FINAL

PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT

RADIOACTIVE SITES
(Operable Unit No. 14)

TEXT
VOLUME I OF II

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

ENVIRONMENTAL RESTORATION PROGRAM

October 1992

REVIEWED FOR CLASSIFICATION/UCNI
By
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Approved by

_____ / / _____ / /
Manager, Remediation Programs RFI Project Manager

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ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
ARAR	Applicable or Relevant and Appropriate Requirement
ASME	American Society of Mechanical Engineers
AST	aboveground storage tank
ASTM	American Society for Testing Materials
ATSDR	Agency for Toxic Substance Disease Registry
ATV	all-terrain vehicle
AWQC	Ambient Water Quality Criteria
BDD	Broomfield Diversion Ditch
BRA	baseline risk assessment
cfs	cubic feet per second
CDH	Colorado Department of Health
CDW	Colorado Division of Wildlife
CEARP	Comprehensive Environmental Assessment and Response Program
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CMS	Corrective Measures Study
cm	square centimeters
cm/s	centimeters per second
COC	contaminants of concern
CPM	counts per minute
CRP	Community Relations Plan
CUHP	Colorado Urban Hydrograph Procedure
CWA	Clean Water Act
°F	degrees Farenheit
DCN	Document Change Notice
DOE	Department of Energy
dpm	disintegrations per minute
DQO	data quality objective
DRCOG	Denver Regional Council of Governments

EE	environmental evaluation
EG&G	EG&G Rocky Flats, Inc.
EM	environmental management
EMD	Environmental Management Division
EMRG	Environmental Management Radiological Guidelines
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERDA	Energy Research and Development Administration
FID	flame ionization detector
FIDLER	Field Instruments for Detecting Low Energy Radiation
FS	feasibility study
FSP	field sampling plan
FWS	U.S. Fish and Wildlife Service
g	grams
G-M	Geiger-Mueller
GC	gas chromatograph
GPR	ground penetrating radar
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Tables
HHRA	human health risk assessment
HI	Hazard Index
HPGe system	High-Purity Germanium Detection System
HRR	Historical Release Report
IAG	Interagency Agreement
ICRP	International Commission of Radiological Protection
IHSS	Individual Hazardous Substance Site
IRIS	Integrated Risk Information System
K_d	transfer coefficient
kg	kilograms
LOAEL	lowest observed adverse effect level

m	meter
m^2	square meters
m^3/day	cubic meters per day
mCi	millicurie
μCi	microcurie
MCL	Maximum Contaminant Levels
MF	modifying factor
mg	milligrams
mg/kg/day	milligrams per kilogram per day
mg/m^3	milligrams per cubic meter
NCP	National Contingency Plan
NIST	National Institute for Standards and Technology
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
OP	operating procedure
OPWL	Original Process Waste Lines
OU	Operable Unit
OU14	Operable Unit 14
PAC	Potential Area of Concern
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCB	polychlorinated biphenyl
pCi	picocurie
PHRED	Public Health Risk Evaluation Database
PID	
ppb	parts per billion
PRG	preliminary remediation goals
QA	Quality Assurance
QAA	Quality Assurance Addendum
QAPjP	Quality Assessment Project Plan
QC	Quality Control

RAAMP	Radiological Ambient Air Monitoring Program
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RFEDS	Rocky Flats Environmental Data System
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RFP	Rocky Flats Plant
RPD	Remediation Program Division
RSP	respirable suspended particulates
SAP	Sampling and Analysis Plan
SC	specific conductance
SDWA	Safe Drinking Water Act
SEAM	Superfund Exposure Assessment Manual
SF	slope factor
SOP	Standard Operating Procedure
SPHEM	Superfund Public Health Evaluation Manual
STP	Sewage Treatment Plant
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TBC	To Be Considered
TCL	Target Compound List
TDS	total dissolved solids
TOC	total organic carbon
UF	uncertainty factor
USC	United States Code
UTL	upper tolerance limit
VOC	volatile organic compounds
WQCC	Water Quality Control Commission

Approved by

Manager, Remediation Programs ___/___/___

RI Project Manager ___/___/___

EXECUTIVE SUMMARY

This document presents the work plan for the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Radioactive Sites (Operable Unit Number 14) at the Rocky Flats Plant, Jefferson County, Colorado. This work plan includes a field sampling plan (FSP) that presents the investigation planned to evaluate the presence or absence of contamination at Individual Hazardous Substance Sites (IHSSs) within the OU14 Radioactive Sites. The FSP developed in this work plan is based on the requirements of the Interagency Agreement (IAG) amongst the Department of Energy (DOE), Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH) and what additional work is needed to initially assess each IHSSs.

Eight IHSSs are located in Operable Unit Number 14 (OU14). They are the 700 Area Site No. 1 (IHSS 131), Building 334 Parking Lot (IHSS 156.1), Building 444 Parking Lot (IHSS 160), Area West of Building 664 (IHSS 161), 700 Area- Site No. 2 (IHSS 162), 800 Area No. 2 Concrete Slab (IHSS 164.1), 800 Area Site No. 2 Building 886 Spills (IHSS 164.2), and 800 Area Site No. 2 Building 889 Storage (IHSS 164.3). Of these eight sites, two are parking lots approximately 313,000 square feet in area; four are paved areas near buildings approximately 83,000 square feet in area; one is a storage pad approximately 25,000 square feet in area; and the last is a paved road within the plant with an approximate

area of 161,000 square feet. All areas described above are located immediately adjacent to buildings and are partially or completely covered with concrete or asphalt

Volume I - Text includes 12 sections which are based on the Environmental Protection Agency Guidance for Conducting Remedial Investigations, and Feasibility Studies This work plan was also written in accordance with the IAG requirements in that field sampling activities complied with task "Required Actions" at a minimum, plus justification for any additional staged investigative actions is presented in detail Individual IHSS boundaries were defined based upon the IAG and the Historical Release Report (HRR) . The HRR information sources and aerial photographs were reviewed to redefine the IHSS boundaries using the most current and accurate information The Rocky Flats Environmental Database System (RFEDS) was accessed to review data derived from; borehole investigations, monitoring wells, surface water sampling, and other sources of environmental data in or adjacent to the OU14 IHSSs This information was summarized and presented as a Appendix F in Volume II - Appendices The Aerial Radiological Surveys were evaluated to ascertain the useability of the information presented. The contaminant isopleth contours were deemed to be misleading in regards to identifying potential soil contamination around processing buildings.

The site conceptual model was developed for OU14 taking into consideration the historical and current sources of contaminants One conceptual model was developed to cover all of the pertinent exposure pathways for each IHSS.

The potential applicable or relevant and appropriate requirements were developed and presented with a list of chemical-specific benchmarks which have been developed on a site-wide basis Additional To Be Considered (TBC) guidance was also presented in a tabular format

The Field Sampling Plan (FSP) was developed using a staged approach which presents the results of the field investigation activities in the form of technical memoranda. Technical memoranda are presented to CDH/EPA after State 1 activities are conducted Based on the results and discussions with the regulators Stage 2 activities are defined. A modified grid selection process is presented to provide an example of a logical redefinition process for selecting a sampling grid. The FSP addresses the difficulties in working with artificial covering (i.e., pavement and concrete) and their impacts on radiation detection systems and soil sampling activities. Specific procedures are referenced to conduct the FSP and to develop a Health and Safety Plan

The Human Health Risk Assessment section was based on EPA guidance documents. Additional specific guidance was added to define how uncertainty is to be addressed and how the data will be utilized to assess the risk to environmental and human health.

The schedule and the sequence of work for completing the OU14 investigation is specified in the IAG and is outlined below to provide background on the requirements for the OU14 RFI/RI. The IAG states that each OU may proceed through several phases of investigation dependent on the information gathered to characterize the OU (Section 1.B.9, IAG Statement of Work).

Following completion of the Phase I work plan, the IAG requires that the results of the Phase I RFI/RI for OU14 be documented within a draft Phase I RFI/RI report. This draft RFI/RI report will include a Preliminary Site Characterization and will also recommend work to be performed for the Phase II investigation, if required The IAG specifies that this draft Phase I report be submitted to EPA and the State for review, and DOE will address the regulatory agency's comments and submit a Final Phase I RFI/RI report for EPA and/or State approval.

The IAG specifies that the priority and schedule for the Phase I RFI/RI investigations for OUs 3, 5, 6, 8, 12, 13, 14, 14, 15, and 16 will be determined after evaluating the Final Phase I RFI/RI Reports for the operable units If EPA and/or the State determine that no further investigatory work is required for OU14 after the Phase I investigation is complete, EPA and/or the State shall approve the Final Phase I RFI/RI Report as a Final RFI/RI Report.

1.0 INTRODUCTION

This document presents the Phase I work plan for the Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI), and Comprehensive Environmental Resource, Compensation, and Liability Act (CERCLA) for Operable Unit No. 14 (OU14) at the U.S Department of Energy (DOE) 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, pursuant to an Interagency Agreement (IAG) between DOE, the U.S. Environmental Protection Agency (EPA), and the Colorado Department of Health (CDH) dated January 22, 1991 (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, CERCLA regulations apply to remedial investigations at OU14. In accordance with the IAG, the CERCLA terms "Remedial Investigation" (RI), "Feasibility Study" (FS), and "Individual Hazardous Substance Site" (IHSS) are used in this document.

As required by the IAG, this Phase I work plan addresses characterization of source materials, soils, and groundwater at OU14 and surface water potentially affected by OU14.

The RFI/RI will also investigate the nature and source of contamination and evaluate potential contaminant migration pathways.

This work plan summarizes existing information characterizing OU14, identifies data gaps, establishes Data Quality Objectives (DQOs), and develops a Stage 1 field sampling plan (FSP) to characterize physical site features and define contaminant sources. Rationale for developing the Stage 2 FSP is also provided.

The RFI/RI will be conducted in accordance with the *RCRA Facility Investigation (RFI) Guidance* (EPA 1989a) and *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988a). The RFI/RI will be conducted in two stages to maximize the use of the data generated and efficiency in program design. Existing data were used to develop the RFI/RI approach. The data generated by the RFI/RI will be used to estimate the risks to human health and the environment posed by sources within OU14 and to begin developing and screening remedial alternatives.

1.1 Environmental Restoration Program

The DOE Environmental Restoration (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 RFP (DOE 1986), and Phase 2 is currently in progress for OU14.

1.2 Work Plan Overview

This work plan evaluates and summarizes previous data and investigations, defines DQOs and data needs based on that evaluation, specifies RFI/RI tasks, and presents the Stage 1 FSP for the RFI/RI. Rationale for the development of the Stage 2 FSP is also provided.

Section 2.0, Site Characterization, presents a comprehensive review and analysis of available historical information, previous site investigations, recently published reports, available data, and past and present activities pertinent to OU14. Included in Section 2.0 are characterization results for site geology and hydrology as well as the known nature and extent of contamination in nearby soils and groundwater. Additionally, Section 2.0 presents a conceptual model for contaminant migration and exposure pathways based on site physical characteristics and available information regarding the nature and extent of contamination. Section 3.0 presents potential sitewide Applicable or Relevant and Appropriate Requirements (ARARs) and benchmarks, as required by the IAG, and discusses their application to the RFI/RI activities at OU14. Section 4.0 discusses the DQOs and work plan rationale for the RFI/RI. Section 5.0 specifies tasks to be performed for the RFI/RI. Section 6.0 presents the Stage 1 FSP and rationale for the development of the Stage 2 FSP to meet the objectives presented in Section 4.0 Section 7 0 lays out the RFI/RI activities schedule. Sections 8.0

and 9.0 detail the Baseline Human Health Risk Assessment Plan (HHRA) and the Environmental Evaluation Work Plan, respectively. Section 10.0 discusses the site-specific Quality Assurance Addendum (QAA) for OU14. Section 11.0 provides references.

The appendices contain the available supporting information used to characterize the physical setting and contamination at OU14. Appendix A contains several memorandums describing the strengths and weaknesses of the Field Instrument for Detecting Low Energy Radiation (FIDLER) radiological surveys. Appendix B contains the Data Summary which was derived from the Rocky Flats Environmental Database System (RFEDS) for sampling locations in or around OU14 The complete database as applicable has been included as Volume II of this work plan. Appendix C contains the *Excerpts From the Background Geochemical Report* (EG&G 1990a). Appendix D includes only the *Table of Contents From the Environmental Management Department Operating Procedures* (EG&G 1992c). Appendix E represents a listing of the *Rocky Flats Photo History*, and Appendix F includes the *EG&G Site Specific Health and Safety Plant Template*

1.3 Regional And Plant Site Background Information

The following sections provide general information on RFP and the surrounding region including RFP history, regional land-use and population data, and site conditions Site-specific conditions at OU14 are addressed in Section 2.0.

1.3.1 Facility Background and Plant Operations

RFP is a government-owned, contractor-operated facility that is part of the nationwide nuclear weapons complex. The plant was under the aegis of 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 operating contractor from July 1, 1975 until December 31, 1989. EG&G became the prime contractor at RFP on January 1, 1990.

Under the original mission, RFP fabricated nuclear weapons components from plutonium, uranium, and nonradioactive metals (principally beryllium and stainless steel) which were then shipped elsewhere for assembly. In addition, RFP reprocessed components for recovery of plutonium after it was removed from obsolete weapons. RFP is currently undergoing a mission transition from nuclear production to environmental restoration and waste management. Although no further production of plutonium weapons components is contemplated, certain production facilities will be preserved in a ready state until a final decision is made that such production is no longer needed Other activities previously conducted at RFP will continue as before, these include research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics.

Both radioactive and nonradioactive wastes have been generated in the RFP production process and must be taken into account when formulating environmental

restoration and waste management plans Current waste handling practices involve on-site and off-site recycling of hazardous materials, on-site storage of hazardous and radioactive mixed wastes, and off-site disposal of solid radioactive materials at another DOE facility; however, preliminary assessments under the ER Program indicate that some of the past on-site storage and decontamination practices could present potential sources of environmental contamination

1.3.2 Previous Investigations

Various sitewide 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:

- 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)
- Several drilling programs beginning in 1960 that resulted in construction of approximately 60 monitoring wells by 1982
- An investigation of surface water and groundwater flow systems by the U.S Geological Survey (Hurr 1976)
- Environmental, ecological, and public health studies that culminated in an Environmental Impact Statement (DOE 1980)
- A summary report on groundwater hydrology using data from 1960 to 1985 (Hydro-Search 1985)
- A preliminary electromagnetic survey of the plant perimeter (Hydro-Search 1986)

- A soil-gas survey of the plant perimeter and buffer zone (Tracer 1986)
- Routine environmental monitoring programs addressing air, surface water, groundwater, and soils (Rockwell 1975 through 1985, and 1986b).

In 1986, two major investigations were completed at RFP. The first was the DOE Comprehensive Environmental Assessment and Response Program (CEARP) Phase 1 Installation Assessment (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. CEARP was succeeded by the ER Program. 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 (1987) In accordance with the IAG, SWMUs are now designated as IHSSs, and are divided into the following three categories.

- Hazardous substance sites that will continue to operate and need a RCRA operating permit
- Hazardous substance sites that will be closed under RCRA interim status
- Inactive hazardous substance sites that will be investigated and cleaned up under Section 3004(u) of RCRA or under CERCLA

The second major investigation completed at RFP in 1986 involved a hydrogeologic and hydrochemical characterization of the 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

As required by the IAG, the *Historical Release Report* (HRR) for the Rocky Flats Plant (EG&G 1992g) was developed to provide information on existing and potentially new IHSSs at RFP. The HRR focuses on 1) the incidental releases that took place outdoors or had an immediate impact on the out-of-building environment; and 2) waste management practices that have been discontinued due to environmental concerns.

The *Background Geochemical Characterization Report* (EG&G 1990a) presents the chemistry of environmental materials from areas near RFP which are undisturbed by plant operations The geochemistry of surface water, stream sediments, groundwater and borehole materials are discussed. Sample data was obtained from stations located in the Buffer Zone areas west, north, and south of the plant. The samples were analyzed for chemical constituents including radioactive isotopes, EPA target analyte list (TAL) metals, major anions, and indicator parameters such as pH, specific conductance (SC) and total dissolved solids (TDS).

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). Surrounding cities include Boulder, Broomfield, Westminster, and Arvada, all of which are located less than 10 miles to the northwest, east, and southeast of RFP, respectively. RFP consists of approximately 6,550 acres of federal land in Sections 1 through 4 and 9 through 15 of T2S, R70W, 6th Principal Meridian. Most plant structures are located within a protected central area site of approximately 400 acres and are surrounded by a buffer zone of approximately 6,150 acres.

RFP 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 nearby State Highway 72, and on the west by State Highway 93 (Figure 1-1). Figure 1-2 is a vicinity map of RFP.

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 situated on a broad, eastward-sloping pediment that is capped by alluvial deposits of the Quaternary age (Rocky Flats Alluvium). The pediment surface has a fan-like form, with its apex and distal margins approximately 2 miles east of RFP. The tops of alluvial-covered pediments are nearly flat but slope gently eastward at 50 to 100 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.

1.3.3.3 Meteorology and Climatology. The meteorology of Rocky Flats is strongly influenced by topography The proximity of the Rocky Mountains and High Plains produce a semiarid climate characteristic, seasonal chinook wind storms and diurnal cycle to the wind patterns at the RFP.

Wind, temperature, precipitation and atmospheric pressure are collected on the plant site and summarized in monthly and annual reports The semiarid nature of the land is reflected in the 15-inch annual average precipitation recorded at the RFP. Spring is the wettest season with approximately 40 percent of the annual average, much of it falling as wet

snow. Summer thunderstorms (June through August) account for an additional 30 percent of the annual precipitation Autumn and winter are drier seasons (DOE 1980).

Figure 1-3 represents a two year wind frequency distribution (16 compass points for 6 wind speed classes) at the RFP for 1990 through 1991. Winds at the RFP are predominantly northwesterly. The diurnal nature of the wind can be seen when separating day from night at the plant site during mild weather conditions. Under these conditions, the wind generally blows 'upslope' from the plains towards the mountains during the day and 'downslope' from the mountains to the plains at night. In the winter during chinook windstorms the wind speeds may reach 90 to 100 miles an hour During these chinook events, winds may blow from the northwest for three consecutive days

Temperatures at the RFP are moderate. Extremely hot or cold weather is usually of short duration. Daily summer averages range from 55 to 85 degrees Fahrenheit (°F), while winter daily temperatures range from 20 to 45 °F. Temperature extremes recorded at the plant range from 102 °F to -26 °F (DOE 1980).

Special attention has been focused on dispersion meteorology surrounding RFP due to the potential transport of atmospheric contaminants to the Denver Metropolitan area. Studies of the airflow indicate that the wind flows from the west, then turns and moves northeast along the South Platte River Valley and passes north of Denver. Pasquill stability classes are used to evaluate dispersion characteristics at the RFP. Stability class D (neutral conditions) is the prevailing dispersion characteristic at the RFP (EG&G, 1991g).

1.3.3.4 Surface Water Hydrology. A generalized map of the principal drainage basins and surface-water flow across the site is generally from west to east. A topographic

divide bisects the site along an east-west trend slightly south of Central Avenue (the approximate center line of the site). The Rock Creek drainage basin traverses and drains the northwestern portion of the plant site and is located in the buffer zone, entirely separate from the operational plant complex. Rocky Creek flows to the northeast to its off-site confluence with Coal Creek. Preliminary surface water modeling of the Rock Creek basin, using the Colorado Urban Hydrograph Procedure (CUHP), indicates that a 2-year, 2-hour storm would result in a flood peak of approximately 55 cubic feet per second (cfs) at the outlet of the basin at Colorado Route 128.

The Woman Creek drainage basin traverses and drains the southern portion of the site Although this basin is located primarily in the buffer zone, it does extend into the extreme southern boundary of the plant complex. An interceptor ditch (South Interceptor Ditch) is located between and parallel to Woman Creek and the southern boundary of the plant complex. The relatively small quantity of surface runoff that flows from the southern boundary of the plant complex toward Woman Creek is intercepted by this ditch. This intercepted flow eventually enters detention Pond C-2.

Surface runoff downgradient of the South Interceptor Ditch is tributary to Woman Creek, which flows east to Standley Lake, a water supply for the city of Westminster and for portions of the cities of Northglenn and Thornton. In 1990, water discharges from Pond C-2 were piped, in accordance with National Pollutant Discharge Elimination System (NPDES) (EPA 1984) and bypass limitations set by EPA, to a diversion ditch that goes around Great Western Reservoir. Woman Creek also delivers some water off site to Mower Reservoir.

The Walnut Creek drainage basin traverses the western, northern, and northeastern portions of the RFP site and receives runoff from the majority of the plant complex. Three

epthermal streams are actually tributary to Walnut Creek: Dry Creek, North Walnut Creek, and South Walnut Creek (which receives most of the runoff from the plant complex) These three forks of Walnut Creek join in the buffer zone (approximately 0.7 mile west of the eastern perimeter of RFP) and until recently flowed east off site to Great Western Reservoir, a water supply for a portion of the City of Broomfield and located approximately one mile east of this confluence. The City of Broomfield has built and currently uses the Broomfield Diversion Ditch (BDD) to divert Walnut Creek around Great Western Reservoir.

In addition to natural flows and the South Interceptor Ditch, there are seven ditches or diversion canals in the general vicinity of RFP. The Upper Church, McKay, Kinnear, and Reservoir Co Ditches (diversions of Coal Creek) cross the site Upper Church Ditch delivers water to Upper Church Lake and Great Western Reservoir McKay Ditch also supplies water to Great Western Reservoir. Kinnear Ditch and Reservoir Co. Ditch divert water from Coal Creek and deliver it to Woman Creek and eventually to Standley Lake. Last Chance Ditch flows south of RFP and supplies water to Rocky Flats Lake and Twin Lakes. Smart Ditch diverts water from Rocky Flats Lake and transports it off site to the east. The South Boulder Diversion Canal, located immediately west of the western RFP boundary, diverts water from South Boulder Creek and delivers it to Ralston Reservoir, a water supply for the City of Denver.

Dams, detention ponds, diversion structures, and ditches have been constructed at RFP to control the release of plant discharges and surface (storm water) runoff. The ponds located downstream of the plant complex on North Walnut Creek are designated A-1 through A-4 Ponds on South Walnut Creek are designated B-1 through B-5. These A- and B-series ponds receive runoff from the plant complex. Ponds A-1, A-2, B-1, and B-2 are non-discharged (retention) ponds. Volumes are controlled at Ponds A-1 and A-2 by over-pond

spray evaporation, and water from Ponds B-1 and B-2 is transferred to Pond A-2 after characterization. Pond B-3 receives treated effluent from the Sewage Treatment Plant (STP). Pond C-1 is located on Woman Creek and receives natural flows, and Pond C-2, located immediately south of Woman Creek (the creek is diverted to the north around the pond), receives flow from the South Interceptor Ditch as well as some natural flows from its immediate drainage basin. One retention pond (the Landfill pond) is located in an unnamed basin immediately downgradient of the present Landfill. The Landfill pond is operated in a zero discharge mode through spray evaporation. Any off-site discharges from the terminal ponds on Walnut Creek or Woman Creek (Ponds A-4, N-05, or C-2) are regularly monitored according to the requirements of the RFP MPDES permit (CO-0001333).

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 mountain, and foothill ravine regions. Riparian vegetation exists along RFP drainages and in wetlands. None of the vegetative species known to be 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 (DOE 1980).

The fauna inhabiting RFP and its buffer zone consist 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 (*ephitis*

mephitis), and long-tailed weasel (*ustela frenata*). Small herbivores can be found throughout the plant complex around buildings and along drainages, and buffer zone, including species such as the pocket gopher (*Thomomys talpoides*), cottontail (*Sylvilagus sp.*), white-tailed jackrabbit (*Lepus townsendii*), and the meadow vole (*icrotus pennsylvanicus*) (DOE 1980).

Commonly observed birds include western meadowlarks (*Sturnella neglecta*), horned larks (*Eremophila alpestris*), mourning doves (*Zenaidura macroura*), vesper sparrows (*Pooecetes gramineus*), western kingbirds (*Tyrannus vociferans*), black-billed magpies (*Pica pica*), American robins (*Turdus migratorius*), and yellow warblers (*Dendroica magnolia*). 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*) (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 this 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 (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 (DOE 1991b). This report classifies general use of areas within 0 to 10 miles of RFP into residential, commercial, industrial, parks and open spaces, agricultural and vacant, and institutional categories, and also considers current and future land-use near RFP.

The majority of residential use within 5 miles of RFP is located immediately northeast, east, and southeast of the plant The 1989 population distribution within 5 miles of the RFP main production facility (i.e , the center of the RFP site) is illustrated in Figure 1-4 Commercial development is concentrated near residential areas 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. The west, north, and east sides of Standley Lake are encompassed by Standley Lake Park open space. Irrigated and nonirrigated croplands, producing primarily wheat and barley, are located north and northeast of RFP near the cities of Broomfield, Lafayette, 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 (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 (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 increase and subsequent distributions projected around RFP for the years 2000 and 2010 are shown in Figures 1-5 and 1-6, respectively.

1.3.3.7 Regional Geology. RFP is located on a broad, eastward-sloping pediment surface along the western edge of the Denver Basin (Figure 1-7). 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. In the western buffer zone, Upper Cretaceous sandstones of the Laramie Formation make up an east-dipping (45° to 55°) hogback that strikes approximately north-northwest (Scott 1960) Immediately west of RFP, steeply dipping sedimentary strata abruptly flatten to less than two 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 (Figure 1-7) (Scott 1963).

Figure 1-8 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 overlying surficial Quaternary age deposits at RFP are described below.

Quaternary Age Deposits

The Quaternary age deposits in the RFP area (Figure 1-7) have been categorized into pediment cover and valley fill The Rocky Flats, Verdos, and Slocum Alluviums represent pediment covers The valley fill alluviums include the Louviers and the Broadway Alluviums. Additional recent alluvial valley fill deposits include the Piney Creek and Post-Piney Creek Alluviums (EG&G 1991c).

With the exception of a "Pre-Rocky Flats Alluvium" deposit located west of the RFP (EG&G 1992b), the Rocky Flats Alluvium is the oldest alluvial deposit in the vicinity of the RFP The alluvium consists of poorly sorted, angular to rounded, coarse gravels, sands, and gravelly clay Caliche amounts vary from trace to abundant (EG&G 1991c) Dominant lithologies include detritus from Precambrian quartzite, schist, and gneiss deposited by Coal Creek. Thickness at the type locality just south of RFP is 50 feet and ranges from 10 to 90 feet (Machette et al 1976). As shown on Figure 1-7, the RFP overlies Rocky Flats Alluvium

The Verdos Alluvium consists of sandy, cobbly to bouldery gravel, deposited by Ralston Creek. Its thickness ranges from 15 to 35 feet. The Slocum Alluvium is composed of well-stratified, clayey, coarse gravel and coarse sand, and its thickness ranges from 10 to 90 feet The Louviers and Broadway Alluviums are composed of coarse sand and cobbly gravel and range from 10 to 25 feet in thickness. The Louviers Alluvium forms well-developed terraces above modern streams. The Broadway Alluvium occurs in channels cut into the Louviers Alluvium

The Pre-Piney Creek, Piney Creek, and Post-Piney Creek Alluviums are the most recent identified deposits The Pre-Piney Creek Alluvium consists of silt and sand

with pebble lenses, and the Piney Creek Alluvium is composed of clay, silt, and sand with some pebble beds The Post-Piney Creek Alluvium consists of poorly consolidated, humic, fine-grained to medium-grained sands interbedded with magnetite-rich sands.

Upper Cretaceous Deposits

Depositional environments east of the Front Range in the Late Cretaceous period were influenced by the Laramide Orogeny, which resulted in the uplift of the ancestral Colorado Front Range Mountains The uplift caused a regression of the intercontinental Cretaceous sea from the west to the east, resulting in a lateral progradation of Pierre Shale prodelta shales and siltstones, Fox Hills Formation delta front sandstones, Laramie Formation delta plain sandstones, claystones, and coals, and Arapahoe Formation fluvial conglomerates, sandstones, and claystones (Weimer 1973).

The above-mentioned formations are relatively distinct, from a regional perspective, reflecting increasingly higher gradients of deposition with correspondingly higher energy facies However, lateral and vertical variations in the depositional history of the Arapahoe Formation have been observed as a function of localized tectonic surges, creating the accumulation of higher energy, braided stream facies south of RFP in the Golden area, whereas lower energy, meandering stream facies occur in the RFP area. The *Geologic Characterization Report for RFP* (EG&G 1991c) contains one interpretation of the sequence of deposition for the Laramie and Arapahoe Formations; however, it presents two different interpretive maps showing the lateral distribution of the uppermost Arapahoe sandstone. The first interpretation shows a single continuous meandering channel system containing channel

and point bar deposits The second interpretation depicts a multiple channel system containing migrated channel and point bar deposits (EG&G 1991c).

The Arapahoe Formation, the uppermost bedrock unit underlying RFP, consists of claystones, siltstones, and sandstones. According to the Draft Final Geologic Characterization Report (EG&G 1991c), the Arapahoe Formation is approximately 150 feet thick and contains at least five mappable sandstone units. However, the Arapahoe/Laramie contact is currently being evaluated. The uppermost Arapahoe sandstone unit, Sandstone Number One, varies in thickness from 0 to over 40 feet and crops out in the RFP area. Its areal extent has been predicted according to two fluvial depositional interpretations presented in the Draft Final Geologic Characterization Report discussed above

Lithologic similarities between the Laramie and Arapahoe Formations makes definition of the contact between the formations difficult A regional surface mapping project of the RFP area was conducted during 1991 as part of the sitewide Phase II Geologic Characterization efforts (EG&G 1992b). In this study, the base of the Arapahoe Formation was correlated to the base of Sandstone Number One. Field criteria for the definition of Arapahoe sandstones included frosted, well-rounded, medium size quartz grains; however, in the subsurface, these characteristics have been observed in lower Arapahoe Formation sandstones, which were mapped as Laramie Formation during the field mapping effort. Sitewide geologic characterization investigations are continuing to resolve this issue (EG&G 1992b)

Arapahoe Formation sandstones are very fine-grained to medium-grained, with minor conglomeratic lenses Weathered sandstones are pale orange, yellowish gray, and dark yellowish orange Unweathered sandstones are light gray to olive gray. The sandstones

typically are interlayered with claystones and have lenticular geometrics. The dominant claystones and silty claystones are light olive gray to medium olive gray and weather to dark yellowish orange. Iron-oxide staining is common in the upper 20 feet of the sandstones (EG&G 1991c).

The Laramie Formation, which is composed of an upper claystone interval and a lower sandstone and coal interval, is approximately 600 to 800 feet thick. The upper Laramie Formation consists of silty claystones, siltstones, and fine-grained small scale lenticular channel sandstones. The silty claystones are light olive gray to olive black, massive, occasionally sandy, and contain carbonaceous material. The siltstones are also carbonaceous, with iron oxide nodules and slickensides along fractures. The lower Laramie Formation consists of very fine-grained to medium-grained sandstones up to 50 feet thick and coal beds ranging from 2 to 8 feet thick (EG&G 1991c).

The Fox Hills Formation averages 75 feet thick and consists of thick-bedded to massive, very fine-grained to medium-sized feldspathic sandstone that is grayish orange to light gray in color. The sandstones are interlayered with thin beds of siltstone and claystone (EG&G 1991c). The Fox Hills Formation crops out west of the RFP and is not likely impacted by RFP activities.

1.3.3.8 Hydrogeology. RFP is situated in a regional groundwater recharge area. Groundwater recharge occurs primarily from infiltration of precipitation into bedrock, which crops out in the western portion of RFP along the west limb of a monoclinal fold. Recharge also occurs as a result of seepage from streams, ditches, and ponds, and into subcropping bedrock (EG&G 1991c).

Unconfined groundwater occurs at RFP in the unconsolidated Quaternary alluvial deposits. These include the Rocky Flats Alluvium and other pediment cover deposits present on broad topographic highs, and the various valley fill alluvium deposits present in modern stream drainages. In the western portion of RFP, where the alluvium is thickest, the depth to water is 50 to 70 feet below the surface. Although the water table is variable, it becomes generally shallower from west to east as the alluvium thins Seeps are common in stream drainages along the contact between the Rocky Flats Alluvium and the underlying Arapahoe and Laramie Formations, and where Arapahoe Formation sandstones outcrop. The unconfined groundwater flows generally to the east along the gently sloping contact between the alluvium and the underlying bedrock The claystones that typically underlie the alluvium have a hydraulic conductivity on the order of 1×10^{-7} centimeters per second (cm/s), and effectively constrain much of the unconfined groundwater flow to the more permeable alluvial deposits. Unconfined groundwater also exists in Arapahoe Formation sandstones which subcrop at the alluvial/bedrock unconformity. In some areas of RFP, including OU14, Arapahoe Sandstone Number One subcrops below the Rocky Flats Alluvium, stratigraphically lower Arapahoe sandstones subcrop below quaternary colluvium in limited areas along valley slopes. The Rocky Flats Alluvium, subcropping Arapahoe sandstones, and weathered Arapahoe siltstones and claystones constitute the uppermost aquifer at RFP (EG&G 1991c)

Generally, unconfined groundwater flows along the contact of the surficial material and the underlying Arapahoe Formation claystones in a downgradient direction to the east. The alluvial aquifer, as well as the bedrock aquifers, exhibits a highly variable range of hydraulic conductivity values. Hydraulic conductivity values reported for the Rocky Flats Alluvium range from 1×10^{-2} cm/s (Hurr 1976) to 4×10^{-8} cm/s (DOE 1988). This wide range of hydraulic conductivity values for the Rocky Flats Alluvium is due to its

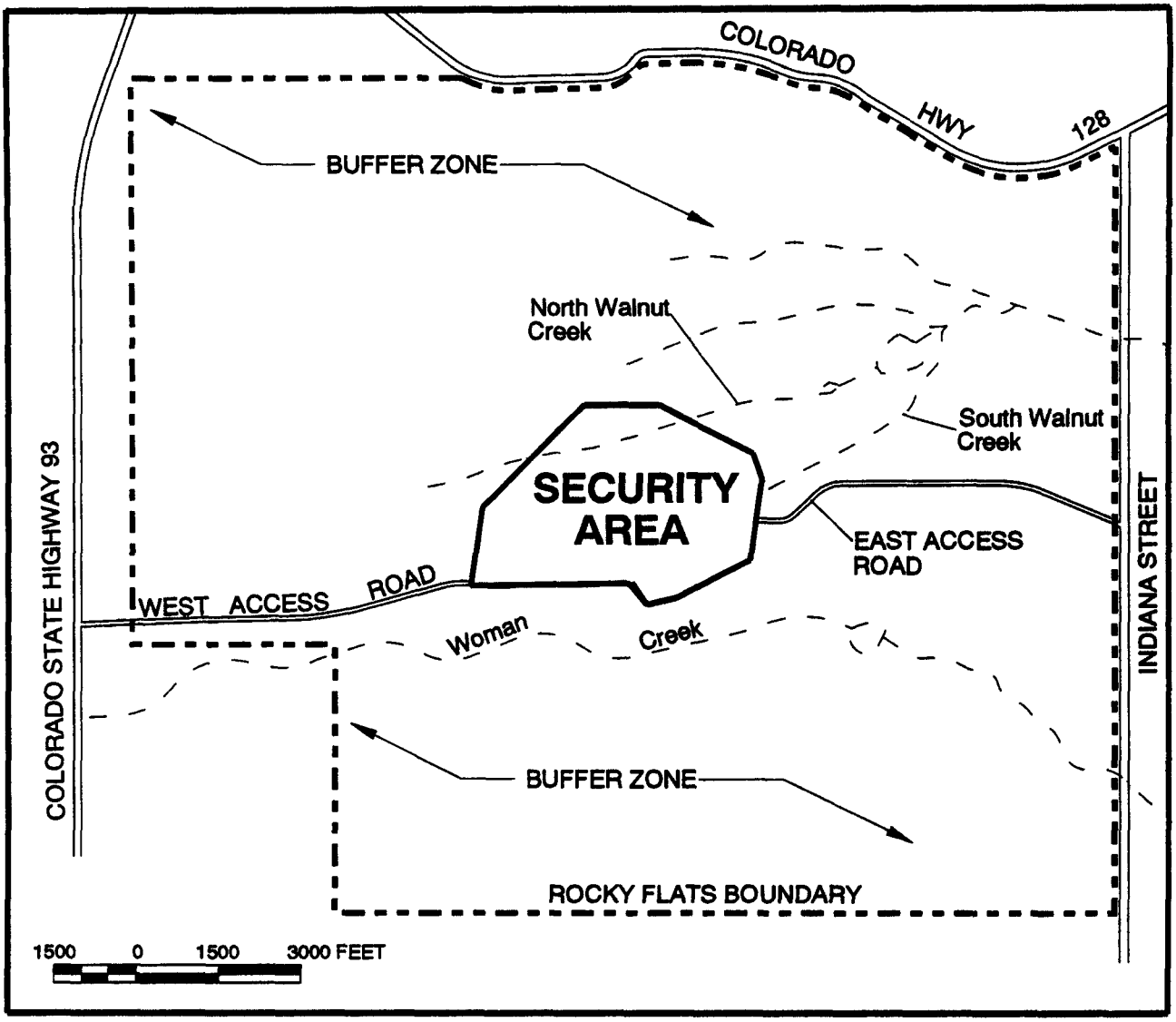
heterogeneity and vertical and lateral variability. The most recent hydrogeologic investigation suggests the hydraulic conductivity of the Rocky Flats Alluvium and the Sandstone Number One is approximately 6 x 10^{-5} cm/s, whereas the Arapahoe Formation claystones have a lower hydraulic conductivity on the order of 1 x 10^{-7} cm/s (EG&G 1991c) This effectively constrains much of the flow within the alluvial aquifer to the more permeable surficial material.

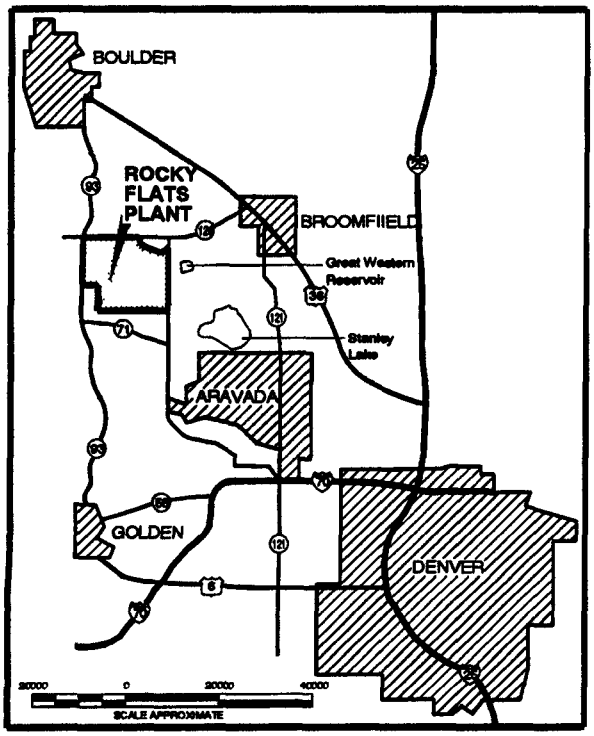
Groundwater in Arapahoe Formation sandstones exists under confined conditions throughout most of the RFP area The confining layers for the sandstones are the Arapahoe Formation claystones and silty claystones. The Arapahoe Formation and the uppermost aquifer have relatively low hydraulic conductivities; therefore, they are not generally believed to be capable of producing economical amounts of water. Currently, there are ongoing hydraulic conductivity studies being conducted on both a sitewide and OU-specific basis. Hydraulic conductivity values presented in past studies are being validated, and new permeameter testing is being conducted. Pump testing to obtain aquifer parameters is being accomplished at OU2. Results will be available during the summer of 1992 The lower Arapahoe Formation sandstones have a hydraulic conductivity of approximately 1 x 10^{-6} cm/s (EG&G 1991c).

The amount of caliche mineralization in the Rocky Flats Alluvium tends to increase as the thickness of the alluvium decreases. There are some areas where the amount of caliche in the interstices of the surficial material approaches 100 percent. The presence of caliche may prove to be useful in determining localized changes in hydraulic conductivities and groundwater flow directions; however, due to insufficient data on caliche in RFP surficial deposits, the extent to which this may be helpful is unknown at this time.

1.4 Overview of Operable Unit 14 - Radioactive Sites

OU14 consists of eight IHSSs believed to be contaminated with radiological constituents The IHSSs in OU14 fall within Building Areas 300, 400, 600, 700, and 800 at RFP and include two parking lot sites as shown in Figure 1-9. The IHSSs to be included in OU14 were negotiated with the EPA, DOE, and CDH for the establishment of the IAG. The IAG was signed in final form on January 22, 1991 The separate IHSSs that can be identified by type and size. IHSS 131, IHSS 156.1, IHSS 160, IHSS 161, IHSS 162, IHSS 164 1, IHSS 164.2, and IHSS 164.3. Of these eight sites, two are parking lots approximately 313,000 square feet in area, four are paved areas near buildings approximately 83,000 square feet in area; one is a storage pad approximately 25,000 square feet in area; and the last is a paved road within the plant with an approximate area of 161,000 square feet. All areas described above are located immediately adjacent to buildings and are partially or completely covered with concrete or asphalt.





MODIFIED FROM PHASE ONE RFI/RI WORK PLAN, OU9, EG&G, 1992

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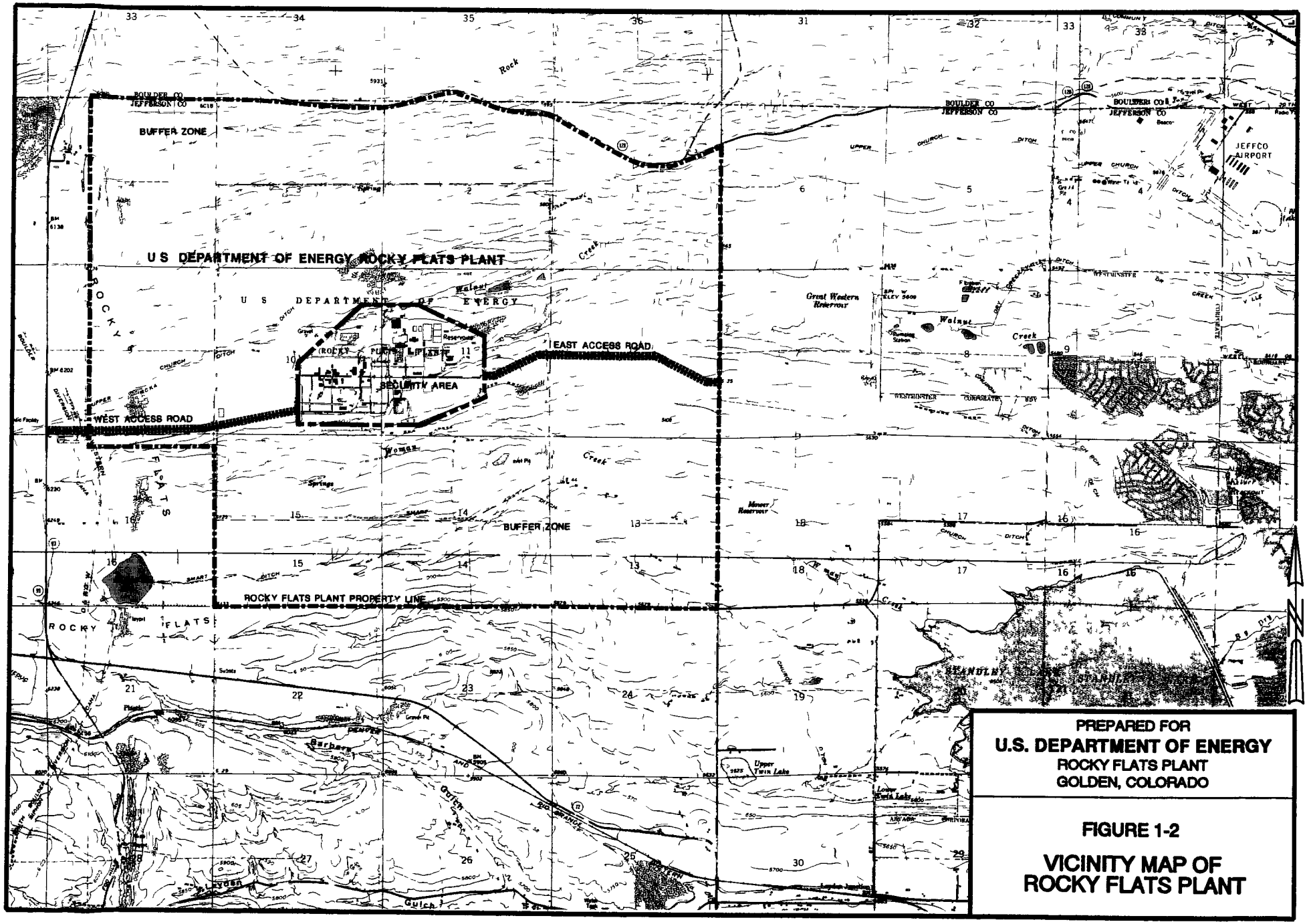
FIGURE 1-1

ROCKY FLATS LOCATION MAP



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GOLDEN, COLORADO

FIGURE 1-2

VICINITY MAP OF ROCKY FLATS PLANT

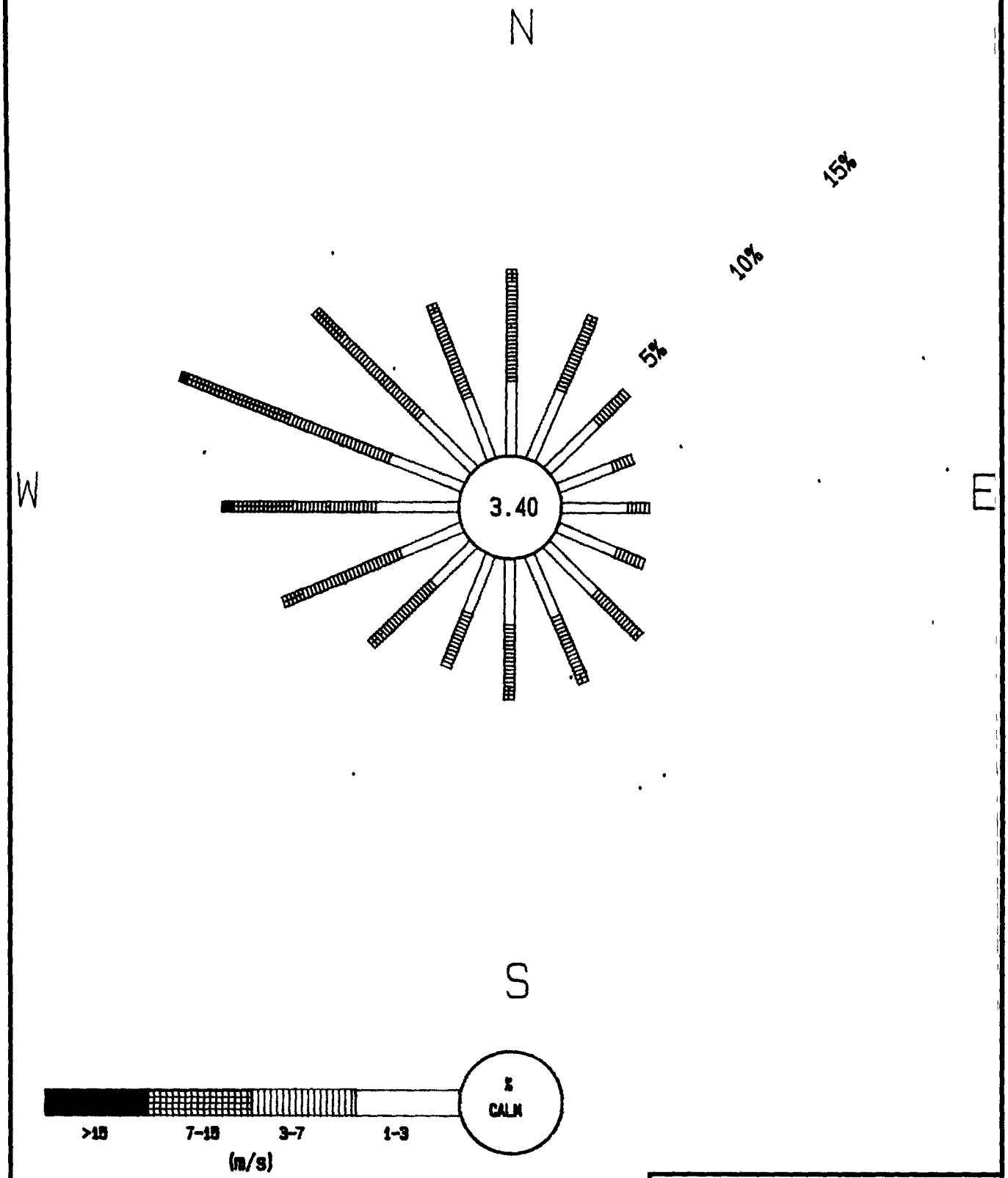

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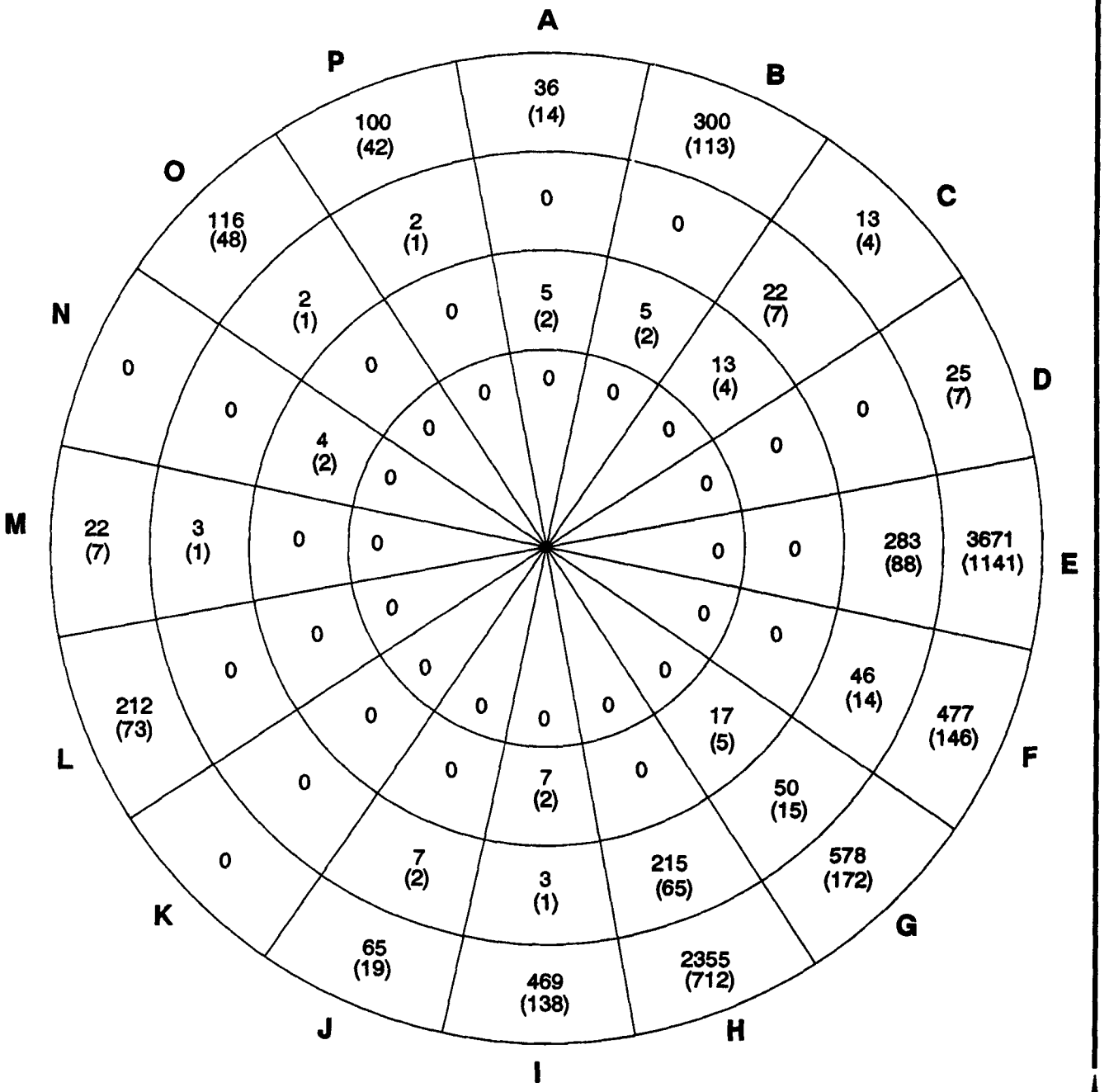
FIGURE 1-3

WIND ROSE FOR THE ROCKY FLATS PLANT 1990 THROUGH 1991



REFERENCE DOE, 1989 POPULATION ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT (DOE, 1991b)

(MILES)	SECTOR NUMBER
0-1	SECTOR 1
1-2	SECTOR 2
2-3	SECTOR 3
3-4	SECTOR 4
4-5	SECTOR 5

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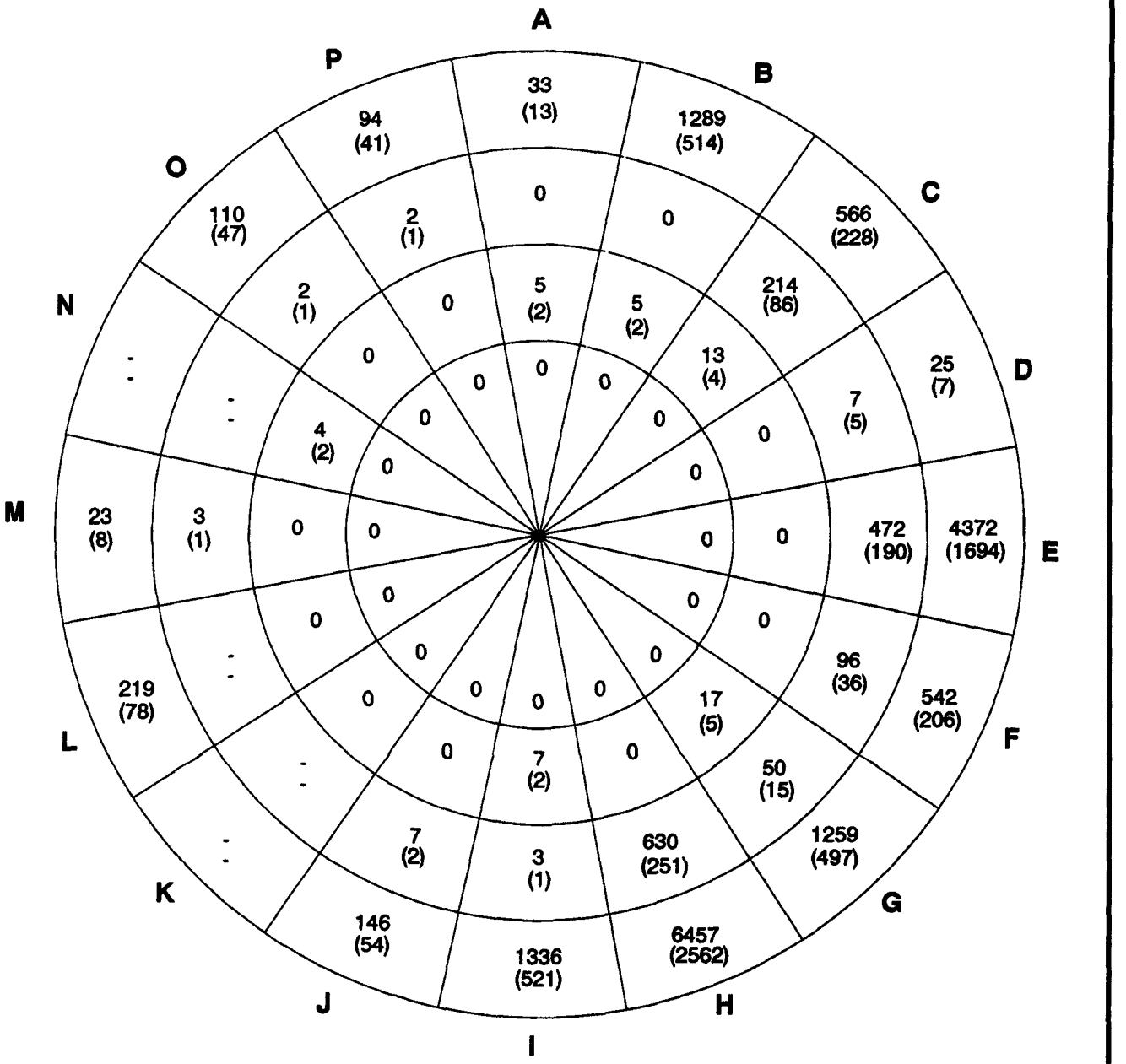
FIGURE 1-4

