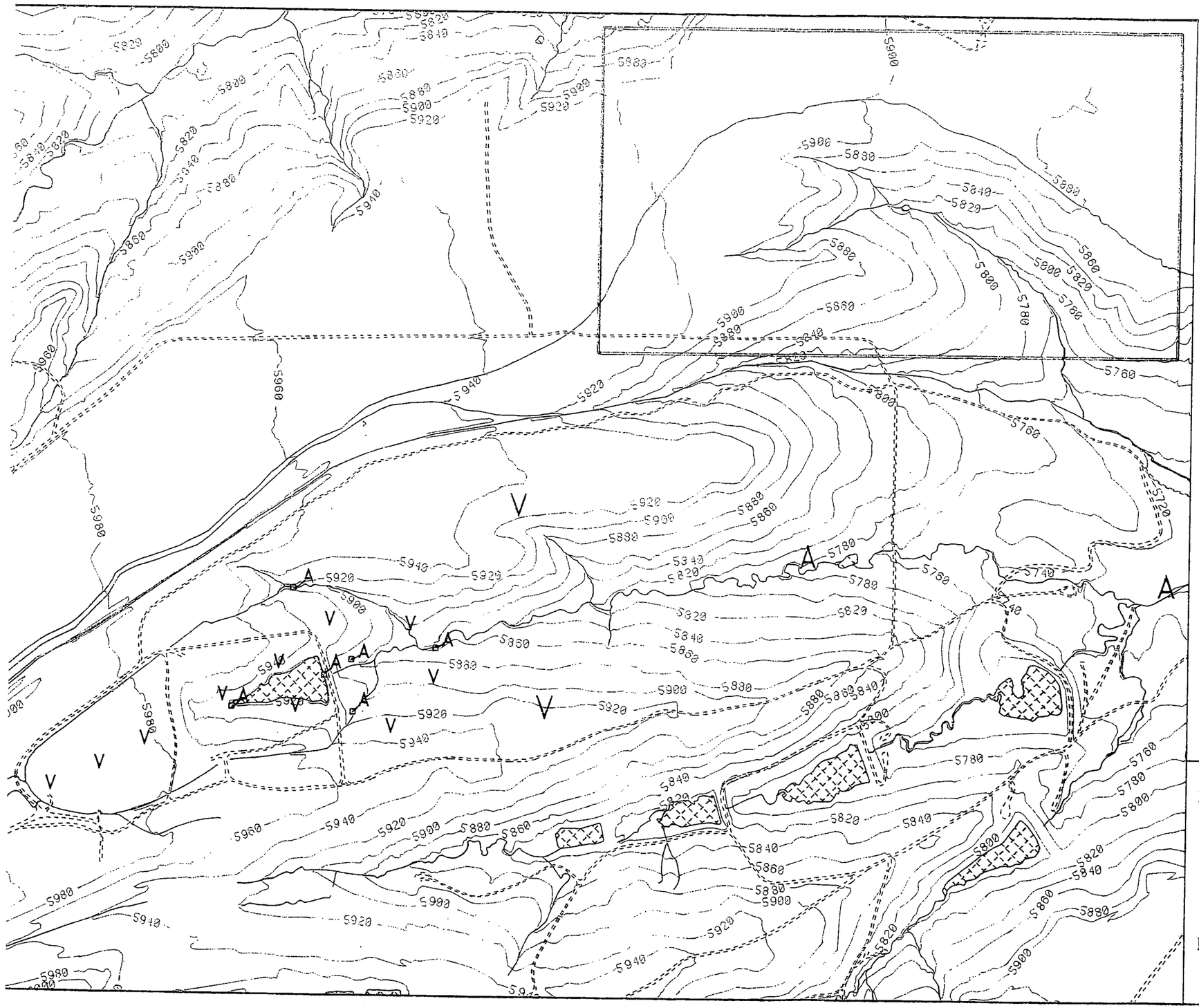
Preliminary reference area selections for OU7 biota studies include the upper and lower hillsides of the drainage immediately northeast of OU7 (Figure 9-6). This area is near OU7 in the Walnut Creek drainage and contains habitats typical of the lower eastern slope of the Rocky Flats mesa. This habitat is similar to those indicated in Figure 9-2. This drainage area is not as large as that of the area drained by the unnamed tributary included in Figure 9-2, and it is further east and downslope. Additional reference areas in the Rock Creek drainage may be utilized if needed.

### 9.3.1 Objectives

Terrestrial Sampling.

The objective of data and sample collection in terrestrial habitats is to gather data for construction of food web and exposure pathways models. Relative abundance and distribution will be assessed for all major groups of terrestrial organisms. Sampling locations for small mammals, terrestrial arthropods, pellet counts, and (to a lesser extent) birds will coincide with vegetation sampling locations. Collection of samples for tissue analysis will be limited to small mammals, arthropods, and vegetation. Preliminary sampling locations are shown in Figures 9-6 and 9-7.

#### 9.3.1.1 Vegetation (SOP 5.10)




## EXPLANATION

V — VEGETATION SAMPLING SITE (APPROXIMATE)

A — AQUATIC SAMPLING SITE (APPROXIMATE)

REFERENCE AREA (PRELIMINARY IDENTIFICATION)

DIRT ROADS

STREAMS, DITCHES, DRAINAGE FEATURES

SURFACE WATER IMPOUNDMENTS

N

0 feet 700 1400

CONTOUR INTERVAL = 20 FEET

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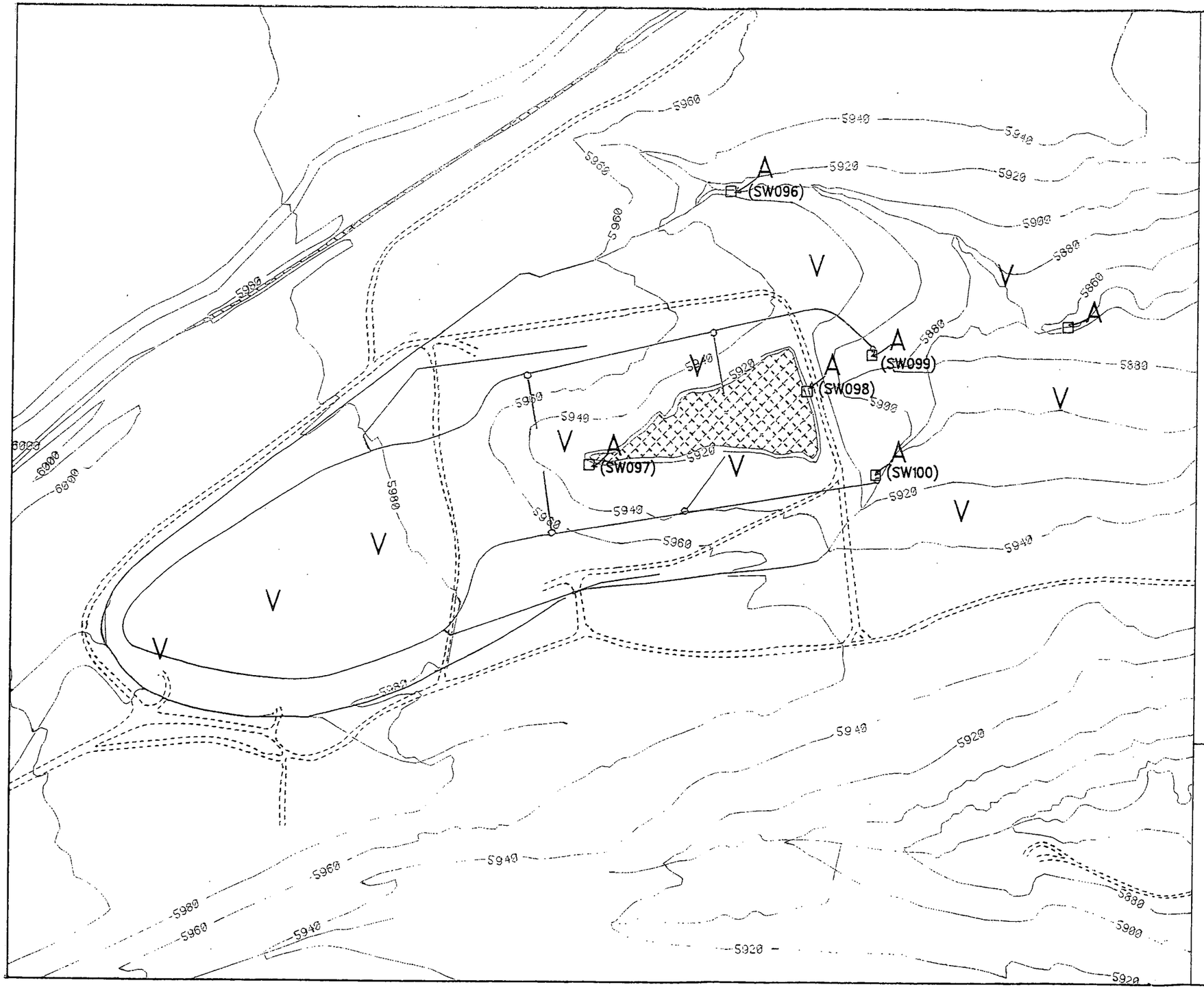
# POTENTIAL REFERENCE AREA AND DOWN-DRAINAGE SAMPLING LOCATIONS FOR OU7 ENVIRONMENTAL EVALUATION

**Figure 9-6**




## EXPLANATION

- DIRT ROADS
- STREAMS, DITCHES, DRAINAGE FEATURES
- LANDFILL STRUCTURES
- OU7 BOUNDARY
- V — VEGETATION SAMPLING SITE (APPROXIMATE)
- A — AQUATIC SAMPLING SITE (APPROXIMATE)
- SURFACE WATER IMPOUNDMENTS

N

0 feet 300 600

CONTOUR INTERVAL = 20 FEET

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Terrestrial and Aquatic Sampling Locations for OU7 Environmental Evaluation

Figure 9-7

Vegetation will be sampled for species composition, richness, dominance, cover, and analysis of tissue for target analytes. Data and sample collection will follow procedures described in SOP 5.10. Spring and late summer data will be collected, and tissues will be sampled at a time to be determined later. Data collected will be used to assess the following endpoints:

- Total plant cover
- Cover by perennial grasses, annual grasses, perennial forbs, annual or biennial forbs, woody plants, and cacti
- Cover by individual species
- Richness (number of species)
- Density (for woody plants and cacti)
- Production (standing biomass in grams per square meter [$g/m^2$] and pounds per acre [lbs/acre])
- Height (in centimeters)

Ten 50-meter transects will be located in each sampling unit (i.e., each major habitat type in each area); in small units, only five transects will be located. Within the IHSSs and other areas of known contamination, sampling locations will coincide with the RFI/RI soil sampling locations specified in Section 7.0 (Figure 9-7). Tissue samples will be collected from these areas and from reference areas, where appropriate. For tissue analysis, six samples per transect will be collected. The six samples will consist of aboveground biomass from 0.5-$m^2$ plots along the 50-meter vegetation (belt) transect (see SOP 5.10). The six plots to be sampled will be selected randomly from the 100 available in each transect to be

sampled. Sample size adequacy in cover and biomass surveys will be determined using Cochran's formula (Cochran, 1977).

#### 9.3.1.2 Terrestrial Arthropods (SOP 5.9)

Terrestrial arthropods (e.g., insects, spiders, ticks) will be surveyed for relative abundance, and composite samples of selected taxa will be collected for tissue analysis. Collection of survey data will involve use of sweep nets and pitfall traps, in accordance with SOP 5.9. Assessment of community composition will include evaluation of the following endpoints:

- Richness (number of species collected from a given transect)
- Biomass ($g/m^2$ of selected taxa collected from transect)

Coleopterans (beetles) will be empahsized in collection of specimens for tissue analysis. In grasslands, this group is primarily ground dwelling, and relatively large numbers can be obtained. Pitfall traps will be used to collect specimens for tissue analysis. Sampling locations will coincide with vegetation sampling locations in the IHSSs, other areas of known contamination, and reference areas. One pitfall trap will be located every 5 meters along a line parallel to the 50-meter vegetation transect. For tissue analysis, six samples will be seleceted at random from the ten collected along the 50-meter vegetation transect.

#### 9.3.1.3 Small Mammals (SOP 5.6)

Small mammal populations will be surveyed to determine habitat use and relative abundance. The results will be used to select species to be collected for tissue analysis. The data will be used in development of pathways models and the exposure assessment. Small mammals will be collected using the live-trapping techniques described in SOP 5.6. Trap grids or lines (25 traps each) will be set for four consecutive nights, as described in SOP 5.6.

Sampling locations will coincide with vegetation sampling locations in areas of suspected contamination and in reference areas, where appropriate.

For community evaluation, endpoints will include:

- Richness (number of species)
- Abundance (number per trap-night) by species
- Mean weight

Tissue samples will be collected from grids corresponding to vegetation transects in areas of known contamination. To collect individuals for tissue analysis, each individual of the designated target taxon will be randomly assigned to a particular analytical suite. Collection will continue until of the required sample quantity is obtained. If composite samples are required, each individual will be randomly assigned to a sample, and collection will continue until six samples of the appropriate quantity are obtained. If multiple trap-nights are required to obtain adequate sample quantity, individuals will be frozen as soon as possible, but within four hours of collection. Tissue sampling will occur in late summer or fall. Reference areas may be used in the tissue sampling section of the study.

Small mammal populations will be surveyed to determine habitat use and relative abundance. The results will be used to select species to be collected for tissue analysis. The data will be used in food web model construction and exposure assessment.

#### 9.3.1.4 Large Mammals (SOP 5.5)

The relative abundance and distribution of large mammals such as deer, coyotes, and jackrabbits will be determined to assess the use of OU7 areas by these species. The resulting data will be used in construction of food web models and the exposure assessment.

Data collection will follow the procedures described in SOP 5.5. Sampling locations will include at least one area of each habitat type identified for OU7. Surveys will be conducted in spring and fall. The use of reference areas is not anticipated. Pellet counts at vegetation sites in areas of known contamination will be employed to assess use of these specific areas. The endpoint will be the number of fecal pellet groups per unit area (hectares [ha]).