1989 POPULATIONS AND (HOUSEHOLDS) SECTORS 1-5



REFERENCE DOE, 1989 POPULATION ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT (DOE, 1991b)

(MILES)	SECTOR NUMBER
0-1	SECTOR 1
1-2	SECTOR 2
2-3	SECTOR 3
3-4	SECTOR 4
4-5	SECTOR 5

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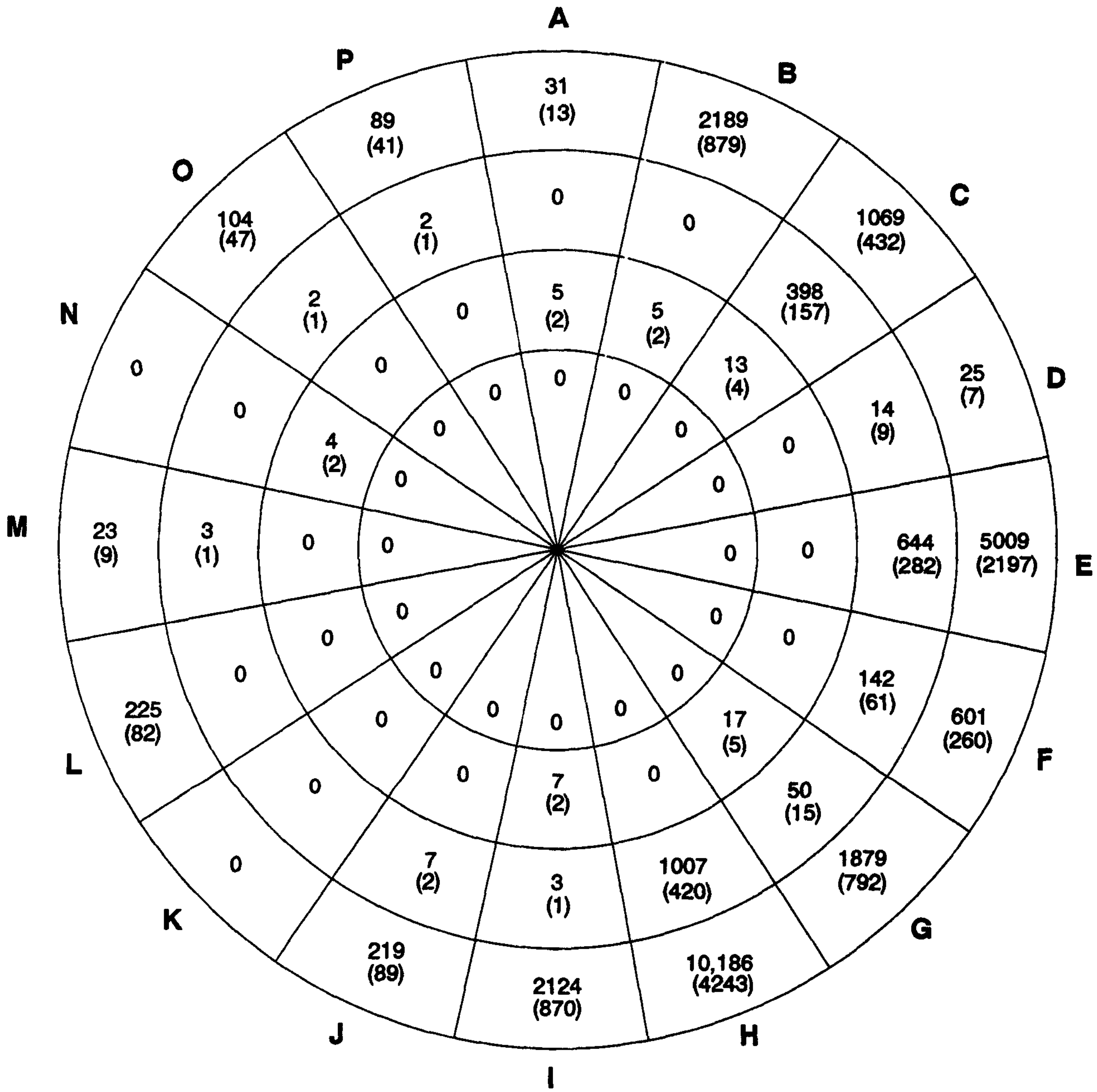
FIGURE 1-5

2000 POPULATIONS AND (HOUSEHOLDS) SECTORS 1-5



REFERENCE. DOE, 1989 POPULATION ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT (DOE, 1991b)

(MILES)	SECTOR NUMBER
0-1	SECTOR 1
1-2	SECTOR 2
2-3	SECTOR 3
3-4	SECTOR 4
4-5	SECTOR 5

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FIGURE 1-6

2010 POPULATIONS AND (HOUSEHOLDS) SECTORS 1-5

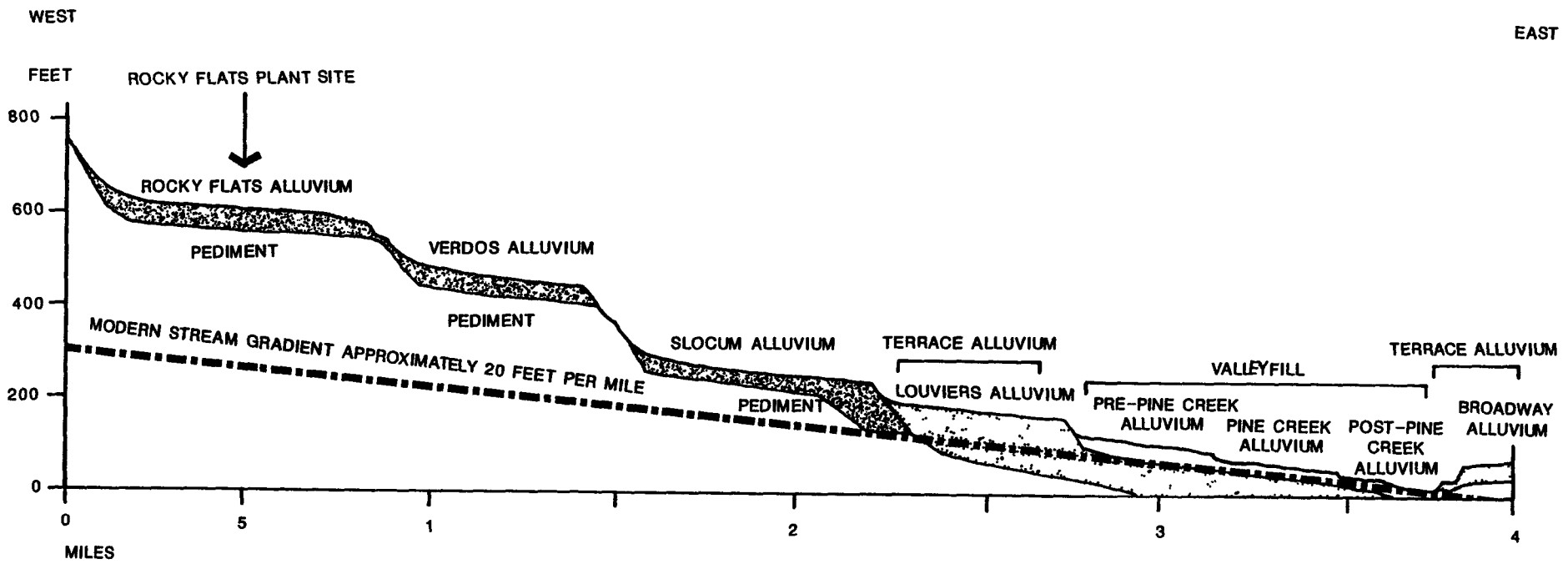

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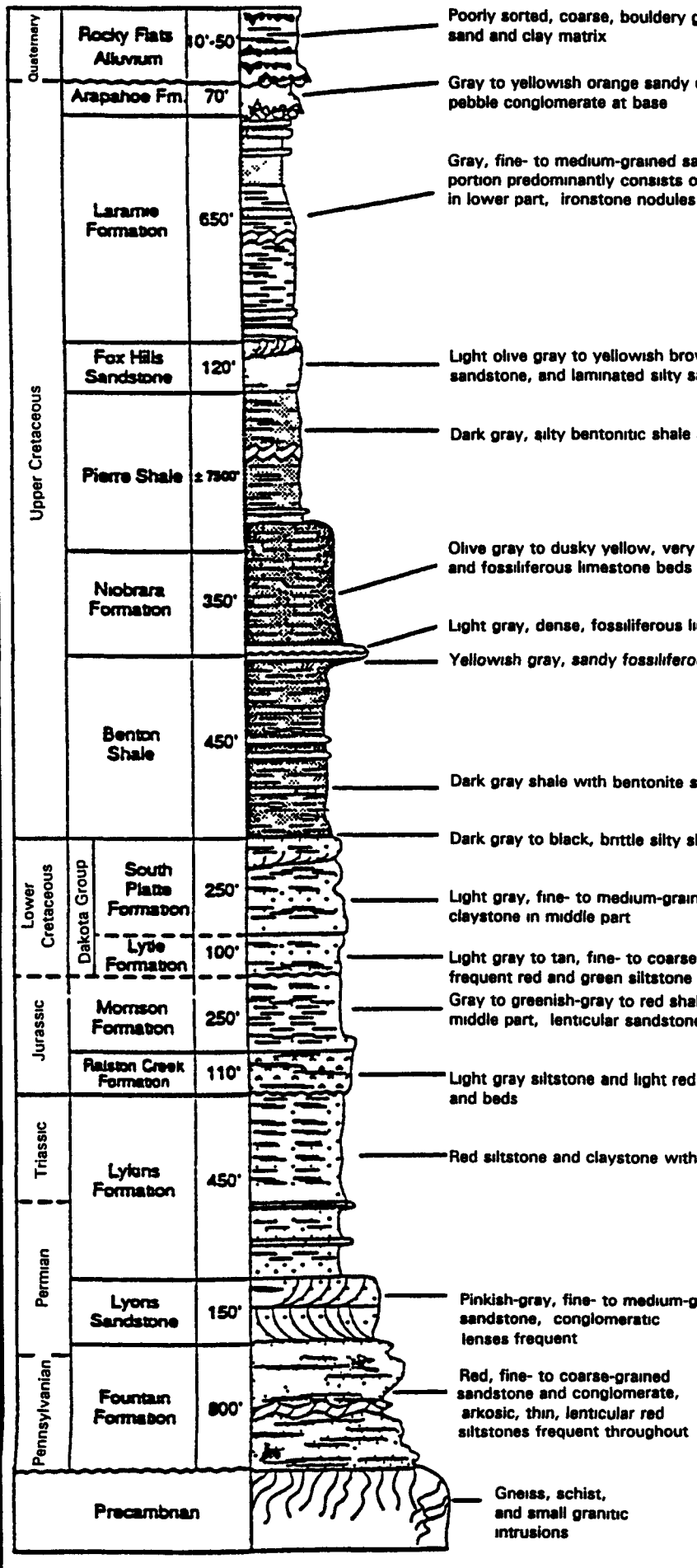
FIGURE 1-7

EROSIONAL SURFACES AND ALLUVIAL DEPOSITS EAST OF THE FRONT RANGE

REPRODUCED FROM: PHASE ONE RFI/RI WORKPLAN OU9, EG&G 1992a



Poorly sorted, coarse, bouldery gravel in yellowish brown to reddish brown sand and clay matrix

Gray to yellowish orange sandy claystone and clayey sandstone, chert pebble conglomerate at base

Gray, fine- to medium-grained sandstone and claystones, upper portion predominantly consists of massive claystones, thin coal beds in lower part, ironstone nodules

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

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

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

Light gray, dense, fossiliferous limestone

Yellowish gray, sandy fossiliferous limestone

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

Dark gray to black, brittle silty shale

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

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

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

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

Red siltstone and claystone with two laminated limestones in lower part

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

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

Gneiss, schist, and small granitic intrusions

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FIGURE 1-8

STRATIGRAPHY IN THE VICINITY OF THE ROCKY FLATS PLANT

2.0 SITE CHARACTERIZATION

2.1 Hydrogeology and Surface Water Hydrology at OU14

Regional and localized geology and hydrogeology are described in Sections 1.3.3.7 and 1 3.3 8 Additionally, surface water hydrology for the RFP is discussed in Section 1 3 3 4 These descriptions serve as the basis for the following detailed discussions Industrialization of RFP has significantly affected the hydrogeology and hydrology of the OU14 IHSSs Heightened awareness and understanding of these modifications will facilitate a more accurate site characterization One pivotal effect of construction on the alluvial aquifer is the creation of potential preferential migration pathways. These potential pathways are infilled trenches from underground utilities such as storm sewers, sanitary sewers, electrical lines, and building foundations. Additionally, asphalt or concrete surfaces in the industrialized area of RFP prevent significant infiltration or reroute precipitation accumulation to diversion ditches. Approximately 80 percent of OU14 is covered by artificial groundcover The extent to which these attributes affect preferred migration pathways is not fully known but must be considered when evaluating OU14

2.1.1 Hydrogeology

In the vicinity of OU14, the alluvium ranges in thickness from approximately 10 to 25 feet as illustrated in Figure 2-1. Generally, the alluvium is described as unconsolidated

clay, silt, sand, gravel, and pebbles However, many areas of OU14 possess disturbed or artificial groundcover The Bedrock Geology and Geologic Cross Section Location Map (Figure 2-2) shows where the Arapahoe Formation sandstone, silt, and claystone is located beneath several IHSSs contained in this area The geologic cross-sections A-A' and B-B' (indicated on Figure 2-2) are displayed on Figures 2-3 and 2-4, respectively

Unconfined groundwater occurs in OU14 in the Rocky Flats Alluvium, the disturbed ground, and artificial fill Where the Arapahoe sandstones subcrop directly beneath the surficial material, they are in hydraulic connection The Arapahoe sandstone geometries are assumed lenticular and laterally discontinuous However, in some areas at RFP they are relatively continuous Although individual sandstones may not be in lateral hydraulic communication, the Arapahoe Sandstone Number One subcrops frequently throughout the RFP area and acts as an unconfined aquifer for a substantial portion of its occurrence (EG&G 1991a)

Recharge is by infiltration of incidental precipitation and by seepage from ponds, ditches, and creeks, although the situation in OU14 probably differs from undeveloped areas because of the greater amount of paved and covered surfaces. Water table fluctuations have been observed in response to seasonal recharge (Hurr 1976) Fluctuations are expected to be minimal in OU14 because of the lack of infiltration Alluvial water levels are highest during late summer and fall As a result of water table fluctuations, the extent of saturated surficial deposits fluctuates The shallow groundwater system discharges in streams, ditches, and at seeps along slopes at the alluvium/bedrock contact.

Confined groundwater is present in the deeper sandstone units of the Arapahoe Formation projected to exist throughout most of OU14 Specific influence from OU14 to the

Arapahoe Formation groundwater is expected to be minimal because of reduced infiltration In other areas, groundwater recharge to the Arapahoe Formation occurs as infiltration of alluvial groundwater and as infiltration of precipitation where the bedrock sandstones outcrop in the western portion of RFP (EG&G 1991c). Exceptions to this are the local occurrence of groundwater in subcropping sandstone units directly beneath the surficial material The confining layers are the relatively impermeable claystones and silty claystones of the Arapahoe Formation

The deeper Arapahoe sandstones have a hydraulic conductivity of approximately 1×10^{-6} cm/s (EG&G 1991c) An overall downward vertical gradient has been identified but has not been quantified. Its existence is evidenced in the overall decrease in static water levels in monitoring wells with depth (EG&G 1991c) Based on the water table contour maps of the site area (Figures 2-5 and 2-6), the unconfined groundwater generally flows easterly as well as northeast towards North Walnut Creek and southeast towards Woman Creek The main plant area is on an east-west trending groundwater divide which lies approximately beneath Central Avenue Groundwater flow appears to be topographically controlled, flowing to the east-northeast coincident with the sitewide gradient. Some groundwater within the bedrock aquifer becomes surface water as it appears as seeps along slopes and in stream drainages, however, none of these slope or drainage areas are present within OU14

2.1.2 Surface Water Hydrology

Surface water drainage in OU14 is controlled for the most part by water diversion works such as ditches, pavements, gutters, drains, and culverts. The largest of the runoff control ditches in the area is the Central Avenue Ditch This ditch runs eastward along

Central Avenue and discharges to South Walnut Creek, which flows to the northeast and into the B-series ponds. The other major runoff control ditch is the South Interceptor Ditch, which prevents runoff from the south side of the RFP main production area from entering Woman Creek, the ditch discharges to Pond C-2 (Rockwell 1988) In the past, Pond C-2 was discharged to Woman Creek, which flows to the southeast. Over the last two years, water from Pond C-2 has been diverted via pipeline to the Broomfield Diversion Ditch, rather than discharging to Woman Creek

The discharges from the ponds are monitored to document compliance with NPDES permit requirements In addition to NPDES monitoring requirements, all off-site pond discharges are monitored for concentrations of plutonium, americium-241, uranium, and tritium (Rockwell 1988)

2.2 Operable Unit 14 Background

OU14 originally consisted of nine IHSSs identified in the 1986 CEARP The IHSSs in OU14 fall within Building Areas 300, 400, 600, 700, and 800 at RFP and include two parking lot sites as shown in Figure 2-7 The IHSSs to be included in OU14 were negotiated with the EPA, DOE, and CDH for the establishment of the IAG. The IAG was signed in final form on January 22, 1991

An investigation of the history and location of the nine IHSSs identified in the IAG is summarized in the HRR (EG&G 1992c) Information in the HRR obtained from record reviews and personnel interviews indicates that only eight of the original IHSSs are located in OU14, the ninth IHSS (IHSS Reference No 156.2) may be included in the OU6 investigations due to its geographic location and potential releases to OU6 Table 2-1 lists

the nine original IHSSs identified in the CEARP, the eight IHSSs identified as a result of the HRR, and the reason for discrepancies or location changes Figure 2-8 illustrates the discrepancies in the IHSS locations from the IAG and the HRR The gray shaded areas surrounded by dashed lines on Figure 2-8 are the IAG IHSS locations The areas in red on Figure 2-8 illustrate the HRR IHSS locations The information developed in the HRR is considered the most complete and accurate compilation of IHSS history currently available and will be used as a basis of this work plan The revised IHSS locations and history will be used for development of the FSP Where inconsistencies in history or rationale are identified in the HRR, the original IHSS location will also be considered in development of the FSP

Access to certain OU14 IHSSs may be limited due to physical obstructions or security provisions Much of OU14 is located in highly developed areas restricted by buildings, overhead lines, and underground utilities The eight IHSSs are presumed to be contaminated with the radioactive constituents uranium and/or plutonium Based on the information in the HRR and the RFEDS, with direction provided in the IAG, some of the IHSSs are potentially contaminated with semivolatile and volatile constituents or degradation products from oils, coolants, and solvents stored or spilled at the sites. The eight IHSSs are listed in Table 2-2 along with brief site descriptions, compounds reported or suspected at the site (based on information in the HRR), and the anticipated current location of suspect compounds

The following sections provide available historical descriptions of the OU14 IHSSs These historical descriptions are derived primarily from the HRR for the RFP (EG&G 1992c) and the references supporting the HRR, supplemented with the CEARP IHSS summaries

2.2.1 Radioactive Site - 700 Area Site No. 1 (IHSS 131)

An explosion in June 1964 in Building 776 resulted in a plutonium release that contaminated approximately 1,500 square feet of soil surrounding the Building 776 gas bottle dock Radiological surveys showed some areas had activities exceeding 300,000 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) A later account stated that 40 square feet of soil situated north of Building 776 was contaminated with plutonium as a result of the explosion Removal of soil in areas of high contamination was undertaken, followed by the placement of a seal coat of oil and approximately 2 inches of clean gravel over the contaminated soil (EG&G 1992c).

Approximately 2,000 square feet on the west end of the north side of Building 776 was radioactively contaminated as a result of the fire-fighting activities. Plutonium was tracked out of Door 17 in Building 776 by the fire-fighters during the blaze Radiological surveys detected plutonium contamination along three northern exterior walls of Building 776, therefore, to reduce mobility of the contaminated soil, the area around Door 17 was paved twice with asphalt In the fall of 1971 the asphalt was removed and placed into barrels No documentation has been found detailing the final disposition of the removed asphalt (EG&G 1992c) Asphalt was later reapplied (date unknown) as shown in Figure 2-10

IHSS 131 was defined as a result of these occurrences, and the current location of this IHSS is on the north side of Building 776 Figures 2-9 and 2-10 provide the IHSS-specific location map and a recent photograph, respectively.

2.2.2 Radioactive Site - Building 334 Parking Lot (IHSS 156.1)

In February 1973 a soil pile contaminated with plutonium was found west of Building 334 in the construction area for Building 371 CEARP interview notes indicate that the soil was removed from the Building 334 Area (Figure 2-11) and was spread over an area situated southwest of Building 371 (Figure 2-12) The Building 371 parking lot and Building 223 (nitrogen plant) now exist on the site where the soil pile was deposited Figure 2-13 provides an IHSS-specific location map Aerial photograph inspections revealed that the soil pile may have been in the area north of Building 334 as early as 1969 Portions of the pile may have originated either from the construction of a Building 774 addition or from an area adjacent to Building 774 in which the soil was removed as a result of an overflow of two underground holding tanks Prior to the removal of the pile, soil sample results showed activities in the pile ranging from 3 to 704 dpm per gram (g) (the average background concentration for Rocky Flats Alluvium is 85.2 dpm/g gross alpha) The volume of the pile was estimated as being approximately 250 cubic yards at the time of removal from the 300 Area

2.2.3 Radioactive Site - Building 444 Parking Lot (IHSS 160)

IHSS 160 consists of an area that contains the Building 444 parking lot and a section of Seventh Avenue located east of Building 444 (See Figures 2-14 and 2-15). This area was previously used as a storage area containing punctured or leaking waste drums and boxes Wastes resulting from the Building 776/777 fire in May 1969 were stored in this area The waste containers enclosed both solid and liquid wastes comprised of uranium and plutonium contaminants as well as oils and coolants Surface soils were removed from the Building 444 parking lot and areas east and west of the lot in the early 1970s An unsuccessful attempt

was made to confirm the destination of the excavated soils Retired RFP personnel expressed that this cleanup attempt was not entirely successful in removing all of the contamination (DOE 1986); however, no contamination was detected during an alpha ground survey performed in the contaminated waste storage yard east of Building 444 in February 1973 This survey was performed after all the waste containers had been removed from the storage yard.

2.2.4 Radioactive Site - Area West of Building 664 (IHSS 161)

RFP personnel indicated during CEARP Phase I interviews that low level residual contamination from plutonium and uranium existed in PAC #400-807, which is adjacent to the west side of Building 664 (See Figures 2-14 and 2-16) (DOE 1986). This contamination occurred as a result of punctured or leaking drums and boxes containing solid and liquid wastes that were being stored in the area An attempt was made to clean up the area by removing the contaminated soil in the early 1970s. Historical Release Report authors were questioned, aerial photographs were reviewed, all available survey records were reviewed, and site personnel were interviewed in an unsuccessful attempt to verify the destination of the excavated soils During the CEARP Phase I interviews, RFP personnel indicated that this cleanup attempt was not entirely successful in removing all of the contamination in the area Results of a radiometric survey conducted in 1977 show the presence of americium-241 and gamma activity in an area at the northwest corner of Building 664

In November 1988 a 1-inch diameter hose ruptured on a forklift resulting in the release of hydraulic oil outside Building 664 that spread over the asphalt area and the adjacent ground A cleanup of the area was attempted after the accident, however, the

degree of cleanup is not known Figures 2-14 and 2-16 provide an IHSS-specific location map and a recent photograph of the area

2.2.5 Radioactive Site - 700 Area Site No. 2 (IHSS 162)

IHSS 162 is located along Eighth Street and extends from the south end of Building 771 to the north end of Building 850 Radioactive contamination within this IHSS was identified during ground monitoring activities in 1974 In response to this discovery, Eighth Street was paved over to prevent mobilization of the contaminated soil In January 1981, an air sample taken during excavation activities at Eighth Street and Central Avenue yielded a long-lived alpha activity concentration indicating the presence of residual contamination in the area. Following this incident, work crews were required to wet the surface soil prior to any excavation activities in order to reduce the airborne dispersion of the soil.

Any accidents or incidents occurring in IHSS 162 south of the 700 Area are not documented. There are at least ten other IHSSs involving radioactive contamination overlapping or in close proximity to this IHSS (EG&G 1992c) The HRR states that "it is possible that one or more of these PACs (IHSSs) have caused contamination within this IHSS " Figure 2-17 provides an IHSS-specific location map, Figures 2-18a through 2-18e are recent photographs of the IHSS from north to south

2.2.6 Radioactive Site - 800 Area No. 2 - Concrete Slab (IHSS 164.1)

In 1958 a radioactively contaminated concrete slab from Building 776 was placed in an area northwest of Building 881 for temporary storage This action resulted in the contamination of several hundred square feet of ground surface The exact identity of the

radioactive constituents is not known, however, the origin of the slab was from Building 776 which is a plutonium manufacturing facility The slab was broken up and removed from the area, and the area was then cleaned The impacted area, also known as the Radioactive Slab from Building 776, is now covered by the southeast corner of the Building 881 parking lot (See Figures 2-19 and 2-20)

2.2.7 Radioactive Site - 800 Area Site No. 2 - Building 886 Spills (IHSS 164.2)

Since 1965, some areas within and nearby Building 886 have been contaminated with enriched uranium as a result of spills, movement of contaminated equipment, and other activities (See Figures 2-21, 2-22a, and 2-22b) The following material includes information obtained through interviews with building personnel.[1]

A 1000-liter low level waste holding tank, is located in a covered underground concrete pit immediately to the west of Building 886 and below grade The pit is contaminated with uranium, and groundwater has accumulated in this area, indicating the potential for groundwater contamination Activities associated with the removal of waste solution from this tank may have resulted in small spills onto the dirt or concrete One known incident was discovered on September 26, 1989, in which a colorless liquid was found slowly dripping onto the concrete through the drain valve of an "empty" 500-gallon stainless steel transfer tank located on a concrete pad outside the west side of the building This incident created a wet spot on the concrete approximately 5 inches in diameter. Radiological monitoring of the area after discovery, indicated 650 counts per minute (cpm) from a direct survey and 12 to 24 dpm from a removable contamination survey These

[1] Personal communication J Langsted (Dames & Moore) with R Rothe EG&G, May 1992

radiological results indicated the level of contamination was low Analyses of soil samples taken around the tank after the incident identified the contaminant as uranium Cleanup activities were initiated after the incident, and no residual contamination remained

Additionally, a filter plenum existed outside the west side of the building prior to 1969 Filter change and clean-out operations are potential sources of outside uranium contamination. To the south of the building a storage shed (Building 880) is used to store experimental equipment Some equipment in this area is known to be radiologically contaminated The area over which this equipment was transported between buildings has a potential for environmental contamination

Within Building 886 experimental areas, contaminated solutions have periodically been spilled onto the floor The potential exists for solution leakage through cracks in the concrete slab, although none are indicated

2.2.8 Radioactive Site - 800 Area Site No. 2 Building 889 Storage (IHSS 164.3)

Building 889 is a decontamination facility first used in 1969 A storage pad located north of the building was used to store contaminated drums and uranium-contaminated equipment prior to decontamination. An area west of Building 889 may have also been used for storage of contaminated equipment and drums Figure 2-21 provides a IHSS-specific location map Figure 2-23 is a recent photograph of the IHSS.

Three known incidents occurred in the 1980s involving contaminated equipment and drums A waste drum containing uranium chips spontaneously ignited on June 16, 1982, no release of contamination was reported as a result of this incident In September 1983, plastic

sheeting covering a set of contaminated tools was blown off by strong winds Residual contaminants on these tools may have spread On July 20, 1984 a uranium chip fire started in an improperly loaded drum Neither documented responses nor the amount of contamination from the 1983 and 1984 incidents is known

2.3 Previous Investigations

To date, no IHSS-specific investigations have been conducted, but the following sections discuss prior investigation activities conducted in and around the areas contained within OU14

2.3.1 Radiometric Surveys

The radiometric surveys conducted from 1977 to 1984 involved the use of Field Instruments for Detecting Low Energy Radiation (FIDLER) The FIDLER instrumentation was specificallly designed to evaluate alpha contamination in RFP soils. Experimental instruments were being used at RFP as early as 1971 or 1972 A plant-wide survey begun in 1977 and completed in September 1984 located abnormal radiation levels in the soil at RFP.

An organized summary of the results of the 1977 to 1984 radiometric (FIDLER) survey is currently being prepared. The results located to date do not document a survey of any OU14 IHSSs, with the exception of a small portion of IHSS 160. Memos describing the survey do, however, indicate coverage of all areas within the (inner) plant-site chain-link fence, and state "all areas identified as 'above background' by the radiometric survey were indeed remediated" (Appendix A) A discussion of instrument sensitivity indicates that contaminated areas identified by this survey were limited to higher levels (500,000 picocuries

per gram [pCi/g] and above) Therefore, results of this survey give information of limited use on OU14 IHSSs

A review of Environmental Management Division (EMD) radiological aerial surveys of the RFP and surrounding areas were performed in 1972, 1973, and 1975, aerial surveys were also conducted in 1981 (EG&G 1982) and 1989 (EG&G 1990b) These surveys utilized sodium iodide detection systems flown at 100 to 150 feet above the ground Maps developed from these surveys indicate radiation emissions associated with process and storage buildings at RFP. Additionally, there is an indication of americium-241 emissions from the soil at an area east of the 903 Pad

Published analysis of these studies do not indicate emissions from any of the OU14 IHSSs, other than those associated with nearby buildings. Spacial resolution of these aerial surveys is on the order of hundreds of feet, and "the contours of the aerial americium-241 are always extended over an area larger than the actual activity on the ground" (EG&G 1990b) Minimum detectable activities for americium-241 are given as 2.9 millicuries (mCi) for a point source, 0 35 microcuries per square meter ($\mu Ci/m^2$) for uniform surface contamination, and 11 2 pCi/g for uniformly distributed soil concentration None of these levels are adequate for IHSS characterization Thus, the aerial survey data do not provide useful information for identifying contamination within the IHSS areas, and could result in both false positive and false negative indications within these areas.

Ground-based detector surveys and soil sampling were performed in conjunction with several of the aerial surveys, but they concentrated on soil contamination to the east of the plant

2.3.2 Preliminary PCB/Radiological Investigations

Sampling activities conducted in 1991 were designed to find polychlorinated biphenyl (PCB) contamination at designated locations within RFP The samples taken from these investigations were also analyzed for radionuclide contamination (EG&G 1991h) The results for OU14 IHSSs are discussed below At present, areas suspected of PCB contamination are planned for investigation under a separate action [2]

2.3.2.1 Radioactive Site - Building 444 Parking Lot (IHSS 160) Soil samples were taken from around a concrete pad located within IHSS 160 near Building 666, which was used to store unused and/or unusable transformers AROCLOR-1260 was detected in the soil samples with concentrations ranging from 170 to 1,600 parts per billion (ppb) (EG&G 1991h) Plutonium-239,-240 concentrations in the soil samples ranged from 2.3 to 9 1 pCi/g (the upper tolerance limit [UTL] background concentration of plutonium-239 is 0 0150 pCi/g) A figure depicting the location is unavailable The sample location is identified as Site No 14 in the preliminary report (EG&G 1991h)

2.3.2.2 Radioactive Site (IHSS 162) - 700 Area Site No. 2 Four of the sampling locations lie within IHSS 162 or in the immediate vicinity Analyses of samples taken at the northwest and southwest corners of Building 776 (Site No 21, Figure 2-24, and No 22, Figure 2-25) showed the presence of PCBs in the soil AROCLOR-1260 was found in the samples with concentrations ranging from 69 to 480,000 ppb (EG&G 1991h) A sample taken at the northwest corner of Building 776 had an americium-241 concentration of 6.8 pCi/g (the UTL background concentration is 0 0135 pCi/g) (EG&G 1990a)

[2]Personal communication, S M Lewis, Dames & Moore with N Demos, EG&G Rocky Flats, June, 1992

2.3.3 Existing OU14 Data and Comparison to Background

Existing soil boring, groundwater, and surface water analytical data from locations in or adjacent to OU14 are available from previous characterization and routine environmental monitoring activities Sampling locations for each of these media are illustrated on Figures 2-26, 2-27, and 2-28 The field program under which these data were collected did not focus on contaminant characterization of OU14 As a result, many of the boreholes were placed in areas unaffected by site activities, and monitoring locations do not exclusively characterize OU14 conditions Analytical data, including metals, radionuclides, volatile organic compounds, and major ions, were collected as part of these activities, and most of the analytical data were validated in accordance with EG&G Environmental Management (EM) guidelines referenced in the *Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA RI/FS and RCRA RFI/CMS Activities* (QAPjP) (EG&G 1991e) Analyte-specific statistical summaries for each location and media available (e.g., maximum concentration detected, arithmetic mean and standard deviation, geometric mean and variance, detection frequency) are presented in Appendix B All available analytical data from these locations is presented in Volume II

The existing soil data for OU14 and vicinity were compared to background data on radionuclides, metals, major anions, and indicator parameters. Background samples were obtained from samples collected at locations in buffer zone areas west, north, and south of the main plant As a preliminary screening method, the subsurface (alluvial) soil analytical data from the OU14 IHSSs were compared to the UTL (where calculated) or the maximum concentration detected for sitewide background chemical data presented in the *Background Geochemical Characterization Report* (EG&G 1990a) Those compounds detected in excess of the UTL or maximum concentration are considered preliminary contaminants of

concern (COCs) for OU14 and are summarized, by IHSS, in Tables 2-3, 2-4, and 2-5 A statistical summary of the background concentrations is presented in Appendix C

2.3.3.1 Subsurface Soils The IHSS-specific location maps presented throughout Section 2 2 provide the locations of boreholes drilled in 1989 for piezometer/groundwater monitoring well installation Subsurface soil samples were collected at approximately 2-foot intervals (in most cases) for chemical characterization during the drilling operations The chemical data from locations within OU14 IHSSs and selected locations in the vicinity of the OU14 IHSSs were evaluated to aid in preliminary contaminant characterization (Figure 2-26) Chemical data for boreholes located within IHSS 156.1, IHSS 160, IHSS 161, IHSS 162, and IHSS 164 1 represent the most extensive IHSS-specific characterization information available at this time Chemical data for samples located in the vicinity of OU14 IHSSs provide an indication of upgradient and downgradient characteristics Compounds detected above site background at these locations are summarized in Tables 2-3, 2-4, and 2-5. The chemical data from these boreholes will be used, to the extent possible, to identify potential contaminants within the IHSS through comparison with background, upgradient, and downgradient locations

2.3.3.2 Groundwater Routine quarterly groundwater monitoring has been conducted at RFP since 1986 As illustrated on Figure 2-27, three routine monitoring wells are located in the vicinity of OU14 IHSSs. Monitoring well 4486 is located south of IHSS 156 1 and northwest of IHSS 160 and 161 Data from this well will be useful in characterizing groundwater quality upgradient of the OU14 IHSSs but within the industrialized area of the plant Well 0187 is located southeast of IHSSs 160, 161, 162, and 164 1 As indicated on the water level contours (Figures 2-5 and 2-6), groundwater movement is generally in the easterly direction; therefore, contamination in groundwater at

monitoring well 0187 has possibly migrated from the OU14 areas However it should be noted this well is located within OU1 and does not represent water quality exclusive to any OU14 IHSS Water quality data from monitoring well P418289 represents groundwater quality upgradient of IHSS 160 Monitoring well 6186 is located within IHSS 164 3, this may indicate downward migration of contaminants from the surface although other sources of contamination may also exist Statistical summaries of the water quality data from these wells are presented in Appendix B

2.3.3.3 Surface Water Routine surface water monitoring has been conducted at RFP since 1989 Chemical data from monitoring locations SW035 and SW036 (not shown on Figure 2-28) were evaluated to assess potential impact via runoff from IHSSs 160 and 161 These stations are located in the South Interceptor Ditch directly south of IHSSs 160 and 161 Water quality of runoff from 164.2 may be monitored by station SW020 (Figure 2-28) Each of these stations receives runoff from other potential contaminant sources, therefore, chemical characterization is not exclusive to the OU14 IHSSs Statistical summaries of water quality are summarized in Appendix B.

2.4 Nature of Contamination

Operable units that potentially impact OU14 are discussed below. The following description of the nature of contamination has been derived primarily from the HRR (EG&G 1992b) Historical descriptions have been supplemented with an evaluation of available analytical, geologic, and hydrologic data for the overall OU14 site area, however, descriptions of the nature of contamination associated with OU14 IHSSs in some instances are limited to historical documentation of the type of materials released to the environment

2.4.1 Impacts from Other Operable Units

As illustrated on Figure 2-29, IHSSs with other OUs may be potential sources of contamination at some of the OU14 IHSSs Some of the OU14 IHSSs located in the 300, 400, 600, 700, and 800 Building Areas may be impacted not only by events identified for that IHSS, but also by activities occurring at nearby or overlapping IHSSs contained in other OUs The following sections describe the other OUs in the area OU8 (the 700 Area), OU9 (Original Process Waste Lines), OU12 (the 400/800 Area), and OU13 (the 100 Area) are primary OUs of interest because some of their IHSSs overlap or are in close proximity to OU14 IHSSs To avoid duplication of effort, investigation of IHSSs that are in other OUs and are near to or overlap OU14 IHSSs (other than source delineation and potential migration of contaminants to OU14 IHSSs) will not be considered in developing the OU14 field sampling plans

2.4.1.1 OU8 (700 Area). OU8 contains three IHSSs that overlap or lie near OU14 IHSSs IHSS 118 1, IHSS 150 2, and IHSS 150.5 Trichloroethylene and carbon tetrachloride releases are suspected in IHSS 118.1, which is adjacent to the north side of Building 776 and lies in the vicinity of IHSS 131 and IHSS 162 IHSS 150 2 overlaps IHSS 162 and is adjacent to the western sides of Buildings 771 and 776 Plutonium contamination was released primarily to the north and southwest of Building 771 as a result of a fire that occurred in September 1957 In addition, plutonium contamination was detected in an area that lies within IHSS 150 2 and IHSS 162 after the Building 776/777 fire in 1969. IHSS 150 5 overlaps IHSS 162 and is adjacent to the south end of the western side of Building 707 Process wastewater, which may have contained uranium, solvents, oils, beryllium, nitric acid, hydrochloric acid, and fluoride, leaked into an area west of Building 707 from Valve Vault 7 and another valve vault which was removed from the area in March 1973.

2.4.1.2 OU9 (Original Process Waste Lines) The Original Process Waste Lines (OPWL), designated as IHSS 121, are a network of tanks and underground pipelines constructed throughout the RFP facility This network was created for the transport and temporary storage of aqueous chemical and radioactive process wastes from point of origin to on-site treatment and discharge points Numerous releases have occurred from this system as a result of pipeline leaks, pipeline breakage, tank and pipeline junction box/valve vault overflows, and tank and pipeline corrosion and deterioration Wastes transported through the OPWL include the following uranium-238, uranium-235, plutonium, nitrate, acids, bases, hexavalent chromium, chromium (other than hexavalent), beryllium, iron, iodine, phosphate, and tritium IHSS 121 overlaps IHSS 162, IHSS 164.3, and IHSS 131 and runs close to IHSS 160 and 164 1.

IHSS 132 is suspected to have contamination related to a small radioactively contaminated sludge spill and leakage of water containing small amounts of detergent and radionuclides from tanks in Building 730 This IHSS is located approximately 80 feet north of Building 776 and is situated near IHSS 131 IHSS 159 is located west of IHSS 162 adjacent to the east side of Building 559 This area is suspected of being contaminated with radioactive contaminants as a result of leakage of aqueous waste solution from areas around Building 559

2.4.1.3 OU12 (400/800 Area) OU12 contains two IHSSs, IHSS 120 1 and IHSS 120 2, that overlap OU14 IHSSs IHSS 120 1 is located north of Building 664 and overlaps IHSS 160 IHSS 120 2 is located west of Building 664 and overlaps IHSS 161 The areas within IHSS 120 1 and 120.2 were used to store waste packages during the 1970s CEARP Phase 1 investigations report that spills occurred within these areas. Suspected contaminants within these IHSSs are polyester resin, peroxide catalyst, unspecified cleaning solvents, and

americium-241. Elevated (above background) gamma radiation and americium-241 concentrations were found in the near vicinity of these IHSSs by the Aerial Radiological Measurements survey, however, this could be expanded contours from Building 664

2.4.1.4 OU13 (100 Area). OU13 contains two IHSSs, IHSS 117.3 and IHSS 190, that overlap or lie in the vicinity of OU14 IHSSs IHSS 117 3 is south of Central Avenue and west of Seventh Street In May 1965 a container filled with radioactive waste oil leaked along a 400-foot stretch of roadway near the intersection of Central Avenue and Seventh Street as it was being transported from Building 776 to a storage area near Building 663. This is the only known incident that occurred within this IHSS The southern portion of IHSS 117 3 ends at IHSS 160 IHSS 190 contains the Central Avenue Surface Ditch, which runs through IHSS 162 and near IHSS 164 2 and IHSS 164.3 In December 1978 a storage tank leaked 1,000 to 1,500 gallons of caustic solution containing concentrated sodium hydroxide into a spill catch basin An operator erroneously released the solution from the catch basin into the Central Avenue Ditch The sodium hydroxide solution flowed eastward and was diverted to South Walnut Creek and Pond B-1 for temporary containment

2.4.2 OU14 IHSSs - Radioactive Sites

The nature of contamination at the following individual IHSSs is based on historical information presented in the HRR (EG&G 1992b) and supplemented by information from previous investigations and other OU descriptions, where available

2.4.2.1 Radioactive Site - 700 Area Site No. 1 (IHSS 131) As previously summarized, soils within this IHSS are suspected of being contaminated with plutonium resulting from the 1964 and 1969 Building 776/777 fires Potential volatile organic

contamination of groundwater could also exist in IHSS 131 due to its close association with OU8 IHSS 118.1. Extent of volatile organic contamination from this IHSS is within the scope of the OU8

Contaminant levels in three borehole locations to the northeast of IHSS 131 may indicate downgradient contaminant characteristics for the IHSS (See Tables 2-3, 2-4, 2-5), however, influence from other OUs, particularly the Solar Evaporation Ponds (OU4), may overshadow potential impact from IHSS 131 Characterization data, other than that presented here, is not available for IHSS 131

2.4.2.2 Radioactive Site - Building 371 Parking Lot (IHSS 156.1). As previously summarized, approximately 250 cubic yards of a plutonium-contaminated soil was initially stored in a location north of Building 334, then removed and placed in a location southeast of Building 371 The pile was leveled out over the area, and the Building 371 parking lot now exists over the soil pile area Radiological surveys of the pile showed activities ranging from 3 to 704 dpm/g No other documentation has been found detailing other releases in the IHSS 156 1 location. Documentation indicating that the previous (initial) storage area (north of Building 334) has been sufficiently decontaminated has also not been found

As summarized in Appendix B, several metals were detected in borehole P114889 (located in the south central portion of the IHSS) including antimony, arsenic, beryllium, and lead Radionuclides detected include plutonium-239,-240, radium-226, radium-228, strontium-89,-90, and the americium-241 although concentrations do not indicate significantly high levels of contamination in this area Similar concentrations of inorganics and radionuclides were observed in the upgradient and downgradient borehole locations Acetone and methylene chloride, which are common laboratory contaminants, were the only organic

constituents detected in borehole P114889 These contaminants were detected in many of the boreholes evaluated Tetrachloroethylene and carbon tetrachloride were detected in the top 4 feet of soil collected in borehole P119389 This borehole is located upgradient (northwest) of IHSS 156 1 Potential for migration of volatile organic compounds (VOCs) from this area to areas within IHSS 156.1 does exist given the general direction of groundwater flow in the area

2.4.2.3 Radioactive Site - Building 444 Parking Lot (IHSS 160). As previously summarized, IHSS 160 has been impacted several times by leaking or spilled waste material The wastes stored in the containers were in both liquid and solid forms and were comprised of uranium and plutonium contaminants as well as oils and coolants Waste material taken out of Buildings 776 and 777 after the 1969 fire were also stored in the IHSS 160 area OU12 IHSS 120 1 is adjacent and to the west of IHSS 160 Some of the suspected contaminants from IHSS 120 1 include volatile organics and americium-241

PCBs were positively identified within the IHSS during the preliminary assessment of PCB contamination (EG&G 1991a) throughout the industrialized area of RFP Samples collected in the vicinity of Building 668 (Site No 14, figure unavailable) also indicate plutonium-239,-240 is present at levels above sitewide background (Appendix C).

Plutonium-239,-240 was also detected at 15 9 pCi/g in the 0- to 3-foot interval of borehole P313489, which is located in the extreme northeast corner of the IHSS Radionuclide results from the other borehole locations within the IHSS did not indicate high levels of contamination, although results above sitewide background were observed for most radionuclides (Appendix C) Inorganic constituents were not detected

Routine laboratory contaminants methylene chloride, acetone, and toluene were detected in boreholes in and around the vicinity of IHSS 160 Tetrachloroethylene (5 ppb) and carbon disulfide (9 ppb) were detected in borehole P411589 in the 12- to 14-foot interval and the 18- to 20-foot interval, respectively Additionally, 1,1,1-trichloroethane was detected in each of the 2-foot interval samples collected from 0 to 10 feet in borehole P313489 The total depth of borehole P313489 is 24 feet, and it was completed as a piezometer/groundwater monitoring well, however, water quality data either has not been collected or is not available

As summarized in Appendix B, several organic constituents were detected in monitoring well 0187 groundwater including trichloroethylene, tetrachloroethylene, and trans-1,2-dichloroethylene. This well is located downgradient of IHSS 160, however, concentrations do not represent water quality information exclusive to this IHSS

2.4.2.4 Radioactive Site - Area West of Building 664 (IHSS 161). As previously summarized, RFP personnel have indicated that the area directly adjacent to the west side of Building 664 has low level residual contamination from plutonium and uranium resulting from leaking drums and boxes containing solid and liquid wastes that were being stored in the area. Other potential contamination problems within the IHSS include an uncharacterized hydraulic oil spill and influence from suspect americium-241 and volatile organics contamination from OU12 IHSS 120.2 It should be noted that IHSS 120.2 is entirely enclosed by IHSS 161

Chemical data collected within the IHSS are available from borehole samples collected during 1989 The results do not indicate high concentrations of radionuclides or inorganics in the areas where the boreholes were drilled With the exception of methylene

chloride and acetone, tetrachloroethylene (7 ppb) was the only other organic compound detected within the IHSS in borehole P412189, which is located in the northwest portion As summarized in Appendix B, several organic constituents were detected in monitoring well 0187 groundwater including trichloroethylene, tetrachloroethylene, and trans-1,2-dichloroethylene This well is located downgradient of IHSS 161, however, concentrations do not represent water quality information exclusive to this IHSS Monitoring well 0187 is within OU1 boundaries Monitoring well P418289 is located northwest of the IHSS Low levels of volatile organics, 1,1-dichloroethane, 1,1-dichloroethene, and chloromethane were detected in this well There is a potential for volatile organic contamination of groundwater underlying IHSS 161

2.4.2.5 Radioactive Site - 700 Area Site No. 2 (IHSS 162) The identity and amount of contamination in the southern and central sections of this IHSS are unknown, however, contamination was detected by ground surveying activities in 1974 and air sampling activities in 1981 It is believed that contamination within these two sectors resulted from the migration of contaminants from other IHSSs IHSS 162 is greatly affected by the other IHSSs in the area Potential contamination from other IHSSs overlapping IHSS 162 include volatile organics, radionuclides, beryllium, iron, chromium, hexavalent chromium, nitric acid, hydrochloric acid, and fluoride

Radiological surveys have shown the presence of contamination on three sides of Building 776 PCB contamination in the northern area of the IHSS is also suspected because of the results of the preliminary PCB investigation (EG&G 1991a) discussed in Section 2 3 3 2 Samples collected during this investigation also indicate plutonium-239,-240 and americium-241 are present at levels above the sitewide background concentrations (Appendix C) As summarized in Tables 2-3, 2-4, and 2-5, chemical data from boreholes

located downgradient of the IHSS do not indicate contaminant concentrations substantially different from other boreholes within the industrialized area of the plant

2.4.2.6 Radioactive Slab From Building 776 - (IHSS 164.1) The southeast corner of the Building 881 parking lot is suspected of being contaminated with plutonium resulting from the placement and storage of a radioactively contaminated slab originating from Building 776 in 1958 Several hundred square feet of soil area are suspected of being contaminated, although documentation of radiological monitoring activities within this IHSS has not been found

One borehole completed within the boundaries of IHSS 164 1 is borehole P313589 Data from the borehole are summarized in Appendix B. Preliminary assessment of the results do not indicate high levels of contamination

2.4.2.7 Radioactive Site - 800 Area Site No. 2 Building 886 Spills (IHSS 164.2) This IHSS is suspected of being contaminated with uranium as a result of spills that occurred within and outside of Building 886 A thorough investigation of the contaminated area has not been conducted The extent of the contamination is unknown, however, additional information acquired through discussions with Building 886 personnel indicate the probability of encountering potentially significant contamination problems in this IHSS As indicated in Section 2 2 7, the potential for radiological contamination of groundwater is suspected because of groundwater accumulation in an underground concrete pit.

2.4.2.8 Radioactive Site - 800 Area Site No. 2 889 Storage (IHSS 164.3) Areas within this IHSS were used temporarily to store uranium-contaminated equipment and materials prior to decontamination Radiological surveys have detected the presence of

contamination within this IHSS The total amount of contaminants that was released within these storage areas is unknown

Routine groundwater monitoring well 6186 is located within IHSS 164 3 boundaries The chemical data, summarized in Appendix B, do not indicate substantial presence of contaminants

2.5 Site Conceptual Model

By using the known physical conditions and potential contamination sources described in the preceding sections, a site conceptual model of exposure pathways was developed for the OU14 IHSSs The conceptual models have been developed for use in the evaluation of potential risks of OU14 contamination to human health and the environment

The primary purpose of a conceptual model is to aid in identifying exposure pathways by which human and biotic receptors may be exposed to contaminants. EPA defines an exposure pathway as "a unique mechanism by which population may be exposed to chemicals at or originating from the site . " (EPA 1989b)

An exposure pathway must include a contaminant source, a release mechanism, a transport medium, an exposure route, and a receptor An exposure pathway is not complete without each of these five components The individual components of the exposure pathway are defined as follows

- **Contaminant Source** For purposes of the OU14 conceptual models, the contaminant source is divided into primary sources (IHSSs) and secondary sources (media that have potentially been affected by these releases). Secondary sources

will be closely investigated since they may currently contain contaminants that can still be released to the environment

- **Release Mechanism** Release mechanisms are physical and/or chemical processes by which contaminants are released from the source The conceptual model identifies mechanisms that released contaminants directly from the primary sources (i e., leaks, spills, overflows, fire, explosion, etc.), and mechanisms that may release contaminants from the secondary contaminant sources

- **Transport Media.** Transport media are the environmental media into which contaminants are released from the source and are in turn released to a receptor Potential transport media for OU14 include air, surface water, groundwater, and biota

- **Exposure Route·** Exposure routes are avenues through which contaminants are physiologically incorporated by a receptor Exposure routes for receptors at OU14 are inhalation, ingestion, and dermal contact.

- **Receptor·** Receptors are human or environmental populations that are affected by the contamination released from a site Human receptors for OU14 include the RFP workers/visitors and off-site residents Environmental receptors are biota (both flora and fauna) indigenous to the OU14 environs.

2.5.1 Generalized Conceptual Model for OU14

Diagrams of the conceptual models for potential secondary contaminant sources, transport media, exposure routes, and receptors relating to the OU14 IHSSs are presented in Figure 2-30 An IHSS specific conceptual model figure showing a cross sectional diagram is included as Figure 2-31 The various aspects of the conceptual model are explained in the following sections

2.5.1.1 Contaminant Sources Primary contamination sources within the various IHSSs include aboveground tanks, storage areas, and processing facilities Contaminants

from these sources may have been introduced into the environment through spills on the ground surface, explosion and/or fire, physical contact with contaminated materials, and through incident precipitation runon and runoff Contamination may still be entering the environment from some of the sources, in other areas, the sources may be exhausted or may have been physically mitigated through remediation at the time of the initial release

Exclusive of volatilization to the atmosphere, the contaminants first enter the environment through the soil and are transported by various mechanisms from affected soil to unaffected media Groundwater is another medium that once affected, could spread contaminants to unaffected media, therefore, for conceptual purposes, contaminated soils and groundwater are considered secondary contaminant sources. These secondary groups may receive the most attention during RFI/RI activities since they are a potential current source Contaminants from secondary sources could be spread to other media through secondary release mechanisms including disturbance of soil, volatilization and resettling of dust, surface water runoff, infiltration/percolation of water, bioconcentration/accumulation, and physical tracking The chemical composition of the contaminants varies widely between the IHSSs, ranging from mixed wastes to nonradioactive organic and inorganic compounds.

Contaminants generally suspected in OU14 IHSSs include plutonium-239,-240, americium-241, and uranium-241. Some of the existing data quantitatively confirms the presence of these contaminants such as the results from the PCB investigation around IHSS 160 and 162 and one borehole drilled in IHSS 160. VOCs are suspected in several IHSSs as well, either directly from past activities at the IHSS or influence from other OUs. PCB presence in two IHSS has been confirmed, semivolatile organic contamination spills may also be present in some IHSSs

Most IHSSs in OU14 overlie or are immediately adjacent to other OU IHSSs, therefore, it may not always be possible to differentiate between contaminants from specific IHSSs It follows that the precise extent of contamination from a given IHSS may be difficult or impossible to determine

2.5.1.2 Potential Transport and Release Mechanisms. The human health priority pathways and transport mechanisms in OU14 including air, surface water, groundwater, biota, and tracking are summarized on Figure 2-30 Air pathways will be addressed by surface soil and soil gas characterization The surface water pathway will be addressed by surface water sampling if feasible (i e , if a suitable location is identified within the IHSS or at a point outside the IHSS potentially affected by runoff) The groundwater pathway will be addressed by subsurface soil and water sampling, and by hydrostratigraphic unit examination through the use of soil and bedrock boreholes and groundwater monitoring wells during Stage II investigations Additionally, specific IHSS potential contaminant pathways may commingle with pathways from other IHSSs The potential transport and release mechanisms are described briefly below.

- **Air:** Potential dispersion of contaminants by wind is possible wherever contaminated soil exists The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction, or similar activity Dust-borne contaminants mobilized by the wind have been documented in some areas of RFP

  Most of the OU14 IHSSs are fully or partially covered with artificial groundcover (i.e., pavement or concrete). As indicated in the IHSS background information (Section 2.2), the groundcover was applied as a means of controlling or preventing contaminant migration The artificial groundcover reduces the potential for contaminant transport and release via the air pathway; however, uncovered areas may have been impacted prior to application of a groundcover.

Additionally, some releases involving constituents such as VOCs, while impacting air quality for a time near the release, typically do not spread contamination to secondary media through the air transport mechanism However, organic vapors emanating from soils in the vadose zone can serve as an indicator of subsurface releases and potential subsurface soil and groundwater contamination The movement of organic vapors through soil is controlled by the specific properties of the contaminant and the soil as well as other physical parameters and physical characteristics of the soil.

- **Surface Water:** Surface water and sediments may have been affected by releases that originated at the ground surface, precipitation runoff across these areas could also mobilize and transport the contamination into nearby drainages or surface impoundments A system of collection ditches and ponds contain and control runoff at RFP Surface water can also be affected by surfacing of contaminated groundwater in the form of seeps

  As described under the air transport and release mechanism, a substantial portion of OU14 has been covered with pavement or concrete The groundcover potentially prevents mobilization and transport of contaminants via runoff

- **Groundwater:** Groundwater recharge from incident precipitation can occur through undeveloped ground surfaces within RFP Mobile constituents of contamination such as volatile organics may eventually migrate into the vadose zone or eventually to the groundwater system. Immobile constituents, such as radionuclides and metals may exhibit some downward migration; however, they usually remain sorbed to clays and silts. As is the case in OU14, soils overlain by pavement and buildings may be subject to little or no downward percolation of water Contaminants in such soils may remain relatively immobile

  In the vadose (unsaturated) zone, free liquids are expected to move generally downward to the water table The water table varies in the OU14 area depending upon location and time of year Liquids infiltrating the soil may also encounter a less permeable (low-flow boundary) and flow laterally through the more permeable soil along the boundary At RFP, such permeability contrasts are likely at the alluvium/bedrock contact. If, however, the leakage or release rate exceeds the infiltration capacity of the soil, or if the surface is covered by an impermeable material (i e , concrete), then the liquid may pool or flow across the material surface to a more permeable material where infiltration can occur

Another factor affecting groundwater and contaminant flow is the potential for preferential migration pathways within the industrialized areas of RFP Buried utilities, trenches, and pits may provide conduits for migration of contaminants Because OU14 is located in the developed areas of RFP, this is a potentially viable mechanism for transport and release

- **Biota:** Bioconcentration and bioaccumulation can occur as plants and animals uptake or ingest contaminants from their surrounding environment Additionally, deposition of contaminated dust on plant foliage or animal coats can occur

  Because of the industrialized nature of OU14, flora and fauna are considered a limited means of transport and release Some of the OU14 IHSSs are fenced thus restricting access to site fauna

- **Tracking:** Potential dispersion of contaminants by tracking may occur wherever surface contamination exists and is exposed Contaminated dust may be transported and released from adherence to fauna inhabiting an area

  The majority of OU14 is covered with pavement or concrete which provided a barrier against the tracking mechanism, however, uncovered areas within OU14 do exist Fencing, present at some of the OU14 IHSSs, provides additional restriction

2.5.2 Exposure Routes and Receptors

- **Exposure Routes:** Contaminants released from OU14 IHSSs could potentially affect receptors through inhalation of airborne particles or vapors, and through ingestion of or dermal contact with contaminated source/transport media

- **Receptors:** Potential human receptors include RFP workers and visitors and off-site residents Environmental receptors include biota (both flora and fauna) indigenous to the OU14 IHSS localities and environs Because OU14 is in the industrialized areas of RFP, biota receptors are extremely limited.

TABLE 2-1
OU14 IAG AND HRR IHSS COMPARISON

IAG IHSS NUMBER	IAG IHSS TITLE	HRR IHSS NUMBER	HRR IHSS TITLE	DISCREPANCIES	IHSS INVESTIGATED IN OU14
131	Radioactive Site - 700 Area Site No 1	131	Radioactive Site - 700 Area Site No 1	HRR IHSS 131 is smaller than IAG IHSS 131	HRR IHSS 131 IAG IHSS 131
156 1	Radioactive Soil Burial-Building 334 Parking Lot	156 1	Building 371 Parking Lot	IAG IHSS 156 1 is in a different location than HRR IHSS 156 1 IAG IHSS 156.1 is located in the Building 334 Parking Lot, while HRR IHSS 156.1 is located in the Building 371 Parking Lot	IAG IHSS 156 1 HRR IHSS 156 1
160	Radioactive Site - Building 444 Parking Lot	160	Radioactive Site - 444 Parking Lot	HRR IHSS 160 is smaller than IAG IHSS 160 HRR IHSS 160 does not include a fenced waste storage area adjacent to Building 663 and east of Building 444 This area was unique in location and in operations compared to the other areas of IHSS 160	HRR IHSS 160
161	Radioactive Site - Building 664	161	Storage Site West of Building 664	No discrepancies	HRR IHSS 161 IAG IHSS 161
162	Radioactive Site - 700 Area Site No.2	162	Radioactive Site - 700 Area Site No 2	No discrepancies	HRR IHSS 162 IAG IHSS 162

TABLE 2-1
OU14 IAG AND HRR IHSS COMPARISON
(continued)

IAG IHSS NUMBER	IAG IHSS TITLE	HRR IHSS NUMBER	HRR IHSS TITLE	DISCREPANCIES	IHSS INVESTIGATED IN OU14
164 1	Radioactive Site - 800 Area Site No 2, Concrete Slab	164 1	Radioactive Slab from Building 776	HRR IHSS 164 1 is in a different location than IAG IHSS 164 1 HRR IHSS 164 1 is located in the southeast corner of the Building 881 Parking Lot while IAG IHSS 164 1 is adjacent to the northwest side of Building 881	HRR IHSS 164 1
164 2	Radioactive Site - 800 Area Site No 2, Building 886 Spills	164 2	Radioactive Site - 800 Area Site No 2, Building 886 Spills	No discrepancies	HRR IHSS 164 2 IAG IHSS 164 2
164 3	Radioactive Site - 800 Area Site No 2, Building 889 Storage Pad	164 3	Radioactive Site - 800 Area Site No 2, 889 Storage	IAG IHSS 164 3 is smaller than HRR IHSS 164 3 HRR IHSS 164 3 includes the area west of Building 889	HRR IHSS 164 3

TABLE 2-2
OU14 IHSS SUMMARY

IHSS #	TITLE	HISTORICAL ACTIVITY DESCRIPTION	SUSPECT CONTAMINANTS	SUSPECT LOCATION
131	Radioactive Site - 700 area Site No 1	This area is located near the northwest corner of Building 776 and is believed to be contaminated as a result of the 1964 Building 776 explosion and the 1969 Building 776/777 plutonium fire	Plutonium	Surface from tracking and airborne dispersion of contaminated material
156 1	Radioactive Site - Building 334 Parking Lot	Potential contamination of Building 334 parking area from storage of a radioactively contaminated soil pile between 1969 (?) and 1973 on the site	Plutonium	Surface from contact with contaminated soil, surface from airborne dispersion and surface runoff.
160	Radioactive Site - Building 444 Parking Lot	This site was used as a storage area that contained punctured or leaking waste containers. The wastes stored in these containers were in liquid or solid forms	Uranium, Plutonium, Oil, Coolant	Surface from spills, leaks, and airborne dispersion; subsurface from infiltration
161	Radioactive Site - Area West of Building 664	Contamination may exist as a result of leaking or punctured waste containers that were stored in this area	Plutonium, Uranium	Surface from spills, leaks, and airborne dispersion, subsurface from infiltration
162	Radioactive Site - 700 Area Site No 2	This area is located along Eighth Street and extends from the north end of Building 776 to the north end of Building 881 Monitoring activities within this area have detected the presence of radioactive contamination Contamination exists in the northern part of this IHSS resulting from the Building 776/777 fires of 1964 and 1969	Plutonium	Surface from tracking, airborne dispersion, and surface runoff

(P:\OU14\WORKPLN\TABLES\2-2 TBL\10/14/92)

TABLE 2-2
OU14 IHSS SUMMARY
(continued)

IHSS #	TITLE	HISTORICAL ACTIVITY DESCRIPTION	SUSPECT CONTAMINANTS	SUSPECT LOCATION
164 1	Radioactive Site - 800 Area No 2 - Concrete Slab	A radioactively contaminated slab from Building 771 was placed in an area northwest of Building 881 for temporary storage Several hundred square feet of ground surface was contaminated as a result of this action	Plutonium	Surface as a result of contact with radioactively contaminated slab
164 2	Radioactive Site - 800 Area Site No 2 - Building 886 Spills	This IHSS consists of Building 886 and the surrounding areas This site is believed to be contaminated as a result of spills, movement of contaminated equipment, and other activities	Uranium	Surface from spills and leaks, subsurface from infiltration.
164 3	Radioactive Site - 800 Area Site No 2 - 889 Storage	This IHSS area was used for storing contaminated materials prior to decontamination Contaminated residues may have migrated from the stored equipment to the ground surface throughout the storage area's lifetime	Uranium	Surface from contact with contaminated materials, surface from airborne dispersion and spills

Table 2-3
SUMMARY OF RADIOLOGICAL CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATION FOR OU14 AND ASSOCIATED BOREHOLES

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	RESULT pCi/g (Tritium - pCi/L)	QUALIFIER
Located in the northeast corner of IHSS 160 within the IHSS boundaries. Chemical data represent IHSS concentrations	P313489	0-3	PLUTONIUM-239/240	1.59E+01	
		0-3	RADIUM-226	1.00E+00	
		3-7	PLUTONIUM-239/240	2.40E-02	
		8-12	GROSS BETA PARTICLE RADIOACTIVITY	4.99E+01	
		8-12	URANIUM-233,-234	7.90E-01	
		8-12	URANIUM-238	8.90E-01	
		12-18	RADIUM-226	1.20E+00	
		12-18	URANIUM-238	7.00E-01	
		18-21	PLUTONIUM-239/240	2.30E-02	
		18-21	RADIUM-226	9.00E-01	
		18-21	URANIUM-233,-234	7.60E-01	
		18-21	URANIUM-235	8.00E-02	
		18-21	URANIUM-238	9.40E-01	
		21-24	RADIUM-226	1.50E+00	

Table 2-3
SUMMARY OF RADIOLOGICAL CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATION FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	RESULT pCi/g (Tritium - pCi/L)	QUALIFIER
IHSS 160	P313489 (cont.)	21-24	RADIUM-228	2 40E+00	
		21-24	URANIUM-233,-234	9.90E-01	
		21-24	URANIUM-238	1.09E+00	
Located southwest of IHSS 161. Chemical data represent upgradient concentrations	P416789	0-3	PLUTONIUM-239/240	8.30E-02	
		3-6	GROSS BETA PARTICLE RADIOACTIVITY	4 15E+01	
		3-6	PLUTONIUM-239/240	2.00E-02	
		3-6	RADIUM-226	8.00E-01	
		3-6	TRITIUM	5.00E+01	
		3-6	URANIUM-233,-234	1.06E+00	
		3-6	URANIUM-238	7.90E-01	
		6-10	GROSS BETA PARTICLE RADIOACTIVITY	3.72E+01	
		6-10	PLUTONIUM-239/240	1.90E-02	
		10-12	GROSS BETA PARTICLE RADIOACTIVITY	3.97E+01	
		10-12	TRITIUM	1.00E+02	
		10-12	URANIUM-233,-234	1.09E+00	
		10-12	URANIUM-235	1.10E-01	

Table 2-3
SUMMARY OF RADIOLOGICAL CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATION FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	RESULT pCi/g (Tritium - pCi/L)	QUALIFIER
IHSS 161	P416789	10-12	URANIUM-238	1.21E+00	
		12-17	AMERICIUM-241	2.01E-01	
		12-17	RADIUM-226	8.00E-01	
		12-17	TRITIUM	1.50E+02	
		12-17	URANIUM-233,-234	9.70E-01	
		12-17	URANIUM-238	1.06E+00	
		17-20	AMERICIUM-241	2.50E-02	
		17-20	RADIUM-226	1.10E+00	
		17-20	RADIUM-228	2.10E+00	
		17-20	TRITIUM	9.00E+01	
		17-20	URANIUM-233,-234	9.10E-01	
		17-20	URANIUM-238	1.20E+00	
		20-22	AMERICIUM-241	3.50E-02	
		20-22	GROSS BETA PARTICLE RADIOACTIVITY	3.86E+01	
		20-22	PLUTONIUM-239/240	8.40E-02	
		20-22	RADIUM-226	7.00E-01	
		20-22	TRITIUM	2.60E+02	

Table 2-3
SUMMARY OF RADIOLOGICAL CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATION FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	RESULT pCi/g (Tritium - pCi/L)	QUALIFIER
IHSS 161	P416789 (cont.)	20-22	URANIUM-233,-234	1.41E+00	
		20-22	URANIUM-238	1.09E+00	
		22-26	AMERICIUM-241	4.60E-02	
		22-26	RADIUM-226	1.40E+00	
		22-26	RADIUM-228	2.70E+00	
		22-26	TRITIUM	3.20E+02	
		22-26	URANIUM-233,-234	1.15E+00	
		22-26	URANIUM-235	1.20E-01	
		22-26	URANIUM-238	1.24E+00	
		26-30	AMERICIUM-241	1.60E-02	
		26-30	RADIUM-226	8.00E-01	
		26-30	TRITIUM	3.00E+02	
		26-30	URANIUM-233,-234	6 80E-01	
		26-30	URANIUM-235	9.00E-02	
		26-30	URANIUM-238	9.70E-01	
Located northwest of IHSS 156.1 Chemical data represent upgradient concentrations	P119389	3-7	RADIUM-226	7.00E-01	
		3-7	TRITIUM	2.40E+02	
		3-7	URANIUM-233,-234	1.98E+00	
		3-7	URANIUM-235	1.70E-01	
		3-7	URANIUM-238	7.60E-01	
		7-11	RADIUM-226	9.00E-01	

Table 2-3
SUMMARY OF RADIOLOGICAL CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATION FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	RESULT pCi/g (Tritium - pCi/L)	QUALIFIER
IHSS 156.1	P119389 (cont.)	7-11	TRITIUM	3.70E+02	
		7-11	URANIUM-235	8.00E-02	
		11-13	RADIUM-226	7.00E-01	
		13-16	RADIUM-226	1.30E+00	
		13-16	TRITIUM	1.60E+02	
		16-20	RADIUM-226	1.10E+00	
		16-20	RADIUM-228	2.10E+00	
		16-20	TRITIUM	9.00E+01	
		16-20	URANIUM-233,-234	8.20E-01	
		16-20	URANIUM-238	9.10E-01	
The borehole is located southeast of IHSS 160 and east of IHSS 161. Chemical data may represent downgradient concentrations.	P314289	0-3	PLUTONIUM-239/240	9.60E-02	
		0-3	RADIUM-226	1 10E+00	
		0-3	RADIUM-228	2.00E+00	
		0-3	TRITIUM	7.00E+01	
		0-3	URANIUM-233,-234	1.66E+00	
		0-3	URANIUM-238	1.20E+00	
		3-7	PLUTONIUM-239/240	2.30E-02	
		3-7	RADIUM-226	9.00E-01	
		3-7	RADIUM-228	2.40E+00	
		3-7	TRITIUM	1.90E+02	

Table 2-3
SUMMARY OF RADIOLOGICAL CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATION FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	RESULT pCi/g (Tritium - pCi/L)	QUALIFIER
IHSS 160, 161	P314289 (cont.)	3-7	URANIUM-233,-234	7.10E-01	
		3-7	URANIUM-238	1.32E+00	
		7-11	RADIUM-226	7.00E-01	
		7-11	URANIUM-235	1.10E-01	
		7-11	URANIUM-238	8 30E-01	
		11-13	GROSS BETA PARTICLE RADIOACTIVITY	4 37E+01	
		11-13	RADIUM-226	9.00E-01	
		11-13	TRITIUM	8.00E+01	
		11-13	URANIUM-238	1.08E+00	
		13-18	PLUTONIUM-239/240	1.60E-02	
		13-18	RADIUM-226	1.00E+00	
		13-18	URANIUM-235	9.00E-02	
		13-18	URANIUM-238	9.60E-01	

Table 2-3
SUMMARY OF RADIOLOGICAL CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATION FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	RESULT pCi/g (Tritium - pCi/L)	QUALIFIER
The borehole is located south of IHSS 160 and southeast of IHSS 161. Chemical data represent downgradient concentrations.	P416889	0-2	GROSS BETA PARTICLE RADIOACTIVITY	4.22E+01	
		0-2	PLUTONIUM-239/240	1.37E-01	
		0-2	URANIUM-233,-234	9.50E-01	
		0-2	URANIUM-238	1.01E+00	
		5-7	TRITIUM	1.20E+02	
		7-9	RADIUM-226	9.00E-01	
		7-9	URANIUM-235	1.30E-01	
		9-12	PLUTONIUM-239/240	5.30E-02	
		9-12	RADIUM-226	8.00E-01	
		9-12	URANIUM-233,-234	7.40E-01	
		9-12	URANIUM-235	8.00E-02	
		13-15	PLUTONIUM-239/240	2.30E-02	
		13-15	RADIUM-226	1.90E+00	
		13-15	RADIUM-228	2.00E+00	
		13-15	TRITIUM	2.60E+02	
		13-15	URANIUM-233,-234	1.08E+00	
		13-15	URANIUM-235	1.20E-01	
		13-15	URANIUM-238	7.50E-01	
		15-20	GROSS BETA PARTICLE RADIOACTIVITY	4.10E+01	
		15-20	RADIUM-226	8.00E-01	

Table 2-3
SUMMARY OF RADIOLOGICAL CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATION FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	RESULT pCi/g (Tritium - pCi/L)	QUALIFIER
IHSS 160, 161	P416889 (cont.)	15-20	TRITIUM	1.30E+02	
		15-20	URANIUM-233,-234	7.00E-01	
		15-20	URANIUM-238	8.20E-01	
		20-23	RADIUM-226	1.40E+00	
		20-23	TRITIUM	3.80E+02	
		20-23	URANIUM-233,-234	1.13E+00	
		20-23	URANIUM-238	9.90E-01	
The borehole is located east of IHSS 156 1. Chemical data represent downgradient concentrations.	P114789	0-3	PLUTONIUM-239/240	9.00E-02	
		0-3	URANIUM-233,-234	8.00E-01	
		0-3	URANIUM-238	7.30E-01	
		3-7	PLUTONIUM-239/240	2.20E-02	
		7-11	RADIUM-226	9.00E-01	
		11-15	TRITIUM	1.40E+02	
		11-15	URANIUM-233,-234	6.60E-01	
		15-19	RADIUM-226	8.00E-01	
		15-19	TRITIUM	9.00E+01	
IHSS 156.1	P114789 (cont.)	19-22	RADIUM-226	7.00E-01	
		19-22	TRITIUM	2.30E+02	
		19-22	URANIUM-238	8.80E-01	
		22-26	RADIUM-226	1.60E+00	

Table 2-3
SUMMARY OF RADIOLOGICAL CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATION FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	RESULT pCi/g (Tritium - pCi/L)	QUALIFIER
IHSS 156.1	P114789 (cont.)	22-26	TRITIUM	1.10E+02	
		22-26	URANIUM-235	3.30E-01	
		22-26	URANIUM-238	8.30E-01	
		26-31	TRITIUM	5.00E+01	
		26-31	URANIUM-235	2.50E-01	
		26-31	URANIUM-238	9.50E-01	
The borehole is located northwest of IHSS 160. Chemical data represent upgradient concentrations.	P418289	0-3	PLUTONIUM-239	4.00E-02	
		0-3	RADIUM-226	7.00E-01	
		0-3	TRITIUM	2.50E+02	
		0-3	URANIUM-235	8.00E-02	
		3-6	TRITIUM	1.40E+02	
		6-10	RADIUM-226	9.00E-01	
		6-10	RADIUM-228	2.10E+00	
		6-10	TRITIUM	1.10E+02	
		6-10	URANIUM-235	8.00E-02	
		10-14	TRITIUM	2.80E+02	
		10-14	URANIUM-235	8.00E-02	
		14-16	RADIUM-226	9.00E-01	
		14-16	TRITIUM	1.10E+02	
		16-19	TRITIUM	2.00E+01	
		16-19	URANIUM-235	9.00E-02	

Table 2-3
SUMMARY OF RADIOLOGICAL CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATION FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	RESULT pCi/g (Tritium - pCi/L)	QUALIFIER
IHSS 160	P418289	19-23	RADIUM-226	1.20E+00	
		19-23	RADIUM-228	2.20E+00	
		19-23	TRITIUM	1.00E+02	
		23-26	RADIUM-226	8.00E-01	
		23-26	TRITIUM	1.10E+02	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES.

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
Locate East of IHSS 162 near Central Avenue. Chemical data represent downgradient concentrations	P214089	0-3	BARIUM	7.95E+04	
		0-3	COPPER	1.69E+04	
		0-3	IRON	1.46E+07	
		0-3	LEAD	1.41E+04	
		0-3	MAGNESIUM	2 79E+06	
		0-3	MANGANESE	2 48E+05	
		0-3	POTASSIUM	1 79E+06	
		0-3	ZINC	6 39E+04	
		3-7	ALUMINUM	1.42E+07	
		3-7	ANTIMONY	3.96E+04	
		3-7	ARSENIC	5.20E+03	
		3-7	BARIUM	1.01E+05	
		3-7	COPPER	1.79E+04	
		3-7	IRON	3.93E+07	
		3-7	LEAD	2.11E+04	
		3-7	MAGNESIUM	3.27E+06	
		3-7	MANGANESE	5.20E+05	
		3-7	VANADIUM	5.30E+04	
		3-7	ZINC	1.73E+05	
		7-9	ALUMINUM	1.40E+07	
		7-9	ARSENIC	7.00E+03	
		7-9	BARIUM	1.09E+05	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 162	P214089 (cont.)	7-9	CALCIUM	4.60E+07	
		7-9	LEAD	1.77E+04	
		7-9	MAGNESIUM	3.00E+06	
		7-9	MANGANESE	4 87E+05	
		7-9	VANADIUM	4.43E+04	
		7-9	ZINC	4.50E+04	
		9-13	ARSENIC	4.50E+03	
		9-13	BARIUM	5.53E+05	
		9-13	CALCIUM	1.52E+07	
		9-13	LEAD	1.78E+04	
		9-13	MAGNESIUM	2.83E+06	
		9-13	ZINC	6.45E+04	
		13-19	CALCIUM	8.54E+06	
		13-19	COPPER	1.52E+04	
		13-19	LEAD	1.80E+04	
		13-19	MERCURY	3.60E+02	
		13-19	ZINC	8.28E+04	
Located in south central IHSS 160 boundaries. These concentrations represent IHSS characteristics.	P411889	0-3	LEAD	1.25E+04	
		0-3	NITRATE/NITRITE	1.10E+04	
		9-15	BARIUM	8.82E+04	
		9-15	COPPER	1.41E+04	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 160	P411889 (cont.)	9-15	IRON	1.78E+07	
		9-15	VANADIUM	5.60E+04	
		15-18	BARIUM	8.06E+04	
		15-18	POTASSIUM	1.83E+06	
		24-28	BARIUM	3.04E+05	
		24-28	MANGANESE	2.38E+05	
Located in the southeast portion of IHSS 160 within IHSS boundaries. Chemical data represent IHSS concentrations	P411589	3-9	ALUMINUM	1.76E+07	
		3-9	ARSENIC	7.30E+03	
		3-9	CHROMIUM	4.93E+04	
		3-9	IRON	1.66E+07	
		3-9	VANADIUM	3.98E+04	
		3-9	ZINC	7.01E+04	
		9-15	BARIUM	9.65E+04	
		9-15	ALUMINUM	1.69E+07	
		9-15	ARSENIC	5.50E+03	
		9-15	COPPER	2.08E+04	
		9-15	IRON	2.02E+07	
		9-15	MAGNESIUM	3.87E+06	
		9-15	MANGANESE	3.45E+05	
		9-15	POTASSIUM	1.96E+06	
		9-15	VANADIUM	4.68E+04	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 160	P411589 (cont.)	9-15	ZINC	5.46E+04	
		15-21	ARSENIC	6.30E+03	
		15-21	COPPER	1.37E+04	
		15-21	LEAD	1.79E+04	
		15-21	ZINC	4 73E+04	
		22-25	COPPER	2.73E+04	
		22-25	IRON	2.33E+07	
		22-25	VANADIUM	3.91E+04	
		22-25	ZINC	7.05E+04	
Located in the northeast corner of IHSS 160 within IHSS boundaries. Chemical data represent IHSS concentrations	P313489	0-3	ARSENIC	4.80E+03	
		0-3	CALCIUM	3.61E+07	
		0-3	LEAD	2.71E+04	
		0-3	LITHIUM	1.35E+04	B
		0-3	MAGNESIUM	2.63E+06	
		3-7	CALCIUM	1.33E+07	
		3-7	CHROMIUM	2.74E+04	
		8-12	ARSENIC	5.00E+03	
		8-12	BARIUM	1.24E+05	
		8-12	CHROMIUM	2.64E+04	
		8-12	COPPER	1.27E+04	
		8-12	IRON	1.51E+07	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BORENOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 160	P313489 (cont.)	8-12	MANGANESE	3.50E+05	
		12-18	COPPER	1.18E+04	
		12-18	LITHIUM	9 90E+03	B
		18-21	COPPER	1.29E+04	
		18-21	IRON	1.23E+08	
		18-21	MAGNESIUM	2.59E+06	
		18-21	LITHIUM	1.05E+04	B
		18-21	POTASSIUM	1 59E+06	
		18-21	ZINC	4.23E+04	
		21-24	BARIUM	5.30E+05	
		21-24	COPPER	2 36E+04	
		21-24	LEAD	2.63E+04	
		18-21	MANGANESE	2.46E+05	
		21-24	MANGANESE	5.51E+05	
		21-24	ZINC	4.62E+04	
Located Southwest of IHSS 161. Chemical data represent upgradient concentrations.	P416789	0-3	LEAD	3.76E+04	
		0-3	ZINC	9.61E+04	
		3-6	ALUMINUM	4.66E+07	
		3-6	ARSENIC	1.38E+04	
		3-6	BARIUM	1.21E+05	
		3-6	CHROMIUM	3.32E+04	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED INSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
INSS 161	P416789 (cont.)	3-6	COPPER	1.15E+04	
		3-6	IRON	2.74E+07	
		3-6	LEAD	2.49E+04	
		3-6	MAGNESIUM	2.80E+06	
		3-6	MERCURY	3.10E+02	
		3-6	MOLYBDENUM	2.74E+04	
		3-6	NICKEL	3.46E+04	
		3-6	POTASSIUM	1 98E+06	
		3-6	SULFIDE	2 00E+03	
		3-6	VANADIUM	8.14E+04	
		3-6	ZINC	7.70E+04	
		6-10	CALCIUM	2.44E+07	
		10-12	ARSENIC	4.50E+03	
		10-12	SULFIDE	2.00E+03	
		12-17	MANGANESE	2.39E+05	
		17-20	ALUMINUM	1.71E+07	
		17-20	ARSENIC	4.80E+03	
		17-20	BARIUM	1.02E+05	
		17-20	COPPER	1.57E+04	
		17-20	IRON	2.00E+07	
		17-20	MAGNESIUM	4.74E+06	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 161	P416789 (cont.)	17-20	POTASSIUM	3 53E+06	
		17-20	VANADIUM	4.23E+04	
		17-20	ZINC	1.03E+05	
		20-22	ALUMINUM	1.80E+07	
		20-22	ARSENIC	4.70E+03	
		20-22	BARIUM	8.99E+04	
		20-22	COPPER	1.57E+04	
		20-22	IRON	1.87E+07	
		20-22	MAGNESIUM	4.43E+06	
		20-22	NITRATE/NITRITE	8.70E+03	
		20-22	POTASSIUM	3.28E+06	
		20-22	VANADIUM	4.40E+04	
		20-22	ZINC	7.07E+04	
		22-26	SULFIDE	2.00E+03	
		26-30	LEAD	1.39E+04	
		26-30	MERCURY	2.80E+02	
		26-30	SULFIDE	2.00E+03	
		26-30	ZINC	4.66E+04	
Located northwest of IHSS 156.1. Chemical data represent upgradient concentrations.	P119389	3-7	NITRATE/NITRITE	8.80E+03	
		11-13	CHROMIUM	3.68E+04	
		11-13	COPPER	1.33E+04	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 156.1	P119389 (cont.)	13-16	COPPER	1.21E+04	
		13-16	LEAD	1.42E+04	
		16-20	COPPER	2.33E+04	
		16-20	BARIUM	1.09E+05	
		16-20	LEAD	1.53E+04	
		16-20	ZINC	8.86E+04	
Located east of IHSS 161. Chemical data may represent downgradient concentrations.	P314289	0-3	ALUMINUM	1.41E+07	
		0-3	ARSENIC	8.70E+03	
		0-3	BARIUM	8.82E+04	
		0-3	COPPER	3.69E+04	
		0-3	IRON	1.39E+07	
		0-3	LEAD	4.77E+04	
		0-3	LITHIUM	9.90E+03	B
		0-3	MERCURY	2.30E+02	
		0-3	POTASSIUM	1.92E+06	
		0-3	ZINC	9.53E+04	
		3-7	ALUMINUM	3.45E+07	
		3-7	ARSENIC	1.02E+04	B
		3-7	BARIUM	1.57E+05	
		3-7	CALCIUM	2.73E+07	
		3-7	CHROMIUM	3.37E+04	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 161	P314289 (cont.)	3-7	IRON	2.27E+07	
		3-7	LEAD	1.25E+04	
		3-7	LITHIUM	2.26E+04	B
		3-7	MAGNESIUM	4.53E+06	
		3-7	MERCURY	2.10E+02	
		3-7	NICKEL	2.81E+04	
		3-7	VANADIUM	6.31E+04	
		7-11	ARSENIC	7.40E+03	B
		11-13	ARSENIC	4.30E+03	
		11-13	COPPER	1.98E+04	
		11-13	IRON	2.21E+07	
		11-13	MANGANESE	3.82E+05	
		11-13	VANADIUM	3.85E+04	
		13-18	ARSENIC	6.80E+03	
		13-18	BARIUM	1.20E+05	
		13-18	COPPER	1.85E+04	
		13-18	IRON	2.78E+07	
		13-18	LEAD	1.35E+04	
		13-18	MANGANESE	4.61E+05	
		13-18	NICKEL	2.98E+04	
		13-18	ZINC	1.15E+05	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
Located south of IHSS 160 and southeast of 161. Chemical data represent downgradient concentrations.	P416889	0-2	LEAD	6.33E+04	
		0-2	MANGANESE	7.51E+05	
		3-5	ARSENIC	4.40E+03	
		3-5	CALCIUM	3.11E+07	
		3-5	MAGNESIUM	2.72E+06	
		3-5	SULFIDE	2.00E+03	
		5-7	ZINC	4.79E+04	
		7-9	ARSENIC	8 00E+03	
		7-9	BARIUM	9.53E+04	
		7-9	MANGANESE	4.18E+05	
		7-9	SULFIDE	2.00E+03	
		7-9	ZINC	4.38E+04	
		9-12	ARSENIC	5.40E+03	
		9-12	COPPER	1.40E+04	
		9-12	IRON	1.75E+07	
		9-12	MANGANESE	3.27E+05	
		9-12	VANADIUM	4.44E+04	
		13-15	ALUMINUM	1.64E+07	
		13-15	ARSENIC	4.50E+03	
		13-15	BARIUM	1.10E+05	
		13-15	CHROMIUM	2.26E+04	
		13-15	COPPER	1.72E+04	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 160/161	P416889 (cont.)	13-15	IRON	1.94E+07	
		13-15	LEAD	1.74E+04	
		13-15	MAGNESIUM	3.61E+06	
		13-15	MANGANESE	4.81E+05	
		13-15	VANADIUM	4.66E+04	
		13-15	ZINC	7.19E+04	
		15-20	ARSENIC	5.70E+03	
		15-20	BARIUM	8.97E+04	
		15-20	COPPER	1.59E+04	
		15-20	IRON	1.80E+07	
		15-20	MAGNESIUM	2.63E+06	
		15-20	SULFIDE	4.00E+03	
		15-20	VANADIUM	4.00E+04	
		15-20	ZINC	4.85E+04	
		20-23	BARIUM	1.64E+05	
		20-23	COPPER	1.88E+04	
		20-23	IRON	2.08E+07	
		20-23	LEAD	1.89E+04	
		20-23	MANGANESE	3.71E+05	
		20-23	VANADIUM	3.84E+04	
		20-23	ZINC	8.73E+04	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BORENOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
Located east of IHSS 156.1. Chemical data represent downgradient concentrations.	P114789	0-3	ARSENIC	4.70E+03	
		0-3	COPPER	1.31E+04	
		3-7	COPPER	1.70E+04	
		3-7	IRON	1.56E+07	
		3-7	VANADIUM	3.89E+04	
		7-11	MANGANESE	2.68E+05	
		15-19	BARIUM	8 64E+04	
		15-19	COPPER	1.22E+04	
		15-19	MANGANESE	3.58E+05	
		19-22	COPPER	1.15E+04	
		22-26	COPPER	1.31E+04	
		26-31	BARIUM	1.16E+05	
		26-31	COPPER	3.94E+04	
		26-31	IRON	2.45E+07	
		26-31	NICKEL	2.81E+04	
		26-31	VANADIUM	4.14E+04	
		26-31	ZINC	1.08E+05	
Located in IHSS 160. Chemical data represent IHSS concentrations.	P411689	0-6	ARSENIC	5.40E+03	
		0-6	BARIUM	8.90E+04	
		0-6	COPPER	1.18E+04	
		0-6	LEAD	1.36E+04	
		0-6	MANGANESE	2.84E+05	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 160	P411689 (cont.)	0-6	NITRATE/NITRITE	3.20E+04	
		0-6	POTASSIUM	1.95E+06	
		0-6	ZINC	4.15E+04	
Located in IHSS 161 with the IHSS boundaries Chemical data represent IHSS concentrations	P412189	0-3	ARSENIC	7.50E+03	
		0-3	COPPER	1.26E+04	
		0-3	LEAD	1.86E+04	
		0-3	POTASSIUM	1.98E+06	
		3-9	ARSENIC	9.10E+03	
		3-9	CALCIUM	1.17E+07	
		3-9	ZINC	4.09E+04	
		9-15	CHROMIUM	7.56E+04	
		9-15	COPPER	1.65E+04	
		9-15	IRON	1.87E+07	
		9-15	MAGNESIUM	2.58E+06	
		9-15	MANGANESE	2.35E+05	
		9-15	POTASSIUM	1.79E+06	
		9-15	ZINC	4.49E+04	
		15-19	POTASSIUM	1.74E+06	
		15-19	ZINC	4.29E+04	
		19-25	ALUMINUM	1.44E+07	
		19-25	ARSENIC	6.40E+03	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 161	P412189 (cont.)	19-25	BARIUM	1.03E+05	
		19-25	COPPER	2.21E+04	
		19-25	IRON	2.26E+07	
		19-25	MAGNESIUM	3.67E+06	
		19-25	POTASSIUM	3.06E+06	
		19-25	VANADIUM	4.92E+04	
		19-25	ZINC	7.29E+04	
		25-28	ARSENIC	3.21E+04	
		25-28	BARIUM	1.61E+05	
		25-28	COPPER	1.85E+04	
		25-28	IRON	2.05E+07	
		25-28	LEAD	1.73E+04	
		25-28	MANGANESE	5.19E+05	
		25-28	VANADIUM	4.25E+04	
		25-28	ZINC	6.15E+04	
		28-31	ARSENIC	6.10E+03	
Located northwest of IHSS 160. Chemical data represent upgradient concentrations	P418289	0-3	COPPER	1.33E+04	
		0-3	NITRATE/NITRITE	7.20E+03	V
		3-6	SULFIDE	4.00E+03	
		3-6	VANADIUM	4.05E+04	
		6-10	CALCIUM	3.03E+07	

TABLE 2-4
SUMMARY OF INORGANIC CONSTITUENTS DETECTED ABOVE SITEWIDE BACKGROUND CONCENTRATIONS FOR OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 160	P418289 (cont)	6-10	MANGANESE	2 85E+05	
		10-14	COPPER	1.36E+04	
		14-16	COPPER	1.62E+04	
		14-16	MAGNESIUM	2.60E+06	
		16-19	COPPER	1 14E+04	
		19-23	POTASSIUM	1.59E+06	
		19-23	COPPER	1 66E+04	
		23-26	COPPER	1 25E+04	

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BOREHOLES

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
Located east of IHSS 162 near Central Avenue Chemical data from this borehole represent downgradient concentrations.	P214089	0-2	METHYLENE CHLORIDE	9.00E+00	B
		2-4	METHYLENE CHLORIDE	1.20E+01	B
		4-6	METHYLENE CHLORIDE	4.10E+01	B
		6-8	ACETONE	1.40E+02	
		6-8	METHYLENE CHLORIDE	3.20E+01	B
		8-10	METHYLENE CHLORIDE	3.60E+01	B
		10-12	METHYLENE CHLORIDE	4.00E+01	B
Located within south central IHSS 160 boundaries. Chemical data from the borehole reepresent IHSS 160 concentrations	P411889	1-2	ACETONE	1.10E+01	B
		1-2	METHYLENE CHLORIDE	1.00E+01	B
		2-4	TOLUENE	1.00E+00	J
		2-4	ACETONE	6.00E+00	JB
		2-4	METHYLENE CHLORIDE	1.20E+01	B
		4-6	ACETONE	7.00E+03	JB
		4-6	METHYLENE CHLORIDE	1.10E+04	B
		6-8	ACETONE	1.00E+01	JB
		6-8	CARBON DISULFIDE	2.00E+00	J
		6-8	METHYLENE CHLORIDE	1.10E+01	B
		8-10	ACETONE	6.00E+00	JB
		8-10	METHYLENE CHLORIDE	1.10E+01	B
		10-12	ACETONE	1.20E+01	B
		10-12	METHYLENE CHLORIDE	1.30E+01	B
		12-14	ACETONE	7.00E+00	JB

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 160	P411889 (cont)	12-14	METHYLENE CHLORIDE	1.90E+01	B
		14-16	ACETONE	9.00E+00	JB
		14-16	CARBON DISULFIDE	2.00E+00	J
		14-16	METHYLENE CHLORIDE	9.00E+00	B
		16-18	ACETONE	6.00E+00	JB
		16-18	METHYLENE CHLORIDE	1.50E+01	B
		18-20	ACETONE	8.00E+00	JB
		18-20	METHYLENE CHLORIDE	1.70E+01	B
		20-22	ACETONE	7.00E+00	JB
		20-22	METHYLENE CHLORIDE	1.50E+01	B
		22-24	ACETONE	9.00E+00	JB
		22-24	METHYLENE CHLORIDE	1.50E+01	B
		24-26	ACETONE	1.20E+01	JB
		24-26	METHYLENE CHLORIDE	2.10E+01	B
		26-28	METHYLENE CHLORIDE	3.30E+01	B
The borehole was placed in the Southeast corner of IHSS 160 within IHSS boundary. Chemical data represent conditions within IHSS 160.	P411589	4-5	METHYLENE CHLORIDE	6.00E+00	
		4-5	ACETONE	4.50E+01	
		5-6	ACETONE	1.00E+01	J
		5-6	METHYLENE CHLORIDE	3.00E+00	J
		6-8	METHYLENE CHLORIDE	5.00E+00	J

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 160	P411589 (cont.)	8-10	ACETONE	1.70E+01	
		12-14	ACETONE	1.10E+01	J
		12-14	TETRACHLOROETHENE	5.00E+00	J
		14-16	ACETONE	1.00E+01	J
		16-18	ACETONE	2 00E+01	
		16-18	METHYLENE CHLORIDE	4.00E+00	J
		18-20	ACETONE	2.50E+01	
		18-20	CARBON DISULFIDE	9 00E+00	
		20-22	ACETONE	2.60E+01	
		20-22	METHYLENE CHLORIDE	2.00E+00	J
		22-24	ACETONE	1.70E+01	
		22-24	METHYLENE CHLORIDE	3.00E+00	J
		24-25	ACETONE	2 60E+04	
Located in the northeast corner of IHSS 160 within the IHSS boundaries Chemical data represent IHSS concentrations.	P313489	0-2	1,1,1-TRICHLOROETHANE	1.10E+01	
		0-2	ACETONE	1.80E+01	B
		0-2	METHYLENE CHLORIDE	9.00E+00	B
		2-4	1,1,1-TRICHLOROETHANE	9.00E+00	
		2-4	ACETONE	7.50E+01	B
		2-4	METHYLENE CHLORIDE	7.00E+00	B
		4-6	1,1,1-TRICHLOROETHANE	6.00E+00	

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 160	P313489	4-6	ACETONE	3.80E+01	B
		4-6	METHYLENE CHLORIDE	4.00E+00	JB
		6-8	1,1,1-TRICHLOROETHANE	7.00E+00	
		6-8	ACETONE	5.00E+01	B
		6-8	METHYLENE CHLORIDE	4.00E+00	JB
		8-10	1,1,1-TRICHLOROETHANE	1.00E+01	
		8-10	ACETONE	6.20E+01	B
		8-10	METHYLENE CHLORIDE	4.00E+00	JB
		10-12	ACETONE	3.40E+01	B
		10-12	METHYLENE CHLORIDE	6.00E+00	B
		12-14	ACETONE	2.00E+01	B
		12-14	METHYLENE CHLORIDE	3.00E+00	JB
		14-16	ACETONE	1.40E+01	B
		16-18	ACETONE	4.40E+01	B
		16-18	METHYLENE CHLORIDE	5.00E+00	JB
		18-20	ACETONE	1.00E+02	B
		18-20	METHYLENE CHLORIDE	4.00E+00	JB
		20-22	ACETONE	3.60E+01	B
		20-22	METHYLENE CHLORIDE	3.00E+00	JB
		22-24	ACETONE	1.70E+01	B
		22-24	METHYLENE CHLORIDE	6.00E+00	B

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
The borehole has been placed in the southwest area of IHSS 160 within IHSS boundaries. Chemical data represent IHSS concentrations.	P411989	0-2	ACETONE	2 20E+01	B
		0-2	METHYLENE CHLORIDE	8.00E+00	B
The borehole is located southwest of IHSS 161 Chemical data represent upgradient conditions.	P416789	0-2	METHYLENE CHLORIDE	2.20E+01	B
		2-4	CARBON DISULFIDE	9.00E+00	
		2-4	METHYLENE CHLORIDE	2.30E+01	B
		4-6	CARBON DISULFIDE	9.00E+00	
		4-6	METHYLENE CHLORIDE	2.40E+01	B
		6-7	METHYLENE CHLORIDE	1.30E+01	B
		7-8	METHYLENE CHLORIDE	1.10E+01	B
		9-10	METHYLENE CHLORIDE	1.10E+01	B
		10-12	METHYLENE CHLORIDE	6.00E+00	B
		13-14	METHYLENE CHLORIDE	6.00E+03	B
		14-16	METHYLENE CHLORIDE	9 00E+00	B
		16-18	METHYLENE CHLORIDE	1.10E+01	B
		18-20	ACETONE	5.00E+00	J
		18-20	METHYLENE CHLORIDE	1.40E+01	B
		22-24	ACETONE	7.00E+00	J
		22-24	METHYLENE CHLORIDE	6.00E+00	B
		24-26	ACETONE	1.80E+01	
		24-26	METHYLENE CHLORIDE	6.00E+00	B

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BORENOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 161	P416789 (cont.)	26-28	METHYLENE CHLORIDE	7.00E+00	B
		28-30	METHYLENE CHLORIDE	8.00E+00	B
Located northwest of IHSS 156.1. Chemical data represent upgradient concentrations.	P119389	0-2	2-BUTANONE	1.80E+01	B
		0-2	ACETONE	3.70E+01	B
		0-2	METHYLENE CHLORIDE	1.80E+01	
		0-2	TETRACHLOROETHENE	2.20E+01	
		0-2	TOLUENE	7.00E+00	
		0-2	TOTAL XYLENES	1.00E+01	J
		2-4	TOLUENE	6.00E+00	
		2-4	TOTAL XYLENES	5.00E+00	J
		2-4	2-BUTANONE	6 20E+01	B
		2-4	ACETONE	1.50E+02	B
		2-4	METHYLENE CHLORIDE	2 40E+01	
		2-4	TETRACHLOROETHENE	9.00E+00	
		4-6	2-BUTANONE	4.30E+01	B
		4-6	ACETONE	6.10E+01	B
		4-6	METHYLENE CHLORIDE	1.30E+01	
		4-6	TETRACHLOROETHENE	3.00E+00	J
		4-6	TOTAL XYLENES	4.00E+00	J

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BORENOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 156.1	P119389 (cont.)	4-6	TOLUENE	2.00E+00	J
		6-8	2-BUTANONE	3.00E+01	B
		6-8	ACETONE	5.50E+01	B
		6-8	ETHYLBENZENE	5.00E+00	
		6-8	METHYLENE CHLORIDE	1 20E+01	
		6-8	TOLUENE	6.00E+00	
		8-10	2-BUTANONE	5.40E+01	
		8-10	ACETONE	1.60E+02	B
		8-10	METHYLENE CHLORIDE	8.00E+00	
		10-12	2-BUTANONE	5.60E+01	
		10-12	ACETONE	1.40E+02	B
		10-12	METHYLENE CHLORIDE	1.10E+01	
		12-14	2-BUTANONE	5 50E+01	
		12-14	ACETONE	1.40E+02	B
		12-14	METHYLENE CHLORIDE	9.00E+00	
		14-16	2-BUTANONE	1.00E+02	
		14-16	ACETONE	2.60E+02	B
		14-16	METHYLENE CHLORIDE	1.00E+01	
		16-18	2-BUTANONE	3.80E+01	

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 156.1	P119389 (cont.)	16-18	ACETONE	9.90E+01	B
		16-18	METHYLENE CHLORIDE	1 80E+01	
		18-20	ACETONE	1.40E+02	B
		18-20	METHYLENE CHLORIDE	1.20E+01	B
Located southeast of IHSS 160 and east of IHSS 161. Chemical data may represent upgradient concentrations	P314289	0-2	METHYLENE CHLORIDE	7.00E+00	B
		2-4	ACETONE	1.40E+01	B
		2-4	METHYLENE CHLORIDE	8.00E+00	B
		4-6	ACETONE	4 60E+01	B
		4-6	METHYLENE CHLORIDE	7.00E+00	B
		6-8	ACETONE	2.00E+01	B
		6-8	METHYLENE CHLORIDE	6 00E+00	B
		8-10	ACETONE	1 30E+02	B
		8-10	METHYLENE CHLORIDE	1.40E+01	B
		10-12	ACETONE	9.90E+01	
		10-12	METHYLENE CHLORIDE	7.00E+00	
		12-14	ACETONE	7.20E+01	
		12-14	METHYLENE CHLORIDE	2.60E+04	
		14-16	ACETONE	3.50E+01	
		14-16	METHYLENE CHLORIDE	2.90E+01	
		16-18	ACETONE	4.30E+01	

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 161	P314289 (cont.)	16-18	METHYLENE CHLORIDE	2.80E+01	
		1-2	2-BUTANONE	2.00E+00	JB
Located south of IHSS 160 and southeast of IHSS 161 Chemical data represent downgradient conditions.	P416889	3-5	ACETONE	4.00E+00	J
		3-5	CARBON DISULFIDE	1.00E+01	
		3-5	METHYLENE CHLORIDE	1.50E+01	B
		5-7	ACETONE	2.00E+00	J
		5-7	CARBON DISULFIDE	3.20E+01	
		5-7	METHYLENE CHLORIDE	1.50E+01	B
		7-9	ACETONE	1.20E+01	
		7-9	CARBON DISULFIDE	3.00E+00	J
		7-9	METHYLENE CHLORIDE	9.00E+00	B
		9-11	ACETONE	6.00E+00	J
		9-11	CARBON DISULFIDE	1.30E+01	
		9-11	METHYLENE CHLORIDE	8.00E+00	B
		11-12	ACETONE	5.00E+00	J
		11-12	CARBON DISULFIDE	5.00E+00	J
		11-12	METHYLENE CHLORIDE	8.00E+00	B
		13-15	ACETONE	5.00E+00	J
		13-15	CARBON DISULFIDE	2.00E+00	J

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BOREHOLES
(continued)

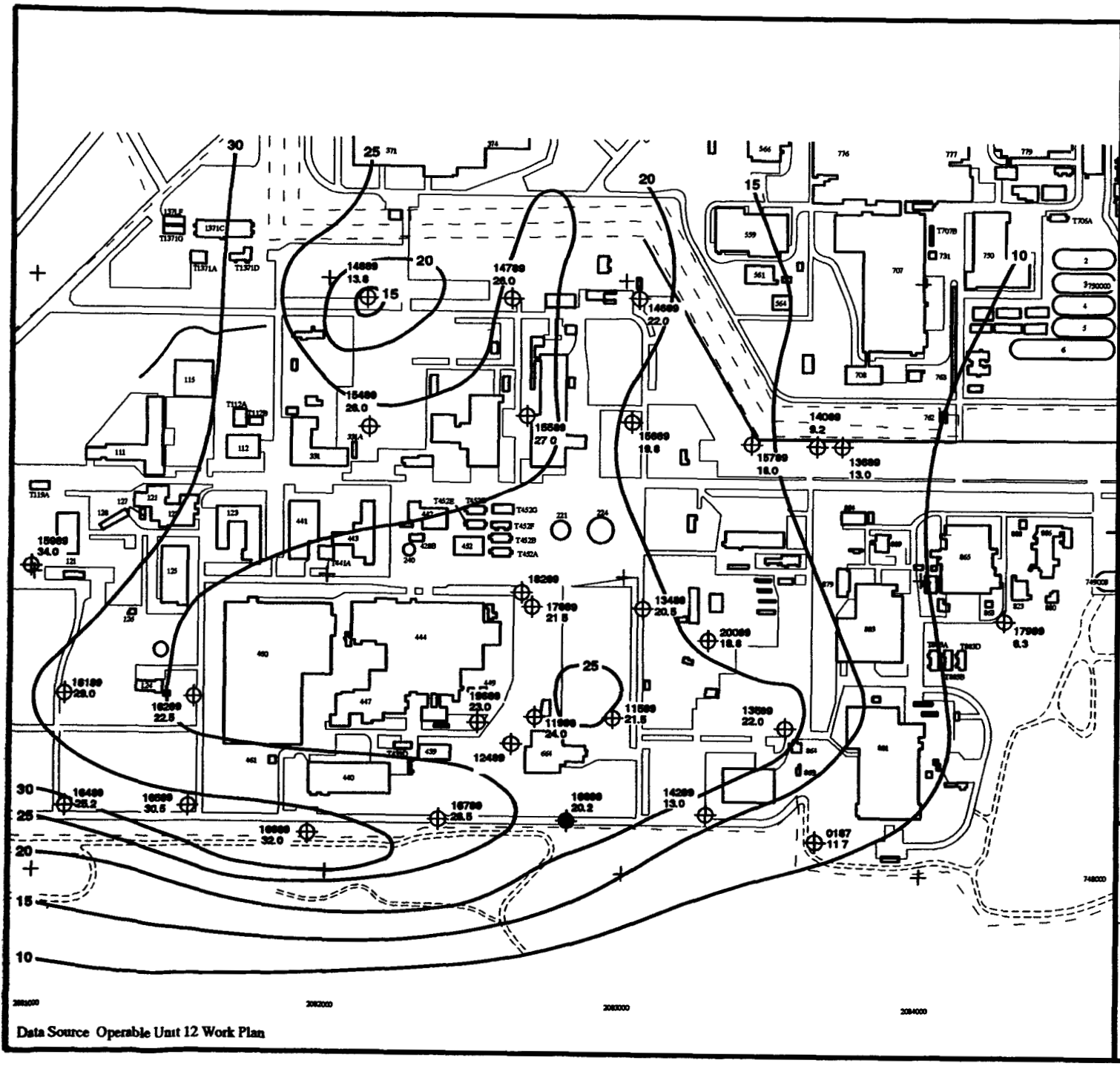
ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 160/161	P416889	13-15	METHYLENE CHLORIDE	4 00E+00	JB
		13-15	TOLUENE	1.00E+00	J
		15-17	ACETONE	4.00E+00	J
		15-17	METHYLENE CHLORIDE	4.00E+00	JB
		17-19	CARBON DISULFIDE	7 00E+00	
		17-19	METHYLENE CHLORIDE	1.70E+01	
		19-21	CARBON DISULFIDE	3.00E+00	J
		19-21	METHYLENE CHLORIDE	1.60E+01	
		21-23	METHYLENE CHLORIDE	1.60E+01	
		0-2	METHYLENE CHLORIDE	1.10E+01	B
Located east of IHSS 156.1 chemical data represent downgradient concentrations.	P114789	0-2	TOLUENE	2.00E+00	JB
		2-4	METHYLENE CHLORIDE	8.00E+00	B
		4-6	METHYLENE CHLORIDE	1 30E+01	B
		6-8	METHYLENE CHLORIDE	1.20E+01	B
		8-10	ACETONE	1.20E+01	
		8-10	METHYLENE CHLORIDE	1.00E+01	B
		12-14	METHYLENE CHLORIDE	1.20E+01	B
		14-16	METHYLENE CHLORIDE	1.00E+01	B
		16-18	METHYLENE CHLORIDE	1.30E+01	B

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 156.1	P114789 (cont.)	18-20	METHYLENE CHLORIDE	9 00E+00	B
		20-22	METHYLENE CHLORIDE	9.00E+00	B
		22-24	ACETONE	8.00E+00	JB
		22-24	METHYLENE CHLORIDE	9.00E+00	B
		27-28	METHYLENE CHLORIDE	1.00E+01	B
		30-31	METHYLENE CHLORIDE	1.00E+01	B
		0-2	ACETONE	2.20E+01	B
Located in IHSS 160. Chemical data represent IHSS concentrations.	P411689	2-4	METHYLENE CHLORIDE	5.00E+00	B
		4-6	CARBON DISULFIDE	1.90E+04	
		4-6	METHYLENE CHLORIDE	1.60E+04	B
		0-2	METHYLENE CHLORIDE	5 00E+00	B
Located in IHSS 161 within IHSS boundaries. Chemical data represent IHSS concentrations	P412189	3-5	METHYLENE CHLORIDE	5 00E+00	JB
		6-8	METHYLENE CHLORIDE	8.00E+00	
		10-12	METHYLENE CHLORIDE	7.00E+00	
		14-16	METHYLENE CHLORIDE	6.00E+00	
		18-20	METHYLENE CHLORIDE	8.00E+00	
		22-24	METHYLENE CHLORIDE	6.00E+00	
		26-28	TETRACHLOROETHENE	7.00E+00	

TABLE 2-5
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN OU14 AND ASSOCIATED BOREHOLES
(continued)

ASSOCIATED IHSS	LOCATION	DEPTH INTERVAL ft	CHEMICAL	CONCENTRATION ug/Kg	QUALIFIER
IHSS 161	P412189 (cont.)	28-29	METHYLENE CHLORIDE	6.00E+00	
		0-2	ACETONE	6 00E+00	JB
		0-2	METHYLENE CHLORIDE	4.00E+00	JB
		2-4	ACETONE	2.80E+01	B
		2-4	METHYLENE CHLORIDE	5.00E+00	JB
		4-6	ACETONE	2 20E+01	B
		4-6	METHYLENE CHLORIDE	3.00E+00	JB
		6-8	ACETONE	3.60E+01	B
		6-8	METHYLENE CHLORIDE	5.00E+00	JB
		8-10	ACETONE	2.10E+01	B
		8-10	METHYLENE CHLORIDE	4.00E+00	JB
		10-12	ACETONE	2.20E+01	B
		10-12	METHYLENE CHLORIDE	4.00E+00	JB
		12-14	ACETONE	2.50E+04	B
		12-14	METHYLENE CHLORIDE	6.00E+03	B
		14-16	ACETONE	1.80E+01	B
		14-16	METHYLENE CHLORIDE	8.00E+00	B
		16-18	ACETONE	2.70E+01	B
		16-18	METHYLENE CHLORIDE	5.00E+00	B
		18-20	ACETONE	2.00E+01	B
		18-20	METHYLENE CHLORIDE	7.00E+00	B



EXPLANATION

16789 MONITORING WELL LOCATION

16889 ABANDONED MONITORING WELL LOCATION

34.0 ALLUVIAL THICKNESS (FEET)

25 ALLUVIAL THICKNESS CONTOURS (FEET)

0 200 400 800 FEET

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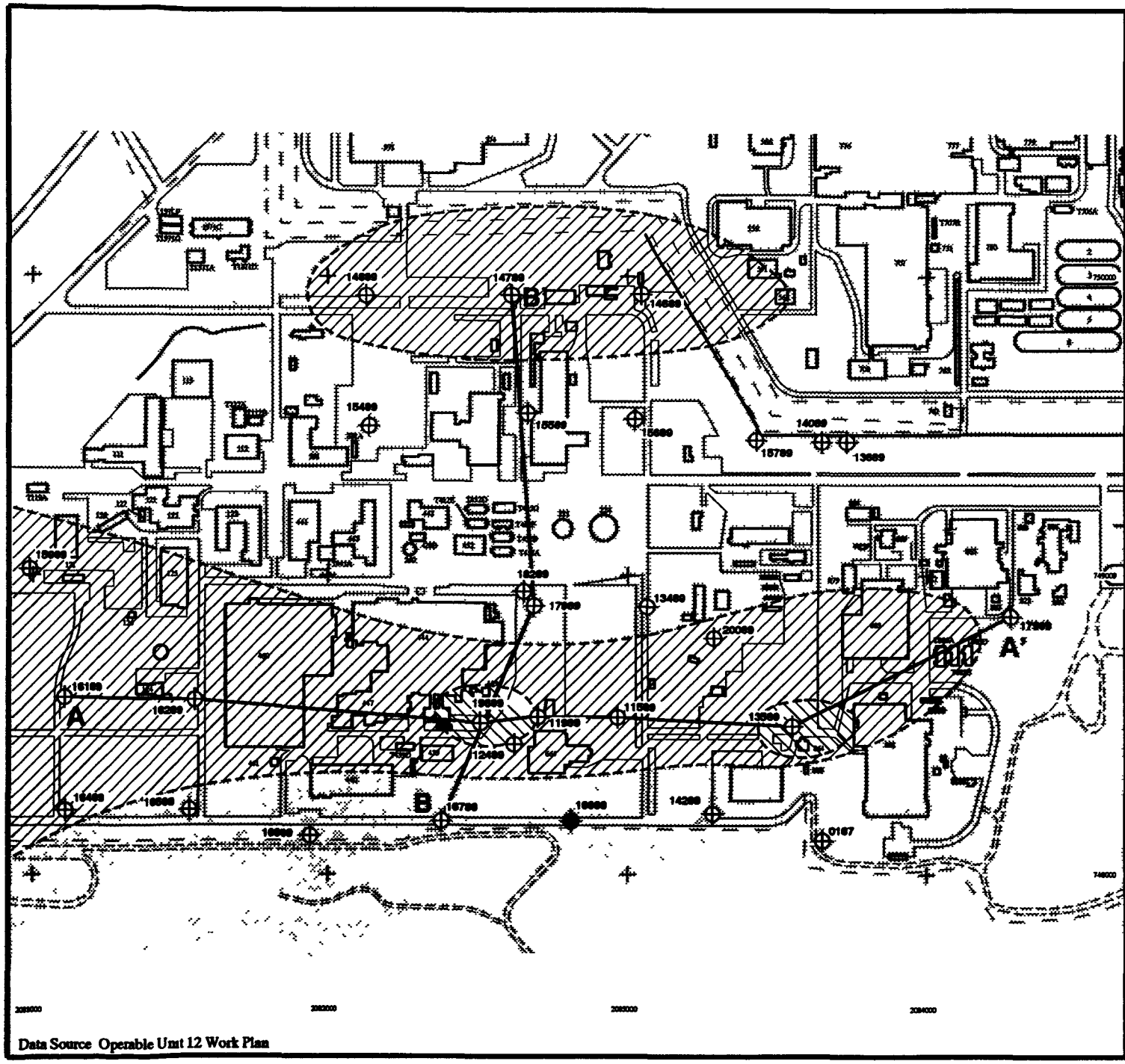
FIGURE 2-1