In addition, relative abundance surveys will yield semi-quantitative data on richness and numbers. These data will not be appropriate for statistical analysis.

#### 9.3.1.5 Birds (SOP 5.7)

Bird surveys will be conducted to determine the use of OU7 habitats by potential avian receptors. Data will be used in development of pathways models and exposure assessments. Songbird surveys will be conducted in the spring, and raptor observations will be conducted throughout the study. Surveys will be conducted in each of the major habitat types according to the procedures described in SOP 5.7 and will consist of five to ten 100-meter by 100-meter census plots in each habitat. Exact sample size will depend on the areal extent of the unit. Songbird surveys will be conducted on at least three mornings during the breeding season, as described in SOP 5.7. Endpoints will include:

- Density (number per hectare) by species
- Richness (number of species)

Semi-quantitative surveys will also be conducted in more limited riparian habitats during the breeding season and in grassland habitats during nonbreeding seasons. These "relative abundance" surveys will also yield information on species richness and numbers but will not be amenable to statistical analysis.

#### 9.3.1.6 Reptiles and Amphibians (SOP 5.8)

Surveys will be conducted in appropriate habitats according to SOP 5.8. Collection of reptiles and amphibians for tissue analysis is not anticipated but may be indicated for Task 9 field sampling.

### 9.3.2 Aquatic Sampling

Aquatic habitat within OU7 is limited to the leachate channel from the landfill, the East Landfill Pond, and the unnamed tributary to Walnut Creek. The objectives of the aquatic sampling program are to assess species composition, relative abundance, and contaminant loads of fish and benthic macroinvertebrates for use in contaminant pathways models and food web analysis. Periphyton may also be sampled to assess primary production of OU7 surface waters in comparison with reference areas. However, the East Landfill Pond was constructed relatively recently, and identification of an appropriate reference pond may not be possible. Aquatic sampling locations include surface water monitoring stations SW096, SW097, SW098, SW099, and SW100 and additional sites along the unnamed tributary to Walnut Creek (Figures 9-6 and 9-7). Reference areas for tissue sampling will be located in the Rock Creek drainage. These areas will be selected in the spring when high flow conditions exist.

#### 9.3.2.1 Periphyton (SOP 5.1) and Plankton (SOP 5.3)

Periphyton and plankton will be sampled to determine species composition and primary production (estimated from standing crop) in the East Landfill Pond and, flow permitting, the unnamed tributary to Walnut Creek (periphyton only). Artificial substrates will be used to collect periphyton for chlorophyll analysis according to the procedures described in SOP 5.1. Species composition will be assessed from artificial substrates and by scraping natural substrates such as vegetation and submerged rocks. Plankton will be sampled with tow nets according to SOP 5.3.

#### 9.3.2.2 Benthic Macroinvertebrates (SOP 5.2)

The benthos community will be sampled qualitatively to determine the composition and relative abundance of species present. Collection techniques will include sampling according to EPA's Rapid Bioassessment protocols. Tissue sampling will emphasize larval insects of the orders Ephemeroptera, Trichoptera, and Diptera. Sampling locations will include each surface water station and other locations on the East Landfill Pond, reaches of the unnamed tributary to Walnut Creek, and Walnut Creek. Sample collection for tissue analysis may include reference areas, especially for analysis of metals in tissues.

#### 9.3.2.3 Fish (SOP 5.4)

The primary purpose of fish sampling will be for tissue analysis. An initial inventory will be compiled to identify the species appropriate for sampling and tissue analysis. Sampling methods will include minnow traps and electrofishing at stream sites and minnow traps and gill nets in the ponds. Stream sampling will include 100-meter sections of the stream, 50 meters on either side of the sampling station. Composite samples will be assembled by first collecting a large number of the taxon in question, then sequentially or randomly assigning each individual to a sample until adequate tissue has been collected for the required number of samples. Collection, sample handling, and preservation of fish samples will follow the procedures in SOP 5.4.

### 9.3.3 Aquatic Toxicity Testing

Aquatic toxicity testing will be performed once at high flow (spring) and once at low flow (late summer). At least two species (probably *Ceriodaphnia spp.* and fathead minnows) will be used to test the toxicity of water, and at least one species (*Hyallela spp.*) will be used in sediment toxicity tests. Testing will be performed by EPA- and Rocky Flats-approved laboratories. Water for toxicity testing will be collected from SW096, SW097, SW098, SW099, SW100, at aquatic sampling locations on the unnamed tributary, and on Walnut

Creek (Figure 9-6). In addition, toxicity tests will be performed on samples from Walnut Creek upstream and downstream from its confluence with the unnamed tributary. Water collected from Antelope Springs (SW104) will be screened for possible use as background water in toxicity testing. Alternative sources for "control" water include Rock Creek or EPA-approved laboratory-mixed water of the appropriate hardness. Initially, undiluted surface water samples will be tested. The need for further toxicity analysis will be evaluated in Task 8.

## 9.4 Schedule

An approximate schedule for completion of the work outlined in this EEWP is presented in Table 9-8. Seasonal changes profoundly affect the results of ecological sampling; therefore, the exact timing of field activities may be subject to change according to the date of contract approval.

Table 9-7: Holding Times, Preservation Methods, and Sample Containers for Biota Samples

| | Holding Time From Date Collected | Preservation Method | Container | Approximate Sample Size++ |
|---|---|---|---|---|
| SAMPLES FOR METALS ANALYSES | | | | |
| Terrestrial Vegetation | | | | |
| - Metals Determined by ICP** | 6 months | Freeze and ship with dry ice | Paper bag inserted into plastic bag and sealed | 25 g |
| - Metals Determined by GFAA+ | 6 months | Freeze and ship with dry ice | Paper bag inserted into plastic bag and sealed | 25 g |
| - Hexavalent Chromium | 24 hours | Freeze and ship with dry ice | Paper bag inserted into plastic bag and sealed | 25 g |
| - Mercury | 28 days | Freeze and ship with dry ice | Paper bag inserted into plastic bag and sealed | 5 g |
| Mammals, Birds, Benthic Macroinvertebrates, Fish | | | | |
| - Metals Determined by ICP | 6 months | Freeze and ship with dry ice | Plastic | 25 g |
| - Metals Determined by GFAA | 6 months | Freeze and ship with dry ice | Plastic | 25 g |
| - Hexavalent Chromium | 24 hours | Freeze and ship with dry ice | Plastic | 25 g |
| - Mercury | 28 days | Freeze and ship with dry ice | Plastic | 5 g |

| | Holding Time From Date Collected | Preservation Method | Container | Approximate Sample Size + + |
|---|---|---|---|---|
| SAMPLES FOR RADIONUCLIDE ANALYSES | | | | |
| Terrestrial Vegetation | | | | |
| - Uranium-233, 234, 235, 238<br>Americium-241<br>Plutonium-239/240 | 6 months | Freeze and ship with dry ice | Paper bag inserted into plastic bag and sealed | 100 g |
| Periphyton, Benthic Macroinvertebrates, Fish | | | | |
| - Uranium-233, 234, 235, 238<br>Americium-241<br>Plutonium-239/240 | 6 months | Freeze and ship with dry ice | Plastic | 100 g |

**ICP - Inductively Coupled Argon Plasma Emission Spectroscopy
+GFAA - Graphite Furnace Atomic Absorption Spectroscopy
+ + - Sample size may vary with specific laboratory requirements.

Table 9-8: Proposed Environmental Evaluation Report Outline, Present Landfill (OU7)

EXECUTIVE SUMMARY

1.0 INTRODUCTION
- 1.1 Objectives
- 1.2 Site History
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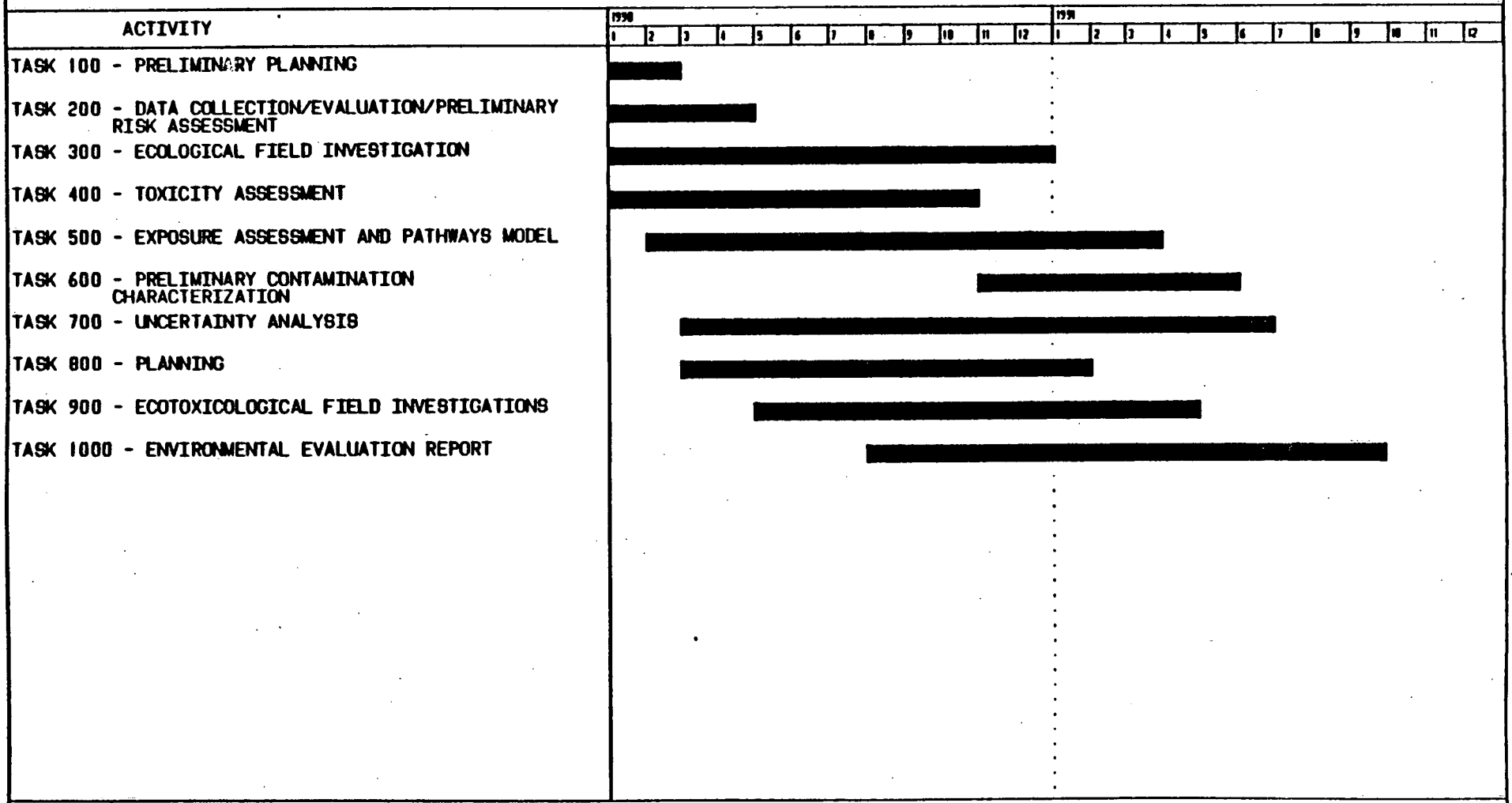
U. S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado
OPERABLE UNIT 7
PHASE I RFI/RI WORK PLAN
PRESENT LANDFILL




ENVIRONMENTAL EVALUATION
ACTIVITY SCHEDULE
FIGURE 9-8 AUGUST 1991

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# ENVIRONMENTAL MANAGEMENT DOCUMENT CHANGE NOTICE (DCN)

Procedure Number 21100-WP-OU7.01, R0



| Title Quality Assurance Addendum Section 10.0 | Date ~~4-Nov-92~~ 1-6-93 MCB | DCN Number 93.01 SERD |
|---|---|---|

Expires ~~4-Nov-93~~ 1-6-94 MCB Procedure Revision Required ☐ Yes ☒ No

Scope Limitation: This covers Phase I RFI/RI Work Plan for OU-7 ~~ops~~

| Item Number | Page | Step or Paragraph | Changes (Use DCN CONTINUATION SHEET for additional space) |
|---|---|---|---|
| 1 | 4/44 Sec. 10 | Figure 1 | Update organizational chart per attached Figure. |

Justification (Reason for change - Provide numbers to reference corresponding items above.)

Several organizational changes to project staff warranted updates to Figure 1.