ALLUVIAL ISOPACH MAP



Data Source Operable Unit 12 Work Plan

EXPLANATION

MONITORING WELL LOCATION

ABANDONED MONITORING WELL LOCATION

B B' CROSS SECTION LOCATION

ARAPAHOE FORMATION SANDSTONE

ARAPAHOE FORMATION SILTY/SANDY CLAYSTONE

ARAPAHOE FORMATION CLAYSTONE

NOTE LOCATIONS 11589 11989 AND 17889 ARE SOIL BORINGS USED TO GENERATE GEOLOGIC CROSS SECTIONS, SEE FIGURES 2 32 AND 2-33

0 200 400 800 FEET

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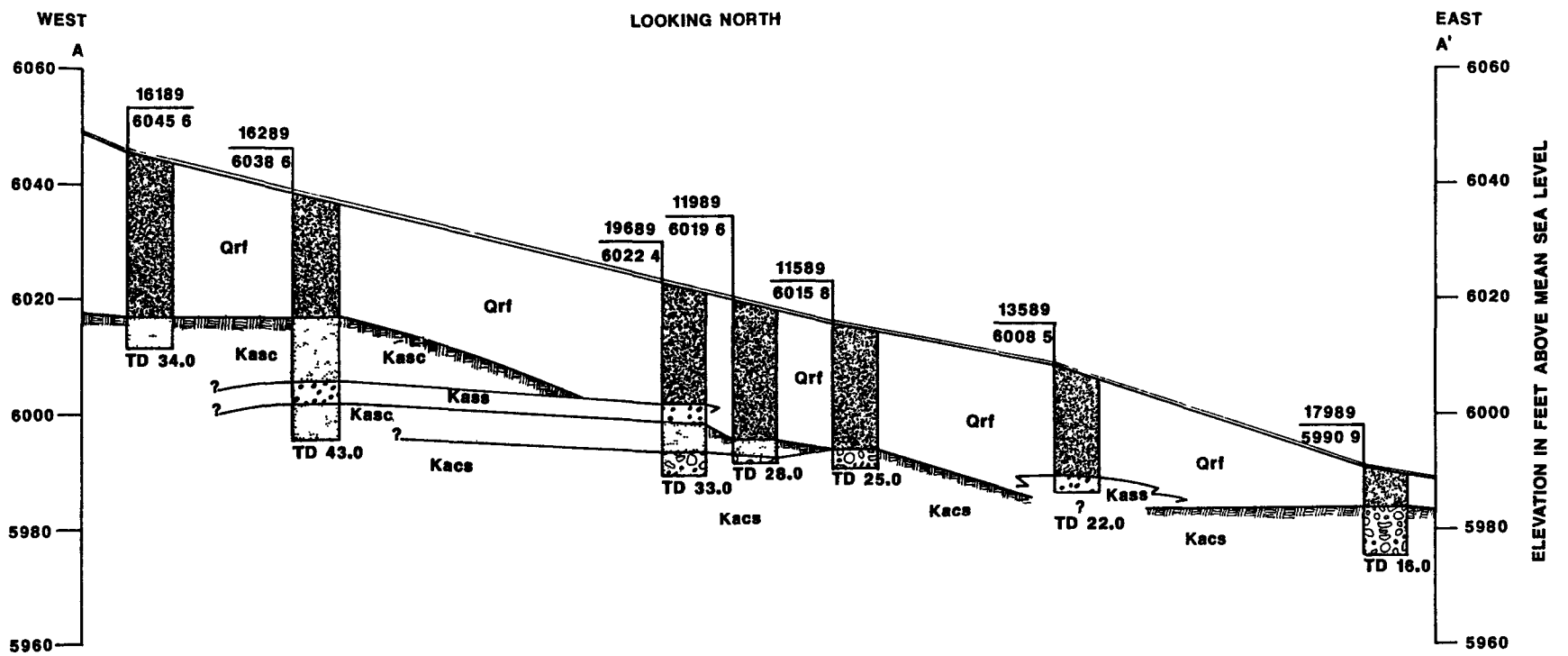
GOLDEN COLORADO

FIGURE 2-2

BEDROCK GEOLOGY AND GEOLOGIC CROSS SECTION LOCATION MAP



EXPLANATION

16189
6045 6 — WELL IDENTIFICATION
GROUND SURFACE ELEVATION(FT)

APPROXIMATE GROUND SURFACE

SCREENED INTERVAL

APPROXIMATE BEDROCK CONTACT

TD 34 0 TOTAL DEPTH DRILLED

NOTE: LOCATION 17889 IS A SOIL BORING LOCATION

QUATERNARY

Qrf — ROCKY FLATS ALLUVIUM

CRETACEOUS

Kass — ARAPAHOE SANDSTONE

Kasc — ARAPAHOE SILTY CLAYSTONE

Kacs — ARAPAHOE CLAYSTONE

100 0 100 200 FEET
HORIZONTAL SCALE

10 0 10 20 FEET
VERTICAL SCALE

VERTICAL EXAGGERATION = 5:10

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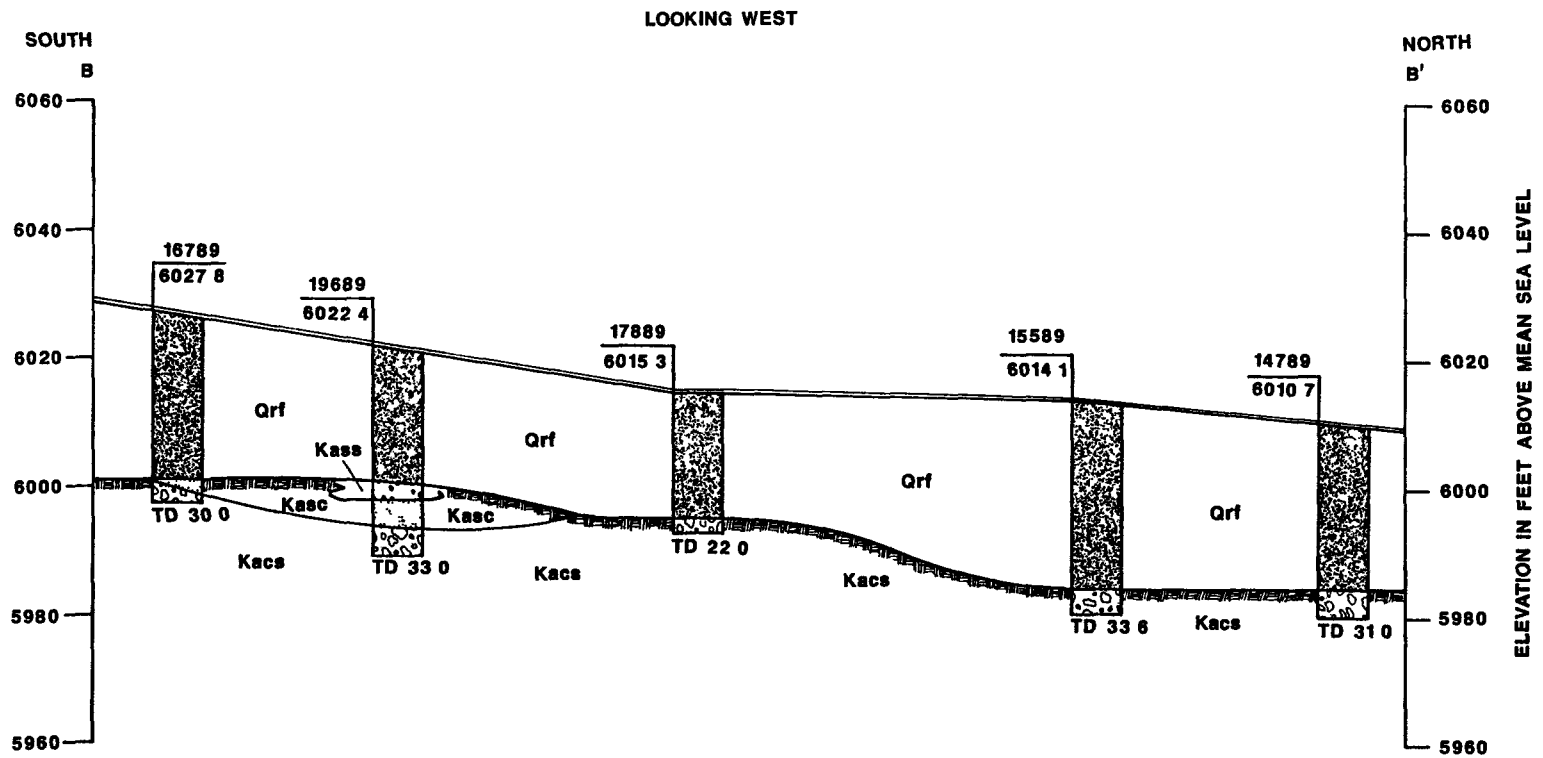
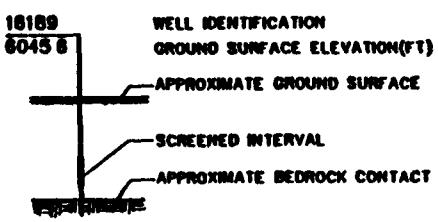
FIGURE 2-3

GEOLOGIC CROSS SECTION A-A'

SOURCE: OPERABLE UNIT 12 WORK PLAN



EXPLANATION



NOTE: LOCATIONS 11989 AND 11589 ARE SOIL BORING LOCATIONS

QUATERNARY

Qrf ROCKY FLATS ALLUVIUM

CRETACEOUS

Kass ARAPAHOE SANDSTONE

Kasc ARAPAHOE SILTY CLAYSTONE

Kacs ARAPAHOE CLAYSTONE

HORIZONTAL SCALE

VERTICAL SCALE

VERTICAL EXAGGERATION = 1:10

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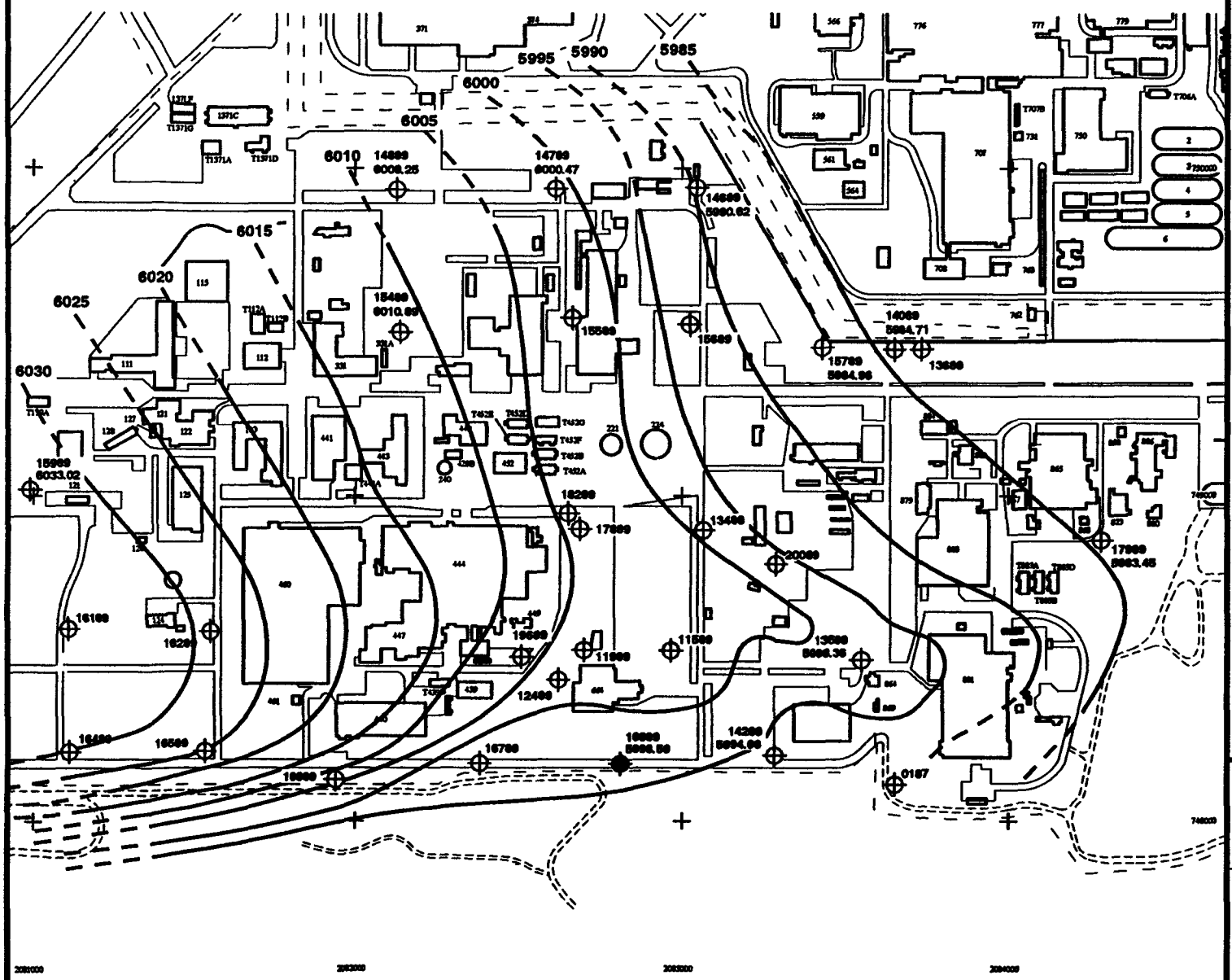
FIGURE 2-4

GEOLOGIC CROSS SECTION B-B'

SOURCE: OPERABLE UNIT 12 WORK PLAN



Data Source Operable Unit 12 Work Plan

EXPLANATION

15700 MONITORING WELL LOCATION

16600 ABANDONED MONITORING WELL LOCATION

5998.50 WATER TABLE ELEVATION (FEET ABOVE MEAN SEA LEVEL)

6025 ELEVATION CONTOUR (DASHED WHERE INFERRED)

0 200 400 800 FEET

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FIGURE 2-5

WATER TABLE CONTOUR MAP APRIL 1991

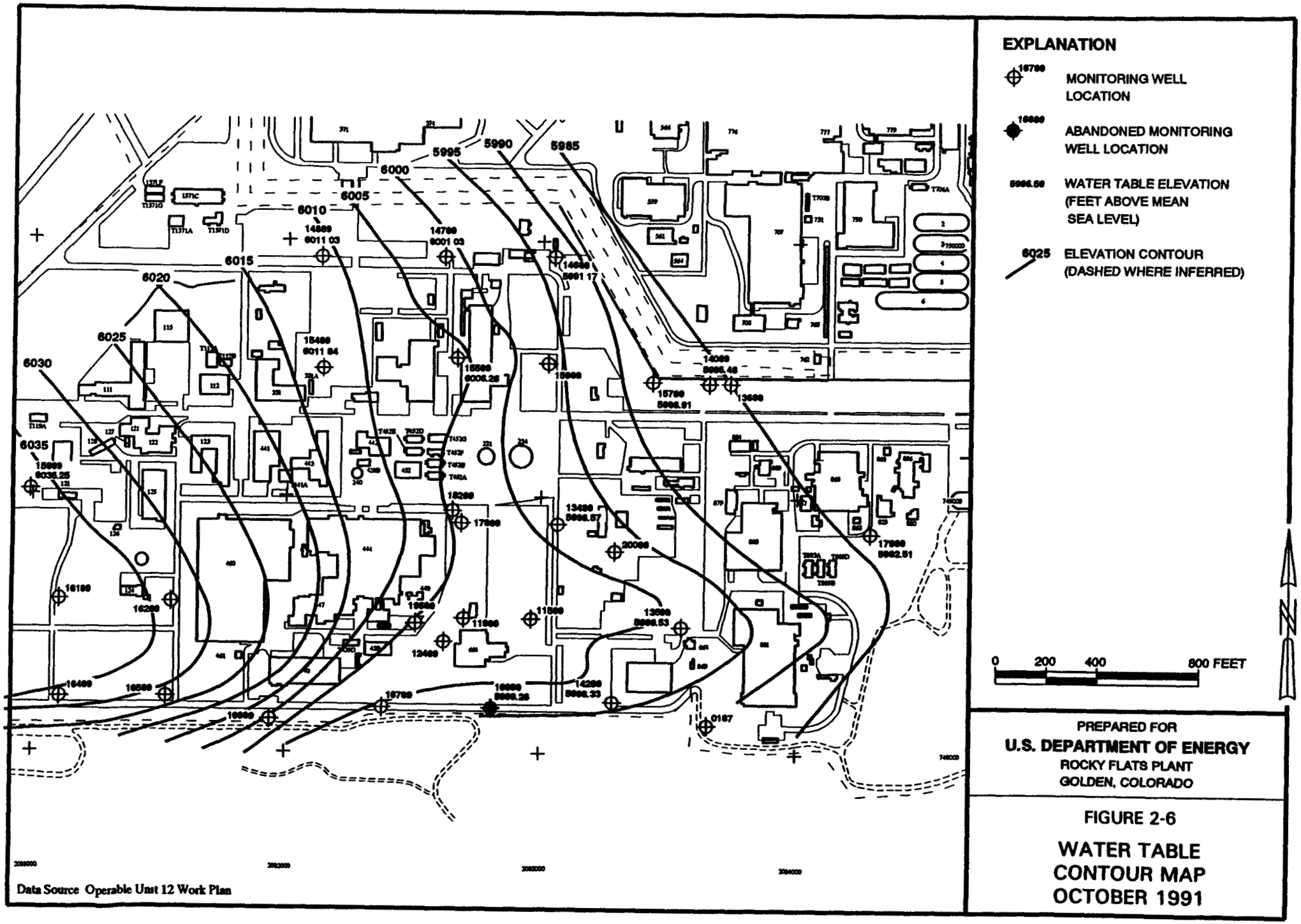

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FIGURE 2-6

WATER TABLE CONTOUR MAP OCTOBER 1991

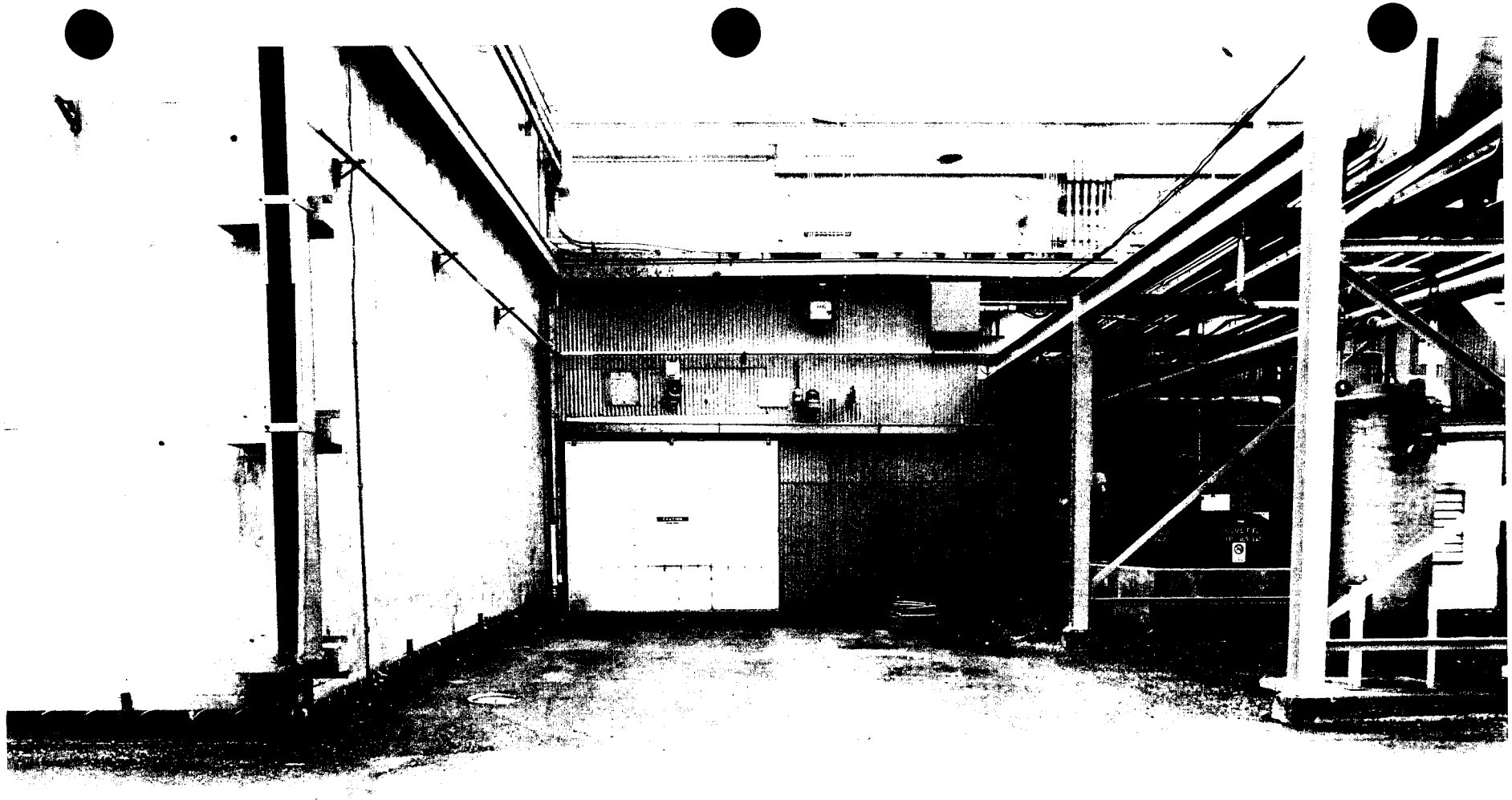


Figure 2-10
IHSS 131
Unit Name: Radioactive Site - 700 Area, Site #1
View looking south at the north side of building 776, Door 17.

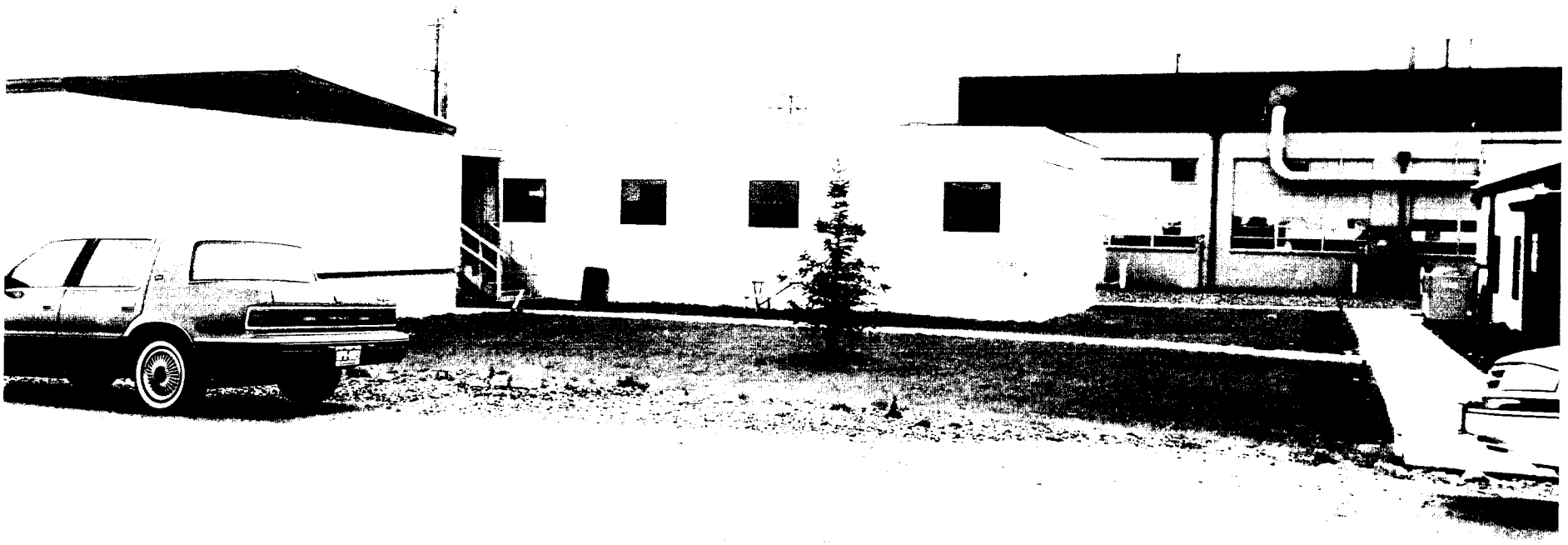


Figure 2-11
IHSS 156.1
Unit Name: Building 334 Parking Lot
View looking east with Building 334 at the right side of the photo.

Figure 2-12
IHSS 156.1
Unit Name: Building 334 Parking Lot
View looking west from the east side of Building 371 parking lot.

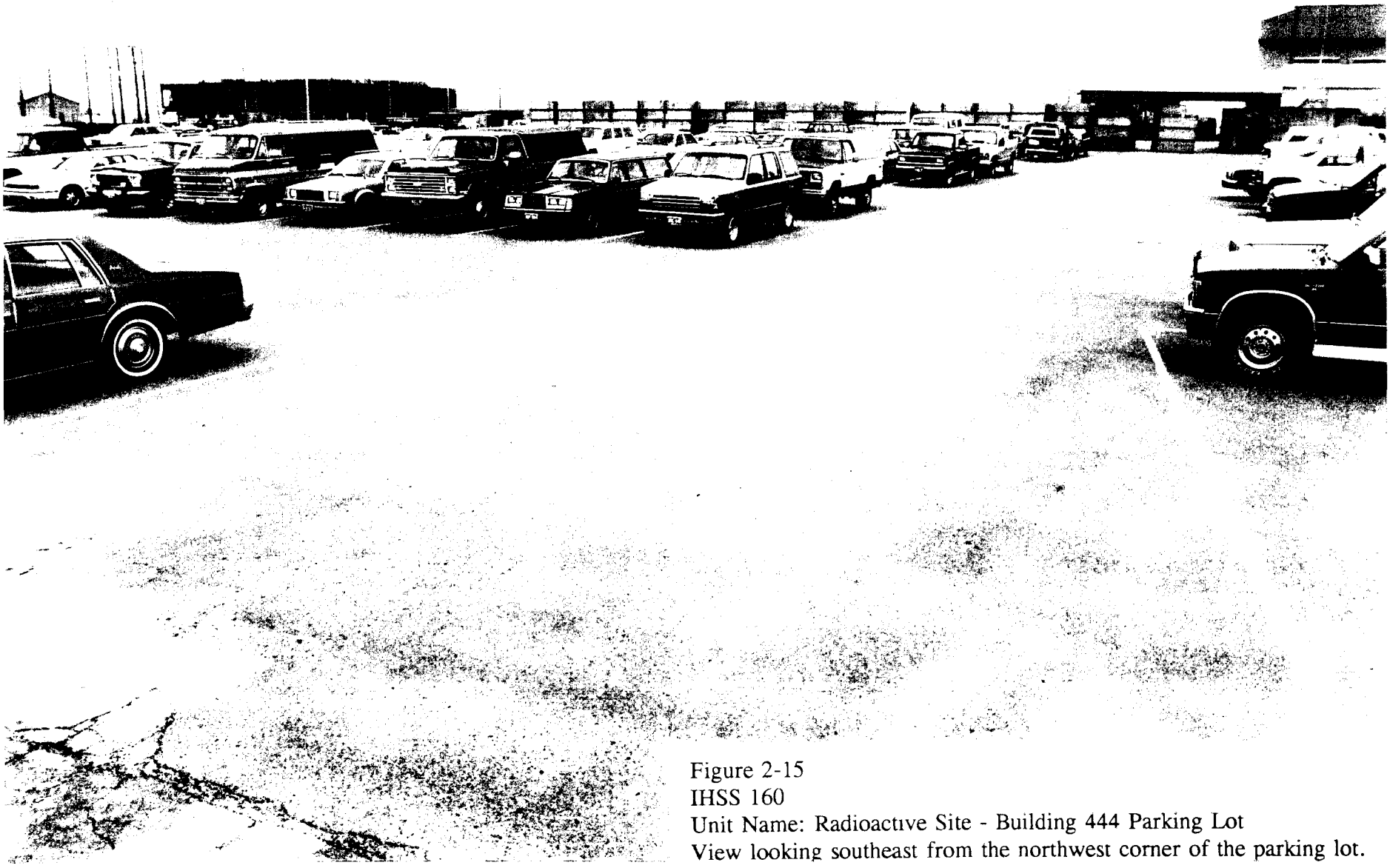


Figure 2-15
IHSS 160
Unit Name: Radioactive Site - Building 444 Parking Lot
View looking southeast from the northwest corner of the parking lot.

Figure 2-16
IHSS 161
Unit Name: Storage Site West of Building 664
View is to the south. The area of concern is between the building and the truck.

Figure 2-18a
IHSS 162
Unit Name: Radioactive Site - 700 Area Site #2
View looking south along Eighth Avenue in proximity to Building 776.

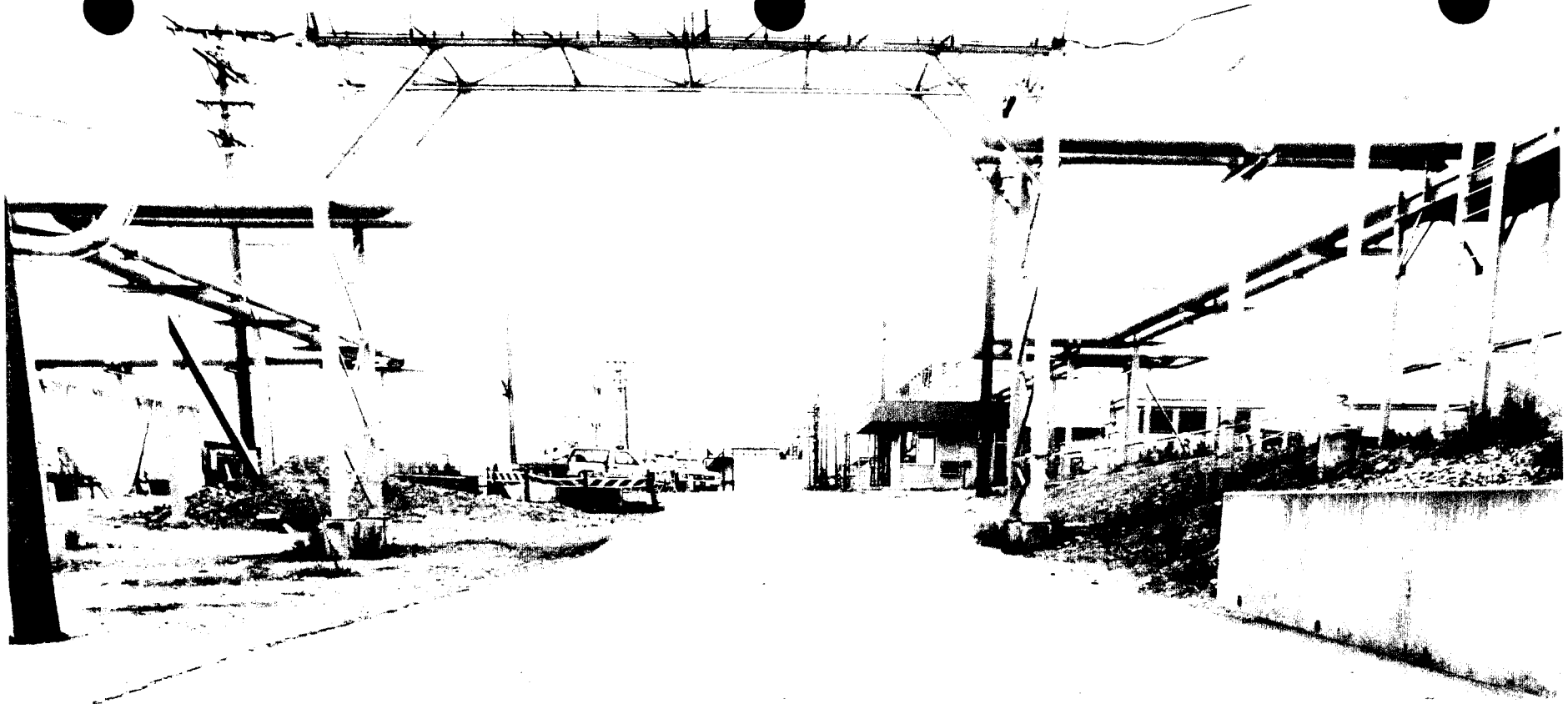


Figure 2-18b
IHSS 162
Unit Name: Radioactive Site - 700 Area Site #2
View looking south along Eighth Avenue in proximity to Building 707.

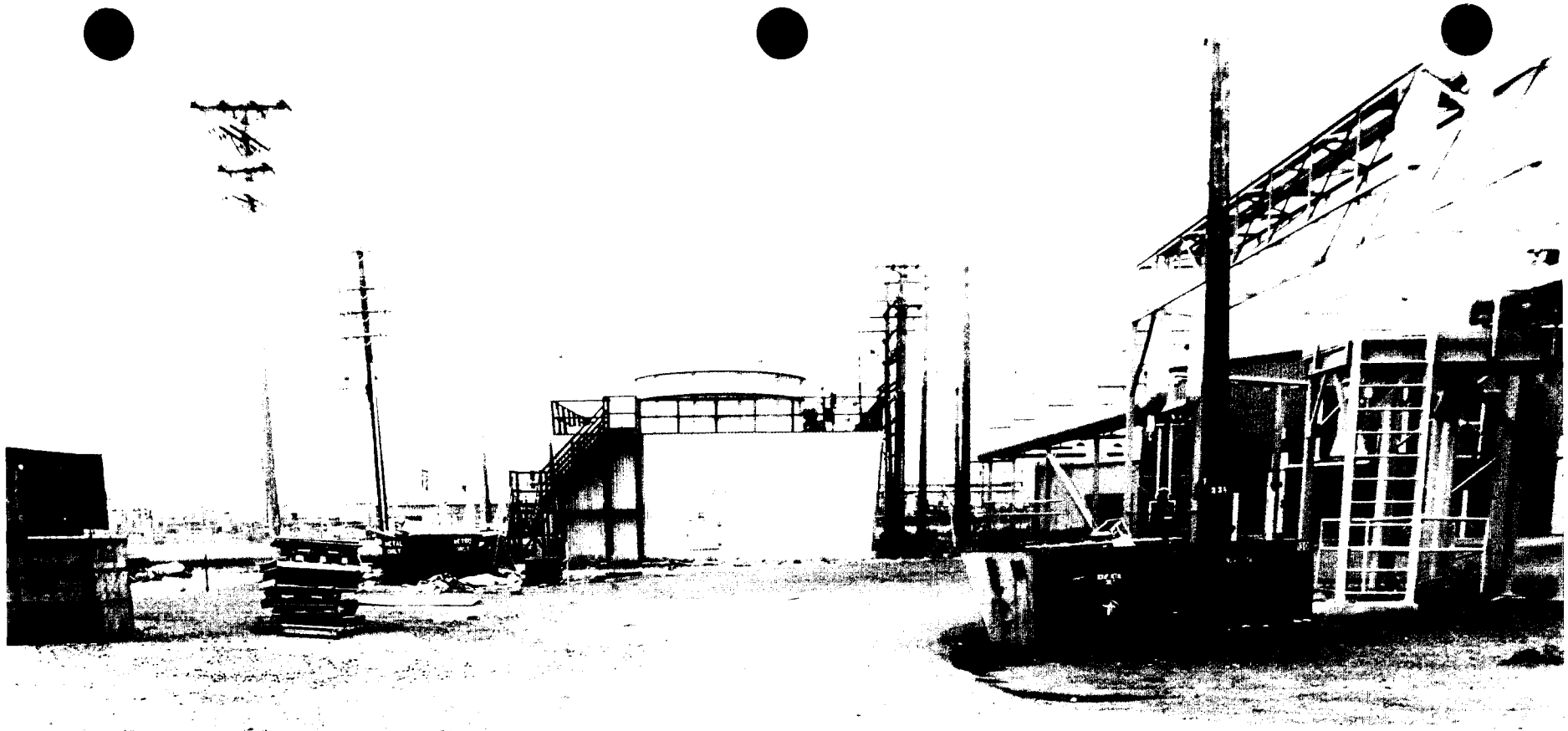


Figure 2-18c
IHSS 162
Unit Name: Radioactive Site - 700 Area Site #2
View looking south toward Building 711

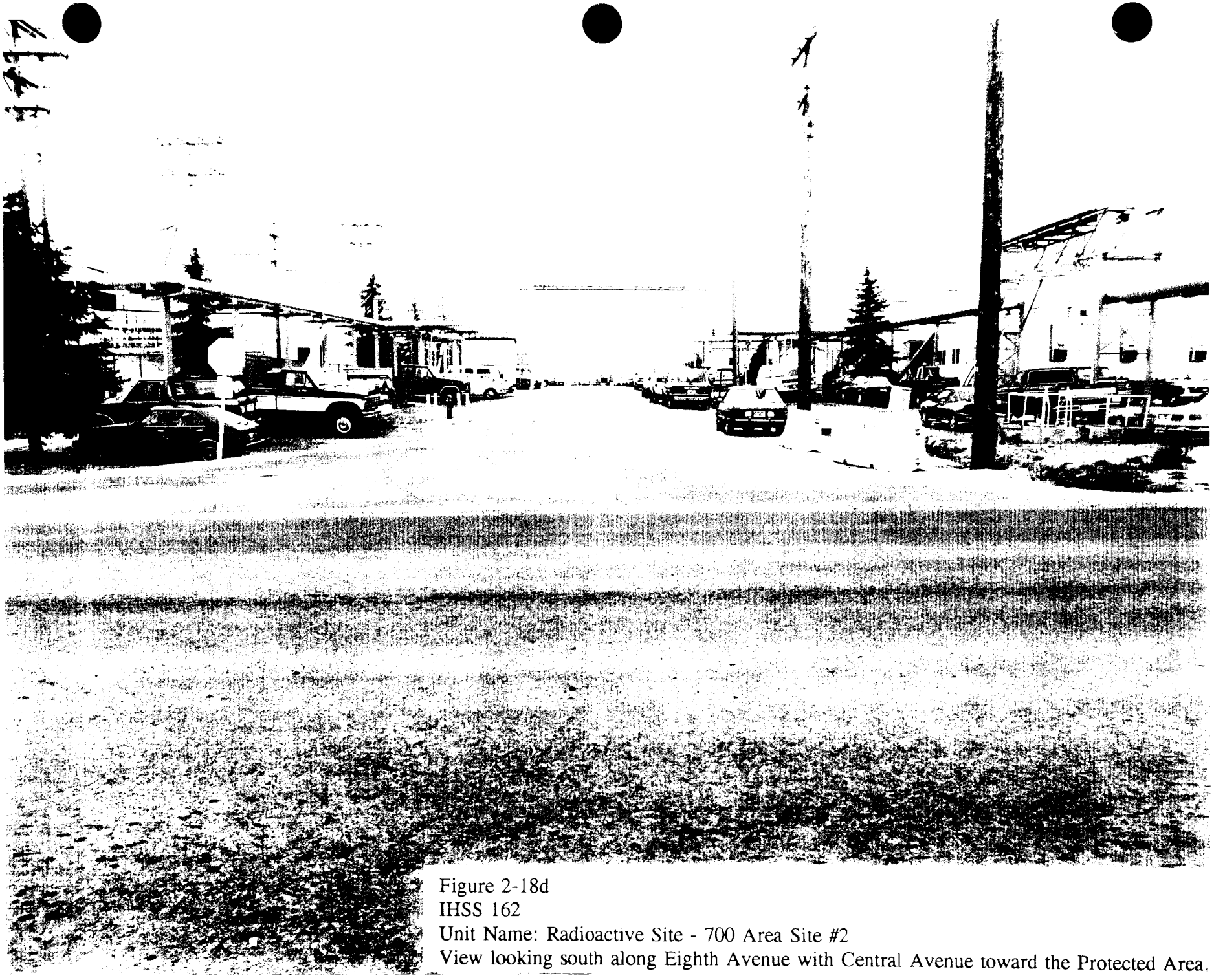


Figure 2-18d
IHSS 162
Unit Name: Radioactive Site - 700 Area Site #2
View looking south along Eighth Avenue with Central Avenue toward the Protected Area.

Figure 2-18e
IHSS 162
Unit Name: Radioactive Site - 700 Area Site #2
View looking south along Eighth Avenue - End of IHSS.

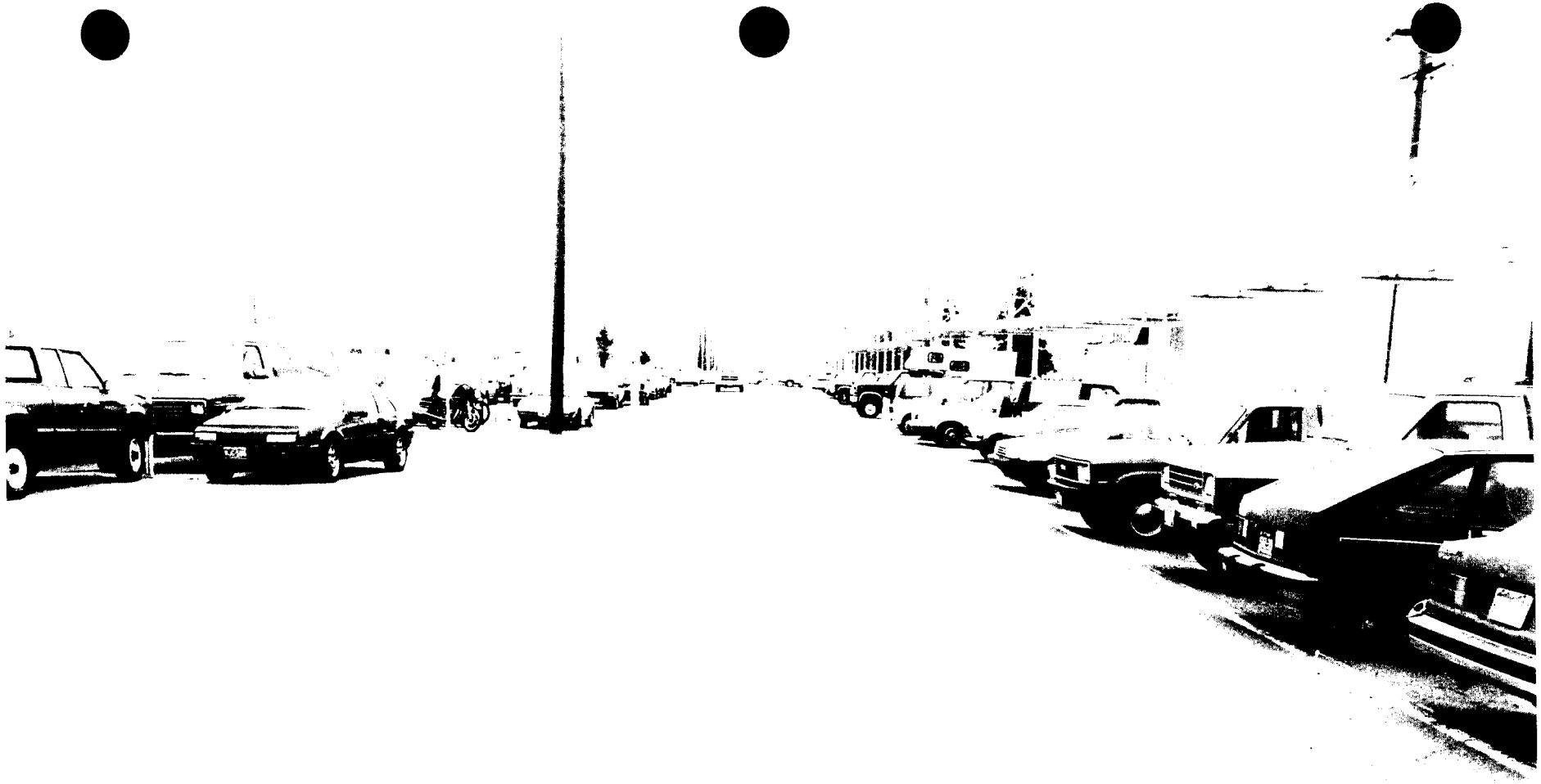


Figure 2-20
IHSS 164.1
Slab from building 776
IHSS is parking area to the left

Figure 2-22a
IHSS 164.2
Unit Name: Radioactive Site - 800 Area, Site #2, Buildiong 886 Spills
View looking northwest from the southeast corner of the building area

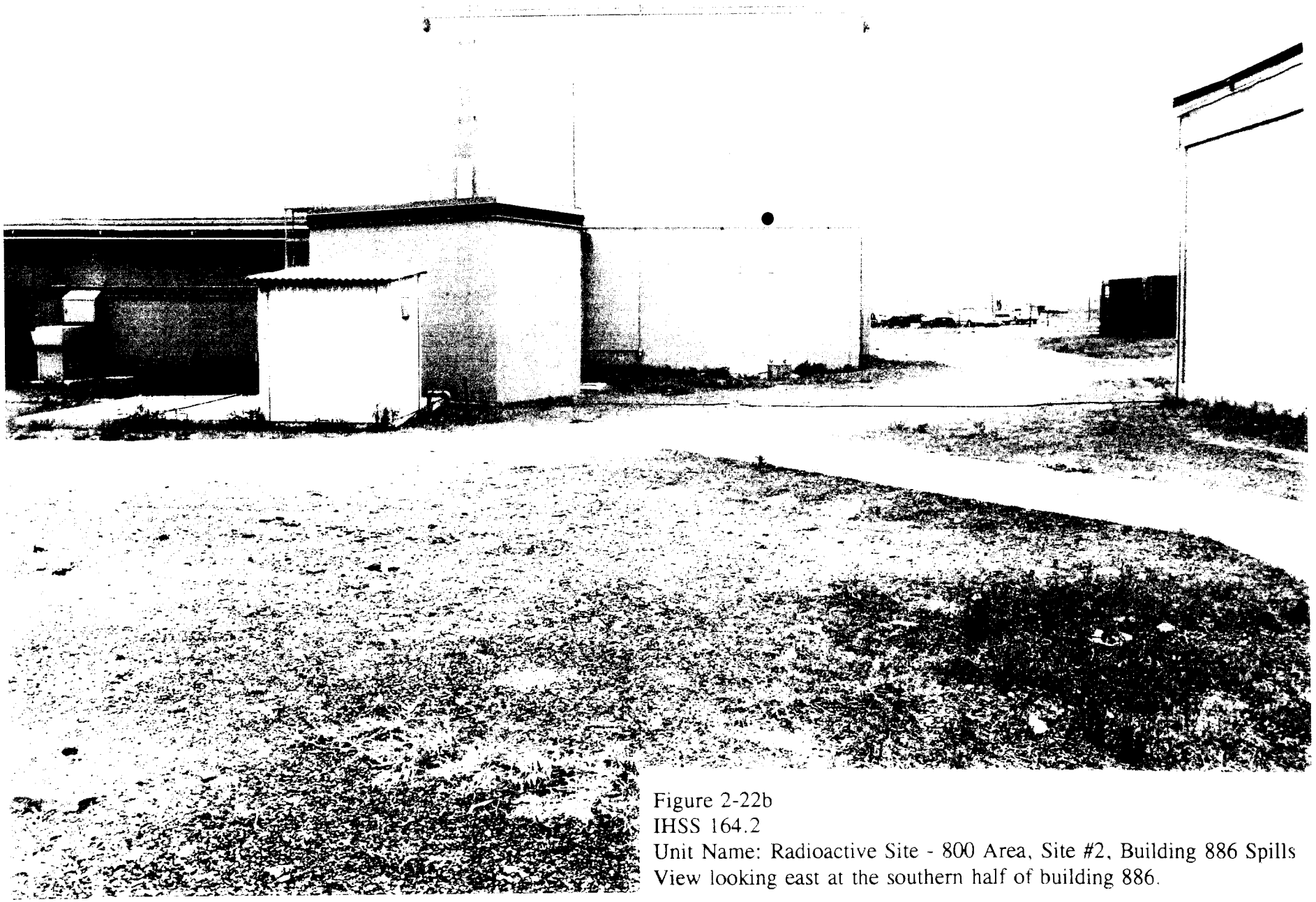
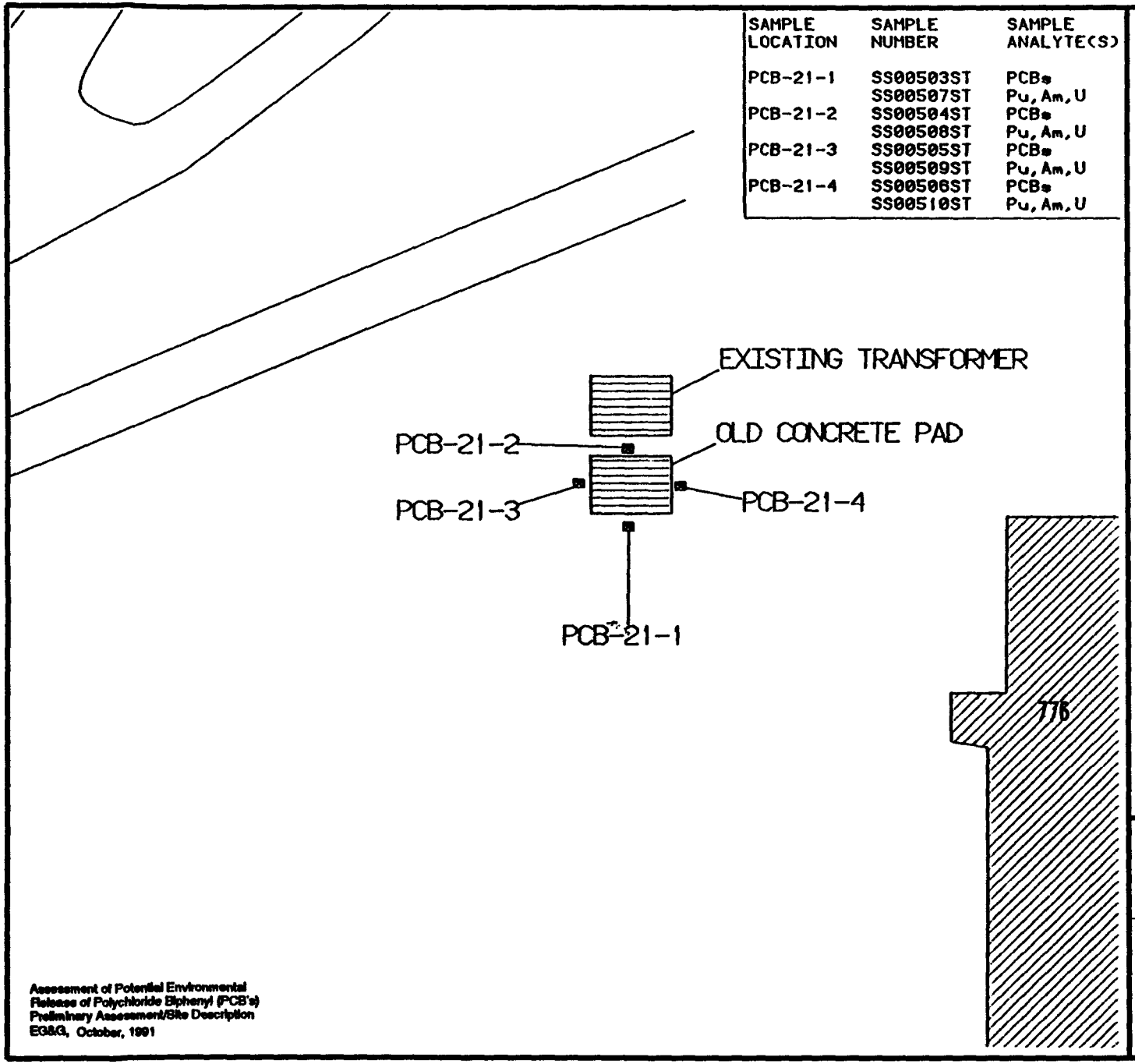


Figure 2-22b
IHSS 164.2
Unit Name: Radioactive Site - 800 Area, Site #2, Building 886 Spills
View looking east at the southern half of building 886.

Figure 2-23
IHSS 164.3
Unit Name: Radioactive Site - 800 Area, Site #2, 889 Storage Pad
View looking northwest from the southeast corner of the building area.

SAMPLE LOCATION	SAMPLE NUMBER	SAMPLE ANALYTE(S)
PCB-21-1	SS00503ST	PCBs
	SS00507ST	Pu, Am, U
PCB-21-2	SS00504ST	PCBs
	SS00508ST	Pu, Am, U
PCB-21-3	SS00505ST	PCBs
	SS00509ST	Pu, Am, U
PCB-21-4	SS00506ST	PCBs
	SS00510ST	Pu, Am, U



MAP LEGEND

- PAVED ROADS
- 776 BUILDINGS
- APPROXIMATE TRANSFORMER/ PAD LOCATIONS (NOT TO SCALE)
- APPROXIMATE SAMPLE LOCATIONS

0 25 50 100
FEET

N

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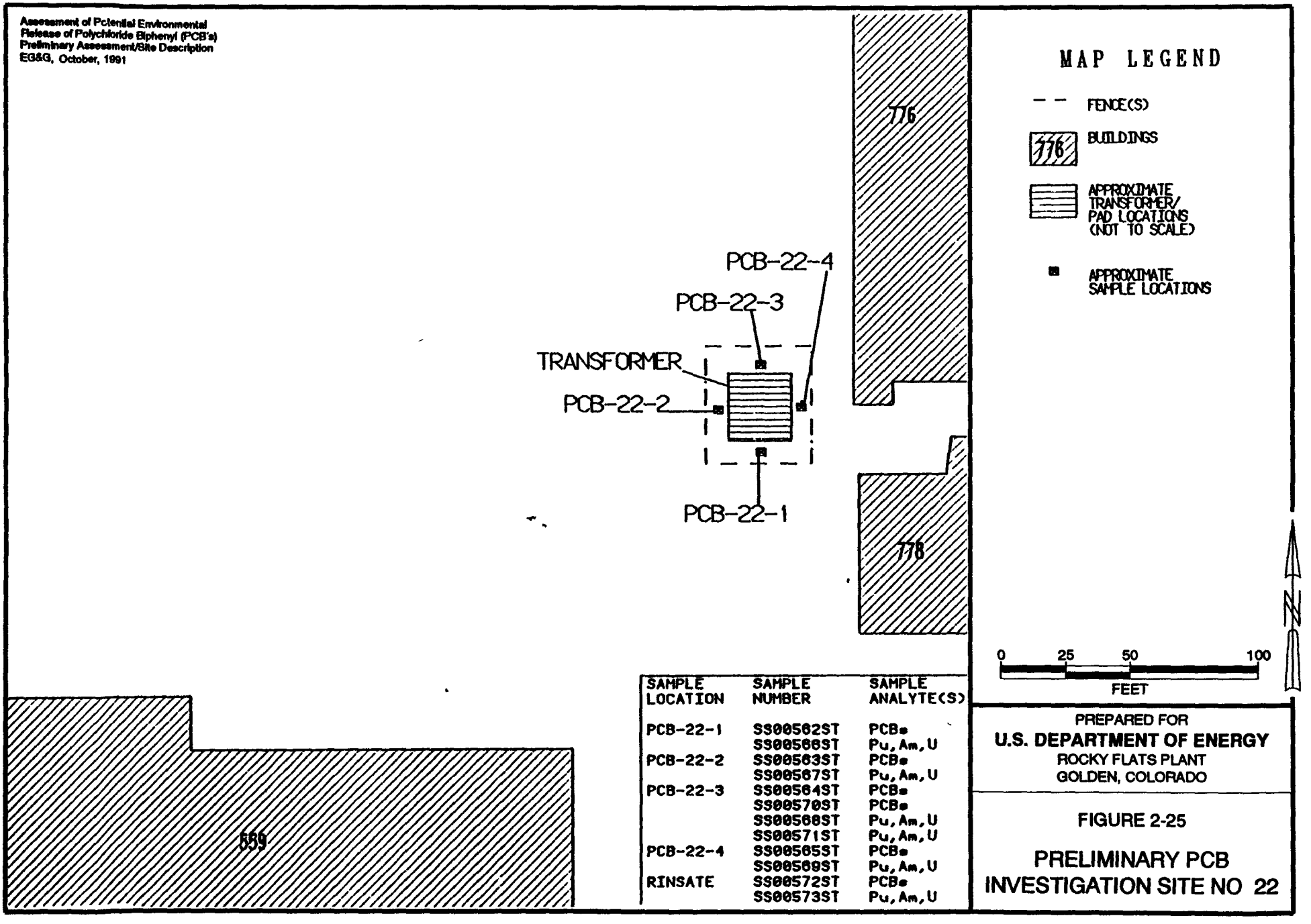
ROCKY FLATS PLANT
GOLDEN, COLORADO

FIGURE 2-24

PRELIMINARY PCB INVESTIGATION SITE NO 21

Assessment of Potential Environmental Release of Polychloride Biphenyl (PCB's) Preliminary Assessment/Site Description
EG&G, October, 1991

Assessment of Potential Environmental
Release of Polychloride Biphenyl (PCB's)
Preliminary Assessment/Site Description
EG&G, October, 1991



SAMPLE LOCATION	SAMPLE NUMBER	SAMPLE ANALYTE(S)
PCB-22-1	SS00562ST	PCBs
	SS00566ST	Pu, Am, U
PCB-22-2	SS00563ST	PCBs
	SS00567ST	Pu, Am, U
PCB-22-3	SS00564ST	PCBs
	SS00570ST	PCBs
	SS00568ST	Pu, Am, U
	SS00571ST	Pu, Am, U
PCB-22-4	SS00565ST	PCBs
	SS00569ST	Pu, Am, U
RINSATE	SS00572ST	PCBs
	SS00573ST	Pu, Am, U

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FIGURE 2-25

PRELIMINARY PCB INVESTIGATION SITE NO 22

10/14/92 C:ROCKYFT\IHSSMDL.DWG

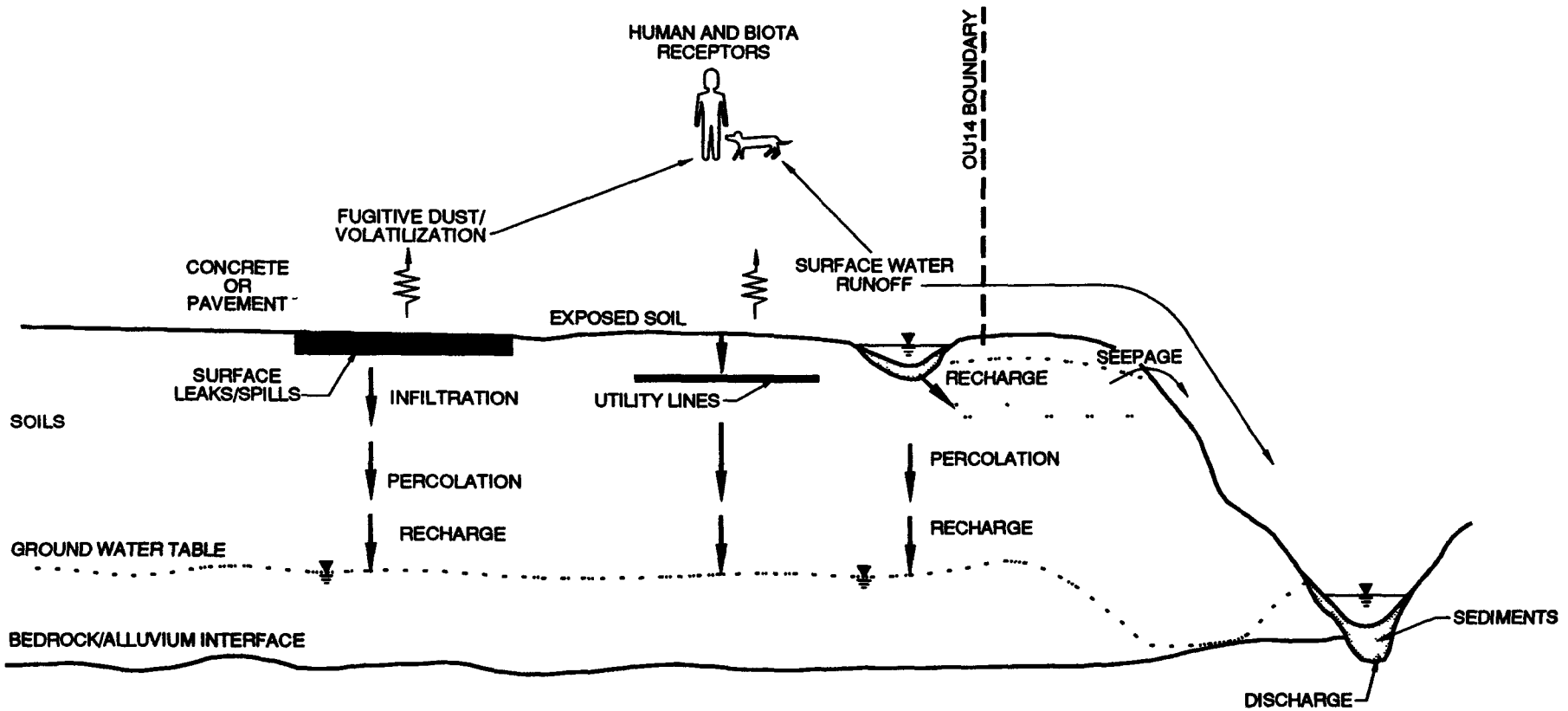

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FIGURE 2-31

IHSS CONCEPTUAL MODEL GRAPHIC

Approved by

_____ / /
Manager, Remediation Programs

_____ / /
RI Project Manager

3.0 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Preliminary identification of potential ARARs in the initial phase of the RFI/RI can assist in the following.

- Identifying remedial action goals
- Identifying potential remedial action responses
- Refining ARARs identification by communicating with involved agencies
- Planning field sampling activities
- Screening contaminants in the effort to determine what is a "level of concern"

Developing and refining a list of potential ARARs is an ongoing process throughout all phased programs conducted pursuant to the IAG. A preliminary list of ARARs for OU14 has been developed based on known site contaminants, as investigations reveal the nature and extent of these contaminants, a list of specific requirements will be developed.

A list of potential ARARs can be used to develop and screen for potential remedial alternatives Identification of potential ARARs for the candidate remedial action responses is determined in part by the COCs, site-specific circumstances, and media of concern

Section 121(d)(2) of CERCLA provides a statutory basis for determining ARARs in a remedial context With respect to any hazardous substance, pollutant, or contaminant that will remain on site, Section 121(d)(2) states

> If any standard, requirement, criteria or limitation under any federal environmental law or any [stringent] promulgated standard, requirement, criteria or limitation under a state environmental or facility siting law is legally applicable to the hazardous substance concerned or is relevant and appropriate under the circumstances of the release or threatened release of such hazardous substance, pollutant or contaminant, the remedial action shall require, at the completion of the remedial action, a level or standard of control for such hazardous substance, pollutant or contaminant which at least attains such legally applicable or relevant and appropriate standard, requirement, criteria or limitation 42 USC § 9621(d)(2)

"Applicable Requirements" are those

> . . Cleanup standards, standards of control, or other substantive environmental protection requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant or contaminant 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

According to the final National Contingency Plan (NCP), 40 CFR§ 300.5 and the Compliance with Other Laws Manual

> "Relevant and appropriate requirements" 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 so 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

3.1 Development of Potential ARARs

Table 3-1 includes potential chemical-specific, location-specific, and possible action-specific requirements identified thus far for further evaluation in the OU14 RI/RFI process EG&G has developed a list of potential chemical-specific benchmarks on a sitewide basis "Benchmark" is defined by EG&G as a site-specific standard that may not be generally applicable to all OUs. These benchmarks include 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, Part 264, Subpart F, Groundwater Concentration Limits (40 CFR 264 94) applicable to groundwater

- WQCC Surface Water Standards for Woman Creek and Walnut Creek (5 CCR 1002-8, Section 3.8.29, effective March 30, 1990) applicable to surface water

- WQCC Basic Standards for Groundwater (5 CCR 1002-8, Section 3.11.0, amended October 1991), potentially applicable to groundwater

- WQCC Classifications and Water Quality Standards for Groundwater (5 CCR 1002-8, Section 3.12 0, amended September 1991) potentially applicable to groundwater

A summary of chemical-specific standards (i.e., potential benchmarks) relating to groundwater is presented in Table 3-2 Table 3-3 summarizes federal chemical-specific standards for surface water Table 3-4 summarizes state chemical-specific standards for surface water, and Table 3-5 summarizes state chemical-specific standards for stream segments These benchmarks have been utilized on other OUs, and have been accepted by EPA as potential ARARs

3.2 To Be Considered Criteria, Advisories, or Guidance

A To Be Considered (TBC) list identifies criteria, advisories, guidance, or policies that do not meet the definition of ARARs but may assist in determining what actions may be protective of the environment and human health when there is no ARAR for a specific substance or activity. TBCs identified for OU14 include the following.

- DOE Orders
- EPA Guidance Documents
- Executive Orders
- New Clean Air Amendments
- New Federal Pollution Minimization Laws for Contaminated Groundwater at Superfund Sites (October 1986)
- Proposed standards under the SDWA
- Federal/state rules pertaining to relevant subjects that are not promulgated (i.e., criteria, limits, or standards)[by definition of Section 121(d)(2) of CERCLA, as amended]

TABLE 3-1.
POTENTIAL FEDERAL AND STATE ARARS FOR OU14

Statute	Regulation
Federal chemical-specific ARARs for OU14	
Safe Drinking Water Act	40 CFR 141, "National Primary Drinking Water Standards"
	40 CFR 141, "Maximum Contaminant Level Goals"
	40 CFR 143, "National Secondary Drinking Water Standards"
Clean Water Act	40 CFR 131, "Water Quality Criteria"
Atomic Energy Act and Energy Reorganization Act	10 CFR 20, "U S. Nuclear Regulatory Commission (NRC) Standards for Protection Against Radiation"
	10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste"
Resource Conservation and Recovery Act	40 CFR 264, "Maximum Concentration Limits"
	40 CFR 268, "Land Disposal Restrictions"
Emergency Planning and Community Right-to-Know Act of 1986	40 CFR 355, "Emergency Planning and Notification under CERCLA"
Federal action-specific ARARs for OU14	
Resource Conservation and Recovery Act	40 CFR 257, "Criteria for Classification of Solid Waste Disposal Facilities and Practices"

Table 3-1. continued

Statute	Regulation
	40 CFR 260, "Hazardous Waste Management Systems"
	40 CFR 262, "Standards Applicable to Generators of Hazardous Waste"
	40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"
	40 CFR 267, "Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities"
	40 CFR 268, "Land Disposal Restrictions"
Standards for Remedial Actions at Uranium Processing Sites	40 CFR Part 192
Toxic Substances Control	15 USC §§ 2601-2629
PCB Requirements	40 CFR Part 761
Radiation Control Act	42 USC § 2022
National Environmental Policy Act	40 CFR 1500 - 1508, "Council on Environmental Quality Regulations for Implementing National Environmental Policy Act Procedures"
Hazardous Material Transportation Act	49 CFRs 171 - 179, "Standards for Transporters of Hazardous Waste"
Clean Air Act	40 CFR 50, "National Primary and Secondary Ambient Air Quality Standards"
	40 CFR 61 90, "National Emission Standards for Radionuclide Emission from DOE Facilities"

Table 3-1. continued

Statute	Regulation
	40 CFR 200, "Standards of Performance for New Stationary Sources"
Atomic Energy Act and Energy Reorganization Act	10 CFR 61, Subpart D, "Technical Requirements for Land Disposal Facilities"
Migratory Bird Treaty Act	50 CFR 20, "Migratory Bird Protection"
Bald and Golden Eagle Protection Act	50 CFR 22, "Bald and Golden Eagle Protection Act"
Endangered Species Act	50 CFR 17, "Endangered and Threatened Wildlife and Plants"
	50 CFR 225, "Federal/State Cooperation in the Conservation of Endangered and Threatened Species"
	50 CFR 226, "Designated Critical Habitat"
	50 CFR 402, "Interagency Cooperation"
Fish and Wildlife Coordination Act	16 USC §§ 661-666 40 CFR § 6.301 (g)
Federal location-specific ARARs for OU14	
National Historic Preservation Act	36 CFR 800
Archeological Resources Protection Act	36 CFR 7, "Protection of Archeological Resources"
Archeological and Historic Preservation	36 CFR 296, "Protection of Archeological Resources, Uniform Regulations"
Preservation of American Antiquities Act	43 CFR 3

Table 3-1. continued

Statute	Regulation
State ARARS	
Colorado Air Pollution Control Regulations	5 CCR 1001-5, No 3 et seq.
Colorado Radiation Control Regulations	6 CCR 1007-1 et seq C R.S 1973, 25-1-107 (1) (s), (t) 25-1-108 and 25-11-104
Colorado Hazardous Materials and Waste Regulations	6 CCR 1007-3, 264, 266, 100 and 1007-2 et seq
Colorado Water Quality Control Regulations	5 CCR 1003-2, 1003-1, 1002-2, et al , 1002-8
Colorado Division of Wildlife Regulations	CRS 1973, 33-4-102
Colorado Soil Conservation Board Regulations	CRS 35-72-101 et seq
Colorado Water Well and Pump Installation Regulations	CRS 402-2, 37-91-101-112
Colorado Public Utility Commission Regulations	CRS 40-2 1-103

TABLE 3–2. POTENTIAL CHEMICAL–SPECIFIC "BENCHMARKS" (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	POL MDL RFP	POL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (e) Acute Value	CWA AWQC for Protection of Aquatic Life (e) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Bicarbonate	A	10,000		E310 1									
Carbonate	A	10,000		E310 1									
Chloride	A	5,000		E325	250,000*				860,000(e)	230,000(e)			
Chlorine	A	1,000		E4500					19	11			
Flouride	A	5,000		E340	4,000; 2,000*		4,000					4,000	
N as Nitrate	A	5,000		E353 1	10,000			10,000			10,000		
N as Nitrate+Nitrite	A	5 000		E353 1		10,000		10,000					
N as Nitrite	A	5,000		E354 1		1,000		1,000					
Sulfate	A	5,000		E375 4	250,000*								
Sulfide	A												
Coliform (Fecal)	B	1		SM9221C	1/100 ml								
Ammonia as N	C	5,000		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	500		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	5,000		E6010									
Total Dissolved Solids	I	10,000		E160 1	500,000*				SS	SS	250,000		
Aluminum	M	200		CT		50 to 200*			750	87			
Antimony	M	60		CT					9,000	1,600	146	45,000	
Arsenic	M	10		CT	50						0.0022	0 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									
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*			1,300 (g)	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 (d)	5 (d)	10		

TABLE 3–2. POTENTIAL CHEMICAL–SPECIFIC "BENCHMARKS" (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	POL MDL RFP	POL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (a) Acute Value	CWA AWQC for Protection of Aquatic Life (a) Chronic Value	CWA AWQC for Protection of Human Health (a) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (a) Fish Consumption Only	NRC Effluent Standards Water pCi/L
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	F		0.5	d	10	50		50					
2,4–Dichlorophenoxyacetic Acid (2,4–D)	F		1	d	100	70		70					
Acrolein	F		10						68(1)	21(1)	320	780	
Aldicarb	F		10			3 (f)		1 (f)					
Aldrin	F	0 05	0.1	CP					3.0		0.000074	0.000079	
Bromacil	F												
Carbofuran	F			d		40		40					
Chloranil													
Chlordane (Alpha)	F	0.5	1	CP		2		0	2.4	0.0043	0.00046	0 00048	
Chlordane (Gamma)	F	0.5	1	CP		2		0	2.4	0 0043	0.00046	0 00048	
Chlorpyrifos	F		0 1	E619					0 063	0.041			
DDT	F	0.1	0 1	CP					1 1	0 0011	0 000024	0 000024	
DDT metabolite (DDD)	F	0.1	0 1	CP					0.06				
DDT metabolite (DDE)	F	0.1	0 1	CP					1,050				
Demeton	F		1							0 1			
Diazinon	F												
Dieldrin	F	0.1	0.1	CP					2.5	0.0019	0 00007	0.000076	
Endosulfan I	F	0 05	0 1	CP					0.22	0.056	74	159	
Endosulfan II	F	0 1	0 1	CP									
Endosulfan Sulfate	F	0 1	0 1	CP									
Endrin	F	0.1	0.1	CP	0.2				0.18	0.0023	1		
Endrin Aldehyde	F		0 1										
Endrin Ketone	F	0 1		CP									
Guthion	F		1.5							0.01			
Heptachlor	F	0.05	0 05	CP		0 4		0	0.52	0 0038	0.00028	0 00029	
Heptachlor Epoxide	F	0.05	0 05	CP		0.2		0					
Hexachlorocyclohexane, Alpha	F	0 05	0 05	CP							0 0092	0 031	
Hexachlorocyclohexane, Beta	F	0.05	0 05	CP							0.0163	0.0547	
Hexachlorocyclohexane, BHC	F	0.05	0.05										
Hexachlorocyclohexane, Delta	F	0.05		CP									
Hexachlorocyclohexane, Technical	F		0.2	f							0 0123	0 0414	
Hexachlorocyclohexane, (Lindane) Gama	F	0.05	0.05	CP	4	0.2		0.2	2.0	0 08			
Malathion	F		0.2							0.01			
Methoxychlor	F	0.5	0.5	CP	100	40		40		0.03	100		
Mirex	F		0 1							0 001			
Parathion	F								0 065	0 013			
PCBs	F	0.5	1	CP		0.5		0	2.0	0.014	0 000079**	0.000079**	

TABLE 3–2. POTENTIAL CHEMICAL–SPECIFIC "BENCHMARKS" (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (e) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (e) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Simazine	F			e									
Toxaphene	F	1	5	CP		3		0	0 73	0 0002	0 00071**	0 00073**	
Vaponite 2	F												
Aroclor 1016	PF	0.5		CP									
Aroclor 1221	PF	0.5		CP									
Aroclor 1232	PF	0.5		CP									
Aroclor 1242	PF	0.5		CP									
Aroclor 1248	PF	0.5		CP									
Aroclor 1254	PF	1		CP									
Aroclor 1260	PF	1		CP									
Atrazine	PF			e		3		3					
Americium (pCi/l)	R												
Americium 241 (pCi/l)	R	0 01											20
Cesium 134 (pCi/l)	R	1											900
Cesium 137 (pCi/l)	R	1											1000
Gross Alpha (pCi/l)	R	2			15 (10)							15	
Gross Beta (pCi/l)	R	4			50 (4 mrem/yr)								
Plutonium (pCi/l)	R												
Plutonium 238+239+240 (pCi/l)	R	0 01											20
Radium 226+228 (pCi/l)	R	0.5/0 1 (9)			5							5	60
Strontium 89+90 (pCi/l)	R	1											500
Strontium 90 (pCi/l)	R				8 (6)							8	500
Thorium 230+232 (pCi/l)	R												30
Tritium (pCi/l)	R				20,000 (6)								1000000
Uranium 233+234 (pCi/l)	R												300
Uranium 235 (pCi/l)	R	0 6											300
Uranium 238 (pCi/l)	R	0 6											300
Uranium (total) (pCi/l)	R												
1,2,4,5–Tetrachlorobenzene	SV		10	Ω							38	48	
1,2,4–Trichlorobenzene	SV	10		Ω									
1,2–Dichlorobenzene (Ortho)	SV	10	10	Ω		600		600					
1,2–Diphenylhydrazine	SV			Ω					270 (1)				
1,3–Dichlorobenzene (Meta)	SV	10	1	Ω									
1,4–Dichlorobenzene (Para)	SV	10	1	Ω	75		75						
2,4,5–Trichlorophenol	SV	50		Ω							2,800		
2,4,6–Trichlorophenol	SV	10	50	Ω						970 (1)	1.2 **	3 6 **	
2,4–Dichlorophenol	SV	10	50	Ω					2,020 (1)	365 (1)	3,090		
2,4–Dimethylphenol	SV	10	50	Ω					2,120 (1)				
2,4–Dinitrophenol	SV	50	50	Ω									
2,4–Dinitrotoluene	SV	10	10	Ω							0.11 **	9 1 **	
2,6–Dinitrotoluene	SV	10	10	Ω					330 (1)	230 (1)	70	14,300	
2–Chloronaphthalene	SV	10		Ω									
2–Chlorophenol	SV	10	50	Ω					4,360 (1)	2,000 (1)			
2–Methylnaphthalene	SV	10		Ω									
2–Methylphenol	SV	10		Ω									
2–Nitroaniline	SV	50		Ω									

TABLE 3–2. POTENTIAL CHEMICAL–SPECIFIC "BENCHMARKS" (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RPT	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (e) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (e) Fish Consumption Only	NRC Effluent Standards Water pCi/L
2–Nitrophenol	SV	10		Ω									
3,3–Dichlorobenzidine	SV	20	10	Ω							0 01	0 02	
3–Nitroaniline	SV	50		Ω									
4,6–Dinitro–2–methylphenol	SV	50	50	Ω									
4–Bromophenyl Phenylether	SV	10		Ω									
4–Chloroaniline	SV	10		Ω									
4–Chlorophenyl Phenyl Ether	SV	10		Ω									
4–Chloro–3–methylphenol	SV	10	50	Ω					30 (1)				
4–Methylphenol	SV	10		Ω									
4–Nitroaniline	SV	50		Ω									
4–Nitrophenol	SV	50		Ω					230 (1)	150 (1)			
Acenaphthene	SV	10	10	Ω					1,700 (1)	520 (1)			
Anthracene	SV	10	1	Ω									
Benzidine	SV		1	Ω					2,500		0.00012	0 00053	
Benzoic Acid	SV	50		Ω									
Benzo(a)anthracene	SV	10	10	Ω									
Benzo(a)pyrene	SV	10	10	Ω									
Benzo(b)fluoranthene	SV	10	10	Ω									
Benzo(g,h,i)perylene	SV	10	10	Ω									
Benzo(k)fluoranthene	SV	10	10	Ω									
Benzyl Alcohol	SV	10		Ω									
bis(2–Chloroethoxy)methane	SV	10		Ω									
bis(2–Chloroethyl)ether	SV	10	10	Ω							0.03**	1.36 **	
bis(2–Chloroisopropyl)ether	SV	10	10	Ω							34 7	4,360	
bis(2–Ethylhexyl)phthalate	SV	10	10	Ω							15,000	50,000	
Butadiene	SV												
Butylbenzylphthalate	SV	10	10	Ω									
Chlorinated Ethers	SV												
Chlorinated Napthalenes	SV								1,600 (1)				
Chloroalkylethers	SV	10		Ω					238,000 (1)				
Chlorophenol	SV		50										
Chrysene	SV	10	10	Ω									
Dibenzofuran	SV	10		Ω									
Dibenz(a,h)anthracene	SV	10	10	Ω									
Dichlorobenzenes	SV		1						1,120 (1)	763 (1)	400	2,600	
Dichlorobenzidine	SV	20	10	Ω							0 01	0.02	
Diethylphthalate	SV	10	10	Ω							350,000	1,800,000	
Dimethylphthalate	SV	10	10	Ω							313,000	2,900,000	
Di–n–butylphthalate	SV	10	10	Ω									
Di–n–octylphthalate	SV	10		Ω									
Ethylene Glycol	SV												
Fluoranthene	SV	10	10	Ω					3,980 (1)		42	54	
Fluorene	SV	10	10	Ω									
Formaldehyde	SV												
Haloethers	SV								360 (1)	122 (1)			
Hexachlorobenzene	SV	10	10	Ω							0 00072**	0 00074**	

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	POL MDL RFP	POL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water, pCi/L
Hexachlorobutadiene	SV	10	10	GC					90 (1)	9.3 (1)	0 45**	50 **	
Hexachlorocyclopentadiene	SV	10	10	GC					7 (1)	5.2 (1)	206		
Hexachloroethane	SV	10	10	GC					980 (1)	540 (1)	1 9	8 74	
Hydrazine	SV												
Indeno(1,2,3-cd)pyrene	SV	10	10	GC									
Isophorone	SV	10	10	GC					117,000 (1)		5,200	520,000	
Naphthalene	SV	10	10	GC					2,300 (1)	620 (1)			
Nitrobenzene	SV	10	10	GC					27,000 (1)		19,800		
Nitrophenols	SV								230 (1)	150 (1)			
Nitrosamines	SV								5,850 (1)				
Nitrosodibutylamine	SV		10								0 0064	0.587	
Nitrosodiethylamine	SV		10								0 0008	1.24	
Nitrosodimethylamine	SV		10								0 0014	16	
Nitrosopyrrolidine	SV		10								0 016	91.9	
N-Nitrosodiphenylamine	SV	10	10								4 9**	16.1 **	
N-Nitroso-di-n-dipropylamine	SV	10	10										
Pentachlorinated Ethanes	SV								7,240 (1)	1,100 (1)			
Pentachlorobenzene	SV		10								74	85	
Pentachlorophenol	SV	50	50	GC		1 (f)		0 (f)	20 (4)	13 (4)	1,010		
Phenanthrene	SV	10	10	GC									
Phenol	SV	10	50	GC					10,200 (1)	2,560 (1)	3,500		
Phthalate Esters	SV								940 (1)	3 (1)			
Polynuclear Aromatic Hydrocarbons	SV		10								0 0028**	0 0311**	
Vinyl Chloride	SV	10	2	GC	2		0				2 **	525 **	
1,1,1-Trichloroethane	V	5	1	GC	200		200				18,400	1,030,000	
1,1,2,2-Tetrachloroethane	V	5	1	GC						2,400	0 17**	10 7 **	
1,1,2-Trichloroethane	V	5	1	GC						9,400	0.6**	41.8 **	

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
1,1-Dichloroethane	V	5		CV									
1,1-Dichloroethene	V	5	1	CV	7		7						
1,2-Dichloroethane	V	5	1	CV	5		0		118,000	20,000	0 94**	243 **	
1,2-Dichloroethene (cis)	V		1	a		70		70					
1,2-Dichloroethene (total)	V	5		CV									
1,2-Dichloroethene (trans)	V	5	1	a		100		100					
1,2-Dichloropropane	V	5	1	CV		5		0	23 000	5,700			
1,3-Dichloropropene (cis)	V	5	1	CV					6,060	244 (1)	87	14,100	
1,3-Dichloropropene (trans)	V	5	1	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		5	c					7,500	2,600	0 058	0.65	
Benzene	V	5	1	CV	5		0		5,300		0 66**	40 **	
Bromodichloromethane	V	5	1	CV									
Bromoform	V	5	1	CV									
Bromomethane	V	10	1	CV									
Carbon Disulfide	V	5		CV									
Carbon Tetrachloride	V	5	1	CV	5		0		35,200 (1)		0 4**	6.94 **	
Chlorinated Benzenes	V	10		CV/CS					250 (1)	50 (1)			
Chlorobenzene	V	5	1	CV/CS		100		100					
Chloroethane	V	10		CV									
Chloroform	V	5	1	CV	Tot THM<100 (2)				28,900 (1)	1,240 (1)	0.19 **	15 7 **	
Chloromethane	V	10	1	CV									
Dibromochloromethane	V	5	1	CV									
Dichloroethenes	V		1						11,600 (1)		0 033**	1.85 **	
Ethyl Benzene	V	5	1	CV		700		700	32,000 (1)		1,400	3,280	
Ethylene Dibromide	V			d		0 05		0					
Ethylene Oxide	V												
Halomethanes	V				100				11,000 (1)		0 19**	15 7 **	
Methylene Chloride	V	5	1	CV									
Pyrene	V	10	10	CS									
Styrene	V	5		CV		100		100					

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (e) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (e) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Tetrachloroethanes	V	5	1	CV					9,320 (1)				
Tetrachloroethene	V	5	1	CV		5		0	5,280 (1)	840 (1)	0.80**	8.85 **	
Toluene	V	5	1	CV		1,000		1,000	17,500 (1)		14,300	424,000	
Trichlorcethanes	V	5	1	CV					18,000 (1)				
Trichlorcethene	V	5	1	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
** = Human health criteria for carcinogens reported for three risk levels Value presented is the 10-5 risk level.

AWQC
CLP
CWA
EPA
pCi/l
PCB
PQL
SDWA
SS
TAL
THM
TIC
MDL
ug/l
VOA
(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, D=dioxin, E=element; 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
(9) MDL for radium 226 is 0.5, MDL for radium 228 is 1.0
(10) Value for gross alpha excludes uranium
(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 (56 Federal Register 3526; 1/30/1991).
(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 12/7/91
(h) NRC Effluent Water Concentrations - 10CFR 20 Appendix A, Table 2, Column 2 "Effluent Concentrations for Water" (56 FR 23412 - 23464, May 21, 1991) effective 6/2091.

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)					
									Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Bicarbonate	A	10,000		E310 1										
Carbonate	A	10,000		E310 1										
Chloride	A	5,000		E325								250,000		
Chlorine	A	1,000		E4500					19	11				
Fluoride	A	5,000		E340								2,000		
N as Nitrate	A	5,000		E353 1							100,000	10,000		
N as Nitrate+Nitrite	A	5,000		E353 1							100,000	10,000		
N as Nitrite	A	5,000		E354 1					SS	SS	10,000	1,000		
Sulfate	A	5,000		E375 4								250,000		
Sulfide	A									2		50		
Coliform (Fecal)	B	1		SM9221C								2000/100 ml		
Ammonia as N	C	5,000		E350					620	60		500		
Dioxin	D			d	0 00000022	0 000000013	0 01	0 00001						
Sulfur	E	100,000		E600										
Dissolved Oxygen	FP	500		SM4500					5,000	5,000	3,000	3,000		
pH	FP	0 1		E150 1					6.5-9 0	6.5-9 0		5 0-9 0		
Specific Conductance	FP	1		E120 1										
Temperature	FP								30 degrees	30 degrees				
Boron	I	5,000		E6010							750			
Total Dissolved Solids	I	10,000		E160 1										
Aluminum	M	200		CT					750	87				
Antimony	M	60		CT								14		
Arsenic	M	10		CT					360	150	100	50		
Arsenic III	M													
Arsenic V	M													
Barium	M	200		CT								1,000		
Beryllium	M	5		CT							100	0 0076		
Cadmium	M	5		CT					TVS	TVS	10	10		
Calcium	M	5,000		CT										
Cesium	M	1,000		NC										
Chromium	M	10		CT										
Chromium III	M	5		SW8467196					TVS	TVS	100	50		
Chromium VI	M	10		E218.5					16	11	100	50		
Cobalt	M	50		CT										
Copper	M	25		CT					TVS	TVS	200	1,000		

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
		PQL MDL							Aquatic Life					
Parameter	Type (5)	RFT	CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Cyanide	M	10		CT					5	5	200	200		
Iron	M	100		CT						1,000		300 (dis)		
Lead	M	5		CT					TVS	TVS	100	50		
Lithium	M	100		NC										
Magnesium	M	5000		CT										
Manganese	M	15		CT						1,000	200	50 (dis)		
Mercury	M	0.2		CT					2 4	0 1		2 0		
Molybdenum	M	200		NC										
Nickel	M	40		CT					TVS	TVS	200			
Potassium	M	5000		CT										
Selenium	M	5		CT					135	17	20	10		
Silver	M	10		CT					TVS	TVS		50		
Sodium	M	5000		CT										
Strontium	M	200		NC										
Thallium	M	10		CT						15		0 012		
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		
2,4,5-TP Silvex	P		0.5	d	50									
2,4-D	P		1	d	70									100
Acrolein			10			320	68	21						
Aldicarb	P		10		10									
Aldrin	P	0 05	0 1	CP	0 002 (8)	0 00013	1.5						0 003	
Bromacil	P													
Carbofuran	P			d	36									
Chloranil	P			E619										
Chlordane (Alpha)	P	0.5	1	CP	0 03 (8)		1.2	0 0043						
Chlordane (Gamma)	P	0.5	1	CP	0 03 (8)	0 00058	1.2	0 0043						
Chlorpyrifos	P		0 1				0 083	0 041						
DDT	P	0.1	0 1	CP	0 1	0 00059	0.55	0 001					0 001	
DDT Metabolite (DDD)	P	0 1	0 1	CP		0.0008	0 6						0 001	
DDT Metabolite (DDE)	P	0 1	0 1	CP	0 1	0 00059	1,050						0 001	
Demeton	P		1					0 1					0 1	
Diazinon	P													
Dieldrin	P	0 1	0 1	CP	0.002	0 00014	1.3	0 0019					0 003	

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)					
									Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Endosulfan I	P	0 05	0 1	CP		0 93	0 11	0 056					0 003	
Endosulfan II	P	0 1	0 1	CP										
Endosulfan Sulfate	P	0 1	0 1	CP		0 93								
Endrin	P	0 1	0 1	CP	0.2		0 09	0 0023					0 004	
Endrin Aldehyde	P		0 1		0.2	0.2								
Endrin Ketone	P	0 1		CP										
Guthion	P		1.5					0 01					0 01	
Heptachlor	P	0 05	0 05	CP	0 008	0 00021	0.26	0 0038					0 001	0.2
Heptachlor Epoxide	P	0 05	0 05	CP	0 09	0 0001	0.26	0 0038						
Hexachlorocyclohexane, Alpha	P	0 05	0 05	CP	0 006		0 0039							
Hexachlorocyclohexane, Beta	P	0 05	0 05	CP		0 014								
Hexachlorocyclohexane, BHC	P	0 05	0 05				100							
Hexachlorocyclohexane, Delta	P	0 05		CP										
Hexachlorocyclohexane, Tech.	P		0.2	f		0 012								
Hexachlorocyclohexane, Lindane	P	0 05	0 05	CP	0.2	0 019	1 0	0 08					0 01	4 0
Malathion	P		0.2					0 1					0 1	
Methoxychlor	P	0.5	0.5	CP	40			0 03					0 03	100
Mirex	P		0 1					0 001					0 001	
Parathion	P												0 04	
PCBs	P	0.5	1	CP	0 005	0 000044	2.0	0 014					0 001	
Simazine	P			e										
Toxaphene	P	1	5	CP	0 03	0 00073	0 73	0 0002					0 005	5 0
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										
Americium (pCi/l)	R													
Americium 241 (pCi/l)	R	0 01												
Cesium 134 (pCi/l)	R	1			80 (10)									
Cesium 137 (pCi/l)	R	1												
Gross Alpha (pCi/l)	R	2												
Gross Beta (pCi/l)	R	4												

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Plutonium (pCi/l)	R													
Plutonium 238+239+240 (pCi/l)	R	0 01			15 (10)									
Radium 226+228 (pCi/l)	R	0.5/1 (9)			5 (10)									
Strontium 89+90 (pCi/l)	R	1												
Strontium 90 (pCi/l)	R				8 (10)									
Thorium 230+232 (pCi/l)	R				60 (10)									
Tritium (pCi/l)	R				20,000 (10)									
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				
1,2,4,5-Tetrachlorobenzene	SV		10	b	2 (8)									
1,2,4-Trichlorobenzene	SV	10		C										
1,2-Dichlorobenzene (Ortho)	SV	10	1	C	620	620								
1,2-Diphenylhydrazine	SV			b	0 05	0 04	270							
1,3-Dichlorobenzene (Meta)	SV	10	1	C	620	400								
1,4-Dichlorobenzene (Para)	SV	10	1	C	75	75								
2,4,5-Trichlorophenol	SV	50		C										
2,4,6-Trichlorophenol	SV	10	50	C	2	2		970						
2,4-Dichlorophenol	SV	10	50	C	21	21	2,020	365						
2,4-Dimethylphenol	SV	10	50	C			2,120							
2,4-Dinitrophenol	SV	50	50	C	14	14								
2,4-Dinitrotoluene	SV	10	10	C		0 11								
2,6-Dinitrotoluene	SV	10	10	C			330	230						
2-Chloronaphthalene	SV	10		C										
2-Chlorophenol	SV	10	50	C			4,380	2,000						
2-Methylnaphthalene	SV	10		C										
2-Methylphenol	SV	10		C										
2-Nitroaniline	SV	50		C										
2-Nitrophenol	SV	10		C										
3,3-Dichlorobenzidine	SV	20	10	C		0 039								
3-Nitroaniline	SV	50		C										
4,6-Dinitro-2-methylphenol	SV	50	50	C		13								
4-Bromophenyl Phenylether	SV	10		C										
4-Chloroaniline	SV	10		C										
4-Chlorophenyl Phenyl Ether	SV	10		C										
4-Chloro-3-methylphenol	SV	10	50	C			30							

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
4-Methylphenol	SV	10		Ω										
4-Nitroaniline	SV	50		Ω										
4-Nitrophenol	SV	50		Ω										
Acenaphthene	SV	10	10	Ω			1,700	520						
Anthracene	SV	10	1	Ω		0 0028								
Benzidine	SV		10	Ω	0 0002	0 00012(8)	2,500						0 1	0 01
Benzoic Acid	SV	50		Ω										
Benzo(a)anthracene	SV	10	10	Ω		0 0028								
Benzo(a)pyrene	SV	10	10	Ω		0 0028								
Benzo(b)fluoranthene	SV	10	10	Ω		0.0028								
Benzo(g,h,i)perylene	SV	10	10	Ω		0 0028								
Benzo(k)fluoranthene	SV	10	10	Ω		0 0028								
Benzyl Alcohol	SV	10		Ω										
bis(2-Chloroethoxy)methane	SV	10		Ω										
bis(2-Chloroethyl)ether	SV	10	10	Ω	0 03 (8)	0 03 (8)								
bis(2-Chloroisopropyl)ether	SV	10	10	Ω		1,400								
bis(2-Ethylhexyl)phthalate	SV	10	10	Ω		1.8 (8)								
Butadiene	SV													
Butyl Benzylphthalate	SV	10	10	Ω		3,000								
Chlorinated Ethers	SV													
Chlorinated Napthalenes	SV													
Chloroalkylethers	SV	10		Ω										
Chlorophenol	SV		50										1 0	1 0
Chrysene	SV	10	10	Ω		0 0028								
Dibenzofuran	SV	10		Ω										
Dibenz(a,h)anthracene	SV	10	10	Ω		0 0028								
Dichlorobenzenes	SV		1											
Dichlorobenzidine	SV	20	10	Ω		0 039								
Diethylphthalate	SV	10	10	Ω		23,000								
Dimethylphthalate	SV	10	10	Ω		313,000								
Di-n-butylphthalate	SV	10	10	Ω		2,700								
Di-n-octylphthalate	SV	10		Ω										
Ethylene Glycol	SV			Ω										
Fluoranthene	SV	10	10	Ω		42	3,980							
Fluorene	SV	10	10	Ω		0.0028								
Formaldehyde	SV													
Haloethers	SV													

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Hexachlorobenzene	SV	1	1	CS	6	0 00072								
Hexachlorobutadiene	SV	1	1	CS	1	0 45	90	9.3						
Hexachlorocyclopentadiene	SV	1	1	CS		24	7	5						
Hexachloroethane	SV	1	1	CS		1 9	980	540						
Hydrazine	SV													
Indeno(1,2,3-cd)pyrene	SV	1	1	CS		0 0028								
Isophorone	SV	1	1	CS	1,050	8.4	117,000							
Naphthalene	SV	1	1	CS		0 002	2,300	620						
Nitrobenzene	SV	1	1	CS	3.5	3.5	27,000							
Nitrophenols	SV													
Nitrosamines	SV													
Nitrosodibutylamine	SV		1	t		0 0064								
Nitrosodiethylamine	SV		1	t		0 0008								
Nitrosodimethylamine	SV		1	t		0 00069								
Nitrosopyrrolidine	SV		1	t		0 016								
N-Nitrosodiphenylamine	SV	1	1	CSt		4 9								
N-Nitroso-di-n-dipropylamine	SV	1	1	CSt		0 005								
Pentachlorinated Ethanes	SV			t										
Pentachlorobenzene	SV		1		6 (8)									
Pentachlorophenol	SV	5	5	CS	200		9	5 7						
Phenanthrene	SV	1	1	CS		0 0028								
Phenol	SV	1	5	CS		21,00	10,200	2,560					500	1 0
Phthalate Esters	SV			s										
Polynuclear Aromatic Hydrocarbons	SV		1	t		0 0028								
Vinyl Chloride	SV	1	2	CV	2	2								
1,1,1-Trichloroethane	V	5	1	CV	200	200								
1,1,2,2-Tetrachloroethane	V	5	1	CV		0 17		2,400						
1,1,2-Trichloroethane	V	5	1	CV	3	0 6	9,400							
1,1-Dichloroethane	V	5		CV										
1,1-Dichloroethene	V	5	1	CV	7	0 057								
1,2-Dichloroethane	V	5	1	CV	0 4	0 4	118,000	20,000						
1,2-Dichloroethene (cis)	V		1		70									
1,2-Dichloroethene (total)	V	5		CV										
1,2-Dichloroethene (trans)	V	5	1		100									
1,2-Dichloropropane	V	5	1	CV	0.56 (8)	0.56	23,000	5,700						
1,3-Dichloropropene (cis)	V	5	1	CV		10	6,060	244						
1,3-Dichloropropene (trans)	V	5	1	CV		10	6,060	244						

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
2-Butanone	V	10		CV										
2-Hexanone	V	10		CV										
4-Methyl-2-pentanone	V	10		CV										
Acetone	V	10		CV										
Acrylonitrile	V		5	c		0.58	7,550	2,600						
Benzene	V	5	1	CV	1	1	5,300							
Bromodichloromethane	V	5	1	CV	0.3	0.3								
Bromoform	V	5	1	CV	4	4								
Bromomethane	V	10	1	CV		48								
Carbon Disulfide	V	5		CV										
Carbon Tetrachloride	V	5	1	CV	0.3	0.25	35,200							
Chlorinated Benzenes	V	10		CV/CS										
Chlorobenzene	V	5	1	CV/CVS	100	100								
Chloroethane	V	10		CV										
Chloroform	V	5	1	CV	6	6	28,900	1,240						
Chloromethane	V	10	1	CV		5 7								
Dibromochloromethane	V	5	1	CV	14	6								
Dichloroethenes	V		1											
Ethyl Benzene	V	5	1	CV	680	3,100	32,000							
Ethylene Dibromide	V			d										
Ethylene Oxide	V													
Halomethanes	V				100									
Methylene Chloride	V	5	1	CV		4 7								
Pyrene	V	10	10	CS		0 0028								
Styrene	V	5		CV										
Tetrachloroethanes	V	5	1	CV										
Tetrachloroethene	V	5	1	CV	5	0.8	5,280	840						
Toluene	V	5	1	CV	1,000	1,000	17,500							
Trichloroethanes	V	5	1	CV										
Trichloroethene	V	5	1	CV	5	2.7	45,000	21,900						
Vinyl Acetate	V	10		CV										
Xylenes (Total)	V	5		CV										

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply

EXPLANATION OF TABLE

CLP
CDH
dis
EPA
pCi/l
PCB
POL
SS
TAL
THM
TIC
TVS
MDL
ug/l
VOA
CWQCC

(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 interpretedas 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) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30-day standards, all others are 1-day standards
(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) See Section 3.8.5 (2)(a) in (b)
(8) Where standard is below (more stringent than) PQL (CDH), PQL is standard.
(9) MDL for Radium 226 is 0.5, MDL for Radium 228 is 1.0
(10) See section 3.1 11 (f) (2) in (a)

(a) CDH/CWQCC, Colorado Water Quality Standards 3 1 0 (5 CCR 1002-8) 1/15/1974, amended 10/17/1991 (ARAR). (Envrionmental Reporter 726:1001-1020:6/1990)
(b) CDH/CWQCC, 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 - Basin-wide standards are ARAR.

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Bicarbonate	A	10,000		E310 1										
Carbonate	A	10,000		E310 1										
Chloride	A	5,000		E325								250,000		
Chlorine	A	1,000		E4500					19	11				
Fluoride	A	5,000		E340								2,000		
N as Nitrate	A	5,000		E353.1							100,000	10,000		
N as Nitrate+Nitrite	A	5,000		E353.1							100,000	10,000		
N as Nitrite	A	5,000		E354 1					SS	SS	10,000	1,000		
Sulfate	A	5,000		E375 4								250,000		
Sulfide	A									2		50		
Coliform (Fecal)	B	1		SM9221C								2000/100 ml		
Ammonia as N	C	5,000		E350					620	60		500		
Dioxin	D			d	0 00000022	0 000000013	0 01	0 00001						
Sulfur	E	100,000		E600										
Dissolved Oxygen	FP	500		SM4500					5,000	5,000	3,000	3,000		
pH	FP	0 1		E150 1					6.5-9 0	6.5-9 0		5 0-9 0		
Specific Conductance	FP	1		E120 1										
Temperature	FP								30 degrees	30 degrees				
Boron	I	5,000		E6010							750			
Total Dissolved Solids	I	10,000		E160 1										
Aluminum	M	200		CT					750	87				
Antimony	M	60		CT								14		
Arsenic	M	10		CT					360	150	100	50		
Arsenic III	M													
Arsenic V	M													
Barium	M	200		CT								1,000		
Beryllium	M	5		CT							100	0 0076		
Cadmium	M	5		CT					TVS	TVS	10	10		
Calcium	M	5,000		CT										
Cesium	M	1,000		NC										
Chromium	M	10		CT										
Chromium III	M	5		SW8467196					TVS	TVS	100	50		
Chromium VI	M	10		E218.5					16	11	100	50		
Cobalt	M	50		CT										
Copper	M	25		CT					TVS	TVS	200	1,000		
Cyanide	M	10		CT					5	5	200	200		
Iron	M	100		CT						1,000		300 (dis)		

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

						Statewide Standards (a)							Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
		PQL MDL					Acute Value	Chronic Value	Aquatic Life Acute Value (2)	Aquatic Life Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Parameter	Type (5)	RFP	CDH	Method (6)	Water Supply	Water and Fish								
Lead	M	5		CT					TVS	TVS	100	50		
Lithium	M	100		NC										
Magnesium	M	5000		CT										
Manganese	M	15		CT						1,000	200	50 (dis)		
Mercury	M	0.2		CT					2.4	0 1		2 0		
Molybdenum	M	200		NC										
Nickel	M	40		CT					TVS	TVS	200			
Potassium	M	5000		CT										
Selenium	M	5		CT					135	17	20	10		
Silver	M	10		CT					TVS	TVS		50		
Sodium	M	5000		CT										
Strontium	M	200		NC										
Thallium	M	10		CT						15		0 012		
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		
2,4,5-TP Silvex	P		0.5	d	50									
2,4-D	P		1	d	70									100
Acrolein			10			320	68	21						
Aldicarb	P		10		10									
Aldrin	P	0.05	0 1	CP	0 002 (8)	0 00013	1.5						0 003	
Bromacil	P													
Carbofuran	P			d	36									
Chloranil	P			E619										
Chlordane (Alpha)	P	0.5	1	CP	0 03 (8)		1.2	0 0043						
Chlordane (Gamma)	P	0.5	1	CP	0 03 (8)	0 00058	1.2	0 0043						
Chlorpyrifos	P		0 1				0 083	0 041						
DDT	P	0 1	0 1	CP	0 1	0 00059	0.55	0 001					0 001	
DDT Metabolite (DDD)	P	0 1	0 1	CP		0 0008	0 6						0 001	
DDT Metabolite (DDE)	P	0 1	0 1	CP	0.1	0 00059	1,050						0 001	
Demeton	P		1					0 1					0 1	
Diazinon	P													
Dieldrin	P	0 1	0 1	CP	0 002	0 00014	1.3	0 0019					0 003	
Endosulfan I	P	0.05	0 1	CP		0 93	0 11	0 056					0 003	
Endosulfan II	P	0 1	0 1	CP										

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
		PQL MDL							Aquatic Life					
Parameter	Type (5)	RFP	CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Endosulfan Sulfate	P	0 1	0 1	CP		0 93								
Endrin	P	0 1	0 1	CP	0.2		0 09	0 0023					0 004	
Endrin Aldehyde	P		0 1		0.2	0.2								
Endrin Ketone	P	0 1		CP										
Guthion	P		1.5					0 01					0 01	
Heptachlor	P	0 05	0 05	CP	0 008	0 00021	0.26	0 0038					0 001	0.2
Heptachlor Epoxide	P	0 05	0 05	CP	0 09	0 0001	0.26	0 0038						
Hexachlorocyclohexane, Alpha	P	0 05	0 05	CP	0 006		0 0039							
Hexachlorocyclohexane, Beta	P	0 05	0 05	CP		0 014								
Hexachlorocyclohexane, BHC	P	0 05	0 05				100							
Hexachlorocyclohexane, Delta	P	0 05		CP										
Hexachlorocyclohexane, Tech.	P		0.2	f		0 012								
Hexachlorocyclohexane, Lindane	P	0 05	0 05	CP	0.2	0 019	1 0	0 08					0 01	4 0
Malathion	P		0.2					0 1					0 1	
Methoxychlor	P	0.5	0.5	CP	40			0 03					0 03	100
Mirex	P		0 1					0 001					0 001	
Parathion	P												0 04	
PCBs	P	0.5	1	CP	0 005	0 000044	2.0	0 014					0 001	
Simazine	P			e										
Toxaphene	P	1	5	CP	0 03	0 00073	0 73	0 0002					0 005	5 0
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										
Americium (pCi/l)	R													
Americium 241 (pCi/l)	R	0 01												
Cesium 134 (pCi/l)	R	1			80 (10)									
Cesium 137 (pCi/l)	R	1												
Gross Alpha (pCi/l)	R	2												
Gross Beta (pCi/l)	R	4												
Plutonium (pCi/l)	R													
Plutonium 238+239+240 (pCi/l)	R	0 01			15 (10)									

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Radium 226+228 (pCi/l)	R	0.5/1 (9)			5 (10)									
Strontium 89+90 (pCi/l)	R	1												
Strontium 90 (pCi/l)	R				8 (10)									
Thorium 230+232 (pCi/l)	R				60 (10)									
Tritium (pCi/l)	R				20,000 (10)									
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				
1,2,4,5-Tetrachlorobenzene	SV		10	b	2 (8)									
1,2,4-Trichlorobenzene	SV	10		CS										
1,2-Dichlorobenzene (Ortho)	SV	10	1	CS	620	620								
1,2-Diphenylhydrazine	SV			b	0 05	0 04	270							
1,3-Dichlorobenzene (Meta)	SV	10	1	CS	620	400								
1,4-Dichlorobenzene (Para)	SV	10	1	CS	75	75								
2,4,5-Trichlorophenol	SV	50		CS										
2,4,6-Trichlorophenol	SV	10	50	CS	2	2		970						
2,4-Dichlorophenol	SV	10	50	CS	21	21	2,020	365						
2,4-Dimethylphenol	SV	10	50	CS			2,120							
2,4-Dinitrophenol	SV	50	50	CS	14	14								
2,4-Dinitrotoluene	SV	10	10	CS		0.11								
2,6-Dinitrotoluene	SV	10	10	CS			330	230						
2-Chloronaphthalene	SV	10		CS										
2-Chlorophenol	SV	10	50	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	10	CS		0 039								
3-Nitroaniline	SV	50		CS										
4,6-Dinitro-2-methylphenol	SV	50	50	CS		13								
4-Bromophenyl Phenylether	SV	10		CS										
4-Chloroaniline	SV	10		CS										
4-Chlorophenyl Phenyl Ether	SV	10		CS										
4-Chloro-3-methylphenol	SV	10	50	CS			30							
4-Methylphenol	SV	10		CS										
4-Nitroaniline	SV	50		CS										

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (6)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
		PQL MDL							Aquatic Life					
Parameter	Type (5)	RFP	CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
4-Nitrophenol	SV	50		Ω										
Acenaphthene	SV	10	10	Ω			1,700	520						
Anthracene	SV	10	1	Ω		0 0028								
Benzidine	SV		10	Ω	0 0002	0 00012(8)	2,500						0 1	0 01
Benzoic Acid	SV	50		Ω										
Benzo(a)anthracene	SV	10	10	Ω		0 0028								
Benzo(a)pyrene	SV	10	10	Ω		0 0028								
Benzo(b)fluoranthene	SV	10	10	Ω		0 0028								
Benzo(g,h,i)perylene	SV	10	10	Ω		0 0028								
Benzo(k)fluoranthene	SV	10	10	Ω		0 0028								
Benzyl Alcohol	SV	10		Ω										
bis(2-Chloroethoxy)methane	SV	10		Ω										
bis(2-Chloroethyl)ether	SV	10	10	Ω	0 03 (8)	0 03 (8)								
bis(2-Chloroisopropyl)ether	SV	10	10	Ω		1,400								
bis(2-Ethylhexyl)phthalate	SV	10	10	Ω		1.8 (8)								
Butadiene	SV													
Butyl Benzylphthalate	SV	10	10	Ω		3,000								
Chlorinated Ethers	SV													
Chlorinated Napthalenes	SV													
Chloroalkylethers	SV	10		Ω										
Chlorophenol	SV		50										1 0	1 0
Chrysene	SV	10	10	Ω		0 0028								
Dibenzofuran	SV	10		Ω										
Dibenz(a,h)anthracene	SV	10	10	Ω		0 0028								
Dichlorobenzenes	SV		1											
Dichlorobenzidine	SV	20	10	Ω		0 039								
Diethylphthalate	SV	10	10	Ω		23,000								
Dimethylphthalate	SV	10	10	Ω		313,000								
Di-n-butylphthalate	SV	10	10	Ω		2,700								
Di-n-octylphthalate	SV	10		Ω										
Ethylene Glycol	SV													
Fluoranthene	SV	10	10	Ω		42	3,980							
Fluorene	SV	10	10	Ω		0 0028								
Formaldehyde	SV													
Haloethers	SV													
Hexachlorobenzene	SV	10	10	Ω	6	0 00072								
Hexachlorobutadiene	SV	10	10	Ω	1	0 45	90	9.3						

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

						Statewide Standards (a)							Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Hexachlorocyclopentadiene	SV	10	10	CS		240	7	5						
Hexachloroethane	SV	10	10	CS		1 9	980	540						
Hydrazine	SV													
Indeno(1,2,3-cd)pyrene	SV	10	10	CS		0 0028								
Isophorone	SV	10	10	CS	1,050	8 4	117,000							
Naphthalene	SV	10	10	CS		0 0028	2,300	620						
Nitrobenzene	SV	10	10	CS	3.5	3.5	27,000							
Nitrophenols	SV													
Nitrosamines	SV													
Nitrosodibutylamine	SV		10	t		0 0064								
Nitrosodiethylamine	SV		10	t		0 0008								
Nitrosodimethylamine	SV		10	t		0 00069								
Nitrosopyrrolidine	SV		10	t		0 016								
N-Nitrosodiphenylamine	SV	10	10	CSt		4 9								
N-Nitroso-di-n-dipropylamine	SV	10	10	CSt		0 005								
Pentachlorinated Ethanes	SV			t										
Pentachlorobenzene	SV		10	t	6 (8)									
Pentachlorophenol	SV	50	50	CS	200		9	5 7						
Phenanthrene	SV	10	10	CS		0 0028								
Phenol	SV	10	50	CS		21,000	10,200	2,560					500	1 0
Phthalate Esters	SV			e										
Polynuclear Aromatic Hydrocarbo	SV		10	t		0 0028								
Vinyl Chloride	SV	10	2	CV	2	2								
1,1,1-Trichloroethane	V	5	1	CV	200	200								
1,1,2,2-Tetrachloroethane	V	5	1	CV		0 17		2,400						
1,1,2-Trichloroethane	V	5	1	CV	3	0 6	9,400							
1,1-Dichloroethane	V	5		CV										
1,1-Dichloroethene	V	5	1	CV	7	0 057								
1,2-Dichloroethane	V	5	1	CV	0 4	0 4	118,000	20,000						
1,2-Dichloroethene (cis)	V		1	a	70									
1,2-Dichloroethene (total)	V	5		CV										
1,2-Dichloroethene (trans)	V	5	1	a	100									
1,2-Dichloropropane	V	5	1	CV	0.56 (8)	0.56	23,000	5,700						
1,3-Dichloropropene (cis)	V	5	1	CV		10	6,060	244						
1,3-Dichloropropene (trans)	V	5	1	CV		10	6,060	244						
2-Butanone	V	10		CV										
2-Hexanone	V	10		CV										

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)							Basin Standards (b)	
				Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
		PQL MDL				Acute Value	Chronic Value	Aquatic Life Acute Value (2)	Aquatic Life Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Parameter	Type (5)	RFP	CDH	Method (6)	Water Supply	Water and Fish							
4-Methyl-2-pentanone	V	10		CV									
Acetone	V	10		CV									
Acrylonitrile	V		5	c		0.58	7,550	2,600					
Benzene	V	5	1	CV	1	1	5,300						
Bromodichloromethane	V	5	1	CV	0.3	0.3							
Bromoform	V	5	1	CV	4	4							
Bromomethane	V	10	1	CV		48							
Carbon Disulfide	V	5		CV									
Carbon Tetrachloride	V	5	1	CV	0.3	0.25	35,200						
Chlorinated Benzenes	V	10		CV/CS									
Chlorobenzene	V	5	1	CV/CVS	100	100							
Chloroethane	V	10		CV									
Chloroform	V	5	1	CV	6	6	28,900	1,240					
Chloromethane	V	10	1	CV		5 7							
Dibromochloromethane	V	5	1	CV	14	6							
Dichloroethenes	V		1										
Ethyl Benzene	V	5	1	CV	680	3,100	32,000						
Ethylene Dibromide	V			d									
Ethylene Oxide	V												
Halomethanes	V				100								
Methylene Chloride	V	5	1	CV		4 7							
Pyrene	V	10	10	CS		0 0028							
Styrene	V	5		CV									
Tetrachloroethanes	V	5	1	CV									
Tetrachloroethene	V	5	1	CV	5	0.8	5,280	840					
Toluene	V	5	1	CV	1,000	1,000	17,500						
Trichloroethanes	V	5	1	CV									
Trichloroethene	V	5	1	CV	5	2 7	45,000	21,900					
Vinyl Acetate	V	10		CV									
Xylenes (Total)	V	5		CV									

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)							Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life			Organics (7)	
Parameter	Type (5)	PQL MDL RFT	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply

EXPLANATION OF TABLE

CLP
CDH
dis
EPA
pCi/l
PCB

SS
TAL
THM
TIC
TVS
MDL
ug/l
VOA
CWQCC

(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 interpretedas 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) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30-day standards, all others are 1-day standards
(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) See Section 3.8.5 (2)(a) in (b)
(8) Where standard is below (more stringent than) PQL(CDH), PQL is standard.
(9) MDL for Radium 226 is 0.5, MDL for Radium 228 is 1 0
(10) See section 3.1 11 (f) (2) in (a)

(a) CDH/CWQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974, amended 10/17/1991 (ARA(Envrionmental Reporter 726:1001-1020:6/1990)
(b) CDH/CWQCC, 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 - Basin-wide standards are ARAR.