DOCUMENT CLASSIFICATION REVIEW WAIVER
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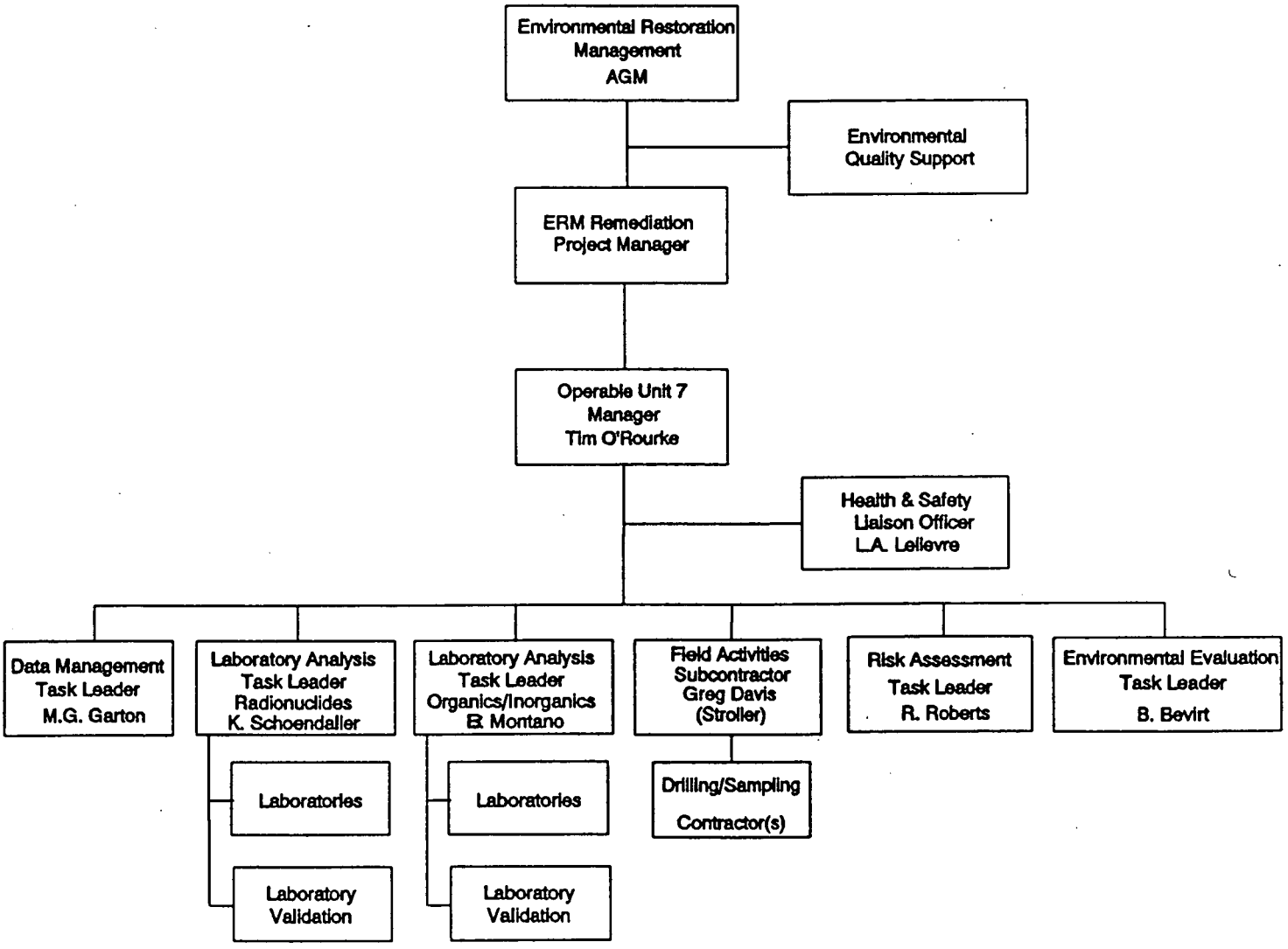
|---|---|
| 21100-WP-OU7.01, R0 | |
| Scope Limitation: This covers Phase I RFI/RI Work Plan | |

Project Management for Operable Unit 7, Present Landfill, Phase I RFI/RI



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ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203
Title: Quality Assurance Addendum

Manual No. 21100-WP-OU 07.01
Section No. 10.0, R0

ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT DEPARTMENT

Organization: Environmental Management

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Approved by:

12/6/91
Effective Date

L. P. O'Rourke
Manager

6/23/92
Date

# QUALITY ASSURANCE ADDENDUM

# QAA 7.1

# to the

# ROCKY FLATS SITE-WIDE QA PROJECT PLAN

# FOR CERCLA RI/FS AND RCRA RFI/CMS ACTIVITIES

# for

# OPERABLE UNIT NO. 7, PRESENT LANDFILL

# PHASE I RFI/RI

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

**Revision 0**

**Draft B**

TITLE:
Quality Assurance Addendum to the Rocky Flats Site-Wide QA Project Plan for CERCLA RI/FS and RCRA RFI/CMS Activities for Operable Unit No. 7, Present Landfill Phase I RFI/RI

Approved By:

_____ Manager, Remediation Programs

___/___/___ Date

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## INTRODUCTION AND SCOPE

This Quality Assurance Addendum (QAA) supplements the "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facilities Investigation/Corrective Measures Study Activities" (QAPjP). The QAA establishes the specific Quality Assurance (QA) controls applicable to the field investigation activities described in the Phase I RCRA Facility Investigations/Remedial Investigations (RFI/RI) Work Plan for the Present Landfill, Operable Unit No. 7 (OU7). OU7 includes two Individual Hazardous Substance Sites (IHSSs): the Present Landfill (IHSS No. 114) and the Inactive Hazardous Waste Storage Area (IHSS No. 203). Also included within OU7 are the East Landfill Pond and areas adjacent to the pond, not included in OU6, but where spray evaporation has historically occurred.

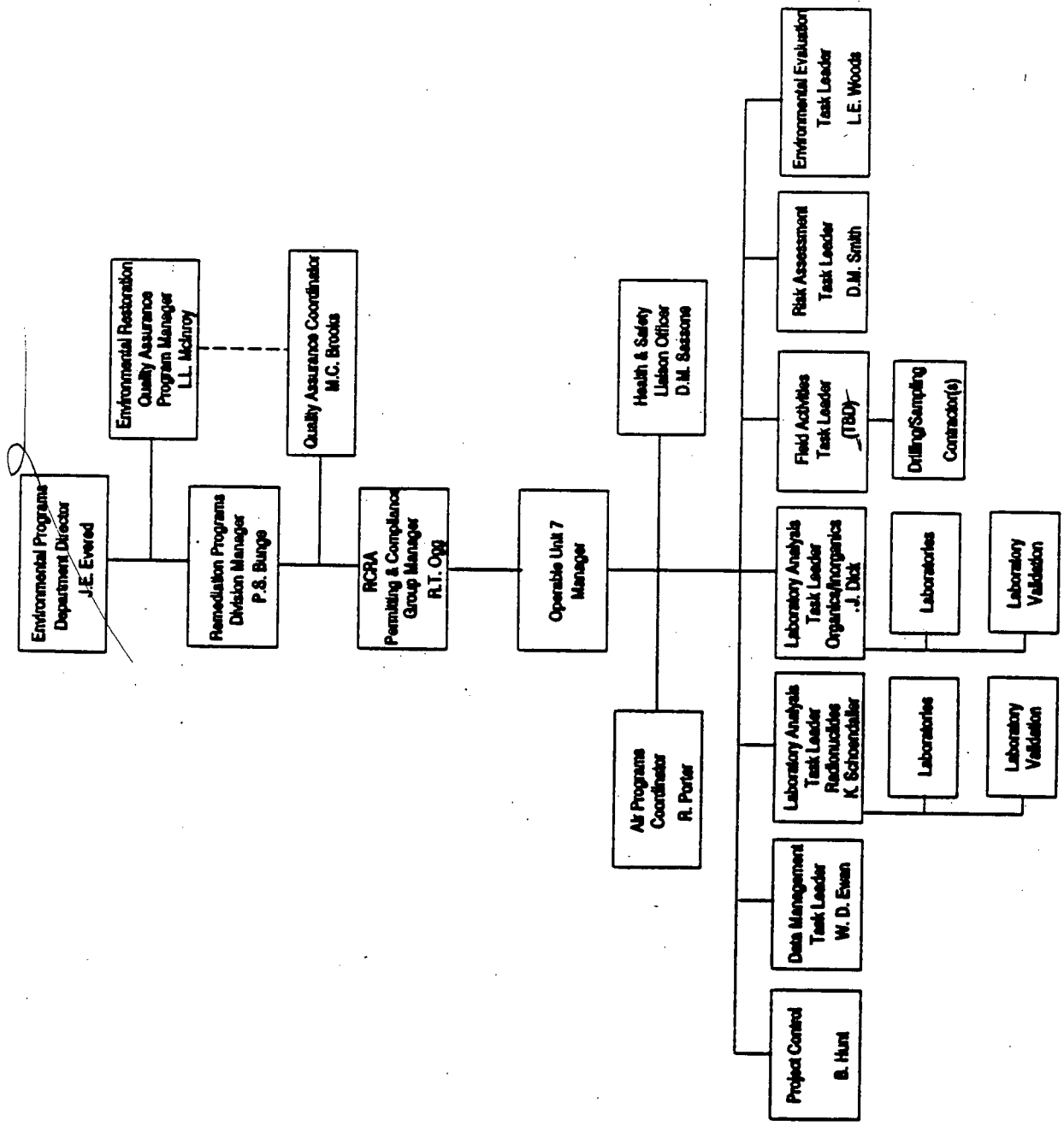
The OU7 Workplan addresses characterization of the source and soil contamination. The OU7 Phase I RFI/RI investigations include (1) landfill waste and leachate, (2) soils beneath the landfill contaminated with leachate, (3) sediments and water in the East Landfill Pond, (4) potentially contaminated soils in IHSS 203, and (5) potentially contaminated soils adjacent to the East Landfill Pond where spray evaporation has historically occurred. The OU7 Workplan contains a complete description of the OU7 area and planned investigations.

## 1.0 ORGANIZATION AND RESPONSIBILITIES

The overall organization of EG&G Rocky Flats and the Environmental Management Department (EMD) divisions involved in environmental restoration activities is shown in Figures 1-1, 1-2, and 1-3 of Section 1.0 of the QAPjP. Individual responsibilities are also described in Section 1.0 of the QAPjP.

Contractors will be tasked by EG&G Rocky Flats to implement the field activities outlined in the OU7 Workplan. The specific EMD personnel who will interface with the contractors and who will provide technical direction are shown in Figure 1.

## FIGURE 1. PROJECT MANAGEMENT FOR OPERABLE UNIT 7, PRESENT LANDFILL, PHASE I RFI/RI



# 2.0 QUALITY ASSURANCE PROGRAM

The QAPjP was written to address QA controls and requirements for implementing Interagency Agreement (IAG) related activities. As such, the controls and requirements addressed in the QAPjP are applicable to OU7 Phase I activities, unless specified otherwise in this QAA. As a supplement to the QAPjP, this QAA addresses additional and site-specific QA controls and requirements that are applicable to OU7 Phase I activities.

## 2.1 Training

All EM, EG&G, and contractor personnel performing field activities at OU7 shall complete the minimum training requirements specified in Section 2.4 of the QAPjP. In addition, all personnel performing activities in accordance with the EMD Operating Procedures (OPS), which are also referred to as EG&G Rocky Flats Standard Operating Procedures (SOPs), specified in this QAA shall receive documented training on the QAPjP, this QAA, and training specified in the applicable OPS prior to performing the work. Such personnel include, but are not limited to, those performing or supervising the following activities:

- Drilling/boring;
- Installation/completion of groundwater monitoring wells;
- Sample collection (all media);
- Sample chain-of-custody/preservation/handling;
- Equipment decontamination;
- Field measurements (e.g., pH, conductivity, temperature, dissolved oxygen, flow rate);
- Water level measurements;
- Data validation; and
- Environmental surveying and sample collection.

### 2.2 Quality Assurance Report to Management

A QA Summary report will be prepared annually or at the conclusion of the activities described in the OU7 Workplan (whichever is more frequent) by the EM Department Quality Assurance Program Manager (QAPM) or designee. The QA report will include a summary of field operation surveillances and audits, laboratory surveillances and audits, and a report of data verification/ validation results.

## 3.0 DESIGN CONTROL AND CONTROL OF SCIENTIFIC INVESTIGATIONS

### 3.1 Design Control

The OU7 Workplan is the investigation design control plan for the Phase I RFI/RI activities to be conducted in the areas designated as OU7. The sampling rationale and investigation program, including sample locations, frequency, and analytical requirements, are presented in the OU-7 Work Plan and are summarized in this QAA. Specific OPS (i.e., SOPs) to be implemented by EG&G Rocky Flats and contractor personnel during all aspects of the field investigation are also identified here. The OU7 Workplan will be reviewed and approved by the EG&G Rocky Flats Remediation Programs Manager, the U.S. Department of Energy (DOE) Rocky Flats Office, the U.S. Environmental Protection Agency (EPA), and the Director of the Colorado Department of Health (CDH) prior to implementing the work described in the Workplan.

### 3.2 Data Quality Objectives

Data quality objectives (DQOs) quantitatively and qualitatively describe the uncertainty that decision makers are willing to accept in results derived from environmental data. This uncertainty is used to specify the quality of the data required to meet the objectives of the investigations. The process of developing DQOs for remedial investigations is summarized in Appendix A of the QAPjP. The development of DQOs for OU7 investigations follows that process and is presented in Section 4 of the OU7 Workplan.

Parameters that are used as indicators of data quality are precision, accuracy, representativeness, comparability, and completeness (referred to as PARCC parameters). The definitions and methods of calculating these parameters are presented in Appendix A of the QAPjP. The objectives of the investigations proposed in the OU7 Workplan are summarized below. The objectives for the PARCC parameters for OU7 analytical data are also established in this QAA.

### 3.2.1 Objectives

The Field Sampling Plan (Section 7.0) of the OU7 Workplan is designed to obtain data necessary to characterize the physical features associated with OU7, define contaminant sources, and support the Baseline Risk Assessment and Environmental Evaluation. A stepped approach as outlined in the IAG will be used in Phase I to accomplish these objectives. The following activities will be performed as part of the Phase I Field Sampling Plan:

- Review new data obtained from ongoing environmental monitoring activities or from other operable unit investigations;
- Conduct field screening activities, including visual observations, cone penetrometer testing (CPT), soil gas surveys, leachate screening for VOCs, and radiological surveys;
- Collect surface water, surface soil, sediment, and leachate samples;
- Drill to collect soil samples at depth and characterize subsurface soil, geologic, and hydrogeologic conditions within OU7 sources; and
- Install and sample groundwater monitoring wells.

Site-specific Phase I RFI/RI objectives/data needs, data types, and corresponding methods of sampling/analysis are outlined in Table 4-1 of the OU7 Workplan.

In addition to the Field Sampling Plan activities described in Section 7.3 of the OU7 Workplan, environmental evaluation (EE) field activities will be conducted as described in the Environmental Evaluation Workplan for OU7 (Section 9.0 of the OU7 Workplan). These EE activities include:

- Identification and delineation of habitats and vegetation mapping units;
- Selection of reference areas;
- Characterization of biota present at OU7, which involves sampling terrestrial and aquatic ecosystem components;
- Initial aquatic toxicity investigations.