TABLE 3-5. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A, B (1)	Table C	Table D Radionuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
Bicarbonate	A	10,000		E310 1							
Carbonate	A	10,000		E310 1							
Chloride	A	5,000		E325				250,000	250,000		
Chlorine	A	1,000		E4500				3	3		
Fluoride	A	5,000		E340							
N as Nitrate	A	5,000		E353 1				10,000	10,000		
N as Nitrate+Nitrite	A	5,000		E353.1							
N as Nitrite	A	5,000		E354 1				1,000	1,000		
Sulfate	A	5,000		E375 4				250,000	250,000		
Sulfide	A										
Coliform (Fecal)	B	1		SM9221C							
Ammonia as N	C	5,000		E350				620	60		
Dioxin	D			d	0 00000022	0 000000013			0 000000013		
Sulfur	E	100,000		E600				2 0	2 0		
Dissolved Oxygen	FP	500		SM4500				5,000	5,000		
pH	FP	0 1		E150 1				6.5-9	6 5-9		
Specific Conductance	FP	1		E120 1							
Temperature	FP										
Boron	I	5,000		E6010				750	750		
Total Dissolved Solids	I	10,000		E160 1							
Aluminum	M	200		CT							
Antimony	M	60		CT							
Arsenic	M	10		CT				50			
Arsenic III	M										
Arsenic V	M										
Barium	M	200		CT							
Beryllium	M	5		CT							
Cadmium	M	5		CT				TVS	TVS		
Calcium	M	5,000		CT							
Cesium	M	1,000		NC							
Chromium	M	10		CT							
Chromium III	M	5		SW8467196				50			
Chromium VI	M	10		E218.5				TVS	TVS		
Cobalt	M	50		CT							
Copper	M	25		CT				TVS	TVS		
Cyanide	M	10		CT				5	5		

TABLE 3-5. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A, B (1)	Table C	Table D Radionuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
Iron	M	100		CT					300 (3)		
Lead	M	5		CT				TVS	TVS		
Lithium	M	100		NC							
Magnesium	M	5000		CT							
Manganese	M	15		CT					50 (3)		
Mercury	M	0.2		CT					0 01		
Molybdenum	M	200		NC							
Nickel	M	40		CT				TVS	TVS		
Potassium	M	5000		CT							
Selenium	M	5		CT				10			
Silver	M	10		CT				TVS	TVS		
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							
Zinc	M	20		CT				TVS	TVS		
2,4,5-TP Silvex	P		0.5	d	10						
2,4-D	P		1	d	100						
Acrolein	P		10								
Aldicarb	P		10		10						
Aldrin	P	0 05	0 1	CP	0 002 (6)	0 000074			0 000074		
Bromacil	P										
Carbofuran	P			d	36						
Chloranil	P			E619							
Chlordane (Alpha)	P	0.5	1	CP	0 03 (6)	0 00046			0 00046		
Chlordane (Gamma)	P	0.5	1	CP	0 03 (6)	0 00046			0 00046		
Chlorpyrifos	P		0 1								
DDT	P	0 1	0 1	CP	0 1 (6)	0 000024			0 000024		
DDT Metabolite (DDD)	P	0.1	0 1	CP							
DDT Metabolite (DDE)	P	0 1	0 1	CP							
Demeton	P		1								
Diazinon	P										
Dieldrin	P	0.1	0.1	CP	0 002 (6)	0 000071			0 000071		

TABLE 3-5. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		POL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A, B (1)	Table C	Table D Radionuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
Endosulfan I	P	0 05	0 1	CP							
Endosulfan II	P	0 1	0 1	CP							
Endosulfan Sulfate	P	0 1	0 1	CP							
Endrin	P	0 1	0 1	CP	0.2						
Endrin Aldehyde	P		0 1								
Endrin Ketone	P	0 1		CP							
Guthion	P		1.5								
Heptachlor	P	0 05	0 05	CP	0 008 (6)	0 00028			0 00028		
Heptachlor Epoxide	P	0 05	0 05	CP	0 004 (6)						
Hexachlorocyclohexane, Alpha	P	0 05	0 05	CP		0 0092			0 0092		
Hexachlorocyclohexane, Beta	P	0 05	0 05	CP		0 0163			0 0163		
Hexachlorocyclohexane, BHC	P	0 05	0 05								
Hexachlorocyclohexane, Delta	P	0 05		CP							
Hexachlorocyclohexane, Tech	P		0 2	f		0 0123			0 0123		
Hexachlorocyclohexane, Lindane	P	0 05	0 05	CP	4	0 0186			0 0186		
Malathion	P		0.2								
Methoxychlor	P	0.5	0.5	CP	100						
Mirex	P		0 1								
Parathion	P										
PCBs	P	0.5	1	CP	0 005 (6)	0 000079			0 000079		
Simazine	P			e		4			4		
Toxaphene	P	1	5	CP	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		80			80	80
Cesium 137 (pCi/l)	R	1									
Gross Alpha (pCi/l)	R	2								7	11

TABLE 3-5. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A, B (1)	Table C	Table D Radionuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
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				
Radium 226+228 (pCi/l)	R	0.5/1 0 (7)					5				
Strontium 89+90 (pCi/l)	R	1									
Strontium 90 (pCi/l)	R						8			8	8
Thorium 230+232 (pCi/l)	R						60				
Tritium (pCi/l)	R						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						40			5	10
1,2,4,5-Tetrachlorobenzene	SV		10	b	2 (6)						
1,2,4-Trichlorobenzene	SV	10		CS							
1,2-Dichlorobenzene (Ortho)	SV	10	1	CS	620						
1,2-Diphenylhydrazine	SV			b	0 05 (6)						
1,3-Dichlorobenzene (Meta)	SV	10	1	CS	620						
1,4-Dichlorobenzene (Para)	SV	10	1	CS	75						
2,4,5-Trichlorophenol	SV	50		CS	700						
2,4,6-Trichlorophenol	SV	10	50	CS	2 0 (6)	1.2			1.2		
2,4-Dichlorophenol	SV	10	50	CS	21 (6)						
2,4-Dimethylphenol	SV	10	50	CS							
2,4-Dinitrophenol	SV	50	50	CS							
2,4-Dinitrotoluene	SV	10	10	CS							
2,6-Dinitrotoluene	SV	10	10	CS							
2-Chloronaphthalene	SV	10		CS							
2-Chlorophenol	SV	10	50	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	10	CS		0 01			0 01		
3-Nitroaniline	SV	50		CS							
4,6-Dinitro-2-methylphenol	SV	50	50	CS							
4-Bromophenyl Phenylether	SV	10		CS							
4-Chloroaniline	SV	10		CS							

TABLE 3-5. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A, B (1)	Table C	Table D Radionuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
4-Chlorophenyl Phenyl Ether	SV	10		CS							
4-Chloro-3-methylphenol	SV	10	50	CS							
4-Methylphenol	SV	10		CS							
4-Nitroaniline	SV	50		CS							
4-Nitrophenol	SV	50		CS							
Acenaphthene	SV	10	10	CS							
Anthracene	SV	10	1	CS							
Benzidine	SV		10	d	0 0002 (6)	0 00012			0 00012		
Benzoic Acid	SV	50		CS							
Benzo(a)anthracene	SV	10	10	CS							
Benzo(a)pyrene	SV	10	10	CS							
Benzo(b)fluoranthene	SV	10	10	CS							
Benzo(g,h,i)perylene	SV	10	10	CS							
Benzo(k)fluoranthene	SV	10	10	CS							
Benzyl Alcohol	SV	10		CS							
bis(2-Chloroethoxy)methane	SV	10		CS							
bis(2-Chloroethyl)ether	SV	10	10	CS	0.03 (6)	0 0000037			0 0000037		
bis(2-Chloroisopropyl)ether	SV	10	10	CS							
bis(2-Ethylhexyl)phthalate	SV	10	10	CS							
Butadiene	SV										
Butyl Benzylphthalate	SV	10		CS							
Chlorinated Ethers	SV										
Chlorinated Napthalenes	SV										
Chloroalkylethers	SV	10		CS							
Chlorophenol	SV		50								
Chrysene	SV	10	10	CS							
Dibenzofuran	SV	10		CS							
Dibenz(a,h)anthracene	SV	10	10	CS							
Dichlorobenzenes	SV		1								
Dichlorobenzidine	SV	20	10	CS		0 01			0 01		
Diethylphthalate	SV	10	10	CS							
Dimethylphthalate	SV	10	10	CS							
Di-n-butylphthalate	SV	10	10	CS							
Di-n-octylphthalate	SV	10		CS							
Ethylene Glycol	SV			d							
Fluoranthene	SV	10	10	CS							

TABLE 3-5. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A, B (1)	Table C	Table D Radionuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
Fluorene	SV	10	10	CS							
Formaldehyde	SV										
Haloethers	SV										
Hexachlorobenzene	SV	10	10	CS	0 02 (6)	0 00072			0 00072		
Hexachlorobutadiene	SV	10	10	CS	14	0 45			0 45		
Hexachlorocyclopentadiene	SV	10	10	CS	49						
Hexachloroethane	SV	10	10	CS		1 9			1 9		
Hydrazine	SV										
Indeno(1,2,3-cd)pyrene	SV	10	10	CS							
Isophorone	SV	10	10	CS	1,050						
Naphthalene	SV	10	10	CS							
Nitrobenzene	SV	10	10	CS	3.5 (6)						
Nitrophenols	SV										
Nitrosamines	SV										
Nitrosodibutylamine	SV		10	b		0 0064			0 0064		
Nitrosodiethylamine	SV		10	b		0 0008			0 0008		
Nitrosodimethylamine	SV		10	b		0 0014			0 0014		
Nitrosopyrrolidine	SV		10	b		0 016			0 016		
N-Nitrosodiphenylamine	SV	10	10	CSb		4 9			4 9		
N-Nitroso-di-n-dipropylamine	SV	10	10	CSb							
Pentachlorinated Ethanes	SV			b							
Pentachlorobenzene	SV		10	b	6 (6)						
Pentachlorophenol	SV	50	50	CS	200						
Phenanthrene	SV	10	10	CS							
Phenol	SV	10	50	CS							
Phthalate Esters	SV			e							
Polynuclear Aromatic Hydrocarbons	SV		10	b		0 0028			0 0028		
Vinyl Chloride	SV	10	2	CV	2						
1,1,1-Trichloroethane	V	5	1	CV	200						
1,1,2,2-Tetrachloroethane	V	5	1	CV		0.17			0 17		
1,1,2-Trichloroethane	V	5	1	CV	28	0 60			0 60		
1,1-Dichloroethane	V	5		CV							
1,1-Dichloroethene	V	5	1	CV	7						
1,2-Dichloroethane	V	5	1	CV	5						
1,2-Dichloroethene (cis)	V		1	a	70						
1,2-Dichloroethene (total)	V	5		CV							

TABLE 3-5. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A, B (1)	Table C	Table D Radionuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
1,2-Dichloroethene (trans)	V	5	1	a	70						
1,2-Dichloropropane	V	5	1	CV	0.56 (6)						
1,3-Dichloropropene (cis)	V	5	1	CV							
1,3-Dichloropropene (trans)	V	5	1	CV							
2-Butanone	V	10		CV							
2-Hexanone	V	10		CV							
4-Methyl-2-pentanone	V	10		CV							
Acetone	V	10		CV							
Acrylonitrile	V		5	c		0 058			0 058		
Benzene	V	5	1	CV	5						
Bromodichloromethane	V	5	1	CV							
Bromoform	V	5	1	CV							
Bromomethane	V	10	1	CV							
Carbon Disulfide	V	5		CV							
Carbon Tetrachloride	V	1		CV	5						
Chlorinated Benzenes	V	10		CV/CS							
Chlorobenzene	V	5	1	CV/CVS	300						
Chloroethane	V	10		CV							
Chloroform	V	5	1	CV	Tot THM <100*	0 19			0 19		
Chloromethane	V	10	1	CV							
Dibromochloromethane	V	5	1	CV							
Dichloroethenes	V		1								
Ethyl Benzene	V	5	1	CV	680						
Ethylene Dibromide	V			d							
Ethylene Oxide	V										
Halomethanes	V				100	0 19			0 19		
Methylene Chloride	V	5	1	CV							
Pyrene	V	10	10	CS							
Styrene	V	5		CV							
Tetrachloroethanes	V	5	1	CV		0.8			0.8		
Tetrachloroethene	V	5	1	CV	10						
Toluene	V	5	1	CV	2,420						
Trichloroethanes	V	5	1	CV							

TABLE 3-5. POTENTIAL CHEMICAL-SPECIFIC "BENCHMARKS" (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A, B (1)	Table C	Table D Radionuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
Trichloroethene	V	5	1	CV	5						
Vinyl Acetate	V	10		CV							
Xylenes (Total)	V	5		CV							

EXPLANATION OF TABLE

•
CLP
CDH
dis
EPA
pCi/l
PCB
PQL
RFP
SS
TAL
THM
TIC
TVS
MDL
ug/l
VOA
CWQCC

(1) In the absence of specific, numeric standards for non–naturally occurring organics, the narrative standard is interpretedas zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/CWQCC or EPA
(2) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30–day standards, all others are 1–day standards
(3) Lowest value given dissolved or total recoverable
(4) Segment 5 standards are goals
(5) Includes Table 1 Additional Organic Chemical Standards (chronic only)
(6) Standard is below (more stringent than) PQL, therefore PQL is standard.
(7) MDL for Radium 226 is 0.5; MDL for Radium 228 is 1 0

(a) CDH/CWQCC, 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/CWQCC, 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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4.0 DATA REQUIREMENTS AND DATA QUALITY OBJECTIVES

Under the terms of the IAG, data must be provided that satisfy CERCLA and RCRA requirements; these data are necessary to characterize the nature and extent of contamination, support the risk assessment, support the evaluation of corrective/remedial action, and assist in the development and evaluation of remedial alternatives. Data requirements for this work plan are presented below and are derived from guidance documents previously cited

The objectives of the RFI/RI are to characterize the nature, distribution, and migration pathways of contaminants for each OU14 IHSS in support of the baseline risk assessment (BRA), as well as to support the evaluation of remedial alternatives

DQOs have been specified for each data collection activity, and the work will be conducted and documented in a manner that ensures that the data collected are sufficient and of adequate quality for their intended uses (EPA 1987). DQOs are qualitative and quantitative descriptions of the data required to support decisions made during remedial response activities The DQOs are developed prior to data collection activities and are incorporated into the process, resulting in a well-planned FSP that details the chosen sampling and analysis options and provides confidence in the decisions made during the remedial process DQOs were established for the OU14 RFI/RI in accordance with Appendix A of the *Rocky Flats Plant Site-Wide Quality Assurance Project Plan* (EG&G 1991e) DQOs are developed using a three-stage process· Stage 1 identifies decision types,

Stage 2 identifies data uses/needs, and Stage 3 is the design of a data collection program This section explains the DQO process specific to the RFI/RI for OU14

4.1 Stage 1 - Identify Decision Types

The major elements of Stage 1 include identifying and involving data users, evaluating available data, developing a site conceptual model, and specifying objectives and decision types that will be made during the RFI/RI process Available data must be obtained and evaluated during this stage to aid in the development of DQOs and to develop a site conceptual model (EPA 1987) The site conceptual model presented in Section 2.5 identifies the sources, release mechanisms, transport pathways, exposure routes, and receptors The following sections address each of the Stage 1 elements

4.1.1 Identify and Involve Data Users

Data users are divided into three general groups: decision makers, program management staff, and technical personnel. The principal decision makers for OU14 are federal officials responsible for RFP operations and the federal and state regulatory officials responsible for environmental protection These include the DOE Office of Environmental Restoration and Waste Management, DOE Rocky Flats Office, EPA Region VIII, and CDH. The program management staff are the prime EG&G contractor personnel responsible for ER Program activities, which includes the EG&G RFP EMD Technical personnel include EG&G technical specialists and subcontractors responsible for supervising, coordinating, and performing ER Program activities. The primary technical personnel data users will be risk assessment scientists, statisticians, and feasibility studies engineers.

The data users are brought into the RFI/RI process during planning stages to help define data quality requirements The work plan is reviewed by the data users and their comments are incorporated in the work plan structure

4.1.2 Evaluate Available Data

The historical conditions of OU14 are described in Section 2.2, and previous investigations are described in Section 2.3. Existing soil boring, groundwater, and surface water analytical data from locations in or adjacent to OU14, available from previous characterization and routine environmental monitoring activities, are presented in Volume II of this work plan These data are discussed in Section 2 3.3 Most of the quantitative data compiled to date have been validated in accordance with the guidelines specified in the QAPjP (EG&G 1991e) All data used in the development of this work plan are considered adequate for this end Personnel interviews may provide additional direction while implementing the Stage 1 investigation

4.1.3 Develop Site Conceptual Model

An integral part of the DQO process is the development of a site conceptual model to identify contaminant pathways to support data collection needs. A site conceptual model for OU14 has been developed based on the site physical characteristics and available data (Figure 2-30). The model includes descriptions of historical and current sources, release mechanisms, contaminant migration pathways, exposure routes, and receptors This preliminary model will be refined as IHSS-specific contaminant and physical data is collected

The historical release mechanisms of contaminants from surface spills, ponds, and process lines are wind erosion/volatile emissions, storm water runoff, and infiltration/ percolation of water through the vadose zone to groundwater Current release mechanisms include deposition and seepage Exposure (human and biota) to contaminants can occur through multiple pathways including ingestion, inhalation, and dermal contact, however, the actual pathways of significance and potential receptor populations for each exposure pathway will be determined during the risk assessment

4.1.4 Specify RFI/RI Objectives and Decisions

As stated in the IAG, the primary objectives of the RFI/RI are to characterize the nature and extent of contamination for each OU14 IHSS, to provide information necessary to determine the risk associated with the source of contamination at each OU14 IHSS, and to provide information to evaluate potential remedial action alternatives From the information generated by the RFI/RI, decisions can be made as to whether remediation is necessary and which remedial alternatives would be appropriate A summary of the specific DQOs and supporting data needs is presented in Table 4-1 In accordance with the IAG, the specific objectives of the RFI/RI field investigation for OU14 are described below

Characterize the Nature and Extent of Contamination. The intent of the RFI/RI FSP is to determine the physical characteristics of all media and determine the nature and the horizontal and vertical extent of existing contamination at OU14 IHSSs Achieving these objectives will require the following

- Further delineation of the areal extent and location of the IHSSs
- Definition of the horizontal nature and extent of surficial soil contamination
- Definition of the vertical nature and extent of contamination in the soil column beneath each IHSS
- Assessment of the potential for contamination from each IHSS to impact surface water and sediments
- Assessment of the potential for contaminated soil to impact the groundwater
- Determine if groundwater beneath IHSSs has been affected by contamination in the overlying soils
- Determine the nature and extent of groundwater contamination
- Assessment of the groundwater migration potential beyond the IHSS and OU14 boundaries

The specific data needs which support the characterization of the nature and extent of contamination are provided in Table 4-1. An analytical level for all of the objectives is required that yields data of sufficient quality for the BRA subsequent analysis, and determination of remedial alternatives Objectives will be met by adherence to the General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G 1991d) for sample analysis and RFP EMD Operating Procedures (OP) (EG&G 1991f) for sample collection

Other data needs required to characterize OU14 include the following·

- Determination of the location of subsurface utilities and structures
- Characterization of hydrogeologic conditions

- Assessment of the potential for preferential contaminant migration pathways at each IHSS

The data needs, type of data required, sampling/analysis activities, analytical levels, and data uses are presented in Table 4-1

Determine Risks Associated with Contamination To meet the objectives of the BRA, specific data need to be obtained to accomplish the five tasks of the risk assessment (contaminant identification, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis)

These tasks will rely on data collected under a sampling plan that is sufficient to determine the contaminants present and the concentrations at which they occur Analytical data for different environmental media must be sufficient to characterize the lateral and vertical extent of contamination and be representative of sampled areas. Background or control data must also be collected at uncontaminated areas to establish baseline conditions to determine the degree to which contamination may affect receptors.

Reaching the objectives requires an inventory of contaminants detected, associated concentrations, and the lateral and vertical distribution of contaminants. In addition, data pertaining to physical characteristics of topography, soil, aquifers, and weather patterns need to be collected both to determine potential migration pathways and to conduct computer modeling studies. Characteristics and locations of possible human populations and biological populations must also be determined

Recent toxicity information on all identified contaminants must also be collected to evaluate and determine potential risks to the identified receptors

Support Selection of Remedial Action Alternatives· Data requirements for the evaluation of remedial action alternatives include an identification of the nature and extent of contamination at sites of concern In addition, the volumes and areas of contaminated media must be determined This work plan addresses the sampling required to characterize contaminated media at OU14 and to support the selection of remedial alternatives These remedial alternatives may include removal and treatment, in situ treatment, containment, and no action

4.2 Stage 2 - Identify Data Uses, Types, and Needs

Stage 2 has the following six major steps·

- Identify data uses
- Identify data types
- Identify data quality needs
- Identify data quantity needs
- Evaluate sampling and analysis options and
- Review precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters

Stage 2 also includes the selection of the sampling approach and the analytical options for the task including the economic and technical feasibility of the chosen technique The following sections discuss each of the six elements

4.2.1 Identify Data Uses

In order to ensure that the sampling effort will address the objectives outlined in Section 4 1 4, the anticipated uses for the data must be specifically stated Data collected during the RFI/RI will be used to characterize the physical features, the nature and extent of contamination, support the BRA and environmental evaluation (EE), and evaluate remedial alternatives Characterization of each IHSS includes the surface of the site, soils, groundwater, and potentially surface water Samples will be collected to determine the extent and type of contamination present at each IHSS. Data will also be collected to determine the physical characteristics of the media for use in contaminant transport and pathways analyses.

Data collected for the OU14 RFI/RI will be incorporated into the contaminant transport models for the risk assessment Representative data will be utilized in the OU14 IHSSs environmental transport models

4.2.2 Identify Data Types

Following identification of the intended users and use of the data, the specific data types must be identified Data types will consist of data generated from field survey and laboratory analytical results of samples for each RFI/RI objective (Table 4-1). For the most part physical media will be sampled during the RFI/RI The physical media include soils,

soil gas, groundwater, and potentially surface water Additionally, radiation surveys will be performed at all IHSSs The analytical requirements are dictated by the intended use of the data (EPA 1987)

A list of specific analytes and analytical methods for OU14 has been developed and is presented in Section 6 5 The criteria used to develop the list include documentation from the HRR, IAG requirements, and existing analytical data for sampling locations in or adjacent to OU14 As discussed in Section 6 3, there are several potential site contaminants associated with the IHSSs in OU14 The available historical information and evaluation of existing data suggest that, to be conservative, analysis should initially be conducted for several contaminant classes during the FSP

Risk assessment modeling requires additional data types Data necessary for air dispersion modeling generally includes relative wind direction and frequency, atmospheric stability and wind speeds, ambient concentrations of airborne particulates, soil adsorption coefficients, solubility, particle size, and precipitation Most of these parameters will be determined from RFP-wide atmospheric studies (i e., Plan for Prevention of Contaminant Dispersion, RFP Environmental Monitoring Report and others) or from literature values.

4.2.3 Identify Data Quality Needs

Analytical methods and support levels must be evaluated during the DQO process. The parameters for which an analytical method is valid, its limitations, and any special considerations which will affect data quality must be understood in order to select appropriate methods Table 4-1 lists the analytical levels appropriate for the intended data uses The

five levels of data quality as presented in EPA's *Data Quality Objectives for Remedial Response Activities Development Process* (EPA 1987) are as follows

Level I - Screening Provides the lowest data quality but the most rapid results, and is used for purposes of site health and safety monitoring, preliminary comparison to ARARs, and initial site characterization to define areas for further study The data generated provides presence/absence of certain constituents and are generally qualitative rather than quantitative

Level II - Field Analysis. Provides less rapid results but better data quality. Analysis includes some mobile laboratory-generated data and data generated by use of field analytical instruments The data may be qualitative or quantitative

Level III - Engineering. Provides an intermediate level of data quality and may be used for site characterization or risk assessment Engineering analysis includes mobile laboratory-generated data and standard commercial laboratory analyses without full Contract Laboratory Program (CLP) documentation These data are both qualitative and quantitative. If analyses are conducted in support of treatability models, it will be performed to Level III

Level IV - Confirmational Provides the highest level of data quality and is used for purposes of risk assessment, engineering design, and cost recovery documentation Confirmation analyses require full CLP analytical and data validation procedures

Level V - Nonstandard Refers to analysis by nonstandard procedures; for example, exacting detection limits or analyses of an unusual chemical compound These

analyses often require method development or adoption The data validation procedures of Level IV can be applied to Level V, if required

Analytical data derived from the proposed sampling and analysis program at OU14 will be used, in part, to evaluate human health and ecological risks posed by contamination, if any Toxicological interpretation requires validation of analytical data; therefore, select soil and groundwater samples will be subjected to Level IV analytical procedures and reporting requirements based on the results of Level III analytical procedures The sampling plan for OU14 has been designed to allow for a tiered approach beginning with soil and soil gas screening using Level III, with validation of these screening results for randomly selected split samples subjected to Level IV analyses, if required Subsequent sample collection and analysis efforts will be directed by the results of the screening activities

4.2.4 Identify Data Quantity Needs

Data quantity needs are based on an evaluation of available data for characterizing the source/soils of OU14 and for providing input to the risk assessment and assessment of remedial alternatives This is consistent with EPA guidance (EPA 1987, 1990). Data presently available are insufficient to meet the objectives defined by the IAG; therefore, the collection of additional data is warranted

To ensure that a sufficient amount of acceptable data are generated, the FSP was designed to include a rationale for all activities and a staged approach using screening-level techniques to identify critical sampling sites. The program described in Section 6.3 and applied to each IHSS in 6.4 provides Stage 1 sampling to be initially completed on a grid pattern, with additional sample points added to further define areas of contamination

4.2.5 Evaluate Sampling/Analysis Options

The RFI/RI for OU14 will use field screening and surficial soil sampling techniques to direct subsurface data collection activities This approach maximizes collection of useful data because surficial soil sampling and field screening techniques are used to properly locate and minimize borehole drilling. Additionally, this approach minimizes the volume of generated hazardous waste material that requires special management, the potential exposure of field personnel to hazardous waste material, and the overall time to perform the field activities

A staged, multi-task sampling approach has been designed for OU14 Stage 1 activities are designed to locate areas of contamination and to provide an assessment of the nature of the contamination at these locations Stage 1 consists of the following tasks which will be performed at each site, as appropriate.

- Conduct geophysical surveys to locate underground utilities
- Conduct radiological and soil gas surveys and surface soil sampling (2-inch scrapes) and analysis
- Conduct additional personnel interviews to assist in locating areas of probable contamination
- Conduct radiological surveys and soil samples focused in new areas identified in personnel interviews
- Drill boreholes and sample subsurface soils in predetermined locations and predetermined depths

Based on the results of Stage 1, the sampling pattern will be altered as necessary to fully determine the extent of contamination at each IHSS during Stage 2 Stage 2 sampling activities will potentially include drilling additional boreholes and collecting soil samples, sampling existing monitoring wells, and installing, pump testing, and sampling new monitoring wells Additionally, grab surface water samples will be collected if appropriate locations and opportunities are identified Section 6.0 describes the field activities in detail

Section 6.5 of this work plan discusses the analytical program requirements for OU14 Appendix B of the QAPjP (EG&G 1991e) lists the CLP analytes and detection/quantification limits for Target Compound List (TCL) volatile and semivolatile organics, TAL metals, radionuclides, and other surficial soil sampling parameters These analytical methods are appropriate for meeting the data quality requirements for analytical Levels I through V during the RFI/RI

4.2.6 Review of PARCC Parameter Information

The PARCC parameters (precision, accuracy, representativeness, comparability, and completeness) are indicators of data quality. The end use of the measurement data should define the necessary objectives for the PARCC parameters The PARCC goals are specified in the QAA (Section 10 0) of this work plan The PARCC parameters are discussed below. Analyte-specific precision and accuracy objectives are also listed in the QAPjP, Appendix B

Precision measures the reproducibility or degree of agreement among replicate measurements under a given set of conditions. The closer the numerical values of the measurements are to each other, the more precise the measurements. During the OU14 RFI/RI, data collected using field instrumentation such as water level meters, pH meters, and

conductivity meters will be checked by reporting at least three measurements taken at one location and comparing the results Field analysis instruments such as a field gas chromatograph (GC) will be checked by analyzing replicate samples. Sampling precision will be evaluated by the analysis of field replicates Analytical precision will be determined by replicate analysis of single samples The DQO for precision will be to achieve the precision criteria associated with each published analytical method used in the analysis of OU14 samples

Accuracy measures the bias in a measurement system Sources of error include the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and sample analysis techniques. Sampling contamination of the OU14 RFI/RI will be assessed by evaluating the results of field rinse and trip blanks. The accuracy of the laboratory analysis will be determined from the results of matrix spike recovery The DQO for accuracy will be to obtain recoveries within the range of acceptability associated with each published analytical method used in the analysis of OU14 samples

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program Given the lack of previous usable data from OU14 IHSSs, designing a representative sampling program is difficult; however, representativeness can be enhanced for the OU14 RFI/RI by use of proper sampling techniques Section 6.3 describes the sampling rationale and techniques Representativeness will also be assessed by the collection and analysis of field duplicate samples

Completeness is defined as the percentage of measurements made that are judged to be acceptable. The target completeness objective for the OU14 field and analytical data is 100 percent, 90 percent will be the minimum acceptable level The analytical set is considered acceptable if a representative subset of the data are validated (i.e , 20 to 30 percent) and indicate the analyses were acceptable. To ensure that a sufficient amount of acceptable data are generated, the FSP is designed to include a rationale for all field activities and a staged approach using screening level techniques to identify and locate critical sampling sites Section 6.0 further discusses these components of the FSP.

Comparability is a qualitative measure defined by the confidence with which one data set can be compared to another Differences in field and laboratory procedures greatly affect comparability To optimize comparability, all OU14 RFI/RI sampling techniques and analytical methods will be approved EMD standard operating procedure (SOP) methods

4.3 Stage 3 - Design Data Collection Program

The intent of Stage 3 is to compile information and DQOs developed for specific tasks in Stage 2 into a comprehensive data collection program. The data collection program has been prepared for the OU14 RFI/RI and is presented in the FSP (Section 6 0) The FSP also includes a detailed list of all samples to be collected including media and sample type, and sample location maps for each IHSS A listing of the type and frequency of quality control (QC) samples to be collected is provided

The QAA (Section 10.0) and the QAPjP describe the policy, organization, functional activities, and quality assurance (QA) and QC protocols necessary to achieve the DQOs dictated by the intended use of the data

Table 4-1 Phase I RFI/RI Data Quality Objectives for OU14

Activities Supporting RFI/RI Objectives and Specific Data Needs	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
Delineation of the Areal Extent and Location of Each IHSS				
Define the horizontal nature and extent of surficial soil contamination				
• Characterize surficial soils	Radiation survey data	Perform field radiation survey at each IHSS	III	Source/Soil Characterization
	Surficial soil contamination data	Collect and analyze surficial soil samples at each IHSS, analyze for parameters appropriate for each IHSS	IV (V for radiological analyses)	Baseline Risk Assessment Environmental Evaluation
	Surficial soil physical properties data	Collect and analyze surficial soil samples for physical characteristics	I, II	Evaluation of Remedial Alternatives
Define the vertical nature and extent of contamination in the soil column beneath each IHSS and potential for contaminated soil to impact surface water and groundwater				
• Characterize presence or absence of subsurface utilities/structures	Geophysical data/ Existing utilities maps	Conduct borehole clearance geophysical survey at appropriate IHSSs that will have subsurface investigations	I	Source/Soil Characterization

Table 4-1 Phase I RFI/RI Data Quality Objectives for OU14

Activities Supporting RFI/RI Objectives and Specific Data Needs	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
• Characterize presence or absence of soil contamination at each IHSS	Soil chemical and physical properties data	Conduct soil gas surveys at appropriate IHSSs, analyze vapor samples for volatile organic compounds (VOC)	III	Source/Soil, Surface Water, Groundwater Characterization
		Collect and analyze *in situ* soil and subsurface soil samples at all IHSSs	III	Baseline Risk Assessment Environmental Evaluation
		Collect soil and analyze core samples along depth profiles, analyze for parameters appropriate for each IHSS	IV (V for radiological analysis)	Evaluation of Remedial Alternatives
		Collect soil samples for analysis of physical properties	I, II	
• Characterize subsurface stratigraphy and depth to groundwater	Geologic parameters	Drill borings and log subsurface geology	I	Source/Soil, Groundwater Characterization Baseline Risk Assessment Evaluation of Remedial Alternatives

Table 4-1 Phase I RFI/RI Data Quality Objectives for OU14

Activities Supporting RFI/RI Objectives and Specific Data Needs	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
Determine if groundwater beneath IHSS has been affected by contamination in the subsurface soil				
• Characterize presence or absence of groundwater contamination at appropriate IHSS	Groundwater chemical data	Collect and analyze groundwater samples from monitoring wells at selected IHSS	IV (V for radiological analysis)	Soil Groundwater Characterization Baseline Risk Assessment Environmental Evaluation Evaluation of Remedial Alternatives
Assess the groundwater migration potential beyond the IHSS and OU14 boundaries				
• Characterize groundwater flow regime around appropriate IHSSs	Water level data	Obtain quarterly water level measurements from existing monitoring wells around each IHSS	I	Groundwater Characterization
		Install monitoring wells at each IHSS as appropriate and conduct pumping test	I	Baseline Risk Assessment Evaluation of Remedial Alternative

Table 4-1 Phase I RFI/RI Data Quality Objectives for OU14

Activities Supporting RFI/RI Objectives and Specific Data Needs	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
Support Section of Remedial Action Alternative • Treatability studies	Bench-scale testing	Collect and analyze pretreatment samples to determine effectiveness of alternative	IV (V for radiological analytes)	
• Characterize site-specific geologic parameters	Soil physical parameters	Collect and analyze soil samples for parameters identified as appropriate for each IHSS	I, II	Evaluation of Remedial Alternatives

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5.0 RCRA FACILITY INVESTIGATION/REMEDIAL INVESTIGATION TASKS

5.1 Task 1 - Project Planning

Project planning for the implementation of the RFI/RI for OU14 includes numerous activities in addition to tasks completed as part of this work plan Review of previous site investigations, review of the HRR, preliminary site characterization data, preliminary identification of potential ARARs, and the development of DQOs and a FSP have all been completed as part of this work plan and are contained in Sections 2.0, 3.0, 4.0, and 6.0, respectively These key steps and others in the scoping process are illustrated in Figure 5-1.

After approval of this work plan and prior to RFI/RI field activities, historical data and newly generated data that have become available since preparation of this work plan will be compiled and evaluated There are ongoing site investigations at other OUs and plant-wide studies that may provide data relevant to the OU14 investigation These new data may assist in planning and coordination of preparatory activities for OU14. Such activities include coordinating with other field investigation programs occurring in the same vicinity of OU14, accommodating the special security requirements within high security areas, and addressing health and safety concerns for field operations. Additionally, OU14 will require

detailed and accurate delineation of underground utilities and other related physical features for each IHSS

Interviews with plant personnel will be conducted to augment past release information and to identify areas where construction activities may have disturbed and/or removed portions of OU14. Personnel in facility operations will be contacted about any additional information that may be available on OU14 structures and site conditions. Although OU14 IHSSs have been visually inspected during preparation of this work plan, each site will be closely scrutinized prior to mobilizing field equipment to provide additional location and accessibility information.

Field activities proposed for OU14 will be integrated with ongoing or proposed field activities at nearby sites to minimize redundancy and maximize efficiency. The possible investigation sites near OU14 are discussed in further detail in Section 2.2.

It is important to emphasize that planning and coordination will be required throughout the project duration to accommodate any unforeseen developments. Two project planning documents have been prepared for the OU14 RFI/RI as required by the IAG: the FSP, which presents the locations, media, and frequency of sampling efforts; and the Sampling and Analysis Plan (SAP) which includes a QAPjP and SOPs for all field activities. A sitewide SAP has been prepared for RFP, and is currently being revised in accordance with the IAG. QA procedures and SOPs that are used specifically for OU14 are referenced in this work plan. Any deviations from the QAPjP or SOPs are documented as QAA in Section 10.0 of this work plan, or appended to the work plan in the form of SOP Addenda.

5.2 Task 2 - Community Relations

In accordance with the IAG, RFP has developed a Community Relations Plan (CRP) to inform and actively involve the public in decision making as it relates to environmental restoration activities. This CRP meets the requirements for all OUs. The vehicle for public involvement in the RFI/RI process is the Technical Review Group. The CRP addresses the needs and concerns of the surrounding communities as identified through interviews with businesses, medical professionals, educational representatives, interest groups, the media, residents adjacent to the RFP, and federal, state, and local elected officials.

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

In addition, the RFP Speakers Bureau provides lecturers to civic groups and educational organizations, and operates a tour program allowing the public to visit RFP. RFP also produces fact sheets and periodic updates on environmental restoration activities for public information and responds to numerous public inquiries regarding RFP.

5.3 Task 3 - Field Investigation

The OU14 RFI/RI field investigation is designed to meet the objectives outlined in Section 4.0. The data will also be used to support the EE and the HHRA as defined by the IAG. The following activities will be performed as part of the field investigation, as described in detail in Section 6 0.

The RFI/RI field investigation for OU14 has the following specific objectives:

- Characterize the nature and extent of contamination at each IHSS
- Support HHRA requirements and EE
- Support corrective measures studies (CMS), feasibility studies (FS), and treatability studies
- Support exposure assessment.

The field investigation is designed to characterize current sources and potentially affected media at each IHSS Many of these sites are still active and may remain active after the FSP is concluded.

A two-stage field investigation has been developed for each IHSS. Stage 1 activities are designed to detect points of contamination and to provide an assessment of the nature of the contamination at these points; Stage 2 activities are designed to provide an assessment of the extent of contamination present, as identified by Stage 1 results.

The FSP developed for this field investigation emphasizes the Stage 1 activities, which are divided into three tasks to be performed at each IHSS, where appropriate, and a fourth task specific to selected IHSSs. Task 1 involves a review of existing data, including aerial photographs and site records. Task 2 involves screening activities at each IHSS, which include radiation surveys and soil gas surveys. Task 3 involves limited sampling activities for soil and groundwater, and the completion of soil borings at appropriate IHSSs. Task 4, which is specific only to selected IHSSs, involves the installation of groundwater monitoring wells.

A thorough discussion of the field sampling plan in contained in Section 6.0.

5.4 Task 4 - Sample Analysis and Data Validation

Analytical procedures will be completed in accordance with the ER Program QAPjP (EG&G 1991e) Analytical detection limits, sample container and volume requirements, preservation requirements, and sample holding times are discussed in Section 6.5.

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 (EPA 1988c). 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 will be derived from these requirements. Details of the data validation process are described in the QAPjP.

5.5 Task 5 - Data Evaluation

Data collected during the RFI/RI will be incorporated into the existing RFEDS database and will be used to better characterize contaminant sources and soil. RFEDS personnel assist in the early stages of sample collection and analysis in order to facilitate the entry of data collected during the RFI/RI to the existing RFEDS database. Screened data will be stored in independent computerized databases and will be incorporated into RFEDS when appropriate These results also will be used to determine the impact of OU14 on surface water, groundwater, air, the environment, and biota, as well as the potential contaminant migration pathways at OU14. Additionally, data will be used to support the evaluation of proposed remedial alternatives and the BRA.

5.5.1 Site Characterization

The additional physical data collected during the RFI/RI will be incorporated into the existing site characterization. A survey of impervious areas within OU14 will be conducted to assist in surface water runoff characterization. Water level data will be used to characterize the alluvial groundwater flow regime.

5.5.2 Source, Soils, and Groundwater Characterization

Analytical data from OU14 IHSSs will be used to characterize the following:

- Nature of source contaminants
- Lateral and vertical extent of contaminant sources in soils
- Nature and extent of contaminants in groundwater

In addition, the analytical data will be used to evaluate on-site contaminant concentrations

Analytical data obtained from OU14 samples will be summarized graphically and/or in table form to assist interpretation. Contaminant isopleth maps will be prepared to summarize the spatial distribution of source, soil, and groundwater contaminants

The criteria for the identification of contamination will be analyte-specific for each geologic unit (e g., Rocky Flats Alluvium or artificial fill) For all analytes (including radionuclides), only those concentrations exceeding the site-specific background concentrations will be considered likely evidence of contamination. These data will be compared to sitewide background values provided in the *Final Background Geochemical Characterization Report* (EG&G 1991d) and studies performed by the Colorado Department of Health: Environmental Surveillance Report on the USDOE Rocky Flats Plant April, 1992 (CDH 1991) and the paper prepared by Robert Terry entitled "Contamination of Surface Soil

in Colorado by Plutonium, 1970-1989: Summary and Comparison of Plutonium Concentrations in Soil in the Rocky Flats Plant Vicinity and Eastern Colorado" (Terry 1991).

5.6 Task 6 - Baseline Risk Assessment

As required by the IAG, a BRA that addresses the risks associated with OU14 sources and affected media will be performed as part of the OU14 RFI/RI report. This includes an HHRA and EE for OU14. The purpose of the BRA is to characterize the toxicity and levels of hazardous substances present, to characterize contaminant fate and transport, and to assess the potential for human health and environmental impact or risks associated with the site. The BRA provides a basis for determining whether remedial actions are necessary and to justify performing remedial actions. The HHRA will address potential public health risks, and the EE will address environmental impacts

Existing data and data collected during the RFI/RI will be used to the extent possible to support the quantitative HHRA and EE. Data collected during the RFI/RI will support quantitative evaluation of risk due to soil ingestion, inhalation, and dermal contact. Exposure pathways involving surface water, groundwater, and/or biota as transport media will also be quantitatively evaluated, if necessary. The RFI/RI sampling program will be designed to generate data that meet the requirements set forth in *Guidance For Data Useability In Risk Assessment* (EPA 1990).

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

- Data collection/evaluation (identification of COCs)
- Exposure assessment
- Toxicity assessment
- Risk characterization

As stated in the IAG and the NCP, a risk characterization of current, future, or potential site conditions scenarios will be developed

The objectives and the description of work for the HHRA are described in detail in Section 8.0 The Environmental Evaluation Work Plan is presented in Section 9.0.

5.7 Task 7 - Preliminary Remediation Goals (PRGs)

Preliminary remediation goals (PRGs) consist of initial cleanup goals that are protective of human health and the environment. PRGs are described in the recently released EPA guidance document, *Risk Assessment Guidance for Superfund· Volume I - Human Health Evaluation Manual, Part B* (EPA 1991b). They are developed early in the RFI/RI process and are later modified to reflect the pathway analysis in the BRA. They are also used during analysis of remedial alternatives in the RFI/RI and CMS/FS stages. PRGs are

calculated for those contaminants not having specific limits identified in ARARs. The PRGs for these contaminants will result in residual risks that fully satisfy the NCP.

Chemical-specific PRGs are determined by concentrations based on risk assessment, which sets concentration limits using toxicity values under specific exposure conditions Development of PRGs requires the following site-specific data:

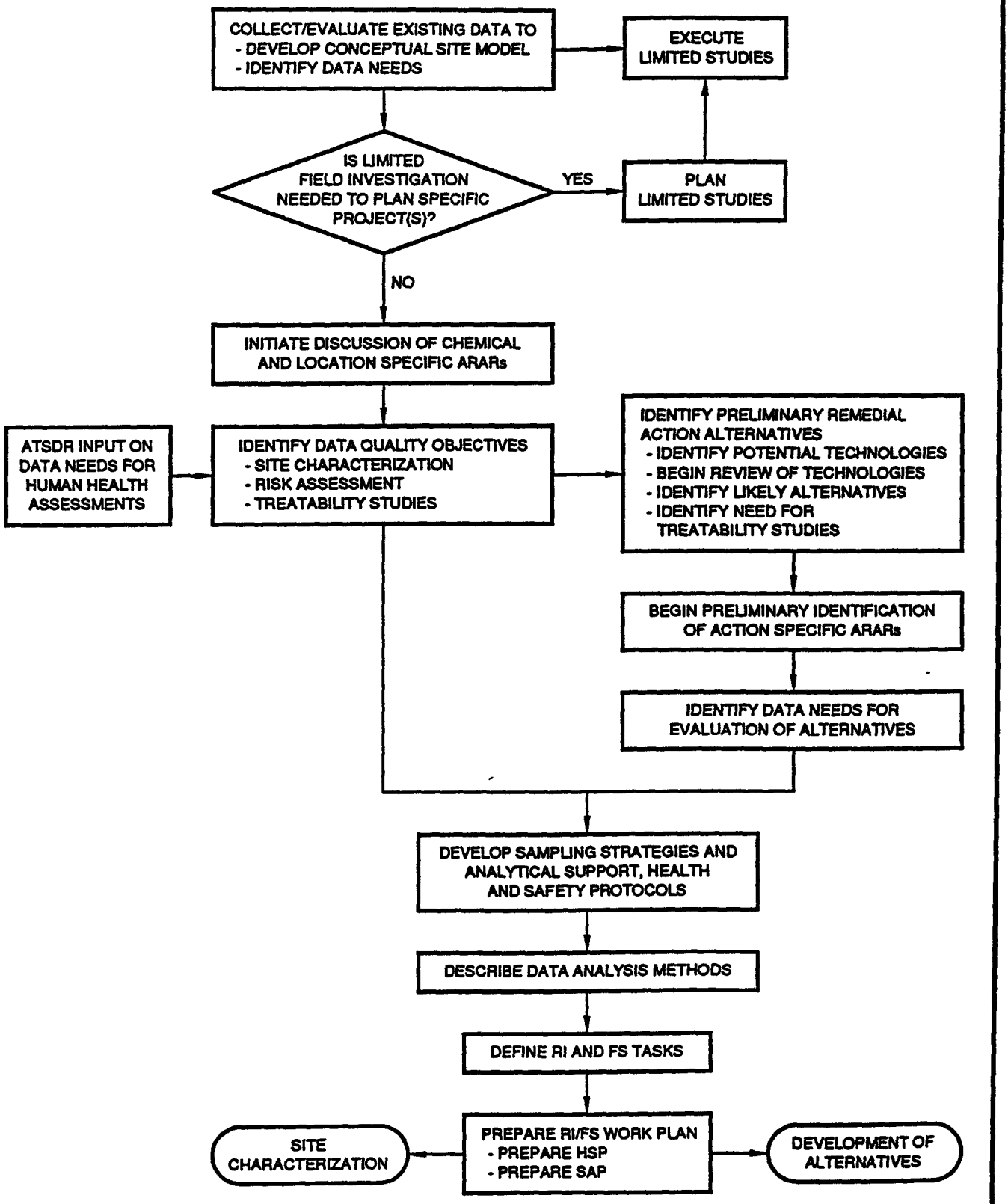
- Media of potential concern
- Chemicals of potential concern
- Probable future land use.

PRGs will be calculated for those chemicals analyzed in this work plan that do not have ARARs associated with them. In order to calculate the PRGs, future land use is assumed to be residential. Details of the risk assessment process are further discussed in Section 8.0.

When the BRA is completed, it will provide remediation goals based on the environmental pathway analysis. Levels of remediation will be decided during the CMS/FS process.

EPA guidance (EPA 1991b) provides standardized default exposure equations and parameters used to calculate PRGs for radioactive materials and chemicals. The guidance also indicates that uncertainty assessment may be applicable to PRGs and can serve as a basis

for recommending further modifications to the PRGs prior to setting final remediation goals. An uncertainty assessment for the PRGs would be similar to that conducted during the BRA.



PREPARED FOR
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO

FIGURE 5-1

RFI/RI
SCOPING ACTIVITIES

Approved by

_____ / /
Manager, Remediation Programs

_____ / /
RI Project Manager

6.0 FIELD SAMPLING PLAN

The purpose of this section of the work plan is to provide a FSP that will generate sufficient data to satisfy the RFI/RI objectives outlined in Section 4.0. Section 6.1 presents objectives specific to each IHSS Section 6.2 summarizes site background information and rationale for the sampling and analysis and other data collection activities Section 6.3 describes the sampling program for each site Section 6.4 describes field sampling procedures and equipment Section 6.5 describes the analytical program including sample designation, analytical requirements, sample containers and preservation, and sample handling and documentation Section 6 6 describes data management procedures, and Section 6 7 describes QA and QC procedures. Appendix F contains the EG&G Site-Specific Health and Safety Plan Template. An OU14-specific Health and Safety Plan will be developed in a separate document

6.1 OU14 RFI/RI Objectives

As detailed in Section 4.0, The specific objectives of the RFI/RI for OU14 are as follows

- Characterize the nature and extent of contamination at each IHSS

- Determine risks to human health and environment associated with the contamination
- Support the selection and evaluation of remedial alternatives

The specific data needs to achieve these objectives are delineated in Table 4-1 Characterizing the nature and extent of contamination at each IHSS requires characterizing the type of contaminant and its distribution in soil and determining the extent of migration (if any) to other media Results obtained from field sampling will be used to refine pertinent pathways and potential receptors identified in the site conceptual model (Section 2.5), conduct the risk assessment and environmental evaluation, and support the evaluation of alternatives and any necessary treatability studies

The objectives will be achieved by implementing a two-stage field program. The staged approach (Figure 6-1) employs a multi-tasked sampling approach. Stage 1 sampling activities are designed to locate areas of contamination and to assess the nature of the contamination at these locations Stage 2 sampling activities are designed to assess the extent, both vertical and horizontal, of the contamination present on a statistically developed sampling grid The number of sampling and locations will be developed using the analytical results from Stage 1 Stage 1 activities will be described in the following section

6.2 Background and FSP Rationale

Section 2.2 provided the historical release information for each of the OU14 IHHSs. Section 2.3 described the previous investigations, and the nature of contamination was described in Section 2 4 A synopsis of the information extracted from both the historical

descriptions and previous investigations was developed and was supplemented by describing the potential impacts from other OUs OU14 consists of eight separate IHSSs that can be identified by type and size. IHSS 131, IHSS 156 1, IHSS 160, IHSS 161, IHSS 162, IHSS 164.1, IHSS 164 2, and IHSS 164.3 Of these eight sites, two are parking lots approximately 313,000 square feet in area, four are paved areas near buildings approximately 83,000 square feet in area, one is a storage pad approximately 25,000 square feet in area; and the last is a paved road within the plant with an approximate area of 161,000 square feet All areas described above are located immediately adjacent to buildings and are partially or completely covered with concrete or asphalt

The design of the program presented in this FSP was based on the following·

- Achieving the sampling requirements outlined in the IAG Table 5 (DOE 1991a)
- Using the existing information and data to direct more concentrated sampling efforts
- Recognizing the technological limitations posed by the field instruments given the physical characteristics of the IHSSs (i.e , extensive artificial groundcover)

The IAG Table 5 requirements (DOE 1991a) which are planned for implementation during Stage 1 along with a comparison to the Stage 1 FSP activities are presented in Table 6-1 The requirements specified in the IAG will be met or exceeded during Stage 1 with the exception of IHSSs 160/161 The IAG specifies drilling and sampling boreholes, based on soil gas results, to transect the volatile organic plume presumed to be present at these IHSSs. Additionally, the IAG requires these transecting boreholes to be completed as monitoring wells Both of these activities will be reserved for Stage 2 of the field program, if deemed

appropriate based on the Stage 1 results Identifying tentative locations for placement of these boreholes and monitoring wells can not justified at this time

As delineated on Table 6-1 and illustrated on the IHSS-specific sampling grids presented throughout Section 6.3, Stage 1 activities are in some cases more sample intensive than that required by the IAG These concentrated sampling and analysis locations have been identified because of citations in the historical release summaries or from the evaluation of existing monitoring data. In summary, IHSS 160, 162, and 164.2, have focused areas of sampling based on the existing information Requirements for sampling of IHSSs 131 and 156.1 cover both the IAG IHSS locations and the HRR IHSS locations The historical information associated with these IHSSs did not provide sufficient data to rule out the potential for contamination in both the IAG and the HRR locations.

Technological limitations of the radiological survey equipment also affect the coverage of the IHSS The fundamental problem associated with applying standard sample design selection criteria is the difficulty associated with working through paved and concrete surfaces. This has a direct influence on the radiological survey field of view, and may affect other field survey requirements (i.e., soil gas surveys). At asphalt- or concrete-covered sites, vehicle- or tripod-mounted High-Purity Germanium Detection (HPGe) system measurements will provide only limited information on radionuclides potentially present in soils beneath the pavement As a result, more extensive programs of surficial soil sampling for radionuclides are necessary in paved areas.

The radiological detectors have limitations in regard to the area or "field of view" The FIDLER probe is limited to the area directly beneath the detector's face The HPGe detectors have a much greater field of view but work from gamma emissions The FIDLER

probe is limited to alpha radiation surveys in a very limited area (approximately 100 cm^2) The HPGe detection system cannot detect low energy gamma emissions (i.e. americium-241, plutonium-239) through a layer of asphalt or concrete The effective detection area of a HPGe detector submerged within a borehole, extends to approximately 3 inches from the submerged probe surface The three inch distance takes into account the mass attenuation coefficient for soil, the energy of the alpha particle and the detector efficiency. Technological limitations have significant impacts in statistically justifying a survey grid considering the field of view coverage This limitation brings into consideration the use of professional field judgement on a routine basis The sampling plan has been designed in a phased approach which will allow the investigator to evaluate the stage 1 results with the statistical methods provided in Appendix IV of the EPA Guidance (EPA 1990)

6.3 Stage 1 Activities and Stage 2 Rationale

Stage 1 consists of several tasks which will be performed at each site, as appropriate Task 1 involves field screening and sampling activities at each IHSS based on the IAG Table 5 requirements including geophysical surveys, radiation surveys, soil gas surveys, and sampling of surface soils and borings. These activities are designed to provide screening-level and confirmatory-level data concerning the presence or absence of contaminants at the sites. Task 1 also includes continued investigation for information that will aid in a more concentrated, or tightened, sampling effort in areas of probable contamination When there is sufficient background information, additional borehole locations may be proposed in specific known areas of contamination. A review of areal photographs in conjunction with conducting interviews with cognizant personnel may provide the information necessary to focus sampling efforts Appendix E includes a chronological listing of the Rocky Flats photographic history

Task 2 involves the refinement or tightening of the initial grid based on the field results and field judgement. For example, if a "hot spot" is located using the initial grid pattern, samples will be collected concentrically around the hot spot to delineate the extent of elevated concentrations Another type of refinement occurs if elevated concentrations are not observed using the initial sampling grid In this case, the grid will be refined systematically (e g decreasing grid spacings by one-half) and a second round of measurements will be collected. The sampling grids presented throughout Section 6.3 serve as the Task 1 sampling scheme. The sampling procedures prescribed in Section 6.3 will not be modified without agency approval (EPA/DOE/CDH) Refinement to the grids during Task 2 will be documented in the field. This procedure is detailed below

Stage 1. Task 2 Grid Modification Process

1 Continue the investigation of all potential information sources that will assist in focusing a more intense intrusive study area.