Table 4-1 of the OU7 Workplan lists the analytical levels that are appropriate to the RFI/RI objectives/data needs, data types, and data uses. (These analytical levels are discussed and described in Appendix A of the QAPjP.) The analytical levels for the Phase I investigations at OU7 include levels I-V.

The data quality objectives for analytical levels I and II field measurement, sampling, and analysis activities consist of establishing instrument readability or detection limits and accuracy objectives. Accuracy objectives for field instruments will be determined by calibrating instruments to known standards. Readability/detection limits and accuracy objectives for field instruments are listed in Appendix A.

The laboratory analytical program requirements for the OU7 Phase I investigations are discussed in Section 7.4 of the OU7 Workplan. The specific analytes for the various media at OU7 are listed in Table 7-2 of the OU7 Workplan. The laboratory analytical program specifies the use of analytical methods referenced in the EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Parts A and B, for all analytes. These analytical methods are appropriate for meeting the data quality requirements for analytical levels III-V. The precision, accuracy, and completeness parameters for analytical levels III-V are discussed below, along with comparability and representativeness for all levels. The following DQOs for precision, accuracy, and completeness will be used by the laboratory validation contractor to evaluate the quality of laboratory data.

### 3.2.2 Precision and Accuracy

**CLP Analyses:** The DQOs for precision and accuracy for the analytical methods referenced in the GRRASP, which includes EPA CLP protocols and standard EPA methods when CLP protocols are

unavailable, are included in Appendix B of the QAPjP. Since the laboratory analytical program for OU7 will utilize the analytical methods referenced in the GRRASP, these objectives are applicable to the OU7 Phase I RFI/RI. Those objectives are reproduced here in Appendix A.

### 3.2.3 Completeness

The target completeness objective for both field and analytical data for this project is 100 percent. The minimum acceptable is 90 percent.

### 3.2.4 Comparability

Comparability is a qualitative parameter that shall be ensured by implementation of an approved sampling and analysis plan, standardized analytical protocols, and OPS for field investigations (discussed in Section 11 of the OU7 Workplan and listed here in Table 1), and by reporting data in uniform units as specified in the OU7 Workplan and EMD OPS listed in Table 1.

### 3.2.5 Representativeness

Representativeness is a qualitative parameter that is ensured through the careful development and review of the sampling and analysis strategy outlined in the OU7 Workplan and OPS for sample collection and analysis and field data collection.

### 3.2.6 DQOs for Environmental Evaluation Investigations

The purpose of the OU7 Environmental Evaluation (EE) Workplan (Section 9.0 of the OU7 Workplan) is to provide a framework for addressing risks to the environment from contaminants within OU7. The overall objective of the EE is to determine the impacts of OU7 contaminants on biota. The field sampling activities discussed in the EE Field Sampling Plan (Section 9.3 of the OU7 Workplan) will characterize the terrestrial and aquatic biota of OU7 and the reference area(s). Reference areas are established as control sites for assessing impacts to biota from contamination. Field sampling and analysis will consist of qualitative and quantitative field surveys and sample

## TABLE 1.
## EMD Operating Procedures and Field Activities for Which They are Applicable

| Former SOP Reference Number | EMD OPS Reference Number | Standard Operating Procedures | Wind Dispersal | Groundwater Development | Ground-Water Sampling | Surface-Water Sampling | Sediment Sampling | Surface Soil Sampling | Subsurface Soil Sampling | Hydrotesting | Source Sampling | Bias Sampling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.1 | F0.01 | Wind Blown Contaminant Dispersion Control | ● | | | | | | ● | | | |
| 1.2 | F0.02 | Field Document Control | | | ● | ● | ● | ● | | ● | ● | ● |
| 1.3 | F0.03 | General Equipment Decontamination | | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 1.4 | F0.04 | Heavy Equipment Decontamination | | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 1.5 | F0.05 | Handling of Purge and Development Water | | ● | ● | | | | | ● | | |
| 1.6 | F0.06 | Handling of Personal Protective Equipment | | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 1.7 | F0.07 | Handling of Decontamination Water & Wash Water | | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 1.8 | F0.08 | Handling of Drilling Fluids & Cuttings | | ● | | ● | ● | | ● | | | |
| 1.9 | F0.09 | Handling of Residual Samples | | | | | | ● | ● | | ● | ● |
| 1.10 | F0.10 | Receiving, Labeling, and Handling Waste Containers | | ● | ● | | | | ● | ● | ● | ● |
| 1.11 | F0.11 | Field Communications | | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 1.12 | F0.12 | Decontamination Facility Operations | | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 1.13 | F0.13 | Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples | | | ● | ● | ● | ● | ● | ● | ● | ● |
| 1.14 | F0.14 | Field Data Management | | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 1.15 | F0.15 | Use of PIDs and FIDs X | | ● | ● | | | ● | ● | | ● | ● |
| 1.16 | F0.16 | Field Radiological Measurements X | | | | | | ● | ● | | | |
| 2.1 | GW.01 | Water Level Measurements in Wells and Piezometers | | ● | ● | | | | | ● | | |
| 2.2 | GW.02 | Well Development | | ● | | | | | | | | |
| | | a) New Wells | | | | | | | | | | |
| | | b) Redevelopment | | ● | | | | | | | | |
| 2.3 | GW.03 | Pump-In Borehole Packer Testing | | ● | | | | | | ● | | |
| 2.5 | GW.04 | Measurements for Groundwater Field Parameters | | | ● | | | | | ● | | |

X = Also as required by H&S plan for all field activities
TBD = To be developed

856D0420.003

## TABLE 1. (Continued)
## EMD Operating Procedures and Field Activities for Which They are Applicable

| Former SOP Reference Number | EMD OPS Reference Number | Standard Operating Procedures | Well Drilling | Construction, Development | Ground-Water Sampling | Surface-Water Sampling | Sediment Sampling | Surface Soil Sampling | Subsurface Soil and Gas Sampling | Hydrocoupe Testing | Source Sampling | Blank Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.0 | GW.06 | Groundwater Sampling | | | ● | | | | | | | |
| 3.1 | GT.01 | Logging Alluvial and Bedrock Material | ● | | | | | | ● | | | |
| 3.2 | GT.02 | Drilling and Sampling Using Hollow-Stem Auger Techniques | ● | | | | | | ● | | ● | |
| 3.3 | GT.03 | Isolating Bedrock from the Alluvium with Grouted Surface Casing | ● | | | | | | | | | |
| 3.4 | GT.04 | Rotary Drilling and Rock Coring | ● | | | | | | ● | | | |
| 3.5 | GT.05 | Plugging and Abandonment of Boreholes | ● | | | | | | ● | | | |
| 3.6 | GT.06 | Monitoring Well and Piezometer Installation | ● | | | | | | | | | |
| 3.8 | GT.08 | Surface Soil Sampling | | | | | | ● | | | | |
| 3.9 | GT.09 | Soil Gas Sampling and Field Analysis | | | | | | | | | | |
| 3.10 | GT.10 | Borehole Clearing | | | | | | | ● | | | |
| 3.11 | GT.11 | Plugging and Abandonment of Wells | ● | | | | | | | | | |
| New | GT.17 | Land Surveying | ● | | ● | ● | | | ● | | ● | |
| New | GT.21 | Cone Penetrometer Testing | | | ● | | | | ● | | | |
| New | GT.22 | In-Situ Gas/ Liquid Sampling Using the BAT System | | | ● | | | | ● | | | |
| 4.1 | SW.01 | Surface Water Data Collection Activities | | | | ● | | | | | | |
| 4.2 | SW.02 | Field Measurement of Surface Water Parameters | | | | ● | | | | | | |
| 4.3 | SW.03 | Surface Water Sampling | | | | ● | | | | | | |
| 4.4 | SW.04 | Discharge Measurements | | | | ● | | | | | | |
| 4.5 | SW.05 | Base Laboratory Work | ● | | ● | ● | | ● | ● | ● | ● | ● |
| 4.6 | SW.06 | Sediment Sampling | | | | | ● | | | | | |

TBD = To be developed

**TABLE 1. (Continued)**
**EMD Operating Procedures and Field Activities for Which They are Applicable**

| Former SOP Reference Number | EMD OPS Reference Number | Standard Operating Procedures | Well Drilling | Contamination Development | Ground-Water Sampling | Surface-Water Sampling | Sediment Sampling | Surface Soil Sampling | Subsurface Soil Sampling | Hydrologic Testing | Source Sampling | Biota Sampling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.1 | EE.01 | Sampling of Periphyton | | | | | | | | | | ● |
| 5.2 | EE.02 | Sampling of Benthic Macroinvertebrates | | | | | | | | | | ● |
| 5.3 | EE.03 | Sampling of Plankton | | | | | | | | | | ● |
| 5.4 | EE.04 | Sampling of Fishes | | | | | | | | | | ● |
| 5.5 | EE.05 | Sampling of Large Mammals | | | | | | | | | | ● |
| 5.6 | EE.06 | Sampling of Small Mammals | | | | | | | | | | ● |
| 5.7 | EE.07 | Sampling of Birds | | | | | | | | | | ● |
| 5.8 | EE.08 | Sampling of Reptiles and Amphibians | | | | | | | | | | ● |
| 5.9 | EE.09 | Sampling of Terrestrial Arthropods | | | | | | | | | | ● |
| 5.10 | EE.10 | Sampling of Terrestrial Vegetation | | | | | | | | | | ● |
| 5.11 | EE.11 | Identification of Habitat Types | | | | | | | | | | ● |
| 5.13 | EE.13 | Development of Field Sampling Plans | | | | | | | | | | ● |
| New | TBD | Aquatic Toxicity Testing | | | | | | | | | | ● |
| 5.12 | MT.15 | Preventive Maintenance Procedure for RFP TSP HVOL Air Sampler | | | | | | | | | | |
| New | MT.16 | Placement, Design, Installation, and Operation of Meteorological Measuring Stations | | | | | | | | | | |
| New | MT.17 | Placement, Design, Installation, and Operation of Particulate and Air Toxics Monitoring Stations | | | | | | | | | | |
| New | MT.18 | Instrument Maintenance and Calibration of Meteorological Monitoring Equipment | | | | | | | | | | |
| New | MT.19 | Site-Specific Particulate and Air Toxic Monitoring at Active Investigation Site | | | | | | | | | | |

TBD = To be developed

collection to provide data that will be analyzed to establish estimates of species composition, relative abundance, dominance, cover, and distribution. Samples will also be collected and stored for tissue analysis at a later date to evaluate contaminant loading.

These characterization activities are considered screening activities that require analytical level I and II data. These characterization data will then be used, along with OU7 site characterization and source contamination data, to develop the conceptual model for the EE study. Data quality for these characterization activities will be controlled by adhering to the field sampling SOPs in implementing the Field Sampling Plan.

The conceptual model developed for the OU7 ecosystem will assist investigators in identifying target species, contaminants of concern, and potential exposure pathways. DQOs for the contamination assessment tasks (Tasks 4 through 7 of the EE Workplan) and the ecotoxicological studies (Task 8) will then be developed following steps recommended by EPA in EPA/600/3-89/013, Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document, and EPA/540/G-90/008, Guidance for Data Usability in Risk Assessment. The ecosystem characterization data and preliminary aquatic toxicity investigation data that will be obtained by implementing the Field Sampling Plan are needed to develop these additional DQOs.

## 3.3 Sampling Locations and Sampling Procedures

The Phase I field investigation programs, including sampling procedures and sampling locations, for each IHSS within the OU7 area are described in Section 7.3 and summarized in Table 7-3 of the OU7 Workplan.

### 3.3.1 Cone Penetrometer Testing

Cone penetrometer tests (CPTs) will be used to determine soil characteristics and to detail fill materials at the present landfill (IHSS 114) in the areas of artificial fill overlying Rocky Flats alluvium and/or bedrock. CPTs will be performed at 38 locations on 100-foot centers over the landfill. EMD-OPS-GT.21, Cone Penetrometer Testing has developed, which described the operation and interpretation of CPTs. This OPS becomes part of the EG&G EMD Operating

Procedures and will be reviewed and approved according to the requirements in Section 5.0 of the QAPjP prior to implementing the activity.

3.3.2 In-Situ Soil-Gas/Groundwater Sampling

A BAT in-situ soil-gas/groundwater sampling system will be used to obtain soil gas/leachate/ groundwater samples within the landfilled material (IHSS 114) for analysis of common landfill gases, VOCs frequently detected in groundwater samples, and VOCs detected in previous borehole samples. The CPT rig is used in conjunction with the BAT system to obtain samples. Each CPT hole will be offset by 5-feet upgradient for gas/leachate/groundwater sampling. In-situ gas will be sampled at two depths within unsaturated landfill material and liquid samples will be obtained from up to three intervals within the saturated zone of the landfilled materials, in addition to obtaining a sample from isolated zones of saturated material above the water table. EMD-OPS-GT.22 has been developed and describes the process of in-situ gas/liquid sampling using the BAT System. This OPS will become part of the EG&G EMD Operating Procedures and will be reviewed and approved according to the requirements in Section 5.0 of the QAPjP prior to implementing the activity.

3.3.3 Radiological Field Screening

Radiation field surveys will be performed at the inactive hazardous waste storage area (IHSS 203) including downwind areas and other areas around the East Landfill Pond affected by spray evaporation operations. Radiation readings will be taken according to OPS-FO.16, Field Radiological Measurements. Thirty-five readings will be taken on 25-foot centers at IHSS 203. Ninety-six readings will be taken on 50-foot centers over the area around the East Landfill Pond.

3.2.4 Borehole Drilling and Sampling

Boreholes will be drilled at 6 locations within IHSS 114 (borings #1, 2, 3, 4, 5, and 6); 2 locations downgradient (east) of IHSS 114 (borings #7 and 8), and at 3 locations upgradient of IHSS 114 (borings #9, 10, and 11). The proposed borehole locations are shown on Figure 7-2 of the OU7 Workplan. Drilling and continuous core sampling through the landfilled materials will be conducted according to OPS-GT.02, Drilling and Sampling Using Hollow Stem Auger Techniques. Rock coring

and sampling to be employed once boreholes penetrate bedrock will be conducted according to OPS-GT.04, Rotary Drilling and Rock Coring. All soil and bedrock samples (i.e., cores) will be logged according to OPS-GT.01, Logging Alluvial and Bedrock Material. The alluvial and fill material will be isolated from the bedrock by pressure grouting according to OPS-GT.03, Isolating Bedrock From the Alluvium With Grouted Surface Casing. Pump-in borehole permeability tests will be conducted in the bedrock portion of each borehole according to OPS-GW.03, Pump-in Borehole Packer Testing.

Discrete soil and rock samples will be collected for laboratory analysis at 2-foot increments in soil and 4-foot increments in rock. During drilling, all cuttings and core samples will be screened for radiological contamination according to OPS-FO.16, Field Radiological Measurement, and for VOCs according to OPS-FO.15, Use of Photoionizing and Flame Ionizing Detectors.

Borehole locations will be surveyed to accurately determine northing and easting coordinates and elevations. Horizontal accuracy (northing and easting coordinates) will be located with an accuracy of ±0.5 foot. Elevation accuracy will be accurate within ±0.1 foot. These location surveys will be conducted according to OPS-GT.17, Land Surveying.

3.3.5 Groundwater Monitoring Well Installation and Sampling

Groundwater monitoring wells will be constructed at IHSS 114 adjacent to and upgradient of boreholes 1 through 7 (see Figure 7.2 of the OU7 Workplan). Cluster wells (3 wells per location) will be installed adjacent to and upgradient of boreholes 9, 10, and 11. Groundwater monitoring wells will be installed according to OPS-GT.06, Monitoring Wells and Piezometer Installation. The alluvial and fill material will be isolated from the bedrock by pressure grouting according to OPS-GT.03, Isolating Bedrock from Alluvium with Grouted Surface Casing.

Groundwater samples will be collected according to OPS-GW.06, Groundwater Sampling, and GW.05, Measurement for Groundwater Field Parameters. Water level measurements will be made according to OPS-GW.01, Water Level Measurements in Wells and Piezometers. The monitoring wells will be developed according to OPS-GW.02, Well Development.

3.3.6 Sediment Sampling

Sediment core samples will be collected from the East Landfill Pond at three locations down the center line of the pond. These sediment core samples will be collected according to a modification of OPS-SW.06, Sediment Sampling, for collecting sediment cores in ponds. Sediment cores will be logged according to OPS-GT.01.

3.3.7 Leachate and Surface Water Sampling

Samples of leachate seeping from surface water sampling station SW097, pond water samples from the East Landfill Pond surface water monitoring station SW098, and samples of effluent discharging from the groundwater diversion system will be collected according to OPS-SW.03, Surface Water Sampling. Surface water field measurements will be obtained from each sample location at the time of sampling according to OPS-SW.02, Field Measurements of Surface Water Field Parameters. Discharge measurements for leachate seepage at station SW097 and from the groundwater diversion system discharge will be obtained according to OPS-SW.04, Discharge Measurements.

3.3.8 Soil Sampling

Surface soil samples (scrapes) will be collected on a 25-foot grid within IHSS 203 according to OPS-GT.08, Surface Soil Sampling. If analytical results of surficial soil samples indicate concentrations of contaminants above background levels, subsurface soil samples will be collected with a hand auger to depths of 10 inches from the same 25-foot grid. A document change notice (DCN) is being prepared that describes the hand augering procedures. The DCN will be submitted to change OPS-GT.08 to include collection of soil samples using a hand auger. The DCN will be reviewed and approved according to Section 5 of this QAA. These soil samples will be collected for analyses of radionuclides, metals, PCBs, and inorganic analytes. In addition to these samples, additional samples will be collected for analyses of radionuclides from hotspots (i.e., locations where field readings were greater than background) according to OPS-GT.08, Surface Soil Sampling. At each location where a soil sample is collected a sample for headspace screening of soil gas will be obtained according to OPS-GT.09, Soil Gas Sampling and Field Analysis.

### 3.4 Analytical Procedures

The analytical program for OU7 Phase I RFI/RI activities is discussed in Section 7.4 of the OU7 Workplan. The analytical methods that shall be adhered to are those that are specified in the GRRASP, Parts A and B, for laboratory analysis and according to methods specified in appropriate SOPs for field analysis and measurements. The methods for laboratory analysis are referenced in Section 3.0 of the QAPjP. Specific analytical methods for each analyte are also referenced here in Appendix A.

### 3.5 Environmental Evaluation: Summary of Surveying and Sampling

The EE Workplan (Section 9 of the OU7 Workplan) consists of 10 Tasks. The field sampling plan (Section 9.3) encompasses Task 3, Ecological Field Investigation, and initial tissue sample collection of Task 9, Ecotoxicological Field Investigations. The ecological field investigations that will be conducted include qualitative and quantitative field surveys and sampling of terrestrial and aquatic ecosystems. The identification and delineation of habitats and vegetation mapping units will be done according to OPS-EE.11, Identification of Habitat Types.

Terrestrial ecosystem sampling will be conducted to gather data for construction of food web and exposure pathways, and will include the following:

- Field surveys to estimate the relative abundance and distribution of large mammals according to OPS-EE.05, Sampling of Large Mammals.

- Field surveys and small mammal trapping to estimate relative abundance and habitat use according to OPS-EE.06, Sampling of Small Mammals. Collection of small mammals for tissue analyses of contaminant concentrations (Task 9) will occur at the conclusion of the spring and fall live-trapping session according to EE.06.
- Field surveys of reptiles and amphibians according to OPS-EE.08, Sampling of Reptiles and Amphibians. Collection for tissue analysis in not anticipated.

- Field surveys and composite samples of terrestrial arthropods to estimate relative abundance and tissue analysis according to OPS-EE.09, Sampling of Terrestrial Arthropods.
- Vegetation surveys and sampling to provide estimates of species composition, richness, dominance, cover, production, and for tissue analysis according to OPS-EE.10, Sampling of Vegetation.

Aquatic habitats within OU7 are limited to the leachate channel from the landfill, the East Landfill Pond, and the unnamed tributary to Walnut Creek. Aquatic habitats will be sampled to assess species composition, relative abundance, and contaminant loads of fish and benthic macroinvertebrates for use in contaminant pathway models and food web analysis. Aquatic sampling stations are shown in figure 9.6 of the OU7 Workplan. Sampling will consist of the following:

- Periphyton and plankton will be sampled to determine species composition and estimate production by standing crop measurement in the East Landfill Pond and the unnamed tributary to Walnut Creek (flow permitting) according to OPS-EE.01, Sampling of Periphyton, and OPS-EE.03, Sampling of Plankton.
- Benthos communities will be sampled to determine the composition and relative abundance of species present and to provide composite samples of select taxa for tissue analysis according to OPS-EE.02, Sampling of Benthic Macroinvertebrates. Sampling sites will include locations on the East Landfill Pond and reaches of the unnamed tributary to Walnut Creek.
- Fish surveys and sampling for tissue analysis will be done in East Landfill Pond and streams according to OPS-EE.04, Sampling of Fishes.

Aquatic toxicity testing will also be conducted to evaluate the toxicity of surface water originating from OU7. This will be conducted according to a procedure that will be developed and included in the Ecology SOPs for the Environmental Restoration Program and Rocky Flats.

Reference areas for the EE investigations will be selected according to OPS-EE.13, Development of Filed Sampling Plans, primarily for tissue sampling tasks.

The data collected from implementation of the field investigations described in the field sampling plan will be used to select target species and contaminants of concern for contamination assessments and ecotoxicological studies. This data will in turn be used in the ecological risk assessment to determine the nature and extent of potential impacts of OU7 contaminants on biota.

### 3.6 Equipment Decontamination

Non-dedicated sampling equipment shall be decontaminated between sampling locations in accordance with OPS-FO.03, General Equipment Decontamination. Other equipment (e.g., heavy equipment) potentially contaminated during drilling, hydrogeologic/geologic testing, boring, sample collection, etc. shall also be decontaminated as specified in OPS-FO.04, Heavy Equipment Decontamination.

### 3.7 Air Quality

Air monitoring will be performed during implementation of field activities that have the potential to create windblown dispersion of contaminants, including drilling, coring, and installation of boreholes and monitoring wells. Air monitoring will be conducted to ensure that RFI/RI activities at OU7 comply with the RFP Interim Plan for Prevention of Contaminant Dispersion. Air monitoring will be conducted according to OPS-FO.01, Wind Blown Contaminant Dispersion Control.

### 3.8 Quality Control Samples

To assure the quality of the field sampling techniques, collection and/or preparation of field quality control (QC) samples are incorporated into the sampling scheme. Field QC samples and collection frequencies for the field investigations are shown in Table 2. A specific sampling schedule will be prepared by the sampling subcontractor for approval by the EG&G Laboratory Analysis Task Leader (Figure 1) prior to sampling.

In addition, a QC sample, which will consist of an extra volume of a designated field sample, shall be collected at a 5-percent frequency for each specific sample matrix. These QC samples shall be collected and submitted to the laboratory to allow for the analysis of laboratory prepared QC

samples to provide the laboratory with a check on its internal operations. The volume required for the QC sample shall be double that of a normal sample.

3.8.1 Objectives for Field QC Samples:

Equipment rinsate blanks are considered acceptable (with no need for data qualification) if the concentration of analytes of interest is less than three times the method detection limit for each analyte as specified in Appendix A. Field duplicate samples shall agree within 30 percent relative percent difference for aqueous samples and 40 percent for homogenous, non-aqueous samples.

Trip blanks and field preservation blanks (for organics and inorganics, respectively) indicate possible field contamination when analytes are detected above the minimum detection limits presented in Appendix A. The Laboratory Analysis Task Leader (Figure 1) is responsible for verifying these criteria and shall be responsible for checking to see if they are met and for qualifying data.

3.8.2 Laboratory QC

Laboratory QC procedures are used to provide measures of internal consistency of analytical and storage procedures. The laboratory contractor will submit written SOPs to the EG&G Laboratory Analysis Task Leader for approval. The interlaboratory SOPs shall be consistent with or equivalent to EPA-CLP QC procedures. The laboratory SOPs must cover the following areas in sufficient detail and reflect actual operating conditions in effect during analysis of EG&G RFP samples:

- Sample receipt and log-in
- Sample storage and security
- Facility security
- Sample tracking (from receipt to sample disposition)
- Sample analysis method references
- Data reduction, verification, and reporting
- Document control (including submitting documents to EG&G)
- Data package assembly (see Section III.A of the GRRASP)

# TABLE 2
# FIELD QC SAMPLE COLLECTION FREQUENCY

| Activity | Frequency |
|---|---|
| Field Duplicate | 1 in 10 or 1 per sampling event[1] |
| Field Preservation Blanks[2] | 1 sample per shipping container (or a minimum of 1 per 20 samples) |
| Trip Blank[3] | 1 in 20 |
| Equipment Rinsate Blank | 1 in 20 or 1 per day[4] |
| Triplicate Samples (benthic samples)[5] | For each sampling site. |

1. Or per sampling event, whichever is more frequent.
2. For samples to be analyzed for inorganics.
3. For samples to be analyzed for volatile organics only. A trip blank shall not be used for radiochemistry samples because radionuclide samples are less likely to be contaminated from direct exposure to air than are samples of volatile organics.
4. One equipment rinsate blank in twenty samples or one per day, whichever is more frequent, for each specific sample matrix being collected when non-dedicated equipment is being used.
5. For samples collected for tissue analysis.

- Qualifications of personnel and resumes
- Preparation of standards
- Equipment maintenance and calibration
- List of instrumentation and equipment (including date purchased, date installed, model number, manufacturer, and service contracts, if any)
- Instrument detection limits
- Acceptance criteria for non-CLP analyses
- Laboratory QC checks applicable to each analytical method

Laboratory QC techniques to ensure consistency and validity of analytical results (including detecting potential laboratory contamination of samples) include using reagent blanks, field blanks, internal standard reference materials, laboratory replicate analysis, and field duplicates. The laboratory contractor will follow the standard evaluation guidelines and QC procedures, including frequency of QC checks, that are applicable to the particular type of analytical method being used as specified in Parts A and B of the GRRASP and Section 3.0 of the QAPjP. All data packages will be forwarded to the Laboratory Analysis Task Leader or validation contractor (Figure 1) for review and verification.

## 3.9 Quality Assurance Monitoring

To assure overall quality of each IAG deliverable required by this activity, a Readiness Review will be conducted under the direction of the EM Department QAPM prior to implementing the activities addressed by the OU7 Workplan. The Readiness Review will determine if all activity prerequisites have been met that are required to begin work. The Readiness Review will address work prerequisites contained in this QAA, the QAPjP, the OPS listed in Table 1, the RFP Site Health and Safety Plan, the IAG, and other applicable RFP, local, State, and Federal regulations. Any deficiencies noted during the Readiness Review will be noted in a Corrective Action Report (CAR), which will be processed as outlined in Section 16.0 of the QAPjP.

In addition to readiness reviews, daily inspections will be conducted of the field activities described in the OU7 Workplan by independent personnel under the direction of the Remediation Programs Division (RPD) Quality Coordinator. Any nonconformances or significant conditions adverse to

quality will be noted during these inspections, and Nonconformance Reports (NCRs) and CARs will be issued and processed as outlined in Sections 15.0 and 16.0 of the QAPjP. In addition to these inspections, surveillances and audits will be conducted by independent personnel outside the RPD as outlined in Section 18.0 of this QAA.

## 3.10 Data Reduction, Validation, and Reporting

### 3.10.1 Analytical Reporting Turnaround Times

Analytical reporting turnaround times are as specified in Table 3-1 of Section 3.0 of the QAPjP.

### 3.10.2 Data Reduction

Reduction of laboratory measurements shall be in accordance with the methods specified for each analytical method. Laboratory data will be compiled into sample data packages by the laboratory contractor. A sample data package shall be developed for each sample delivery group or sample batch, with separate data packages for each type of analysis (e.g., a data package for organics, one for inorganics, one for water quality parameters, and one for radionuclides). The sample data package shall consist of a cover sheet/transmittal letter, a case narrative, data summary forms, and copies of the data checklists found in Exhibit I in Parts A and B of the GRRASP. The reduced data will be used in the analytical data validation process to verify that the laboratory control and the overall system DQOs have been met.