2. Verify if contamination is present or not in the area of concern using field instrumentation and lab analysis

3 Based upon results, reestablish the proposed sampling grid.

- If the results indicate background levels then a smaller grid pattern will be developed if additional information suggests that a "hot spot" may exist elsewhere

- If the results indicate the presence of a contaminant then a specified (EMD OP FO. 16) triangular or similar tightened grid pattern will be developed and implemented

4 If the field instrumentation registers positive readings above background at a specified depth, the boring depth should be increased until background is again achieved Additional samples would also be taken at specific depths

5 Refine the FSP based upon the results obtained from the steps identified above for Stage 2 activities.

6 Select a focused location within the IHSS to perform intrusive investigations (i.e , additional boreholes or penetrations through the concrete or pavement, as appropriate).

At present, background at RFP is defined in the *Background Geochemical Data Characterization Report* (EG&G 1990a) Other reports, as they become available and are approved by DOE/EPA/CDH, may be utilized for this evaluation

An additional Task 2 activity includes the assessment of the potential for preferential contaminant migration pathways Because OU14 is located in the industrialized area of RFP where underground utilities and trenches are fairly widespread, these features may act as transport pathways for IHSS contaminants Utilities such as sanitary sewer pipes, process waste lines, and electrical lines may be surrounded by permeable fill material through which contaminated liquid may travel. The utilities which are most common in OU14 IHSSs are the following with the associated depths provided in parentheses. alarm systems (2.5 to 3'), domestic cold water/fire (5 to 8'), electrical line (0.5 to 3'), natural gas lines (4'), process waste lines (4 to 8'), storm drains (4 to 8'), sanitary sewers (4 to 8'), steam lines (4 to 8'), telephone line (1 to 8'), and underground cables (2.5 to 3'). The types of utility pipes or conduit materials used within the OU14 IHSSs are cast iron, corrugated metal, copper, and ductile iron, fiberglass, polyethylene, polyvinyl chloride, rigid teflon, steel, stainless steel, and vitrified clay. Site Utility Plans which illustrate the location of these buried utilities are contained in an attachment to this section

At the completion of Stage 1, the field survey results will be reviewed and compiled in conjunction with the confirmatory sampling results. The Stage 2 sampling program design will be developed using appropriate statistical methods to evaluate the Stage 1 results and determine the extent of contamination at each IHSS A summary of the Stage 1 field activities, the planned Stage 2 activities, and supporting rationale will be documented in a technical memorandum and approved by DOE/EPA/CDH prior to implementation The technical memoranda planned for submittal during implementation of the OU14 work plan are summarized in Table 6-1A Stage 2 field activities will potentially include collecting additional soil samples, drilling additional boreholes, and installing monitoring wells Existing monitoring wells in the vicinity of OU14 will be sampled as will appropriate surface water locations, if identified

The Stage 1 soil laboratory results will trigger the following Stage 2 investigations.

- Radionuclides - exceedance of background levels using statistical analysis (i.e., students T Test, or ANOVA, or nonparametric techniques as appropriate)
- Organics - values greater than the practical quantitation limits
- Inorganics - exceedance of background levels using statistical analysis (i.e., students T Test, or ANOVA, as appropriate)

6.3.1 Stage 1 and Stage 2 Field Surveys

The following field screening techniques will be used extensively throughout implementation of Stage 1 of the FSP and potentially in Stage 2. A brief description of the methodologies is provided below to support the discussions in the IHSS-specific FSP section, Section 6 4

FIDLER and HPGe Radiological Survey Methods

As indicated on Table 6-1, the IAG Table 5 specifies that the FIDLER radiation detection system be used for surface scrape soil measurements. The FIDLER detection system has been used extensively at RFP as specified in the EMD OP FO.16 The following paragraphs will introduce another system which has been proven to be more appropriate for these types of field surveys This system has been tentatively recommended for use in the Stage 1 field program, however, the implementation procedures are currently under development and not available.

FIDLER instruments provide relative comparisons of radioactivity at discrete survey points whereas the HPGe system provides radionuclide concentrations over the entire area surveyed. The radiological surveys conducted at OU14 IHSSs are set up on a grid that will provide total surface area coverage

A detector is mounted either on a tripod or vehicle and placed at a set distance above the ground surface to measure gamma rays originating from surface media The High-Purity Germanium Detection (HPGe) system integrates gamma activity over the detector's field of view, a defined volume by which 90 percent of those gammas originating in surface media are measured. It is assumed that radionuclide distribution is relatively homogeneous over the field of view, and that the distribution varies only with depth. HPGe system results are typically reported as concentration per unit mass, pCi/g

Gamma rays originating in the soil or surface media are attenuated in such a manner that the number reaching the detector decreases exponentially with depth. The elemental composition of the soil or medium measured changes the attenuation of the gamma rays; the more dense the soils or surface media, the more gamma attenuation will occur Where soils are covered by asphalt or concrete, HPGe system measurements will reflect the activity of the pavement rather than the underlying soil

EG&G currently has in-house capability to conduct HPGe system field surveys using a tripod-mounted detector. The tripod-mounted detector has an approximate field of view of 14 meters, or approximately 45 feet Vehicle-mounted HPGe system instrumentation with a 60-meter (approximately 195-foot) field of view is anticipated to be available for field use in fall of 1992 The large grid spacing proposed for

some OU14 IHSSs will be replaced with a smaller grid spacing in the event that the vehicle-mounted HPGe system is not available during the field investigation

Laboratory results from the surficial soil samples and depth profile (borehole) samples collected for characterization purposes will also be used for the development of the appropriate conversion factors for the HPGe system survey readings Comparison of these system survey readings with surficial soil and borehole samples will allow correlation of these remote and direct measurements Depth profile samples, used to correlate the HPGe system survey with direct radionuclide activities in exposed soils, will be collected in the paved areas on a limited basis. A concrete or asphalt sample will also be collected at survey points with anomalous surface activity Areas identified as having radionuclide contamination will be targeted for surface scrape and borehole sampling The EMD OP FO.16 will be referred to extensively until additional procedures have been approved for use by CDH and EPA

Soil Gas Surveys

Soil gas surveys will be used to detect the general location of historical spills or releases at IHSSs 160 and 161. As with the radiological survey, this field screening method (EMD OP GT 19) provides real-time results from which a focused and efficient field sampling program can be conducted. The equipment selected to conduct field screening is portable, efficient, and provides quality results on which to base further investigations Field screening will emphasize the use of soil gas sample collection and analysis (Table 6-4), with the ability to collect and analyze soil and groundwater samples, if necessary, to identify extent of contamination migration.

Soil gas sampling points have been established on a standard grid at IHSSs 160 and 161. A rig will be set up on each point, and will cut through overlying concrete or pavement if present To collect a soil gas sample, the sampling probe will be driven to a depth of five feet, the retracting tip will then be pulled back, and a vacuum applied to obtain the soil gas sample. The sample will be analyzed using a portable gas chromatograph in accordance with EMD OP GT 19 for VOCs listed in Table 6-4. A borehole will be completed for 1 out of every 25 soil gas sampling points. The locations will be selected at random

Geophysical Surveys

Geophysical surveys will be routinely implemented prior to the implementation of any intrusive field activities Generally, the purpose of these surveys are to aid in locating underground utilities, thus preventing damage to the utilities or injury to sampling personnel The Site Utility Plans applicable to each IHSS have been included as an Attachment to this section of the work plan to help direct the geophysical survey activities

6.4 IHSS-Specific Field Sampling Plan

6.4.1 Radioactive Site - 700 Area Site No. 1 (IHSS 131)

The Stage 1, Task 1 investigation includes both surface and subsurface soil sampling The IHSS-specific program has been designed using a 25-foot survey, surface soil scrape, and subsurface soil sampling grid as illustrated on Figure 6-2 A hollow-stem auger will be advanced through the pavement and all debris will be cleared away so that the top 2 inches of soil can be scrape sampled (EMD OP GT 08) A split spoon sampler will be advanced to a depth of 2 feet through a hollow-stem auger and the soil will be composited (EMD OP GT 02) Prior to compositing, the borehole sample will be logged from surface to total depth (EMD OP GT 01)

The 0- to 2-inch scrape sample and 2-foot composite will be analyzed for total plutonium, total americium, uranium-238, uranium-235, uranium-233/234, gross alpha, and gross beta The Task 2 grid modification process as outlined in Section 6 3 will be employed, as necessary, to complete the Stage 1 activities All boreholes will be grouted

after sampling per EMD OP GT 05, and field equipment will be decontaminated between sampling locations in accordance with the RFP EMD OP FO 03.

6.4.2 Radioactive Site - Building 334 Parking Lot (IHSS 156.1)

The Stage 1 investigation includes a radiation survey using the HPGe and/or FIDLER system as described in Section 6.3 on all unpaved areas. The radiation survey will be performed on a 25-foot grid (Figure 6-3); however, if elevated areas are detected, the size of the grid will be reduced in that area to locate the radiation source All positive (i e , above background) results will be plotted, and a follow-up sampling plan will be developed as described in the grid modification process

Surface soil scrapings will initially be collected during the Stage 1 investigation to a depth of 2 inches using 50 foot grids. The surface soil scrapings will be collected in accordance with OP GT 08 In paved areas, a hollow stem auger will be advanced through the pavement and all debris will be cleared away so that the top 2 inches of soil can be scrape sampled. All samples will be analyzed for total plutonium, total americium, uranium 233/234 , uranium 235, uranium 238, gross alpha, and gross beta. Radiation surveys will continue during the surface soil sampling activities Radiation surveys will be conducted in accordance with OP FO 16

6.4.3 Radioactive Site - Building 444 Parking Lot (IHSS 160)

A soil gas survey (Figure 6-4) as introduced in Section 6.3, will be conducted during Stage 1 over the Building 444 parking lot and in the area immediately east of Seventh Street The soil gas samples will be taken on a 50-foot grid, and will be analyzed for VOCs 1,1,1-

trichloroethane, tetrachloroethylene, carbon tetrachloride, acetone, toluene, and benzene If target compounds are detected, the size of the grid will be reduced in that area to delineate the plume Analytical peaks of compounds for which the GC is not calibrated will be noted The soil gas survey will be conducted using a portable GC as described in EMD OP GT 19, Field Gas Chromatographs

Boreholes locations specified on Figure 6-4 were randomly selected and represent approximately 1 in 25 of the soil gas survey locations. The boreholes selected randomly will be drilled 3 feet into weathered bedrock using EMD OP GT.02 Samples collected from each borehole include a 0- to 2-inch surface scrape, a composite of each 2-foot interval, and a 6-foot composite from the uppermost interval of soil using a split spoon sampler. The surface scrape and the 6-foot composite will be analyzed for total uranium, total plutonium, gross alpha, and gross beta The 2-foot composites will be analyzed for TCL volatiles and TCL semivolatiles

A radiological survey will also be performed at IHSS 160 during Stage 1 Readings will be taken prior to any intrusive activities using the FIDLER Survey system to check for surficial radiological contamination. If elevated readings are found, the grid will be modified as described in Section 6 3 to further delineate the extent of contamination.

Potential Stage 2 activities include the completion of select boreholes as alluvial groundwater wells according to EMD OP GT.06. The selected locations would transect the presumed volatile organic plume in the area of this IHSS After development, groundwater samples will be collected and analyzed for TCL volatiles, TCL semivolatiles, TAL metals, total plutonium, total uranium, gross alpha, and gross beta Existing groundwater wells

P419689, P313489, P418289, and P417889 (see Figure 2-27) will be developed and sampled for monitoring purposes during Stage 2

6.4.4 Radioactive Site - Building 664 (IHSS 161)

The IAG Table 5 requirements group this IHSS with IHSS 160, therefore, the field sampling program has a similar basis. Soil gas surveys will be performed on a 50-foot grid (See Figure 6-5) Boreholes will be completed 3 feet into weathered bedrock in 1 out of every 25 soil gas survey sampling locations. Samples will be collected at the intervals as previously described for IHSS 160 The soil sample analysis will include total uranium, total plutonium, gross alpha and gross beta.

Again, Stage 2 activities potentially include placing boreholes in locations which transect the presumed volatile organic plume and completing these boreholes as alluvial monitoring wells The analyte group for these wells is described for IHSS 160. Existing groundwater monitoring wells P416789 and P416889 (See Figure 6-5) will also be sampled as part of the Stage 2 process.

6.4.5 Radioactive Site - 700 Area Site No. 2 (IHSS 162)

A radiological survey as described in Section 6.3, will be performed during Stage 1 along Eighth Street from Building 881 to Building 776. Radiation readings will be taken on the unpaved areas immediately adjacent to the road at 25-foot intervals (See Figure 6-6); however, if elevated areas are detected, the grid will be reduced in that area to locate the source

The top 0- to 2-inch surface scrape will be taken from the soil immediately under the paved area at 100-foot intervals The pavement will be removed to allow access for the radiological detection system A preliminary borehole sampling pattern will be implemented at 100-foot intervals as a starting pointing because specific guidance was not provided in the IAG for this IHSS The boreholes will be composited over the top 2-foot intervals after collection of 2-inch surface scrapes Grid modification as described in Section 6.3 will be implemented in the event elevated readings are observed. The insets shown on Figure 6-6 are based on the PCB/Radiological Survey Study findings conducted in 1991 (EG&G 1991h) and information in the HRR (EG&G 1992g)

Stage 2 sampling activities will include sampling existing monitoring wells and further evaluation of information from the overlapping IHSSs. The monitoring wells in the vicinity of IHSS 162 are already included in other IHSS Stage 2 activities. Wells P313589 (to be sampled during IHSS 164.1 investigation), 6186 (to be sampled during IHSS 164.3 investigation), P214089, and P213689 will be sampled during Stage 2 All groundwater samples will be analyzed for total plutonium, total americium, uranium-238, uranium-235, uranium-233-234, gross alpha, and gross beta

6.4.6 Radioactive Site - 800 Area Site No. 2, Concrete Slab (IHSS 164.1)

The Stage 1 investigation includes a radiation survey using the FIDLER and/or the HPGe system as described in Section 6.3 This survey will be conducted using a 25-foot grid; however, if elevated areas are detected, the size of the grid will be modified according to the radiation source

Surface soil samples will be collected at a depth of 2 inches at 25-foot centers (using EMD OP GT.08) In addition, soil borings will be collected using a hollow stem auger advanced through the paving material until native soils are encountered (using EMD OP GT 02) The soil borings will be drilled to a 6-foot depth and composited at 2-foot intervals if radioactive contaminants are found in the surface scrapes The 2-foot interval composites will be analyzed for TCL volatiles and TCL semivolatiles Additionally, a 6-foot composite will be collected and analyzed for total plutonium, total americium, uranium-233/234, uranium-235, uranium-238, gross alpha, and gross beta Boreholes will be grouted to surface according to OP GT 05, and all field equipment will be decontaminated according to EMD OP FO.03.

Existing groundwater well P31589 will be sampled and analyzed for the analytes mentioned previously as part of Stage 2 This well is located in the IHSS downgradient to IHSS 164.1

6.4.7 Radioactive Sites - 800 Area Site No. 2, Building 886 Spills (IHSS 164.2)

The FSP as specified by the IAG Table 5, Required Actions are similar to the IHSS 164 1) Radiological surveys will be conducted at 25-foot centers. The survey will include surface soil scrapes at 2 inches followed by 6-foot boreholes at locations indicated as radioactive after conducting the radiological survey The samples will be analyzed for total plutonium, total americium, uranium-233/234, uranium-235, uranium-238, gross alpha, and gross beta. The 2-foot interval composites will be analyzed for TCL volatiles and TCL semivolatiles

In addition to the IAG proposed survey and sampling, an additional concentrated survey area has been recommended Upon further investigation and information obtained from employee interviews, the area surrounding the waste holding tank (See Figure 6-8) has an increased likelihood of having contaminants present based on past events Boreholes drilled to bedrock at 5-foot centers with representative sampling at 2-foot intervals will be conducted (EMD OP GT 02) The sample analysis will include the analytes specified above All borings will be grouted to the surface according to EMD OP GT.05, and all equipment will be decontaminated in accordance with EMD FO 04

6.4.8 Radioactive Sites - Building 880 Storage Pad (IHSS 164.3)

The Stage 1 investigation will be similar to that performed in IHSS 164.1 and IHSS 164.2 as required by the IAG Radiological surveys will be conducted using the FIDLER and/or HPGe detection system at 25-foot intervals Surface soil scrapes will be taken to a 2-inch depth according to EMD OP GT.08. The grid will be modified according to the process described in Section 6.3. Boreholes will also be completed at 25-foot centers to a depth of 6 feet at locations indicated as radioactive from the 2-inch scrapes Composites will be collected at a 2-foot interval and then one 6-foot interval composite sample. (Figure 6-9 shows the grid the predetermined spacing) As previously indicated, the 2-foot intervals will be analyzed for TCL volatiles and TCL semivolatiles The 6-foot composites will be analyzed for total plutonium, total americium, uranium- 233/234, uranium-235, uranium-238, gross alpha, and gross beta

6.5 Sampling Equipment and Procedures

Appropriate field sampling and decontamination procedures for the OU14 RFI/RI field investigation will be conducted in accordance with the most recent version of RFP EMD OPs (EG&G 1991f) first released in September 1991. Appropriate EMD OPs are referenced in the following sections. The EMD OPs are supplemented by the EPA procedures (EPA 1989c) and American Society of Testing Materials (ASTM) standards (ASTM 1991) EMD OPs are currently in development for most of the procedures within this plan, the HPGe Radiation Survey procedure is currently under development

6.5.1 Geophysical Survey Procedures

Geophysical surveys will be conducted for borehole clearing in accordance with EMD OP GT.18 to disclose any buried pipelines or equipment. A digitally equipped ground-penetrating radar (GPR) system or magnetometers (as specified in EMD OP GT.18) will be used at each IHSS, depending on site-specific conditions such as the presence or absence of concrete or metallic objects

6.5.2 Radiological Survey Procedure

Sampling locations are IHSS-specific and are discussed in Section 6 3 Radiological surveys will be conducted at all OU14 IHSSs The established grids will provide total coverage of all IHSSs using a FIDLER or HPGe systems. The HPGe system was developed for high resolution spectroscopy allowing for radioisotope identification. The HPGe system has a broad energy range, it exhibits high resolution, excellent gain stability, and moderate area averaging, and has the ability to identify and quantify all gamma emitting radionuclides

The HPGe system can be tripod-mounted or vehicle-mounted to obtain average radionuclide concentrations within the detector's field of view The field of view for a tripod-mounted detector is a circle approximately 45 feet in diameter The field of view for a detector mounted on a vehicle and towed 25 feet above the ground is a circle approximately 195 feet in diameter. The HPGe system detects radionuclide concentrations (if unshielded) in soil in pCi/g of gamma emitting radionuclides including, but not limited to, potassium-40, radium-226, thorium-232, cesium-137, americium-241, plutonium-239, plutonium-240, and uranium-233,-234,-235,-238 The EMD OP for the HPGe system is presently under development and should be available prior to any OU14 field work. Other equipment requirements are listed in Section 5 2 of EMD OP FO.16. It should also be noted that the radiological instrumentation manufacturers are making significant progress in developing state-of-the-art equipment capable of seeing the RFP radionuclide mixtures in soil.

The FIDLER surveys are recommended in the IAG Task 5 "required actions " FIDLER detection systems are based on sodium iodide detector capabilities. This type of detector assembly was developed many years ago and used extensively at RFP and the Johnston Islands Throughout the FSP (Section 6 0) references are made to use the FIDLER and HPGe detection systems. For the purposes of screening alpha particles the FIDLER system can be used however, any isotopic identification will require the use of the HPGe exclusively References to the radiological surveys will be stated as "and/or" when referring to the FIDLER and HPGe survey methods

The specific procedures for implementing the radiological survey are provided in EMD OP FO 16, Field Radiological Measurements. Additional relevant procedures are provided in the Environmental Management Radiological Guidelines The procedures include the following

EMRG 1 0 Organization and Responsibilities
EMRG 1 1 Gamma Radiation Surveys
EMRG 1 2 Beta Radiation Surveys
EMRG 1 3 Posting of Radiation Protection Requirements
EMRG 2.1 Personnel Contamination Monitoring
EMRG 2 2 Possible Inhalation Exposure
EMRG 2 3 Wounds and Skin Contamination
EMRG 3.1 Performance of Surface Contamination Surveys
EMRG 6 6 Use of the Bicon FIDLER
EMRG 9 1 Respiratory Protection Requirements and Posting

Additional procedures may be required in developing the Health & Safety Plan (HASP) for implementing the RFI/RI work plan at OU14 Appendix F contains the EG&G site-specific HASP Guidance for a subcontractor to develop a HASP for OU14 implementation

As discussed in Section 6 3, the HPGe Field Implementation Procedure will be utilized as it becomes available after the required procedure approval process with CDH/EPA

6.5.3 Surficial Soil Sampling Procedure

Surficial soil sampling for radionuclide, organic, and metal analyses will be conducted in accordance with EMD OP GT.2, EMD OP GT.8 and FO.16 These procedures will not be modified unless approved by DOE/EPA/CDH Two-inch surface scrapes will be collected with a stainless steel scoop.

6.5.4 Soil Gas Survey

Real-time soil gas sampling will be conducted at specific OU14 IHSSs presented in Section 6 3 according to procedures in EMD OP GT.9. Soil gas samples will be collected through a 1-inch-diameter stainless-steel probe rod driven by a hydraulic rig mounted on a vehicle Depending on subsurface conditions, the rig will hammer through overlying concrete or asphalt where possible, and drive the probe rod through subsurface materials. Soil gas samples will be collected at an approximate depth of 5 feet through tubing inserted through the center of the rod Samples thus collected will be immediately injected into the mobile laboratory for VOC analysis. Alternative soil gas techniques, such as passive collection methods, may be utilized if site conditions warrant

Soil samples may also be collected using the hydraulic probing rig. A Kansas Soil Sampler is attached to the end of the rod, and an extension rod inserted to release a piston within the sampler The sampler is driven one foot into the soil and a soil core removed The soil sampler will be used to collect discrete screening samples for VOC analysis in the mobile laboratory. An OP will be developed to support collection of soil screening samples using the hydraulic probing rig

6.5.5 Borehole Drilling and Soil Sampling Procedures

Borings will be drilled to determine the geotechnical characteristics of the soil, to further investigate trends identified in screening tasks, to collect samples for physical and chemical analysis, and to install monitoring wells. Before any boreholes are drilled, utilities will be located and the drill site will be cleared in accordance with EMD OP GT.10

Borings drilled for the purpose of documenting soil contamination will be drilled to the water table or 3 feet into weathered bedrock, whichever is encountered first In monitoring well borings, soils collected from beneath the water table will not be submitted for chemical analysis, and borings will be advanced only 3 feet below the bedrock contact.

Hollow-stem auger drilling will be conducted in accordance with EMD OP GT.2, except where material is impenetrable with this method. If auguring is ineffective, rotary drilling will be used in accordance with EMD OP GT 4. Rotary drilling will only be used in situations where material is impenetrable, with hollow-stem auguring the method of choice. At locations with shallow borings where the drill rig cannot enter, hand augers will be used in accordance with guidelines in EMD OP GT 2 and GT.8

All drill cuttings and soil samples will be surveyed for radionuclides and organic vapors in accordance with EMD OP FO.15, Use of Photoionizing and Flame Ionizing Detectors, and EMD OP FO.6, Field Radiological Measurements. Investigation-derived wastes, such as drill cuttings and residual samples, will be handled according to guidelines in EMD OP FO 23 (not yet approved but under development) and FO 9

All equipment must be decontaminated before and after drilling and sampling takes place in accordance with the procedures outlined in the EMD OP FO.3 and FO 4 Decontamination water will be handled according to guidelines in EMD OP FO.7

All of the borings not completed as monitoring wells will be grouted and abandoned immediately after drilling in accordance with procedures outlined in EMD OP GT.5. Procedures specified in this EMD OP are designed to prevent vertical migration of contaminants after abandonment

Equipment requirements are listed in EMD OP GT.2, Section 5 1, other applicable EMD OP are listed in Section 4.2 of this work plan

Soil samples will be collected during drilling for visual logging in accordance with EMD OP GT 1 and for chemical and physical analysis in accordance with EMD OPs GT 2 and FO 13 The soil samples will be collected using a hollow-stem auger with a continuous-core sampler Continuous core will be collected for geologic descriptions for the entire borehole depth From this core, discrete, 2-foot samples will be submitted for laboratory analyses In addition, a discrete sample may be submitted to the laboratory if staining, discoloration, odor or other anomaly is observed during drilling Soil samples should be collected in core liners that are capped and sealed upon recovery

6.5.6 Installing and Sampling of Groundwater Monitoring Wells

All monitoring wells will be constructed with materials specified in EMD OP GW.6. A hollow-stem auger with an inner diameter a minimum of 4 inches larger than the outer diameter of the well casing will be used to drill the monitoring wells, thus producing a minimum annular space of 2 inches Well construction techniques will follow procedures outlined in EMD OP GT 6 Investigation-derived wastes such as cuttings and residual samples, will be handled in accordance with guidelines outlines in EMD OP FO 8.

Well construction techniques for all monitoring wells will follow procedures contained in EMD OP GT.6 Monitoring wells in high-traffic paved areas will be completed flush with the pavement Wells in areas not exposed to vehicular traffic will be protected by the placement of steel posts around the monitoring wells, as described in EMD OP GT 6 Pressure grouting procedures will follow guidelines outlined in EMD OP GT.3 Additional

equipment and materials that may be needed for monitoring well installation are listed in EMD OP GT.6, Section 5 1, other related EMD OPs are cross-referenced in Section 4 2 of EMD OP GT 6

The wells will be developed no sooner than 48 hours and no longer than 2 weeks after completion and will not be sampled until at least 2 weeks after development. Water levels will be measured in all wells and recorded as outlined in EMD OP GW.1 and the appropriately cross-referenced EMD OP listed in Section 4.2 of the EMD OP GW 1. After the water levels reach static conditions, the wells will be developed utilizing low-energy methods, such as an inertial pump or bottom discharging bailer Well development will follow procedures outlined in EMD OP GW.2

Prior to groundwater sampling, three to five casing volumes of water will be purged from the well by either bailing or pumping. Purging procedures will follow those contained in EMD OP GW 6 Field parameters (pH, specific conductance, temperature) will be measured after every half casing volume is removed as described in EMD OP GW.6.

Groundwater samples will be collected in a manner that will minimize the amount of agitation or limit the exposure of the sample to the atmosphere Groundwater sampling will be conducted by bailing or the use of a bladder or peristaltic pump Samples will be collected, handled, and screened in accordance with EMD OP GW.6 and all related EMD OP.

All development and purge water will be handled in accordance with guidelines outlined in EMD OP FO.8 Equipment needed for groundwater sampling is listed in EMD OP GW 6

Field parameters will be measured when each groundwater sample is collected Specific conductance, pH, temperature, dissolved oxygen, redox potential, total alkalinity, and turbidity will be measured when groundwater samples are collected in accordance with EMD OP GW.6

6.5.7 Surveying of Sample Locations

The locations of all radiometric survey points, soil gas survey points borings, and surface sampling points will be measured with a steel tape prior to sampling or drilling After sampling, drilling, or well installation, locations will be surveyed using standard land surveying techniques described in the EMD OP GT 17 Horizontal accuracy will be ±0.5 foot for surficial soil samples, soil gas survey points, and borings and ±0.1 foot for temporary well point locations and wells Vertical accuracy will be ±0.1 foot for borings and well point locations, 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

This section describes the sample handling procedures and analytical program for samples collected during the RFI/RI investigation It includes discussions of sample designations, analytical requirements, sample containers and preservation, and sample handling and documentation

6.5.8 Sample Designation

All sample designations generated for the RFI/RI will conform to the input requirements of the RFEDS Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media sample (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 A similar sample designation system will be used for samples collected during the field screening task including soil gas results, soil and groundwater screening results, and radiological surveys Boring numbers will be developed independently of the sample number for a given boring, and will be assigned by EG&G with appropriate cross-references. These sample numbering procedures are consistent with the RFP QAPjP. If input requirements for the RFEDS system have changed from the above listed, the most current system will be used.

6.5.9 Analytical Requirements

The analytical suites for each OU14 IHSS were developed according to the type of waste suspected to be present at each site Table 6-2 lists the specific analytes in the above groups and their CLP detection/quantitation limits. Generally, samples from the RFI/RI will be analyzed for some or all of the following chemical and radionuclide parameters

- Uranium-233,-234, uranium-235, and uranium-238
- TCL semivolatiles
- Transuranic elements (plutonium and americium radioisotopes)
- Gross alpha and gross beta
- TCL volatiles
- TAL metals

Groundwater samples collected from wells installed in the OU14 RFI/RI will be analyzed for the parameters listed above as well as for major cations, major anions, TDSs,

and pH Other field parameters, including pH, conductivity, temperature, dissolved oxygen, oxidation-reduction potential, sulfate, nitrate, and turbidity will be measured in accordance with EMD OP GW 5

The analytes and limits detailed in Table 6-2 address the bulk of detection of potential soil and groundwater contamination Nitrates are included because low-level radioactive wastes with high nitrate concentrations may be present Metals are suspected at many of the IHSSs in OU14, therefore, all of the TAL analytes have been selected for RFI/RI analysis Both filtered and unfiltered samples of groundwater will be collected and analyzed at each location

The following uranium isotopes have been selected for analysis uranium-233, 234, uranium-235, uranium-236, and uranium-238. Plutonium is a transuranic element that is used on the site, however, americium is a daughter product of plutonium and has also been detected in soil at OU14 Therefore, both plutonium and americium have been selected as radionuclide parameters The gamma emissions coming from uranium, plutonium, and americium can be detected with the HPGe system Gross alpha and gross beta are included as general radiological parameters because they are useful indicators of radionuclides. Gross alpha and gross beta will be requested on all soil and groundwater samples sent to an off-site laboratory for analysis

Volatile and semivolatile organics have been historically stored and spilled at selected OU14 IHSSs, therefore, all of the TCL volatile and semivolatile organics will be included

A list of analytical parameters and proposed detection limits for the soil gas surveys at OU14 are in Table 6-4 The mobile laboratory GC is capable of detecting other volatile organics

6.5.10 Sample Containers and Preservation

Sample volume requirements, preservation techniques, holding times, and container material requirements are dictated by the media being sampled and the analyses to be performed The matrices to be analyzed include soils and groundwater. Table 6-3 lists the analytical parameters of interest in OU14 for water and soil matrices, along with the associated container size, preservatives (chemical and/or temperature), and holding times Additional specific guidance on the appropriate use of containers and preservatives is provided in EMD OP FO 13 (Containerizing, Preserving, Handling, and Shipping of Soil and Waste Samples)

6.5.11 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 EMD OP FO.13.

6.6 Data Management and Reporting

Field data will be input to the RFEDS using a DATACAP remote data entry module supplied by EG&G. Data will be entered on a daily basis, and a 3.5-inch computer diskette will be delivered to EG&G. A hard copy report will be generated from the module for contractor use The data will undergo a prescribed QC process based on EMD OP FO.14

The contractor will maintain a database for field data that is collected during screening task, and will provide 3 5-inch diskettes and hard copies to EG&G for their use

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 provided by EG&G Computer and data security measures will also follow acceptable procedures outlined by EG&G The RFEDS system is evolving, therefore, data management will follow the procedures in effect at the time this field work is implemented

As mentioned previously, forms will be developed to document the results of investigations Forms provided in the various OP referenced in Sections 6.2, 6 3, and 6 4 will also be utilized as appropriate to document and manage the data obtained during the OU14 RFI/RI

6.7 Field Quality Control Procedures

Field QC procedures for media screening tasks, soil sampling, and groundwater sampling are discussed in this section. Field procedures for soil and groundwater sampling are established from previous investigations at RFP. QC procedures for media screening including equipment calibration, media sample collection procedures and equipment, and decontamination procedures are discussed in Section 10 0

Sample duplicates, field preservation blanks, equipment rinsate blanks and trip blanks will be prepared, and the analytical results obtained for these samples will be used by the Remediation Program Division (RPD) 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 6-5

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 original samples. They will also be preserved in the same manner and submitted for the same analyses as required for the original samples.

Field blanks of analyte-free (ASTM Type II) water will be prepared by the sampling team and used to provide an indication of any contamination introduced during field sample preparation

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 Procedures for monitoring field QC are provided in the sitewide QAPjP

Trip blanks consisting of distilled water will be prepared by the laboratory and will accompany each shipment of samples for volatile organic analysis Trip blanks will be stored with the group of samples with which they are associated Results of trip blank analyses will indicate migration of volatile organics or any problems associated with sample shipment, handling, or storage

6.8 Air Monitoring and Sampling 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 Plan for Prevention of Contaminant Dispersion (EG&G 1991g) and in accordance with EMD OP FO 1

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 shall be conducted.

- Local real-time monitoring of respirable suspended particulates (RSP) at individual activity work sites shall be conducted using a TSI Piezobalance Model 3500 Respirable Aerosol Mass Monitor. Local TSP measurements will be used to guide the project manager's evaluation of the potential hazards associated with activity-related emissions. The threshold TSP concentration for curtailing intrusive activities will be designated in the site-specific HASP

- Additional worker health and safety monitoring shall be conducted as required by the site-specific HASP.

As mentioned in Sections 6.0 and 8.0, one goal of the RFI/RI is to support quantitative evaluation of human health risk due to inhalation of contaminants derived from OU14 surface soils Inhalation exposure often is evaluated by direct measurement of suspended particulate concentration, assuming a conservative suspended particulate concentration in ambient air Any surface soil contamination as a result of OU14 releases is expected to occur as individual sites of limited area scattered throughout the RFP 400, 600, 800 Areas As a result, suspended particulate data from air samples collected in the vicinity of OU14 sites probably would be representative of the 400, 600, 800 Areas

Total suspended particulate and respirable particulate data are collected at a monitoring station located near the RFP east gate. Suspended particulate data also have been collected in the vicinity of the 903 Pad east of the 400, 600, and 800 Areas, and may be collected for other RFP OUs prior to or during the OU14 RFI/RI If areas of surface soil contamination are identified at OU14 during field activities, suspended particulate data from these sources will be evaluated for applicability to OU14 inhalation exposure evaluation If appropriate, these data will be used to provide a conservative estimate of total suspended particulates and respirable particulates in the vicinity of OU14. However, if it is determined that these data may not be representative of OU14 conditions, an OU14-specific air sampling program will be designed to provide the necessary data An evaluation of the Radioactive

Ambient Air Monitoring Program (RAAMP) is currently under way This air sampling program could be addressed in a technical memorandum

TABLE 6-1
OU14 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

IHSS NO.	IAG ACTIVITY	PROPOSED FSP ACTIVITY	RATIONALE
131	Submit ARMS Survey	Report Summarized in Section 2 2	Limited use for FSP development
	G-M FIDLER Radiological Survey of Surface	G-M FIDLER and/or HPGe Survey	HPGe provides improved coverage
	2" surface scrapes at 25' centers	Same	Confirmation sampling
	2' soil borings at 25' centers	Same	Depth of contamination
156 1	Submit ARMS Survey	Report Summarized in Section 2 2	Limited use for FSP Development
	G-M FIDLER Radiological Survey of Surface	G-M FIDLER and/or HPGe Survey	HPGe provides improved coverage
	2" surface scrapes on 50' grids	Same	Confirmational sampling
160, 161	Submit ARMS Survey	Report summarized in Section 2 2	Limited use for FSP Development
	Submit Radiometric Survey	None, Appendix A summarizes radiological survey data	Site-specific information can be used to concentrate sampling area

TABLE 6-1
OU14 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

IHSS NO.	IAG ACTIVITY	PROPOSED FSP ACTIVITY	RATIONALE
		Conduct FIDLER and/or HPGe Survey of Surface Surficial Soil Depth Profile Concrete/Asphalt	Increased Areal Coverage
	2" surface scrapes on 50' offset grid	Same with confirmational	Confirmational sampling
	Soil Gas Survey on 50' offset grid	Same	Adequate coverage
	Soil Borings at soil gas survey locations	Same	Confirmational sampling
	Verify Destination of Excavated Soils	Same	--
162	Submit Radiological Survey Data	Appendix A contains the referenced survey data	Site-specific information can be used to concentrate sampling area
	Conduct FIDLER radiological survey on road	FIDLER and HPGe Survey Includes Surface including concrete and asphalt Surficial Soil Depth Profile	Increased areal coverage
	2" surface scrapes depending on survey result	2" surface scrape on 100' interval plus concentrated in areas of known or suspected contaminants	

TABLE 6-1
OU14 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

IHSS NO.	IAG ACTIVITY	PROPOSED FSP ACTIVITY	RATIONALE
164 1,164 2, 164 3	Submit ARMS Survey	Report Summarized in Section 2 2	Limited use in FSP development
	Conduct G-M FIDLER Radiation Survey	Fidler and HPGe Survey Includes Surface including concrete and asphalt Surficial Soil Depth Profile Concrete/Asphalt	Increased Areal Coverage
	2" Surface Scrapes at 25' centers	Some	Confirmational sampling
	Soil Borings at 25 ' centers	Soil Borings	Extent of contamination

TABLE 6-1A
POTENTIAL OU14 RFI/RI TECHNICAL MEMORANDA

Tech. Memo Number	Due Date	Topics Addressed
TM1[a]	Following completion of additional data compilation activities	• Results of additional compilation activities • Detailed plan for surface radiation survey
TM2	Following completion of Stage 1 investigations	• Results of Stage 1 investigations • Stage 2 investigation FSP[b]
TM3	Following completion of Stage 2 investigations	• Results of Stage 2 investigations • FSP for additional Stage 2 investigations, if required

[a] Agency update of any change to workplan required by additional data

[b] If any modifications to the Stage 1 FSPs are necessary based on the results of surface radiation surveys, then the survey results and the necessary FSP modification(s) will be addressed in a separate technical memorandum If no FSP modifications are necessary, the surface radiation survey results will be addressed in the Phase I RFI/RI Report

TABLE 6-2

ANALYTICAL PARAMETERS AND DETECTION/QUANTITATION LIMITS
FOR STAGE 1 SAMPLING ACTIVITIES AT OU14

Analytical Parameter	Water Limits	Soil Limits
Target Analyte List (Metals†)	(µg/l)	(mg/kg)
Aluminum	200	40 0
Antimony	60	12 0
Arsenic	10	2 0
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, Total	100	20
Lead	5	1 0
Lithium*	100	20
Magnesium	5000	2000
Manganese, Total	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
Total Organic Carbon†	1 µg/l	1 mg/kg

TABLE 6.2

ANALYTICAL PARAMETERS AND DETECTION/QUANTITATION LIMITS
FOR STAGE 1 SAMPLING ACTIVITIES AT OU14
(Continued)

Analytical Parameter	Water Limits	Soil Limits
Target Compound List (Volatiles[+])	(µg/l)	(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
1,2-Dichloroethene (Total)	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
1,2-Dichloropropane	5	5
cis-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
Trans-1,3-Dichloropropene	5	5
Bromoform	5	5
4-Methyl-2-pentanone	5	10
2-Hexanone	10	10
Tetrachloroethene	10	5
Toluene	5	5
1,1,2,2,-Tetrachloroethane	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Total Xylenes		5

TABLE 6.2

ANALYTICAL PARAMETERS AND DETECTION/QUANTITATION LIMITS
FOR STAGE 1 SAMPLING ACTIVITIES AT OU14
(Continued)

Analytical Parameter	Water Limits	Soil Limits
Target Compound List (Semivolatiles‡)	(µg/l)	(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

TABLE 6.2

ANALYTICAL PARAMETERS AND DETECTION/QUANTITATION LIMITS
FOR STAGE 1 SAMPLING ACTIVITIES AT OU14
(Continued)

Analytical Parameter	Water Limits	Soil Limits
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

TABLE 6.2

ANALYTICAL PARAMETERS AND DETECTION/QUANTITATION LIMITS
FOR STAGE 1 SAMPLING ACTIVITIES AT OU14
(Continued)

Analytical Parameter	Water Limits	Soil Limits
Radionuclides†	(pCi/l)	(dry)(pCi/g)
Gross Alpha	2	4
Gross Beta	4	10
Uranium 233+234, 235, and 238 (each isotope + Total)	0 6	0 3
Americium 241	0.01	0 02
Plutonium 239+240	0 01	0 03
Anions†	(mg/l)	
Nitrate/Nitrite	5	TBD
Sulfate	5	TBD
Chloride	5	TBD
Fluoride	0 1	TBD
pH	0 1 pH unit	TBD
Specific Conductance	TBD	TBD

†Limits refer to detection limits
‡Limits refer to quantitation limits
*Non-CLP TAL Metals detection limit
TBD - To be determined

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

Detection/quantitation limits for residue samples are not specified by the GRRASP The unknown nature of this matrix prevents establishment of specific limits Detection/quantitation limits will be the minimum obtainable for a given matrix

TABLE 6-3
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SOIL AND WATER SAMPLES

SOIL SAMPLES

Parameter	Container	Preservative	Holding Time
TAL Metals	1 x 250 mℓ wide-mouth glass jar	Cool, 4°C	180 days[1]
Cyanide	1 x 250 mℓ wide-mouth glass jar	Cool, 4°C	14 days
TCL Volatiles	2 x 125 mℓ wide-mouth Teflon-lined jar	Cool, 4°C	7 days
TCL Semivolatiles	1 x 250 mℓ wide-mouth Teflon-lined jar	Cool, 4°C	7 days until extraction, 40 days after extraction
Radionuclides	1 x 1 ℓ wide-mouth glass jar	None	180 days
TOC, Anions, pH, and specific conductance	1 x 250 mℓ wide-mouth glass jar	Cool, 4°C	28 days

[1]Holding time for mercury is 28 days

WATER SAMPLES

Parameter	Container	Preservative	Holding Time
TAL Metals	1 x 1 ℓ polyethylene bottle	Nitric acid pH <2, Cool, 4°C	180 days[1]
Cyanide	1 x 1 ℓ polyethylene bottle	Sodium hydroxide pH >12, Cool, 4°C	14 days
TCL Volatiles	2 x 40 mℓ VOA vials with teflon-lined septum lids	Cool, 4°C	7 days
TCL Semivolatiles	1 x 4 ℓ amber glass bottle	Cool, 4°C	7 days until extraction, 40 days after extraction
Radionuclides	12 ℓ polyethylene bottle(s)	Nitric acid pH <2, Cool, 4°C	180 days
TOC	1 x 250 mℓ polyetheylene bottle	Sulfuric acid pH <2, Cool, 4°C	28 days
Anions	1 x 1 ℓ polyethylene bottle	Cool, 4°C	28 days
Nitrate/Nitrite	1 x 250 mℓ polyethylene bottle	Sulfuric acid pH <2, Cool, 4°C	28 days
pH, temperature, and specific conductance	In-situ, beaker or bucket	None	Analyze immediately

[1]Holding time for mercury is 28 days

TABLE 6-4
SOIL GAS PARAMETERS AND PROPOSED DETECTION LIMITS

Sample Type	Detection Limit (μg/l)
Acetone	1
Carbon tetrachloride	1
PCE	1
Toluene	1
1,1,1-tetrachloride	1
Benzene	1

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

TABLE 6-5
FIELD QC SAMPLE FREQUENCY

Sample Type	Type of Analysis	Sample Frequency	
		Solids	Liquids
Duplicates	Organics	1/10	1/10
	Inorganics	1/10	1/10
	Radionuclides	1/10	1/10
Field Blanks	Organics	N/R	N/R
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Equipment Blanks	Organics	1/20	1/20
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Trip Blanks[1]	Volatiles		

N/R = Not Required
1/10 = one QC sample per ten samples collected
[1] = 1 per cooler containing volatile scan
1/20 =

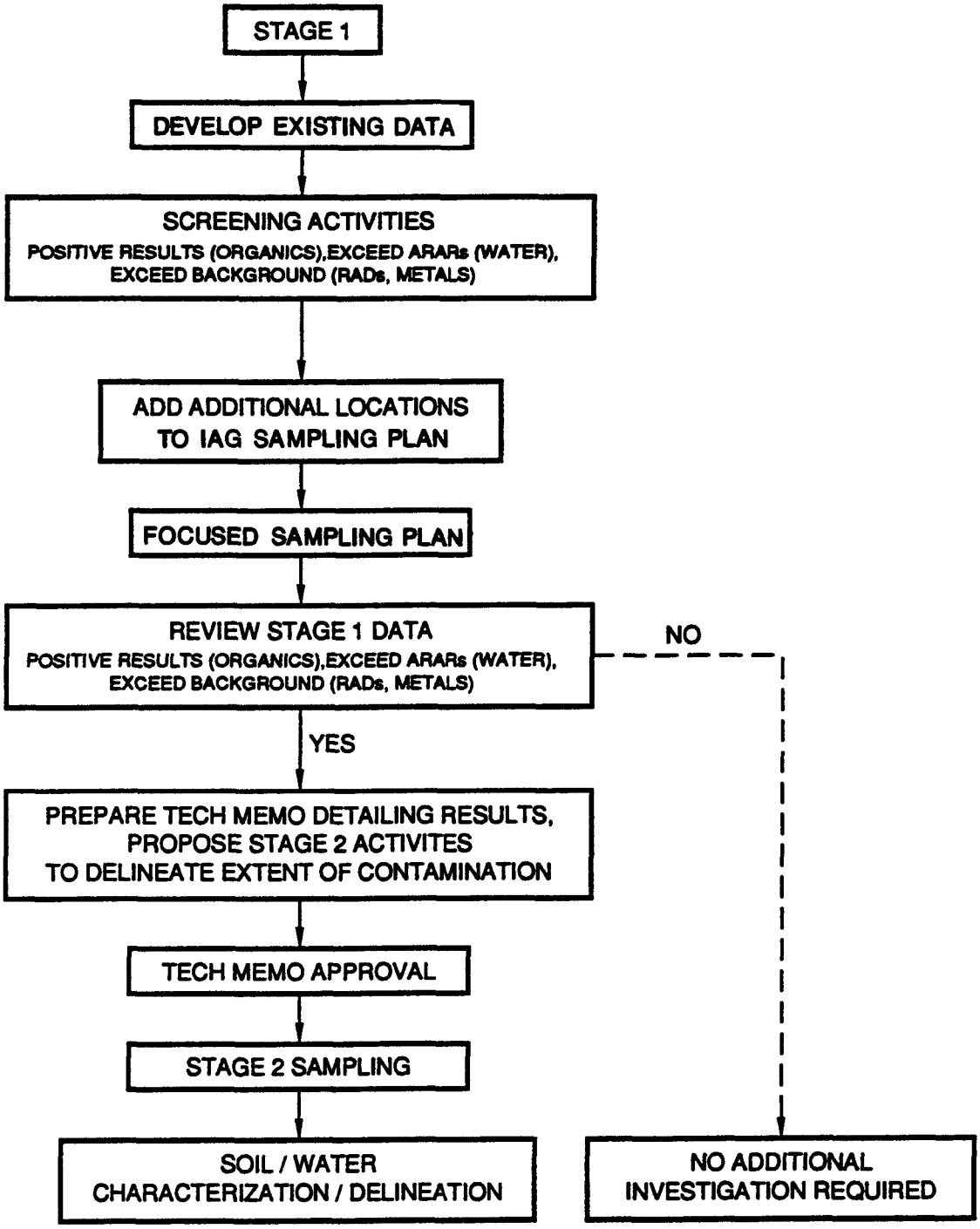


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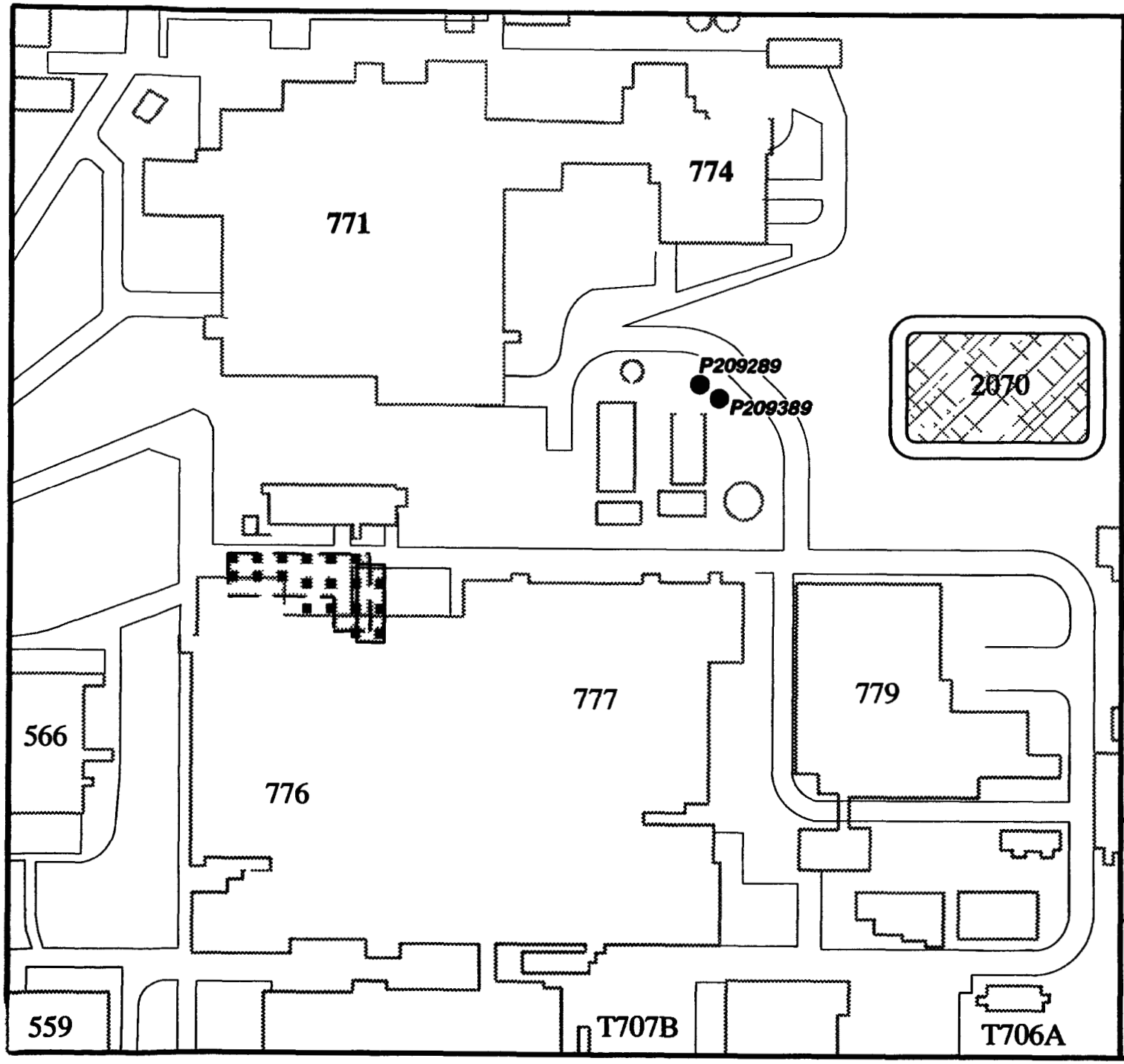
FIGURE 6-1

OU 14 RFI/RI
STAGED APPROACH



Survey Sample Location
- 2" surface scrapes at 25 ft centers
- 2' soil borings at 25 ft centers

Ground water wells

Paved roads

Unimproved dirt roads

Individual hazardous substance sites (IHSS)