### 3.10.3 Data Validation

Validation activities consist of reviewing and verifying field and laboratory data and evaluating these verified data for data quality (i.e., comparison of reduced data to DQOs, where appropriate). The field and laboratory data validation activities and guidelines are described and referenced in Section 3.0 of the QAPjP. The process for validating the quality of the data is illustrated graphically in Figure 3-1 of Section 3.0 of the QAPjP, and is also included as part of the sample collection, chain-of-custody, and analysis process illustrated in Figure 8-1 of the QAPjP. The

criteria for determining the validity of EM Program data at Rocky Flats are described in Section 3.0 of the QAPjP.

3.10.4 Data Reporting

Depending on the data validation process, data are flagged as either "valid," "acceptable with qualifications," or "rejected." The results of the data validation shall be reported in EM Department Data Assessment Summary reports. The usability of data (the criteria of which is also described in Section 3.0 of the QAPjP) shall also be addressed by the RI Project Manager.

## 4.0 PROCUREMENT DOCUMENT CONTROL

Contractors will perform the field investigations described in the OU7 Workplan. Procurement document packages will require the Contractors to implement all requirements contained in the OU7 Workplan, the QAPjP, this QAA, and all applicable SOPs referenced in these documents. Analytical services will also be contracted for analysis of field samples. Appropriate requirements from the QAPjP, this QAA, and the GRRASP shall be passed on to any organizations performing these analyses in the procurement document package. Contractors may also be utilized to validate analytical data packages. Applicable requirements from this QAA shall be transmitted to the validation Contractor.

The implementing Contractors will be required to provide the materials necessary for performing the work described in the OU7 Workplan.

Contractors may be required to submit a QA Program that meets the applicable requirements of the QAPjP and this QAA.

## 5.0 INSTRUCTIONS, PROCEDURES, AND DRAWINGS

The OU7 Workplan describes the activities to be performed. The Workplan will be reviewed and approved in accordance with the requirements for instructions, procedures, and drawings outlined

in Section 5.0 of the QAPjP. Once approved, any changes or revisions to the Workplan will be reviewed and approved as specified in Section 5.0 of the QAPjP.

The OPS that will be adhered to during implementation of the RFI/RI activities described in the OU7 Workplan are listed in Table 1, which also indicates the activities to which they are applicable. The OPS that are listed in Table 1 are subject to the review and approval process outlined in Section 5.0 of the QAPjP prior to initiating the activity for which the procedure is applicable. Any additional procedures proposed for use but not identified in Table 1 will be developed, reviewed, and approved as required in Section 5.0 of the QAPjP prior to performing the applicable activity.

Any changes, modifications, or deviations to approved OPS, either prior to or during field implementation, that are necessary to successfully complete the intended task will be documented by completing and submitting a Document Change Notice (DCN) in accordance with the requirements of Section 5.0 of the QAPjP. (Note: the DCN is referred to as a Procedure Deviation Notice (PDN) in Revision 0 of the QAPjP. The change from PDN to DCN was made to be consistent with other RFP Programs and Operations.)

## 6.0 DOCUMENT CONTROL

The following documents will be controlled in accordance with Section 6.0 of the QAPjP:

- Phase I RFI/RI Work Plan for the Present Landfill (IHSSs 114 and 203), Operable Unit No. 7;
- "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Study and RCRA Facilities Investigation/Corrective Measures Study Activities" (QAPjP);
- Quality Assurance Addendum (QAA) to the Rocky Flats Site-Wide QAPjP for Operable Unit No. 7, Present Landfill Phase I RFI/RI Activities;
- OPS (all OPS specified in the QAPjP, this QAA, and to-be-developed laboratory SOPs).

# 7.0 CONTROL OF PURCHASED ITEMS AND SERVICES

Contractors that provide services to support the OU7 Workplan activities will be selected and evaluated as outlined in Section 7.0 of the QAPjP. This includes preaward evaluation/audit of proposed contractors as well as periodic audit of the acceptability of contractor performance during the life of the contract. Any items or materials that are purchased for use during the OU7 Phase I investigations that have the ability to affect the quality of the data shall be inspected upon receipt.

# 8.0 IDENTIFICATION AND CONTROL OF ITEMS, SAMPLES, AND DATA

## 8.1 Sample Containers/Preservation

Appropriate volumes, containers, preservation requirements, and holding times for samples are presented in Tables 8-1 through 8-4 of Section 8.0 of the QAPjP. Requirements for environmental evaluation tissue samples are included in Table 3 of this QAA.

## 8.2 Sample Identification

RFI/RI samples shall be labeled and identified in accordance with Section 8.0 of the QAPjP and the OPS in Table 1. Samples shall have unique identification that traces the sample to the source(s) and indicates the method(s), date, the sampler(s), and conditions prevailing at the time of sampling. Sample identification requirements for environmental evaluation samples are discussed in the EE Workplan (Section 9 of the OU7 Workplan) and will be specified in the EE field sampling strategy.

## 8.3 Chain-of-Custody

Sample chain-of-custody will be maintained through the application of OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples, and as illustrated in Figure 8-1 of the QAPjP for all environmental samples collected during field investigations.

## TABLE 3

### HOLDING TIMES, PRESERVATION METHODS, AND SAMPLE CONTAINERS FOR BIOTA SAMPLES

| | Holding Time From Date Collected | Preservation Method | Container | Approximate Sample Size* |
|---|---|---|---|---|
| **SAMPLES FOR METALS ANALYSES** | | | | |
| **TERRESTRIAL VEGETATION** | | | | |
| - Metals Determined by ICP** | 6 mos. | Freeze & ship w/dry ice | Paper bag inserted into plastic bag and sealed | 25 g |
| - Metals Determined by GFAA*** | 6 mos. | Freeze & ship w/dry ice | Paper bag inserted into plastic bag and sealed | 25 g |
| - Hexavalent Chromium | 24 hours | Freeze & ship w/dry ice | Paper bag inserted into plastic bag and sealed | 25 g |
| - Mercury | 28 days | Freeze & ship w/dry ice | Paper bag inserted into plastic bag and sealed | 5 g |
| **Periphyton and Benthic Macroinvertebrates** | | | | |
| - Metals Determined by ICP | 6 mos. | Freeze & ship w/dry ice | Plastic | 25 g |
| - Metals Determined by GFAA | 6 mos | Freeze & ship w/dry ice | Plastic | 25 g |
| - Hexavalent Chromium | 24 hours | Freeze & ship w/dry ice | Plastic | 25 g |
| - Mercury | 28 days | Freeze & ship w/dry ice | Plastic | 5 g |

## TABLE 3

### HOLDING TIMES, PRESERVATION METHODS, AND SAMPLE CONTAINERS FOR BIOTA SAMPLES

| | Holding Time From Date Collected | Preservation Method | Container | Approximate Sample Size* |
|---|---|---|---|---|
| **SAMPLES FOR RADIONUCLIDE ANALYSES** | | | | |
| Terrestrial Vegetation | | | | |
| - Uranium 223, 234, 235, 238<br>Americium 241<br>Plutonium 239, 240 | 6 mos | Freeze & ship w/dry ice | Paper bag inserted into plastic bag and sealed | 1 kg |
| Periphyton and Benthic Macroinvertebrates | | | | |
| - Uranium 233, 234, 235, 238<br>Americium 241<br>Plutonium 239, 240 | 6 mos | Freeze & ship w/dry ice | Plastic | 1 kg |

* Sample size may vary with specific laboratory requirements.

**ICP = Inductively Coupled Argon Plasma Emission Spectroscopy. Metals to be determined include Ba, Cr, Cu, and Fe.

***GFAA = Graphite Furnace Atomic Absorption Spectroscopy. Metals to be determined include As, Cd, Li, Pb, Se, and Sr.

## 9.0 CONTROL OF PROCESSES

The overall process of collecting samples, performing analysis, and inputting the data into a database is considered a process that requires control. The process is controlled through a series of written procedures that govern and document the work activities. The process is illustrated diagrammatically in Section 8.0 of the QAPjP.

## 10.0 INSPECTION

Procured materials and construction activities (e.g., groundwater monitoring well installation) shall be inspected (as applicable) in accordance with the requirements specified in Section 10.0 of the QAPjP.

## 11.0 TEST CONTROL

Test control requirements specified in Section 11.0 of the QAPjP are not applicable to any of the Phase I RFI/RI investigations described in the OU7 Workplan.

## 12.0 CONTROL OF MEASURING AND TEST EQUIPMENT (M&TE)

### 12.1 Field Equipment

Temperature, specific conductivity, pH, and dissolved oxygen, chlorine, turbidity, and alkalinity content of water samples shall be measured in the field. Field measurements will be taken and the instruments calibrated as specified in OPS-SW.02 (see Table 1). Measurements shall be made using the following equipment (or EG&G-approved alternates):

- Temperature: mercury-filled, teflon-coated safety type thermometer (VWR Catalogue No. 6107-823 or equivalent) or digital readout thermistor (VWR Catalogue No. 61017-562 or equivalent)
- Specific Conductivity: HACH 44600 Conductivity/TDS Meter
- Dissolved Oxygen: HACH or YSI Model 57 Dissolved Oxygen Meter

- pH: HACH One pH Meter (this meter will also be used for temperature measurements)
- Chlorine and Turbidity: HACH DR 2000 Spectrophotometer
- Alkalinity: HACH digital titrator

In addition to the field measurements for water quality, field measurements for radiation, soil gas, and VOCs in ground water will also be made. The following instruments will be used for these measurements.

- Radiological field readings for field survey grid locations and drill cuttings, core, and samples: A side-shielded field instrument for detection of low energy radiation (FIDLER), Ludlum Model 12-1A or equivalent. Use, calibration, and maintenance according to OPS-FO.16, Field Radiological Measurements.
- Field readings for soil gas and VOCs in groundwater: A portable photoionization detector (PID), HNU Systems P1-101 or equivalent. Use, calibration, and maintenance according to OPS-FO.15, Photoionization Detectors (PIDs) and Flame Ionization Detectors (FIDs).

Each piece of field equipment shall have a file that contains:

- Specific model and instrument identification numbers;
- Operating instructions;
- Routine preventative maintenance procedures, including a list of critical spare parts to be provided or available in the field;
- Calibration methods, frequency, and description of the calibration solutions; and
- Standardization procedures (traceability to nationally recognized standards).

The above information shall, in general, conform to the manufacturer's recommended operating instructions or shall explain the deviation from said instructions.

### 12.2 Laboratory Equipment

Laboratory analyses will be performed by contracted laboratories. The equipment used to analyze environmental samples shall be calibrated, maintained, and controlled in accordance with the

requirements contained in the specific analytical protocols used as specified in Parts A and B of the GRRASP. This information will be supplied to EG&G as a laboratory SOP.

## 13.0 HANDLING, STORAGE, AND SHIPPING

Samples shall be packaged, transported, and stored in accordance with OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Maximum sample holding times, sample preservative, sample volumes, and sample containers are specified in Section 8.0 of the QAPjP. Sample handling and storage controls at the laboratory shall be provided as a laboratory SOP.

## 14.0 STATUS OF INSPECTION, TEST, AND OPERATIONS

The requirements for the identification of inspection, test, and operating status shall be implemented as specified in Section 14.0 of the QAPjP. A log specifying the status of all boreholes and groundwater monitoring wells shall be maintained by the Field Activities Task Leader, which will include: well/borehole identification number, ground elevation, casing depth of hole, depth to bedrock, static water level (as applicable), depth to top and bottom of screen (as applicable), diameter of hole, diameter of casing, and top/bottom of casing.

## 15.0 CONTROL OF NONCONFORMANCES

The requirements for the identification, control, evaluation, and disposition of nonconforming items, samples, and data will be implemented as specified in Section 15.0 of the QAPjP. Nonconformances identified by the implementing contractor shall be submitted to EG&G for processing as outlined in the QAPjP.

## 16.0 CORRECTIVE ACTION

The requirements for the identification, documentation, and verification of corrective actions for conditions adverse to quality will be implemented as outlined in Section 16.0 of the QAPjP.

Conditions adverse to quality identified by the implementing contractor shall be documented and submitted to EG&G for processing as outlined in the QAPjP.

## 17.0 QUALITY ASSURANCE RECORDS

QA records will be controlled in accordance with the SOP 1.2, Field Document Control. QA records to be generated during OU7 Phase I activities include, but are not limited to:

- Field Logs and Data Record Forms (e.g., sample collection notebooks/logs for water, sediment, and air)
- Calibration Records
- Sample Collection and Chain-of-Custody Records
- Laboratory Sample Data Packages
- Drilling Logs
- Work Plan/Field Sampling Plan
- QAPjP/QAA
- Audit/Surveillance/Inspection Reports
- Nonconformance Reports
- Corrective Action Documentation
- Data Validation Results
- Data Reports
- Procurement/Contracting Documentation
- Training/Qualification Records
- Inspection Records

## 18.0 QUALITY VERIFICATION

The requirements for the verification of quality shall be implemented as specified in Section No. 18 of the QAPjP. EG&G will conduct audits of the laboratory contractor as specified in the GRRASP. The EMD QAPM shall develop a surveillance schedule with the surveillance intervals based on the importance and complexity of each sampling/analytical activity. Intervals will also be based on the schedule contained in Section 9.0 of the OU7 Workplan.

Specific tasks that will be monitored by the surveillance program are as follows: (the following are presented as examples)

- Borings and well installations (approximately 10 percent of the holes)
- Field Sampling (approximately 5 percent of each type of sample collected)
- Records Management (a surveillance will be conducted once at the initiation of OU7 activities, and monthly thereafter)
- Data Verification, validation, and reporting

Audits of Contractors providing field investigation, construction, and analytical support services shall be performed at least annually or once during the life of the project, whichever is more frequent.

A Readiness Review shall be conducted by the EMD QAPM prior to the implementation of OU7 field investigation activities. The readiness review will determine if all activity prerequisites have been met that are required to begin work. The applicable requirements of the QAPjP and this QAA will be addressed.

## 19.0 SOFTWARE CONTROL

The requirements for the control of software shall be implemented as specified in Section 19.0 of the QAPjP. Only database software is anticipated to be used for the OU7 Workplan activities. OPS applicable to the use of the database storing environmental data are OPS-FO.14, Field Data Management.

# APPENDIX A

## Analytical Methods, Detection Limits, and Data Quality Objectives

# ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

| Analyte | Method | SW | GW | SOIL | SED | Required Detection Limits Water | Required Detection Limits Soil/Sed. | Precision Objective | Accuracy Objective |
|---|---|---|---|---|---|---|---|---|---|
| **INDICATORS** | | | | | | | | | |
| Total Suspended Solids | EPA 160.2[d] | X[U] | | | | 10 mg/L | NA | 20%RPD[I] | 80-120% LCS Recovery |
| Total Dissolved Solids | EPA 160.1[d] | X[F] | X[F] | | | 5 mg/L | NA | 20%RPD[I] | 80-120% LCS Recovery |
| **INORGANICS** | | | | | | | | | |
| Target Analyte List - Metals | | X[F] | X[F] | X | X | | | WATER/SOIL | WATER/SOIL |
| Aluminum | EPA CLP SOW[e] | | | | | 200 ug/L[4] | 40 mg/Kg[4] | ** | *** |
| Antimony | EPA CLP SOW[e] | | | | | 60 | 12 | | |
| Arsenic (GFAA) | EPA CLP SOW[e] | | | | | 10 | 2 | | |
| Barium | EPA CLP SOW[e] | | | | | 200 | 40 | | |
| Beryllium | EPA CLP SOW[e] | | | | | 5 | 1.0 | | |
| Cadmium | EPA CLP SOW[e] | | | | | 5 | 1.0 | | |
| Calcium | EPA CLP SOW[e] | | | | | 5000 | 2000 | | |
| Chromium | EPA CLP SOW[e] | | | | | 10 | 2.0 | | |
| Cobalt | EPA CLP SOW[e] | | | | | 50 | 10 | | |
| Copper | EPA CLP SOW[e] | | | | | 25 | 5.0 | | |
| Cyanide | EPA 335.3 (modified for CLP)[e,d] | | | | | 5 | 10 | | |
| Iron | EPA CLP SOW[e] | | | | | 100 | 20 | | |
| Lead (GFAA) | EPA CLP SOW[e] | | | | | 3 | 1.0 | | |
| Magnesium | EPA CLP SOW[e] | | | | | 5000 | 2000 | | |
| Manganese | EPA CLP SOW[e] | | | | | 15 | 3.0 | | |
| Mercury (CVAA) | EPA CLP SOW[e] | | | | | 0.2 | 0.2 | | |
| Nickel | EPA CLP SOW[e] | | | | | 40 | 8.0 | | |
| Potassium | EPA CLP SOW[e] | | | | | 5000 | 2000 | | |
| Selenium (GFAA) | EPA CLP SOW[e] | | | | | 5 | 1.0 | | |
| Silver | EPA CLP SOW[e] | | | | | 10 | 2.0 | | |
| Sodium | EPA CLP SOW[e] | | | | | 5000 | 2000 | | |
| Thallium (GFAA) | EPA CLP SOW[e] | | | | | 10 | 2.0 | | |
| Vanadium | EPA CLP SOW[e] | | | | | 50 | 10 | | |
| Zinc | EPA CLP SOW[e] | | | | | 20 | 4.0 | | |

# ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

| Analyte | Method | SW | GW | SOIL | SED | Required Detection Limits Water | Required Detection Limits Soil/Sed. | Precision Objective | Accuracy Objective |
|---|---|---|---|---|---|---|---|---|---|
| Other Metals | | X[U] | X[F] | X | X | | | WATER/SOIL | WATER/SOIL |
| Molybdenum | EPA CLP SOW[b] (ICAP) | | | | | 8 ug/L[4] | 40 mg/Kg[4] | ** | *** |
| Cesium | EPA CLP SOW[b] | | | | | 1000 | 200 | | |
| Strontium | EPA CLP SOW[b] | | | | | 200 | 40 | | |
| Lithium | EPA CLP SOW[b] | | | | | 100 | 20 | | |
| Tin | EPA CLP SOW[b] | | | | | 200 | 40 | | |
| Other Inorganics | | | | | | | | | |
| Percent Solids | EPA 160.3[d] | | | X | X | NA | 10 mg | NA | NA |
| Sulfide | EPA 376.1[d] | | | X | X | NA | 4 ug/g | Same as metals | Same as metals |
| TOTAL ORGANIC CARBON | EPA 9060[e] | X[U] | X[U] | X | X | 1 mg/L | 1 mg/L | ** | *** |
| ANIONS | | | | | | | | WATER/SOIL | WATER/SOIL |
| Carbonate | EPA 310.1[d] | X[U] | X[U] | | | 10 mg/L | NA | Same as metals | Same as metals |
| Bicarbonate | EPA 310.1[d] | X[U] | X[U] | | | 10 mg/L | NA | | |
| Chloride | EPA 325.2[d] | X[U] | X[U] | | | 5 mg/L | NA | | |
| Sulfate | EPA 375.4[d] | X[U] | X[U] | | | 5 mg/L | NA | | |
| Nitrate as N | EPA 353.2[d] or 353.3[d] | X[U] | X[U] | | | 1 mg/L | NA | | |
| Fluoride | EPA 340.2[d] | X[U] | X[U] | | | 5 mg/L | NA | | |
| Oil and Grease | EPA 413.2[d] | X[U] | | | | 5 mg/L | NA | ** | *** |
| Target Compound List - Volatiles | EPA CLP SOW[c] | X[U] | X[U] | X | X | | | WATER/SOIL | WATER/SOIL |
| Chloromethane | EPA CLP SOW[c] | | | | | 10 ug/L | 10 ug/Kg (low)[3] | ** | *** |
| Bromomethane | EPA CLP SOW[c] | | | | | 10 | 10 | | |
| Vinyl Chloride | EPA CLP SOW[c] | | | | | 10 | 10 | | |
| Chloroethane | EPA CLP SOW[c] | | | | | 10 | 10 | | |
| Methylene Chloride | EPA CLP SOW[c] | | | | | 5 | 5 | | |

# ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

| Analyte | Method | SW | GW | SOIL | SED | Required Detection Limits Water | Required Detection Limits Soil/Sed. | Precision Objective | Accuracy Objective |
|---|---|---|---|---|---|---|---|---|---|
| Target Compound List - Volatiles (continued) | | X[U] | X[U] | X | X | | | WATER/SOIL | WATER/SOIL |
| Acetone | EPA CLP SOW[C] | | | | | 10 ug/L | 10 ug/Kg(low)[3] | ** | *** |
| Carbon Disulfide | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| 1,1-Dichloroethene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| 1,1-Dichororethane | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| total 1,2-Dichloroethene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Chloroform | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| 1,2-Dichloroethane | EPA CLP SOW[C] | | | | | 1 | 5 | | |
| 2-Butanone | EPA CLP SOW[C] | | | | | 10 | 10 | | |
| 1,1,1-Trichoroethane | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Carbon Tetrachloride | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Vinyl Acetate | EPA CLP SOW[C] | | | | | 10 | 10 | | |
| Bromodichloromethane | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| 1,2-Dichloropropane | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| cis-1,3-Dichloropropene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Trichloroethene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Dibromochloromethane | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| 1,1,2-Trichloroethane | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Benzene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| trans-1,2-Dichloropropene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Bromoform | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| 4-Methyl-2-pentanone | EPA CLP SOW[C] | | | | | 10 | 10 | | |
| 2-Hexanone | EPA CLP SOW[C] | | | | | 10 | 10 | | |
| Tetrachloroethene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Toluene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| 1,1,2,2-Tetrachoroethane | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Chlorobenzene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Ethyl Benzene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Styrene | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Total Xylenes | EPA CLP SOW[C] | | | | | 5 | 5 | | |
| Target Compound List - Semi-Volatiles | | | X[U] | X | X | | | WATER/SOIL | WATER/SOIL |
| Phenol | EPA CLP SOW[C] | | | | | 10 ug/L | 330 ug/Kg[3] | ** | *** |
| bis(2-Chloroethyl)ether | EPA CLP SOW[C] | | | | | 10 | 330 | | |

# ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

| Analyte | Method | SW | GW | SOIL | SED | Required Detection Limits Water | Required Detection Limits Soil/Sed. | Precision Objective | Accuracy Objective |
|---|---|---|---|---|---|---|---|---|---|
| Target Compound List - Semi-Volatiles (continued) | | | X[u] | X | X | | | WATER/SOIL | WATER/SOIL |
| 2-Chlorophenol | EPA CLP SOW[c] | | | | | 10ug/L | 330 ug/Kg[3] | ** | *** |
| 1,3-Dichlorobenzene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 1,4-Dichlorobenzene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| Benzyl Alcohol | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 1,2-Dichlorobenzene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 2-Methylphenol | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| bis(2-Chloroisopropyl)ether | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 4-Methylphenol | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| N-Nitroso-Dipropylamine | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| Hexachloroethane | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| Nitrobenzene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| Isophorone | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 2-Nitrophenol | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 2,4-Dimethylphenol | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| Benzoic Acid | EPA CLP SOW[c] | | | | | 50 | 1600 | | |
| bis(2-Choroethoxy)methane | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 2,4-Dichlorophenol | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 1,2,4-Trichlorobenzene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| Naphthalene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 4-Chloroanaline | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| Hexachlorobutadiene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 4-Chloro-3-methylphenol | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 2-Methylnaphthalene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| Hexachlorocyclopentadiene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 2,4,6-Trichlorophenol | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 2,4,5-Trichlorophenol | EPA CLP SOW[c] | | | | | 50 | 1600 | | |
| 2-Chloronaphthalene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 2-Nitroanaline | EPA CLP SOW[c] | | | | | 50 | 1600 | | |
| Dimethylphthalate | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| Acenaphthylene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 2,6-Dinitrotoluene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 3-Nitroaniline | EPA CLP SOW[c] | | | | | 50 | 1600 | | |
| Acenaphthene | EPA CLP SOW[c] | | | | | 10 | 330 | | |
| 2,4-Dinitrophenol | EPA CLP SOW[c] | | | | | 50 | 1600 | | |
| 4-Nitrophenol | EPA CLP SOW[c] | | | | | 50 | 1600 | | |

# ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

| Analyte | Method | SW | GW | SOIL | SED | Required Detection Limits Water | Required Detection Limits Soil/Sed. | Precision Objective | Accuracy Objective |
|---|---|---|---|---|---|---|---|---|---|
| Target Compound List - Semi-Volatiles (continued) | | | X[U] | X | X | | | WATER/SOIL | WATER/SOIL |
| Dibenzofuran | EPA CLP SOW[C] | | | | | 10ug/L | 330 ug/Kg[3] | ** | *** |
| 2,4-Dinitrotoluene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Diethylphthalate | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| 4-Chlorophenol Phenyl ether | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Fluorene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| 4-Nitroanaline | EPA CLP SOW[C] | | | | | 50 | 1600 | | |
| 4,6-Dinitro-2-methylphenol | EPA CLP SOW[C] | | | | | 50 | 1600 | | |
| N-nitrosodiphenylamine | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| 4-Bromophenyl Phenyl ether | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Hexachlorobenzene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Pentachlorophenol | EPA CLP SOW[C] | | | | | 50 | 1600 | | |
| Phenanthrene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Anthracene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Di-n-butylphthalate | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Fluoranthene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Pyrene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Butyl Benzylphthalate | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| 3,3'-Dichlorobenzidine | EPA CLP SOW[C] | | | | | 20 | 660 | | |
| Benzo(a)anthracene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Chrysene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| bis(2-ethylhexyl)phthalate | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Di-n-octyl Phthalate | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Benzo(b)fluoranthene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Benzo(k)fluoranthene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Benzo(a)pyrene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Indeno(1,2,3-cd)pyrene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Dibenz(a,h)anthracene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Benzo(g,h,i)perylene | EPA CLP SOW[C] | | | | | 10 | 330 | | |
| Target Compound List - Pesticides/PCBs | | | X[U] | X | X | | | WATER/SOIL (%RPD) | WATER/SOIL (% Recovery) |
| alpha-BHC | EPA CLP SOW[C] | | | | | 0.05 ug/L | 8.0 ug/Kg[3] | ** | *** |
| beta-BHC | EPA CLP SOW[C] | | | | | 0.05 | 8.0 | | |
| delta-BHC | EPA CLP SOW[C] | | | | | 0.05 | 8.0 | | |

# ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

| Analyte | Method | SW | GW | SOIL | SED | Required Detection Limits Water | Required Detection Limits Soil/Sed. | Precision Objective | Accuracy Objective |
|---|---|---|---|---|---|---|---|---|---|
| Target Compound List - Pesticides/PCBs (continued) | | | X[U] | X | X | | | WATER/SOIL (%RPD) | WATER/SOIL (% Recovery) |
| gamma-BHC (Lindane) | EPA CLP SOW[C] | | | | | 0.05ug/L | 8.0ug/Kg[3] | ** | *** |
| Heptachlor | EPA CLP SOW[C] | | | | | 0.05 | 8.0 | | |
| Aldrin | EPA CLP SOW[C] | | | | | 0.05 | 8.0 | | |
| Heptachlor Epoxide | EPA CLP SOW[C] | | | | | 0.05 | 8.0 | | |
| Endosulfan I | EPA CLP SOW[C] | | | | | 0.05 | 8.0 | | |
| Dieldrin | EPA CLP SOW[C] | | | | | 0.10 | 16.0 | | |
| 4,4'-DDE | EPA CLP SOW[C] | | | | | 0.10 | 16.0 | | |
| Endrin | EPA CLP SOW[C] | | | | | 0.10 | 16.0 | | |
| Endosulfan II | EPA CLP SOW[C] | | | | | 0.10 | 16.0 | | |
| 4,4'-DDD | EPA CLP SOW[C] | | | | | 0.10 | 16.0 | | |
| Endosulfan Sulfate | EPA CLP SOW[C] | | | | | 0.10 | 16.0 | | |
| 4,4'-DDT | EPA CLP SOW[C] | | | | | 0.10 | 16.0 | | |
| Methoxychlor | EPA CLP SOW[C] | | | | | 0.5 | 80.0 | | |
| Endrin Ketone | EPA CLP SOW[C] | | | | | 0.10 | 16.0 | | |
| alpha-Chlordane | EPA CLP SOW[C] | | | | | 0.5 | 80.0 | | |
| gamma-Chlordane | EPA CLP SOW[C] | | | | | 0.5 | 80.0 | | |
| Toxaphene | EPA CLP SOW[C] | | | | | 1.0 | 160.0 | | |
| AROCLOR-1016 | EPA CLP SOW[C] | | | | | 0.5 | 80.0 | | |
| AROCLOR-1221 | EPA CLP SOW[C] | | | | | 0.5 | 80.0 | | |
| AROCLOR-1232 | EPA CLP SOW[C] | | | | | 0.5 | 80.0 | | |
| AROCLOR-1242 | EPA CLP SOW[C] | | | | | 0.5 | 80.0 | | |
| AROCLOR-1248 | EPA CLP SOW[C] | | | | | 0.5 | 80.0 | | |
| AROCLOR-1254 | EPA CLP SOW[C] | | | | | 1.0 | 160.0 | | |
| AROCLOR-1260 | EPA CLP SOW[C] | | | | | 1.0 | 160.0 | | |
| RADIONUCLIDES | | | | | | | | (Replicate Analyses) | (Laboratory Control Sample) |
| Gross Alpha | f,g,h,i,k,l,m,n,s | X[F,U] | X[F] | X | X | 2 pCi/L | 4 pCi/g | ** | *** |
| Gross Beta | f,g,h,i,k,l,m,n,s | X[F,U] | X[F] | X | X | 4 pCi/L | 10 pCi/g | | |
| Uranium 233+234 | f,h,i,m,n,l,s | X[F,U] | X[F] | X | X | 0.6 pCi/L | 0.3 pCi/g | | |
| Uranium 235,238 | f,h,i,m,n,l,s | X[F,U] | X[F] | X | X | 0.6 pCi/L | 0.3 pCi/g | | |
| Americium 241 | i,l,p,q,s | X[F,U] | X[F] | X | X | 0.01 pCi/L | 0.02 pCi/g | | |
| Plutonium 239+240 | i,l,o,p,s | X[F,U] | X[F] | X | X | 0.01 pCi/L | 0.03 pCi/g | | |

# ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

| Analyte | Method | SW | GW | SOIL | SED | Required Detection Limits Water | Required Detection Limits Soil/Sed. | Precision Objective | Accuracy Objective |
|---|---|---|---|---|---|---|---|---|---|
| Target Compound List - Pesticides/PCBs (continued) | | | $X^U$ | X | X | | | WATER/SOIL (%RPD) | WATER/SOIL (% Recovery) |
| Tritium | f,g,h,m,i,l,s | $X^U$ | $X^U$ | X | X | 400 pCi/L | 400 pCi/L | | |
| Strontium 89,90 | f,h,i,m,s,l | | | X | X | NA | 1 pCi/g | | |
| Strontium 90 only | f,h,i,m | $X^{F,U}$ | $X^F$ | | | 1 pCi/L | NA | | |
| Cesium 137 | n,i,l,m | $X^{F,U}$ | $X^F$ | X | X | 1 pCi/L | 0.1 pCi/g | | |
| Radium 226 | f,g,h,m[6],i,s,l | $X^{F,U}$ | $X^F$ | | | 0.5 pCi/L | 0.5 pCi/g | | |
| Radium 228 | f,g,h,m[6],i,s,l | $X^{F,U}$ | $X^F$ | | | 1 pCi/L | 0.5 pCi/g | | |
| | | | | | | Detection Limit | | | |
| SOIL GAS PARAMETERS | • | | | X | | 1 mg/L | | | |
| methylene chloride | | | | | | | | | |
| methane | | | | | | | | | |
| hydrogen sulfide | | | | | | | | | |
| chloroform | | | | | | | | | |
| benzene | | | | | | | | | |
| toluene | | | | | | | | | |
| 1,1,1-TCA | | | | | | | | | |
| TCE | | | | | | | | | |

# ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

| Analyte | Method | SW | GW | SOIL | SED | Readability Objective | Accuracy |
|---|---|---|---|---|---|---|---|
| **FIELD PARAMETERS** | | | | | | | |
| pH | 1 | X | X | | | ± 0.1 pH unit | ± 0.2 pH units |
| Specific Conductance | 1 | X | X | | | 2.5 umho/cm[7]<br>25 umho/cm[8]<br>250 umho/cm[9] | ± 2.5% max. error at 500, 5000, 50000 umhos/cm plus probe;<br>± 3.0% max error at 250, 2500, and 25000 plus probe accuracy of ± 2.0%. |
| Temperature | 1 | X | X | | | ± 0.1°C | ± 1.0°C |
| Dissolved Oxygen | 1 | X | | | | ± 0.1 mg/L | ± 10% |
| Barometric Pressure | 1 | | | | | | |

# ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

* Method of analysis for soil gas parameters consists of using a Photovac portable Photoionization Detector Gas Chromatograph.
** Precision objective = control limits specified in referenced method and/or Data Validation Guidelines.
*** Accuracy objective = control limits specified in referenced method (in GRRASP for radionuclides).
F = Filtered
U = Unfiltered

1. Measured in the field in accordance with instrument manufacturer's instructions. The instruments to be used are specified in Section 12.
2. Medium soil/sediment required detection limits for pesticide/PCB TCL compounds are 15 times the individual low soil/sediment required detection limit.
3. Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.
4. Higher detection limits may only be used in the following circumstance: If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the required detection limit. This is illustrated in the example below:

   For lead:

   Method in use - ICP
   Instrument Detection Limit (IDL) - 40
   Sample Concentration - 220
   Required Detection Limit (RDL) - 3

   The value of 220 may be reported even though the instrument detection limit is greater than the RDL.

   Note: The specified detection limits are based on a pure water matrix. The detection limits for samples may be considerably higher depending on the sample matrix.
5. If gross alpha > 5 pCi/L, analyze for Radium 226; if Radium 226 > 3 pCi/L, analyze for Radium 228.
6. The detection limits presented were calculated using the formula in N.R.C. Regulatory Guide 4.14, Appendix Lower Limit of Detection, pg. 21, and follow:

$$LLD = \frac{4.66\ (BKG/BKG\ DUR)^{1/2}}{(2.22)(Eff)(CR)(SR)(e^{-\lambda t})(Aliq)}$$

$$MDA = \frac{4.66\ (BKG/Sample\ DUR)^{1/2}}{(2.22)(Eff)(CR)(SR)e^{-\lambda t}(Aliq)}$$

Where:

LLD = Lower Limit of Detection in pCi per sample unit.
BKG = Instrument Background in counts per minute (CPM).
Eff = Counting efficiency in cpm/disintegration per minute (dpm).
CR = Fractional radiochemical yield.
SR = Fractional radiochemical yield of a known solution.
$\lambda$ = The radioactive decay constant for the particular radionuclide.
t = The elapsed time between sample collection and counting.
Aliq = Sample volume.
BKG DUR = Background count duration in minutes.

MDA = Minimum Detectable Activity in pCi per sample unit
BKG = same as for LLD
Eff = same as for LLD
CR = same as for LLD
SR = same as for LLD
$\lambda$ = same as for LLD
t = same as for LLD
Aliq = same as for LLD
Sample DUR = sample count duration in minutes

# ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

7. On 500 umho/cm range.
8. On 5000 umho/cm range.
9. On 50000 umho/cm range.

a. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version).
b. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version). The specific method to be utilized is at the laboratory's discretion provided it meets the specified detection limit.
c. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, 2/88 (or latest version).
d. Methods are from "Methods for Chemical Analysis of Water and Wastes," U.S. Environmental Protection Agency, 1983, unless otherwise indicated.
e. Methods are from "Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods," (SW-846, 3rd Ed.), U.S. Environmental Protection Agency.
f. U.S. Environmental Protection Agency, 1979, Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No. EMSL-LV-0539-1, Las Vegas, NV, U.S. Environmental Protection Agency.
g. American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985. Standard Methods for the Examination of Water and Wastewater, 16th ed., Washington, D.C., Am. Public Health Association.
h. U.S. Environmental Protection Agency, 1976. Interim Radiochemical Methodology for Drinking Water, Report No. EPA-600/4-75-008. Cincinnati U.S. Environmental Protection Agency.
i. Harley, J.H., ed., 1975, HASL Procedures Manual, HASL-300; Washington, D.C., U.S. Energy Research and Development Administration.
j. EPA, 1982. "Methods for Organic Analysis of Municipal and Industrial Waste Water," US EPA-600/4-82-057.
k. "Handbook of Analytical Procedures," USAEC, Grand Junction Lab. 1970, page 196.
l. "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, August 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.
m. "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," U.S.G.S. Book 5, Chapter A5, 1977.
n. "Acid Dissolution Method for the Analysis of Plutonium in Soil," EPA-600/7-79-081, March 1979, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979.
o. "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium, and Americium," by E.H. Essington and B.J. Drennon, Los Alamos National Laboratory, a private communication.
p. "Isolation of Americium from Urine Samples," Rocky Flats Plant, Health, Safety, and Environmental Laboratories.
q. "Radioactivity in Drinking Water," EPA 570/9-81-002.
r. If the sample or duplicate result is <5 x IDL, then the control limit is ± IDL.
s. U.S. EPA, 1987. "Eastern Environmental Radiation Facility Radiochemistry Procedures Manual," EPA-520/5-84-006.

This is a
CONTROLLED DOCUMENT

ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203

Manual No.: 21100-WP-OU 07.01
Section No.: 1.0 R0

Organization: Environmental Management

EG&G — ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT DEPARTMENT
This Document Contains

Title: Standard Operating Procedures and Addenda

Approved by:

| | | |
|---|---|---|
| 12/6/91 | | 6/20/92 |
| Effective Date | Manager | Date |

## 11.0 STANDARD OPERATING PROCEDURES AND ADDENDA

The following RFP program-wide SOPs will be utilized during the specific field investigations for OU7:

1.1 Windblown Contaminant Dispersion Control
1.2 Field Document Control
1.3 General Equipment Decontamination
1.4 Heavy Equipment Decontamination
1.5 Handling Purge and Development Water
1.6 Handling of Personal Protective Equipment
1.7 Handling of Decontamination Water and Wash Water
1.8 Handling of Drilling Fluids and Cuttings
1.9 Handling of Residual Samples
1.10 Receiving, Labeling, and Handling of Waste Containers
1.11 Field Communications
1.12 Decontamination Facility Operations
1.13 Containerizing, Preserving, Handling, and Shipping Soil and Water Samples
1.14 Field Data Management
1.15 Use of Photoionizing and Flame Ionizing Detectors
1.16 Field Radiological Measurements
2.1 Water Level Measurements in Wells and Piezometers
2.2 Well Development
2.3 Pump-In Borehole Packer Tests
2.5 Measurement of Groundwater Field Parameters

2.6 Groundwater Sampling

3.1 Logging Alluvial and Bedrock Material

3.2 Drilling and Sampling Using Hollow-Stem Auger Techniques

3.3 Isolating Bedrock from Alluvium Using Grouted Surface Casing

3.4 Rotary Drilling and Rock Coring

3.5 Plugging and Abandonment of Wells

3.6 Monitoring Well and Piezometer Installation

3.8 Surface Soil Sampling

3.9 Soil-Gas Sampling and Field Analysis

3.10 Borehole Clearing

4.1 Surface Water Data Collection Activities

4.2 Field Measurement of Surface Water Field Parameters

4.3 Surface Water Sampling

4.4 Discharge Measurements

4.5 Base Laboratory Work

4.6 Sediment Sampling

4.8 Pond Sampling

4.9 Industrial Effluent and Pond Discharge Sampling

Specific information regarding most sampling activities is provided in the FSP (Section 7.0). Project-specific details for this work plan will be included in the Standard Operating Procedures Addenda (SOPAs). These SOPAs will be attached to the SOP for use during field activities. The following SOPs are currently being developed by EG&G:

SOP for In-Situ Gas/Liquid Sampling Using the BAT® System

These documents will be available for review prior to issuing the Final Phase I RFI/RI Work Plan for OU7.

## 11.1 SOP ADDENDUM TO SOP 4.6, SEDIMENT SAMPLING

Samples of sediment will be obtained from the East Landfill Pond at three locations down the centerline of the pond. The first sampling location is at the east end of the pond, the second sampling location is in the middle of the pond, and the third sampling location is at the west end of the pond. Locations are plotted on Figure 7-2.

Sediment samples at each location will be collected such that the entire vertical column of sediment is represented. The thickness of the sediments is anticipated to be between 3 and 6 feet. The samples will be obtained at 20-inch intervals with Wildico Hand Core Sediment Samplers from a floating platform. The boring will be terminated when refusal is encountered at the base of the sediments.

The sampler will be lined with two polybutyrate tubes cut to 10-inch lengths and equipped with an eggshell-type core catcher. Discrete samples from 10-inch intervals with the first sample at the sediment surface, will be submitted for laboratory analysis. Sample handling and decontamination procedures will be performed according to procedures described in SOP 4.6. Sediment samples will be described according to SOP 3.1.

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CONTROLLED DOCUMENT

ROCKY FLATS PLANT
Phase I RFI/RI Work Plan for
Operable Unit 7 - Present Landfill
IHSS 114 and Inactive Hazardous
Waste Storage Area IHSS 203
Title: References

Manual No.: 21100-WP-OU 07.01
Section No.: 12.0 R0

Organization: Environmental Management

EG&G — ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT DEPARTMENT
This is a RED STAMP

Approved by:

12/5/91
Effective Date

E. P. O'Rourke
Manager

6/29/92
Date

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