Buildings or structures

Ponds/lakes

0 75 150 300
FEET

N

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FIGURE 6-2

SOIL BORING LOCATIONS
IHSS 131

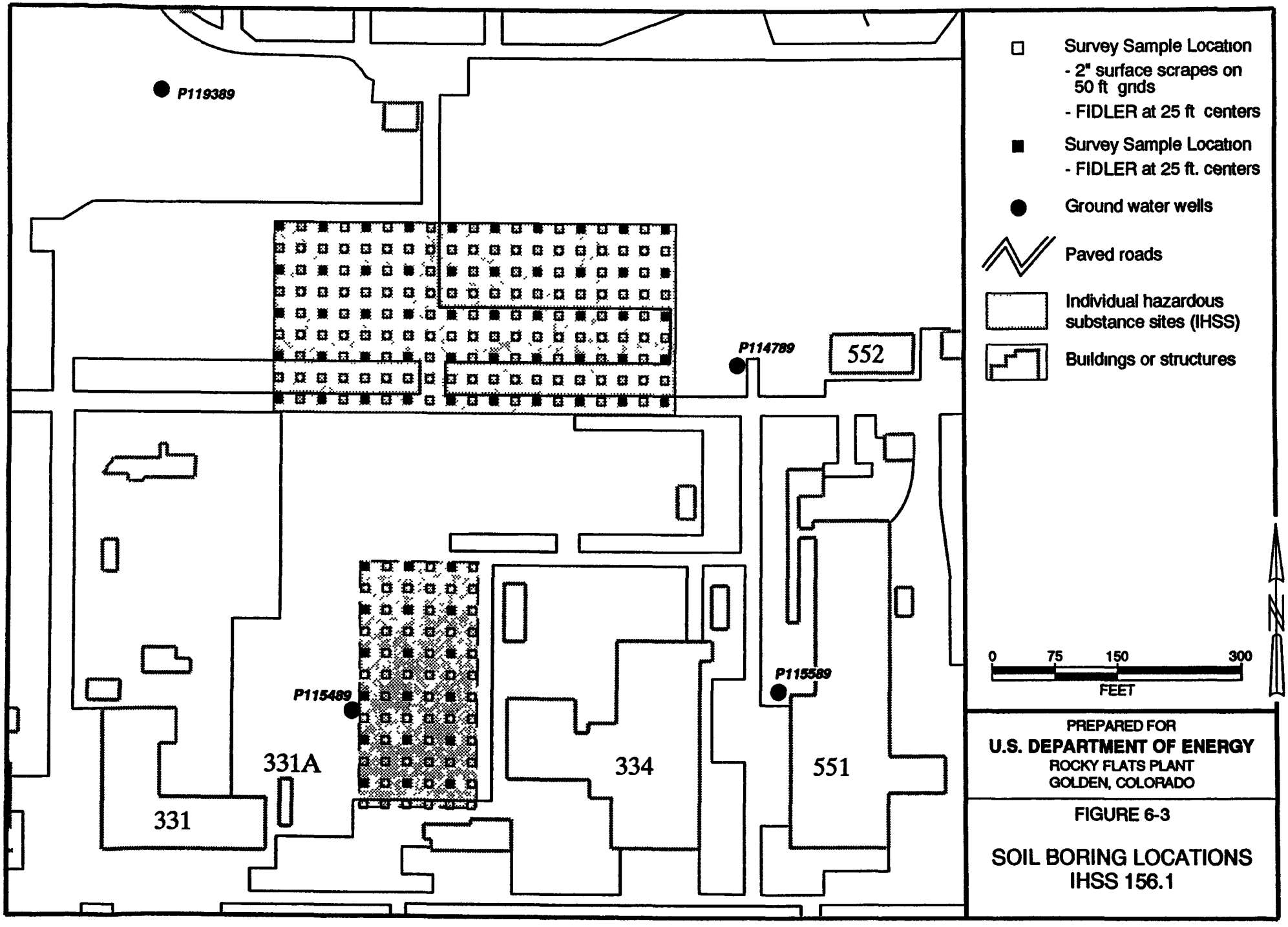

FIGURE 6-3

SOIL BORING LOCATIONS
IHSS 156.1

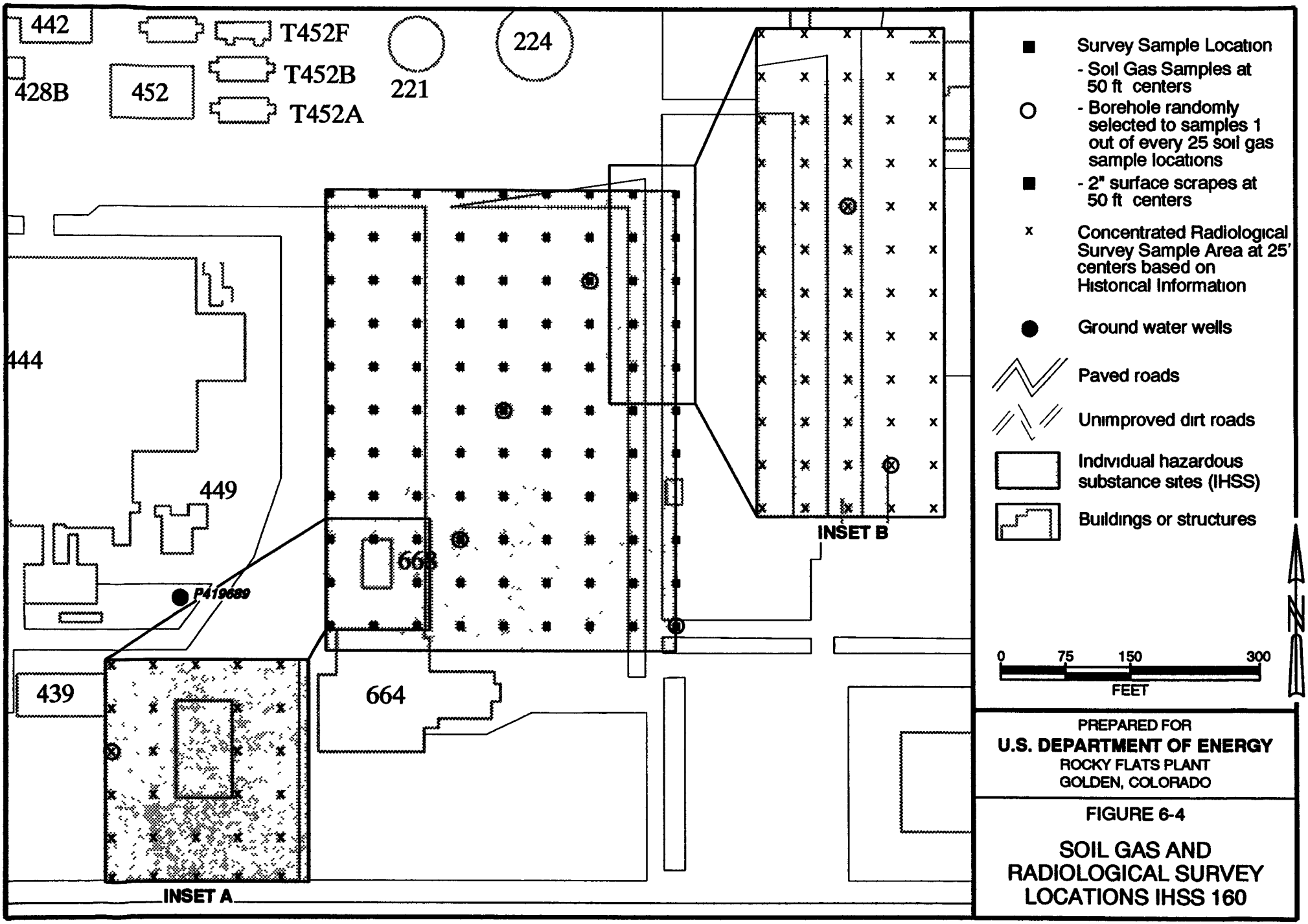

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FIGURE 6-4

SOIL GAS AND RADIOLOGICAL SURVEY LOCATIONS IHSS 160

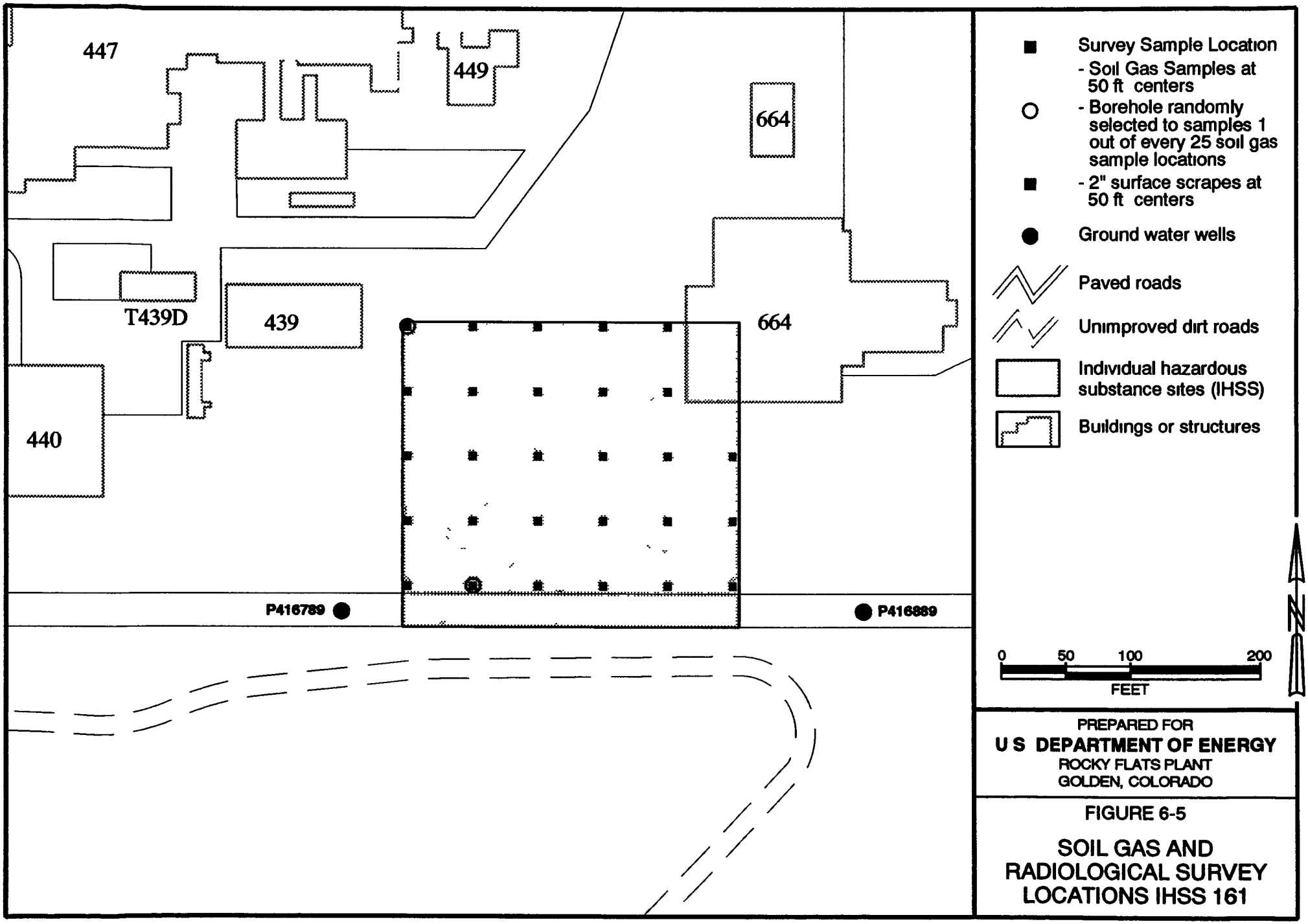

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FIGURE 6-5

SOIL GAS AND RADIOLOGICAL SURVEY LOCATIONS IHSS 161

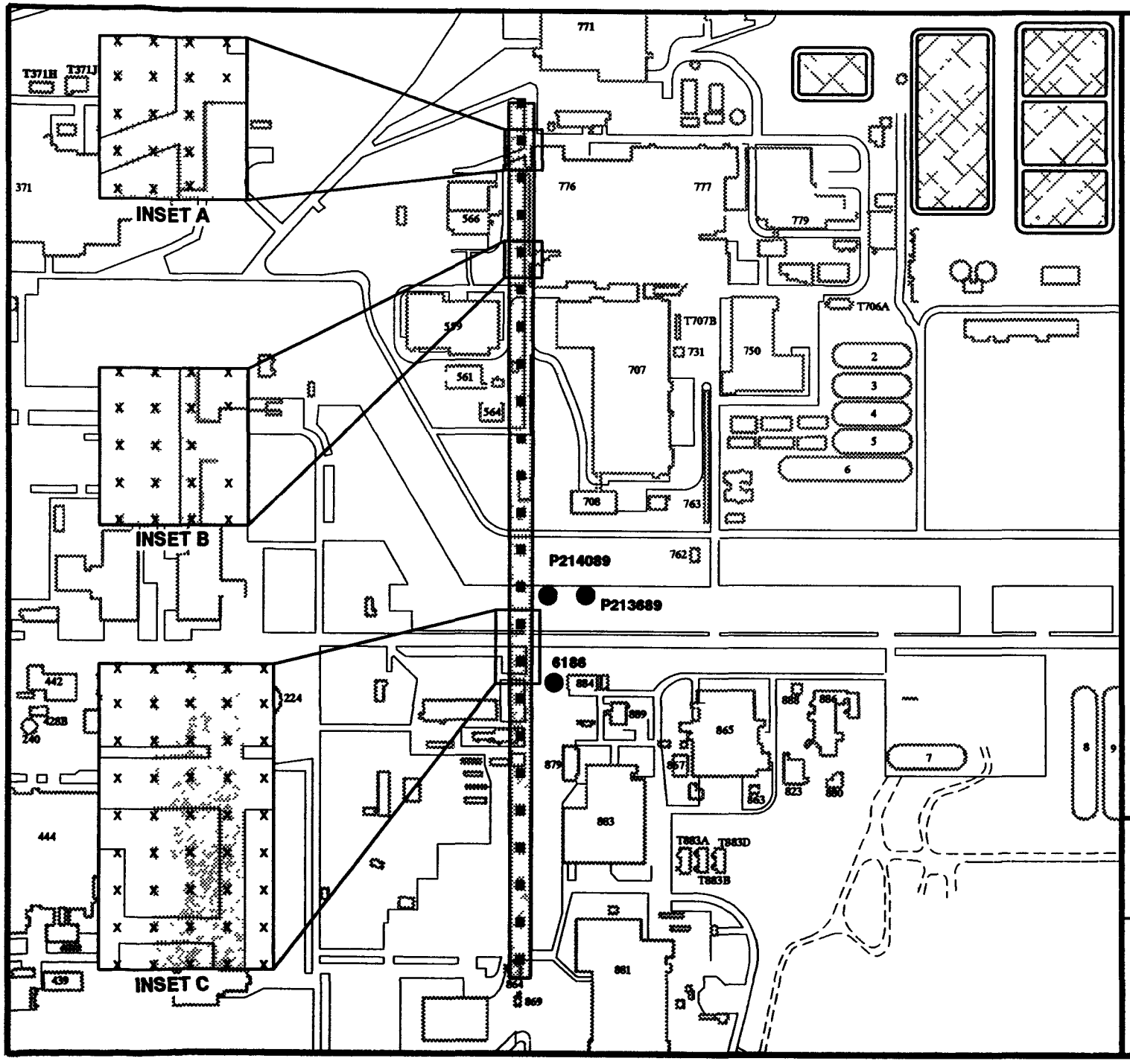

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FIGURE 6-6

RADIOLOGICAL SURVEY LOCATIONS IHSS 162

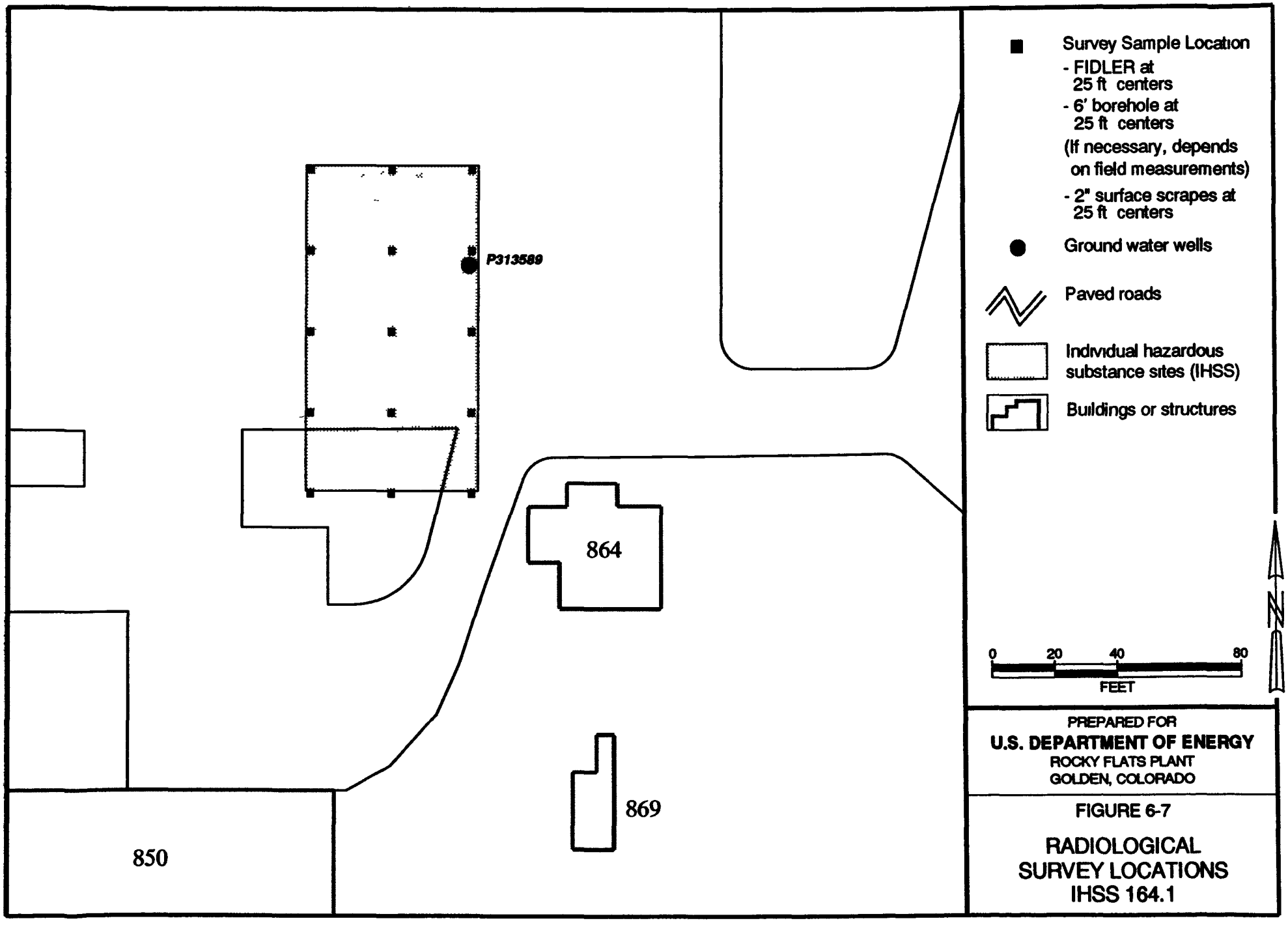

FIGURE 6-7

RADIOLOGICAL SURVEY LOCATIONS IHSS 164.1

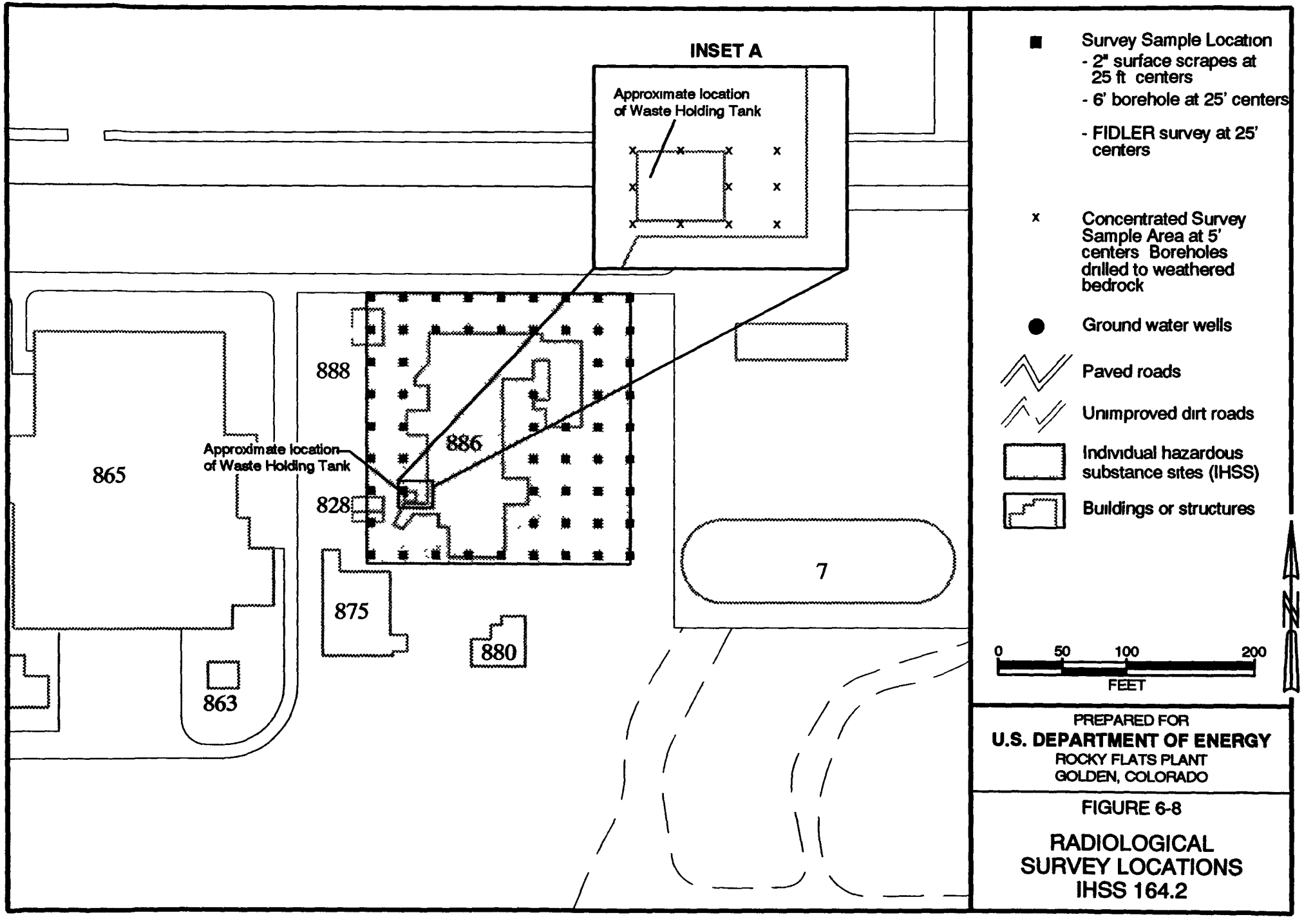

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FIGURE 6-8

RADIOLOGICAL SURVEY LOCATIONS IHSS 164.2

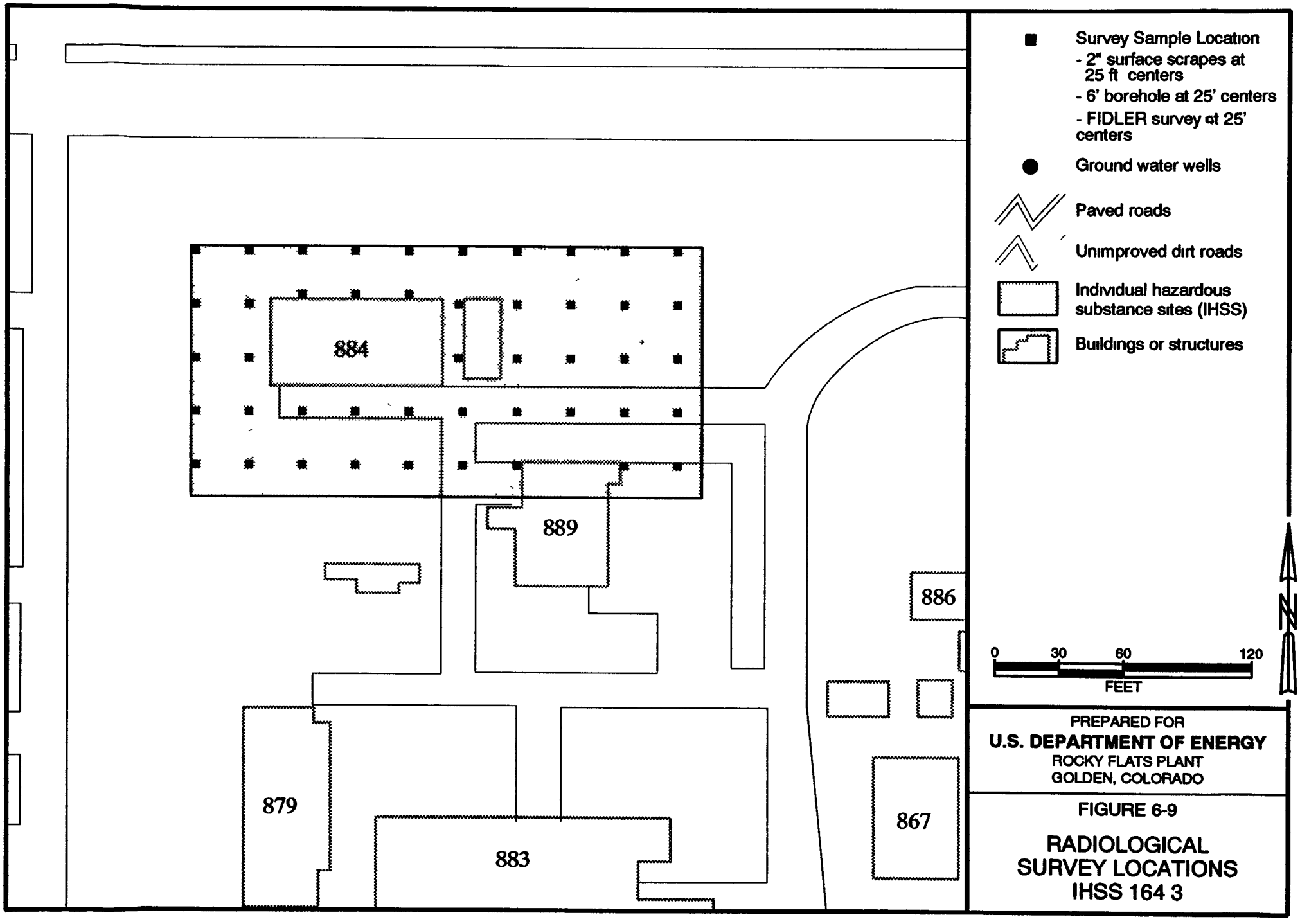

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FIGURE 6-9

RADIOLOGICAL SURVEY LOCATIONS IHSS 164 3

Approved by

_____ / /
Manager, Remediation Programs

_____ / /
RFI Project Manager

7.0 SCHEDULING

A schedule for implementing this OU14 Phase I RFI/RI Work Plan is outlined in the Interagency Agreement However, during preparation of this Final Work Plan, a proposal was developed to conduct an Industrial Area (IA)/Protected Area(PA) IM/IRAP at the Rocky Flats Plant. This proposal is under consideration and pending approval. Further action in regard to this IM/IRAP will impact the schedule for implementing this Work Plan, therefore no schedule is attached at this time

Approved by

Manager, Remediation Programs / /

RFI Project Manager / /

8.0 HUMAN HEALTH RISK ASSESSMENT PLAN

8.1 Overview

The IAG requires that the BRA for each OU include the toxicity and levels of all hazardous substances present, contaminant fate and transport, the potential for human and/or environmental exposure, and the risk of potential impacts or threats on human health and the environment The IAG further states that the BRA must provide the basis for determining whether or not corrective/remedial action is necessary as well as a justification for performing corrective/remedial actions.

Section 300 430(d) of the NCP (Federal Register 55/46/8709) states that as part of the remedial investigation, an HHRA must be conducted as part of a BRA to determine whether, in the absence of remedial action, COCs identified at the site pose a current or potential risk to human health and the environment. This section describes the HHRA and the following component elements

- Contaminant identification
- Exposure assessment
- Toxicity assessment
- Risk characterization
- Uncertainty analysis

8.1.1 Key References

The primary references to be used in conducting the BRA will include but not be limited to the following.

IAG-Specified Current References:

Superfund Exposure Assessment Manual (SEAM)

Office of Emergency and Remedial Response EPA/540/1-88/021 (OSWER Directive 9285.5-1)

Integrated Risk Information System (IRIS)

Interim Final Risk Assessment Guidance for Superfund - Environmental Evaluation Manual

Other References:

Guidance for Data Usability in Risk Assessment Interim Final (EPA/540/6-90/008, October 1990.

International Atomic Energy Agency Safety Series No 100. *Evaluating the Reliability of Predictions Made Using Environmental Transfer Models*, IAEA 1989.

Federal Guidance Report No. 11. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, (EPA-520/1-88-020).

Risk Assessment Guidance for Superfund. Volume I - Human Health Evaluation Manual (Part A, Baseline Risk Assessment) Interim Final. Office of Emergency and Remedial Response (EPA/540/1-89/002).

Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B - Development of Risk-Based Preliminary Remediation Goals) Interim Publication 9285 7-01B, 12/91.

Risk Assessment Guidance for Superfund Volume 1 - Human Health Evaluation Manual Supplemental Guidance: "Standard Default Exposure Factors" Interim Final. Office of Emergency and Remedial Response, OSWER Directive 9285.6-03.

Risk Assessment Guidance for Superfund Volume 1 - Human Health Evaluation Manual ((Part C, Risk Evaluation of Remedial Alternatives) Interim Publication 9285 7-01C, 12/91.

EPA Health Effects Assessment Summary Tables (HEAST) Published by the Office of Research and Development and Office of Solid Waste and Emergency Response. NTIS No. PB91-921100

Publications of the *National Council on Radiation Protection. International Council on Radiation Protection*, United National Scientific Committee on the Effects of Atomic Radiation, as appropriate

Eisenbud, M. *Environmental Radioactivity*, (3rd Edition). Academic Press. 1987

Till and Meyer. *Radiological Assessment: A Textbook on Environmental Dose Analysis.* 1983

8.1.2 Technical Approach to Human Health Risk Assessment

The technical approach to the HHRA component of the BRA is based on the EPA *Risk Assessment Guidance for Superfund Volume I - Human Health Evaluation Manual (Part A Baseline Risk Assessment)* (RAGS) (EPA 1989d). Other technical approach modifications will be evident throughout this section based upon RFP experience in implementing the other BRA Work Plan and meetings with EPA and CDH.

Figure 8-1 illustrates the BRA process taken from RAGS and modified by adding an additional step -- evaluate uncertainty -- to each of the steps. The technical memoranda requirements as specified by the IAG have also been added.

This section focuses on components of the HHRA, while Section 9.0 focuses on the environmental risk assessment The OU14 IHSSs contain a variety of contaminants potentially dominated by the presence of plutonium and other radioactive and/or hazardous materials. This work plan provides a specific methodology to determine the nature and extent of radioactive and hazardous materials noted in previous investigations; it also describes how to identify potential COCs, identify exposure pathways, and estimate exposure concentrations This section of the work plan will also specify a method to collect toxicity information to determine appropriate toxicity values, followed by a characterization of the potential for effects to occur. Uncertainty will be evaluated through each step of the BRA culminating in an overall quantitative BRA uncertainty summary.

Data needs and DQOs are identified in Section 4.0 of this work plan, Section 6.0 describes how these data will be collected. The FSP, the data needs, and the DQOs complement the objectives described in Section 4.2 in that they characterize the nature and extent of contamination and specify the data collection necessary to fully evaluate potential exposure pathways The data to be collected for use in the HHRA include the following media sampling:

- **Soils:** Data characterizing vertical depth of contaminant concentrations in OU14, as a function of depth, will be used to determine whether geostatistical methods, such as spatial correlation or deterministic stats (triangular or polygons) should be employed.

- **Surficial Soils:** Surface soil data will be used to estimate exposure and risk through direct dermal contact, gamma radiation absorption, ingestion (directly as soil, or indirectly as vegetables, and grazing livestock), and, if necessary, to estimate windborne particulate concentrations for subsequent inhalation exposures. Surficial dose rate measurements will also be obtained for purposes of exposure assessment.

- **Surface Water and Sediments:** Data characterizing contaminants in surface water are used to evaluate contaminant fate and transport, and estimate exposure and risk from ingestion or dermal contact with surface water and sediments, and inhalation of sediments

- **Groundwater:** Data characterizing site-specific hydrogeology and potential contaminants in alluvial and confined groundwater systems are used to evaluate contaminant fate and transport and estimate exposure and risk from ingestion, inhalation, or dermal contact with groundwater.

- **Air:** Data characterizing the potential for dispersion of contaminated surficial soils can be used to evaluate contaminant fate and transport and estimate exposure and risk from inhalation and redeposition. Measured and modeled concentrations will be derived to support the exposure assessment.

A comprehensive quantitative assessment of COCs and potential exposure pathways will be performed as part of the RFI/RI The remainder of this section generally describes specific components of the HHRA.

8.2 Potential Contaminants of Concern

This section discusses methods for acquiring reliable radiological and chemical release and exposure data, and presents a protocol to identify COCs.

8.2.1 Data Collection

The objective of the data collection task is to summarize all data available for use in the HHRA in preparation of further data evaluation activities. This step, then, identifies the historical data relevant to performing the HHRA, assembles the RI data, and establishes data formats to facilitate data evaluation. The following data attributes are important to this step:

- Site description
- Sample design with sample locations
- Analytical method and detection limit
- Results for each sample, including qualifiers
- Sample quantification limits and/or detection limits for nondetects

8.2.2 Data Evaluation

Subtasks to be performed as part of the data evaluation task include the following:

- Review of available site data (obtained during all phases of the RI)
- Identification of data gaps
- Analysis of chemicals and radionuclides detected at the site and their frequency of detection
- Testing for statistical distribution of data
- Preliminary identification of potential exposure pathways
- Development of data set for use in the risk assessment

- Identification and selection of appropriate toxicity criteria

Data collected during the RI process will be evaluated for use in developing the preliminary exposure scenarios for the site. Particular attention will be paid to the selection and evaluation of background levels of radionuclides and chemicals, since the BRA quantifies increases in health risks posed by the site over health risks that could be expected if the site were not there In general, synthetic organic chemicals detected at a site, unlike metals, are typically assumed to have zero background concentrations because they are produced by human activities and do not occur in nature. The proper and careful determination of background concentrations will be important in the subsequent attribution of risks to the site.

8.2.3 Hazard Identification

A preliminary review of the existing RFED database was performed on samples taken from boreholes established in or near IHSSs within OU14. The following chemicals were noted as being in concentrations above background (as defined in the *Background Geochemical Characterization Report* for 1989, Rocky Flats Plant (EG&G 1990a). This preliminary list is not intended to limit the analysis to be performed. The chemicals listed below have been provided to introduce a general understanding of what contaminants could be present

The potential COCs have been identified and summarized for each IHSS in Section 2.0. Appendix B includes the statistical summary tables for each IHSS The existing information in most cases was derived from a single location in or near (as in most cases) the IHSS. The following chemicals were consistently identified in concentrations above background

Acetone	Chromium	Nitrate
Aluminum	Copper	Potassium*
Arsenic	Iron*	Toluene
Barium	Lead	Trichloroethene
Beryllium	Magnesium*	Vanadium
Benzene	Manganese	Xylene
Calcium*	Methylene Chloride	Zinc
Carbon Disulfide	Mercury	

* Considered essential nutrients Only high concentrations above background will be considered.

Radioactive material concentrations were detected slightly above background (as currently defined in EG&G 1990a) Radioactive constituents will remain on the potential COC list due to the IHSS history and supporting background information. The radioisotopes currently known to be present include weapons grade plutonium, americium-241, depleted and enriched uranium.

8.2.4 Selection of Contaminants of Concern

Analytical results from OU field sampling will be screened to retain those contaminants most likely to contribute significantly as risks to members of the public. These COCs represent the most toxic, persistent, or mobile contaminants identified at an OU.

RAGs sections 5.8, 5.9, and 10.4 (EPA 1989d) suggests methodologies for the development of a set of chemical data and information for use in the risk assessment and further reduction in the number of chemicals

Generally, the list of chemicals of potential concern include the following:

(1) positively detected in at least one CLP sample (RAS or SAAS) in a given medium, including (a) chemicals with no qualifiers attached (excluding samples with unusually high detection limits), and (b) chemicals with qualifiers attached that indicated known identities but unknown concentrations (e g., J-qualified data),

(2) detected at levels significantly elevated above levels of the same chemicals detected in associated blank samples,

(3) detected at levels significantly elevated above naturally occurring levels of the same chemicals,

(4) only tentatively identified but either may be associated with the site based on historical information or have been confirmed by SAS; and/or

(5) transformation products of chemicals demonstrated to be present.

If a large number of chemicals of potential concern (e.g , > 15) an identified for OU14, a methodology for the reduction of the number of chemicals to be used in the quantitative risk assessment may be employed. The necessity and rationale for eliminated chemicals from the quantitative risk assessment will be developed after the list of potential contaminants is compiled

Consideration of the potential contaminant concentration with respect to historical information, detection frequency, concentration and toxicity, are concentrations in background are examples of activities which can be used to reduce the number of chemicals used in the quantitative risk assessment.

The final screening step is to determine if any of the contaminants retained in the screening process are essential human nutrients As stated in RAGS Section 5.9.4, "chemicals that are (1) essential human nutrients, (2) present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and (3) toxic only at very high doses (i.e., much higher than those associated with contact at the site) need not be considered further in the quantitative risk assessment. Examples of such chemicals are iron, magnesium, calcium, potassium, and sodium." (EPA 1989c) Consequently, contaminants that meet the essential nutrient criteria will not be considered further.

Contaminants retained through the screening process represent the most prevalent, toxic, persistent, or mobile contaminants at an OU These will comprise the list of COCs that will be used in the quantitative risk assessment.

If COCs are selected, adequate documentation will be prepared to justify including or excluding specific contaminants. As required by the IAG Section VII.D.1.a, a technical memorandum that lists the hazardous substances present within OU14 will be prepared and submitted to EPA and the CDH for review and approval. The COCs selected from this list will be included in the technical memorandum with the known corresponding ambient concentrations of these contaminants The memorandum will be submitted prior to the required submittal of the BRA for OU14

8.2.5 Uncertainty in Data Collection and Evaluation

The data collection and evaluation task has four key objectives, and an inherent uncertainty needs to be quantified for each·

- Determine what contamination is present and at what level; estimates of site contamination must be produced including clear descriptions of the degree of confidence associated with each concentration value

- Determine if site concentrations differ significantly from background concentrations, the comparison of data is performed using the null hypothesis at a specified confidence level.

- Evaluate whether analytical data are adequate to identify and examine exposure pathways; the sampling and analysis program should result in data of known quality that quantify spatial and temporal variability, and specify an approach for interpreting the magnitude of observed values.

- Evaluate whether analytical data are adequate to fully characterize exposure pathways, heterogeneity should be considered, and hot spots need to be identified and characterized.

The following PARCC data quality indicators will be used to measure data usability in support of the risk assessment.

- **Precision** - expresses a coefficient of variation or a standard deviation compared to the mean

- **Accuracy** - measures the closeness of a report concentration to the true value (used extensively for blanks and spikes)

- **Representativeness** - expresses the extent to which data defines the risk considering all pathways to human health and the environment

- **Comparability** - expresses the confidence with which data are considered to be equivalent (known precision and accuracy)

- **Completeness** - measures the amount of useable data resulting from a data collection activity

Tables will be developed to document the data usability evaluation process; the example in Table 8-1 illustrates the minimum requirements, impact, and corrective actions for data usability criteria

8.3 Exposure Assessment

The exposure assessment estimates the magnitude, frequency, duration, and route of exposure to humans (see Figure 8-3) The magnitude of exposure is typically determined by measuring or estimating the amount of an agent available at exchange boundaries (e.g., the lungs, gastrointestinal tract, or skin) during a specified time Contact with the agent may lead to some absorption, the magnitude of which is of great importance in applying dose-response data for assessing health risks

Exposure assessments are performed using scenarios that define the conditions of exposure to contaminants at a site. An exposure scenario quantitatively defines the human populations that may be exposed, the frequencies and durations of exposure, the pathways of exposure (e g., inhalation, drinking water, or dermal contact with soil), and the levels of contaminants in the air, water, or soil that contact the population through the exposure pathways

The exposure scenario will identify the site that chemicals could be released from, the potentially exposed populations, the exposure pathways through which the populations could become exposed, release concentrations used for modeling concentrations at points of exposure, and the assumptions used in estimating intake rates in humans.

Exposure assessments for sites involve the following activities:

- Identification of present and future human receptor locations (exposed populations)
- Definition of applicable exposure scenarios for present and future populations
- Definition of physical characteristics of the site that control environmental mobility and contaminant transport
- Identification and evaluation of exposure pathways (fate and transport) applicable to exposure scenarios
- Estimation of exposure concentrations for each applicable pathway at the receptor location for each credible exposure scenario
- Estimation of intakes for each applicable pathway for each credible exposure scenario

8.3.1 Identification of Present and Future Human Receptor Locations

Currently there are approximately 6,000 workers at RFP. In the current exposure scenario, the number of RI personnel (assumed to be less than 100) plus maintenance and construction workers, and consultants totals approximately 200 people potentially exposed to OU14 contaminants The available site data characterizes events that produce contaminated areas For the purposes of this example, the contamination is assumed to be localized and immobile. Present potential human receptors include those individuals performing investigative work similar to the tasks outlined in Section 6.0, and those performing construction or maintenance activities Inadvertent intrusive activities could also lead to potential exposures. As an example, line repairs involving excavations could lead to possible windblown airborne contaminant intakes, inhalation of vapor phase contaminants, and

exposure to external gamma radiation. The current exposure scenarios would be limited due to the site restrictions such as posting and numerous other health and safety requirements.

In 1989, there were 2,201,340 people living within 50 miles of RFP. It is projected that this number will grow steadily to 3,119,309 by the year 2010. Currently, and in future predictions, approximately 14 percent of these inhabitants live within 10 miles of the site (EG&G 1992a). The demographic population wheel is included in Section 1, showing the location of the surrounding populations.

OU14 is located within the developed industrialized area of RFP and consists primarily of asphalt parking lots, concrete loading docks, and paved roads Potential human receptors, therefore, focus on the on-site industrial worker and off-site resident, depending upon resolution of future land-use scenarios, on-site resident commercial/industrial worker activities, residential housing, or research biologist activities might be considered as exposure scenarios for potential on-site receptors. Exposure scenarios will be discussed in detail in the second technical memorandum required by the IAG. Many of the previous RFI/RI work plans and the OU1 RI report have limited the amount of exposure scenarios to be considered. As mentioned in other sections, the current land-use scenarios will be adopted at the time this work plan is implemented

8.3.2 Definition of Applicable Exposure Scenarios for Present and Future Populations

Exposure scenarios will be defined according to the guidance provided in RAGS Reasonable maximum exposure scenarios will be defined considering realistic applications involving contaminant migration and receptor intake. Examples of exposure scenarios for present and future populations are discussed below·

- **Present population scenario:** Current populations of plant site remedial investigators, construction, or maintenance workers could have incidental contact, where workers may have potential intakes via dermal absorption from direct soil contact ingestion, inhalation of vapor phase contaminants, exposure to gamma radiation, and possibly inhale particulates from sudden gusts of resuspended airborne contamination.

- **Future population scenario:** Future populations could potentially be exposed via the on-site industrial complex scenario whereby the plant is converted to a fully developed industrial location, or the residential land-use scenario. In either case, incidental contact from construction or residential activities as described above could also be applicable.

In either case, the technical memorandums on exposure scenarios would discuss all exposure pathways and determine which pathway is complete or incomplete for inclusion in the human health or environmental risk calculations.

8.3.3 Definition of Physical Characteristics of the Site that Control Environmental Mobility and Contaminant Transport

Physical characteristics that could affect the rate of movement of specific contaminants are normally addressed by the environmental fate and transfer models used for each pathway. Groundwater model parameters have input needs that are site-specific involving such factors as transfer coefficients (K_d), which will be selected based upon field investigation. Air model requirements would include knowing the particle size distribution of the contaminated surface. As part of the soil sampling analytical requirements, particle sizing is necessary for radiological dose calculations. Additional field observations including predominant wind direction and influence of the presence of buildings may also be used in the exposure assessment

For each exposure pathway, the model parameters and other unique considerations (chemical and physical) will be summarized. These considerations will provide the necessary input to define the physical characteristics affecting environmental mobility and contaminant transport.

8.3.4 Identification of Exposure Pathways (Fate and Transport) Applicable to Exposure Scenarios

Once potentially exposed populations and exposure scenarios have been identified and characterized, exposure pathways can be traced from the site to identified receptor locations. Each exposure pathway describes a mechanism by which a hypothetical receptor is exposed to chemicals originating from the site Exposure pathways consist of five elements (see Figure 8.3):

- Source of contamination
- Mechanism of chemical release to the environment
- Environmental transport medium (e.g., air, groundwater, fugitive dust emissions, contaminant movement through soil, soil runoff into water bodies) for the released contaminant
- Point of potential human contact with the contaminated medium (i.e., breathing air, drinking water supplied from groundwater, or exposure to contaminated soil)
- Route of entry in humans, either through inhalation, ingestion, or dermal absorption of the contaminated medium

Only those exposure pathways deemed to be complete (i.e., where a plausible route of exposure can be demonstrated from the site to the receptor), will be quantitatively evaluated in the HHRA.

8.3.5 Estimation of Exposure Concentration for Each Applicable Pathway of the Receptor Location for Each Credible Exposure Scenario

Concentrations of COCs in soil, air, and water will be measured or estimated using spreadsheet calculations and computer models. Concentrations are measured as discrete points, or geostatistics (e.g., GEOPAK), or other determinate methods may be used to estimate volume. Typically, the concentrations of COCs in soil with known or suspected contamination will be measured by taking representative soil samples These concentrations in soil will be used as input to the emission, transport and dispersion calculations to determine concentrations at the receptor location for each credible scenario. The estimated concentrations of COCs in each medium will be used to estimate the intake and resulting health risk to the receptor.

Concentrations of COCs in soil are considered to be the primary pathway to the receptor COCs in soil will be sampled and analyzed, other indirect methods of estimating contaminants such as radiological area surveys will be conducted. Measured concentrations in samples collected from representative locations are preferred Depending on the spatial variability of contamination, different averaging criteria may apply to each contaminant Soil concentrations will then be used to derive intake via ingestion and absorption. The other secondary pathways of exposure that were introduced in the conceptual model (Section 2.5.1) will be discussed in the following paragraphs

Emission models will be used to estimate the transfer of COCs from soil to air. The magnitude of this pathway will depend on both the concentrations measured in soil and the transfer mechanism. A preapproved (EPA/CDH) dispersion model will be used to estimate the concentrations of airborne COCs at the selected exposure locations These concentrations will be used in conjunction with estimates of intakes to derive scenario-specific exposure estimates.

Contaminants can be resuspended and transported to other media (e.g., deposition on soil, surface water, or vegetation) through wind erosion or fugitive dust Concentrations of COCs in soil, surface water and sediments, vegetation, meat, and milk are a function of the calculated concentrations in air, deposition rates, and various transfer functions; therefore, the calculated airborne and non-air transfer of contaminants will be used as input to the intake calculations Volatilization rates are also estimated based on the concentrations measured in the soil samples.

Surface runoff can provide a transport mechanism for contaminants to move to a receptor location. Since most of the OU14 IHSSs are paved or contain large amounts of concrete surface materials, this pathway is considered to be highly probable prior to the implementation of the artificial surfacing If the surfacing materials are removed exposing potentially contaminated soil this could affect the estimation of exposure concentrations via this pathway. Currently there is a surface sampling program and sediment sampling has also been specified in Section 6.0 of this workplan

Infiltration/leaching of contaminants into the groundwater has been summarized as a secondary pathway (Section 2.5 1) Contaminants are transported from the surface soils by percolation of surface water through the subsurface media into the groundwater. Appendix B

includes the data from the current groundwater sampling programs. The groundwater moves via seepage and/or pumpage to surface water where it is used as irrigation. The irrigation is for biota which is ingested by humans The exposure estimate for this pathway takes into account a series of transport coefficients and bioaccumulation factors.

Bioaccumulation/bioconcentration is release mechanism for the contaminated soil, plants, surface water and groundwater The combined effect of the various trophic levels through the biological pyramid can be considered however, sampling of various biota will provide the necessary data points to quantitatively evaluate the impact of this pathway

Contaminants could have also been transferred via tracking by humans and/or animals This transport of contaminated material (i.e., soil, plants, or debris) could potentially provide an additional link between the media and human receptors. Prior to the paving or installation of current pads at the various, IHSSs in OU14, the spreading of contamination via man (i.e., including manmade vehicles, etc.) is a highly suspect. Tracking has been summarized in Section 2.5 1 and Figure 2-30. Tracking has been reference in to "biota" which eventually leads to ingestion as a route of entry In reviewing the HRR and the future land uses, human tracking from investigative and remedial actions would be of greater concern.

8.3.6 Estimation of Intakes for Each Applicable Pathway for Each Credible Exposure Scenario

As discussed above, environmental fate and transport modeling and/or monitoring data are used to estimate chemical concentrations in the transport media (i.e., soil, air, water) at the point of contact with the receptor. Such contact constitutes human exposure.

Human exposure is expressed in terms of intake and defined as the amount of a chemical substance taken into the body per unit body weight per unit time. Intake rates are calculated separately for exposures to chemicals in each environmental medium via soil, air, groundwater, surface water, and food. Then, for each exposed population, intake rates are summed for oral and inhalation exposure routes. Intakes are typically expressed in units of milligram of substance per kilogram of body weight per day (mg/kg/day). Adjustments for absorption efficiency may be required for dermal routes of exposure The adjustments include toxicity values (from administered to absorbed doses) and an adjustment for medium of exposure

The following assumptions and calculations are used to estimate intake in humans from exposure to chemicals present in soil, air, groundwater, and surface water The magnitude of exposure to chemicals is influenced by frequency and duration of contact with these media. Also, the age of the potentially exposed individual will influence the extent of contact with these chemicals. Three categories of parameters can be used to estimate intake:

- Contaminant-related parameters (exposure concentration)
- Characteristics of the exposed population (contact rate, frequency and duration of exposure, inhalation rate, soil ingestion rate, drinking water consumption rate, skin surface area, and body weight, among others)
- Averaging time

Concentrations used in the intake calculations generally will be based on the measures of central tendency parameters (e g., mean) of the concentrations detected at the site. Standard statistical measures (e.g , histograms, or goodness of fit) will be used to evaluate the data's statistical distribution.

Contact rate reflects the amount of impacted medium (i.e., air, soil, or water) to which an individual is exposed per unit time or event. Professional judgment will be used to estimate these parameters based on site-specific considerations and on a review of the pertinent scientific literature and EPA guidance documents. Any deviations from standard EPA default assumptions will be clearly noted in the text of the risk assessment document along with the rationale for its use A brief discussion of the pertinent literature is presented in the following sections to support proposed parameter values.

Exposure frequency and duration are site-specific parameters that will be estimated following characterization of the potentially exposed populations The population characterization data will be combined with EPA estimates of residence time (EPA 1991b) to obtain an estimate of duration Exposure frequency will consider human activity patterns Studies of human activity patterns indicate that, for employed individuals, a relatively large fraction of time is spent in activities within one's home, in transit, or in one's workplace. A relatively small fraction of time is spent in all other activities Under current and future use scenarios, this study will use the best available data for site-specific population dynamics. The assumptions made for frequency of potential exposure will attempt to account for this information. If a long-term average contact rate is indicated by the exposure scenario being evaluated, then a daily exposure frequency will be used.

Body weight and inhalation rates change during a lifetime; therefore, intake rates will differ with different age groups. For some exposure pathways, such as soil ingestion, exposure can occur throughout life, but the majority of exposure occurs during childhood (due to higher contact rates and lower body weights of children). In these cases, exposures will be calculated separately for each age group. Lifetime exposure is calculated by taking the time-weighted average of exposure estimates over all age groups Data obtained from the

Supplemental Guidance Document (EPA 1989d) will be used to obtain body weights and inhalation rates for different age groups

Estimates of human intake for each pathway will be calculated based on equations from RAGS (EPA 1989) and other standard reference sources. Calculations will be based upon the pathways and exposure scenario developed for inclusion in the HHRA and will use the estimated chemical concentrations derived from the environmental fate and transport modeling. The products of this subtask will be presented in the HHRA report and will be used to prepare the risk characterization

8.3.7 Uncertainty Analysis in Exposure Assessment

The ultimate effect of uncertainty in the exposure assessment is an uncertain estimate of intake The recommended approach (EPA 1990) to uncertainty analysis in exposure assessment is to explicitly present the range of observed values for chemicals in the environment and the factors used in developing intake estimates. Exposure assessment involves the quantitative evaluation of the exposure concentration of each chemical in each environmental medium, and an assessment of the transport and transformation of the subject compounds. Typically the exposure assessment involves both monitoring data and environmental transport models.

Monitoring data are most appropriately used to estimate current or existing exposure when direct contact with contaminated media is the primary concern. Transport modeling is required to estimate future exposure, or exposure at a distance from the source of release. The selection of an appropriate model matching the complex terrain at RFP, suitable to the geological profile, will be of great importance to the exposure assessment. Chemical intakes

will be derived using equations presented in the RAGS (EPA 1989b). Each input variable or point estimate may have a range of values. Site-specific selection will be conducted wherever available.

The model uncertainty may be evaluated using the range of parameter values tailored to the IHSS specific conditions at OU 14. Standard input variables will be used when site-specific input data is missing Intake values will be selected so that the combination of all values results in an estimate of reasonable maximum exposure for each pathway Additional statistical software may be utilized which involves Monte Carlo and/or Latin Hypercube sampling methodology.

Modeling input variables are classified into three categories constants, state variables, and natural variables. The different values of input parameters that are measured many times are expressed as a distribution The shape of the parameter distribution (width of the curve) conveys the degree of uncertainty of the parameter (input or output). (Literature values must be stated as such; establishing a distribution of a literature value will need additional statistical evaluation) Primary sources of model uncertainty include the following:

- **Averaging Hydraulic Conductivities** - modeling of groundwater flow by averaging the hydraulic conductivity over a cross-sectional area instead of layering (i.e., sand over clay).

- **Dispersion Simulation** - valley models simulate the constant of dispersion by the valley walls; other models handle inversions better. The use of modeling compartments and number of compartments also has an effect on uncertainty.

- **Numerical Models and Analytical Models** - numerical models require more input data and additional computer runs which may provide greater certainty. Analytical models are easier to operate and focus more on closed-form solutions.

- **Chemical Degradation Simulation** - some models only use first-order reaction kinetics; however, this is less accurate if two or more concentrations vary substantially.

- **Model Operational Parameters** - parameter "time step" is used frequently as an iterative dynamic approach requiring many modeling runs. Optimization of the time step is difficult and produces a significant effect on the estimated output concentrations (i.e., negative concentrations).

- **Source Shape** - use of a point source model on an area source can create additional uncertainty Vertical line source versus horizontal line source modeling can also have uncertainty effects

- **Steady-state Modeling** - use of a steady-state model to model dynamic scenarios can cause additional errors.

- **Number of Dimensions Addressed by the Model** - Choice of a one, two, or three dimensional model has effects on uncertainty.

8.4 Toxicity Assessment

The following subsections describe the approach to be used in identifying and/or developing toxicity constants for both carcinogenic and noncarcinogenic COCs

8.4.1 Identification of Contaminant and Exposure Periods for Which Toxicity Information is Required

Toxicity assessment is the process of characterizing the relationship between the dose or intake of a substance and the incidence of an adverse effect in the exposed population.

Toxicity assessments evaluate results from studies with laboratory animals or from human epidemiological studies. These evaluations are used to extrapolate from high levels of exposure where adverse effects are known to occur to low levels of environmental exposures where effects can only be predicted based on statistical probabilities. The results of these extrapolations are used to establish quantitative indicators of toxicity. Toxic effects are divided into two classes for purposes of establishing quantitative indicators of toxicity: noncarcinogens and potential carcinogens.

Health risks from all routes of exposure identified in Sections 4.3 and 4.4 will be characterized by combining the chemical intake information with numerical indicators of toxicity. These health-based toxicity criteria will be obtained through EPA-developed RfDs or slope factors (SFs) which are available in IRIS and the HEAST. If these sources of information do not contain health-based toxicity criteria for a particular chemical, a health-protective number will be derived in the toxicity assessment task using established procedures as listed in the RAGS (EPA 1989b).

This task will result in a toxicological profile for each COC (Section 3.0) that will be submitted as a technical memorandum to EG&G for review by EPA and CDH for inclusion in the HHRA. These profiles will discuss the following·

- Acute and chronic toxic effects of these chemicals in humans
- Uncertainty associated with values (e.g., uncertainty factors, modifying factors, and/or weight of evidence if available)
- Environmental fate and transport (e.g., degradation process, products, mobility within each medium, and potential means of transport from one medium to another)

- ARARS, maximum contaminant levels, and other health-protective criteria for each chemical

8.4.2 Noncarcinogenic Chemicals

The preferred numerical indicators of toxicity are EPA-derived RfDs. The RfDs for chemicals considered in the risk assessment will be obtained primarily from the IRIS database or the HEAST The RfD is based on the assumption that thresholds exist for certain noncarcinogenic toxic effects, such as cellular necrosis, but may not exist for other toxic effects, such as cancer. In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that will not result in a appreciable risk of deleterious effects during a lifetime of exposure.

8.4.3 Carcinogenic Chemicals and Radionuclides

Evidence of carcinogenicity of a chemical comes from two sources: lifetime studies with laboratory animals and human studies where excess cancer risk is determined by regulatory agencies The results of any such derivation will be presented in the technical memorandum and the HHRA report

8.4.4 Uncertainty Analysis in Toxicity Assessment

Uncertainty factors consist of applied mathematical conservatisms which are used to ensure health protective standards for all segments of the affected population. The Oral RfD

is derived from standards established for No Observed Adverse Effect Level (NOAEL), or Lowest Observed Adverse Effect Level (LOAEL), for the critical toxic effect by consistent application of uncertainty factors (UF) and a modifying factor (MF). The UFs generally consist of multiples of ten (although values less than ten are sometimes used), with each factor representing a specific area of uncertainty inherent in the extrapolation from the available data The bases for application of different UFs are explained below.

- A UF of 10 is used to account for variation in the general population and is intended to protect sensitive subpopulations (e.g., elderly, children).
- A UF of 10 is used when extrapolating from animals to humans. This factor is intended to account for the interspecies variability between humans and other mammals.
- A UF of 10 is used when a NOAEL derived from a subchronic, instead of a chronic study, is used as the basis for a chronic RfD
- A UF of 10 is used when a LOAEL is used instead of a NOAEL This factor is intended to account for the uncertainty associated with extrapolating from LOAELs to NOAELs.

In addition to the UFs listed above, a MF is applied

- A MF ranging from greater than 0 to 10 is included to reflect a qualitative professional assessment of additional uncertainties in the critical study and in the entire database for the chemical not explicitly addressed by the preceding UFs. The default MF value is 1.0.

Inhalation RfDs are derived from the NOAELs by applying UFs similar to those listed above for oral RfDs. Inhalation RfDs are generally reported as a concentration in air in milligrams per cubic meter (mg/m^3) for continuous, 24-hour/day exposure, although it

may be reported as a corresponding inhaled intake in milligrams per kilogram per day (mg/kg/day). A human body weight of 70 kg and an inhalation rate of 20 cubic meters per day (m^3/day) are typically used to convert between an intake expressed in units of mg/kg/day and a concentration in air expressed in mg/m^3.

8.5 Risk Characterization

Risk characterization involves estimating the magnitude of the potential adverse effects under study, and presents summary judgments of the nature of the impacts to public health Characterization of risk involves combining the results of the exposure and toxicity assessments to provide numerical estimates of health risk These estimates are comparisons of exposure levels with appropriate RfDs or estimates of lifetime cancer risk with a particular intake Risk characterization also considers the nature and weight of evidence supporting these risk estimates and the magnitude of uncertainty surrounding those estimates. Results of this task will be presented in the HHRA report.

8.5.1 Quantifying Risks from Each Contaminant

The health risks from each contaminant may be calculated using two methods· one to determine carcinogenic effects, and another to determine noncarcinogenic effects.

8.5.1.1 Carcinogenic Effects. The following calculations are used to obtain numerical estimates of lifetime cancer risks

$$\text{RISK} = \text{INTAKE} \times \text{SF}$$

where.

RISK	=	potential cancer risk adjusted for lifetime exposure (unitless)
SF	=	cancer potency slope $(mg/kg/day)^{-1}$
INTAKE	=	chemical intake (mg/kg/day)

Additionally, the Committed Effective Dose Equivalent (CEDE) will be calculated for receptors potentially exposed to radionuclides.

8.5.1.2 Noncarcinogenic Effects Health risks associated with exposure to noncarcinogenic compounds will be evaluated by calculating a hazard index (HI) The hazard index is the ratio of the intake rate to the RfD, as follows·

$$HI = INTAKE/RfD$$

where·

HI	=	hazard index
INTAKE	=	chemical intake (mg/kg/day)
RfD	=	reference Dose (mg/kg/day)

8.5.2 Quantifying Risks from Multiple Contaminants

The summed carcinogenic and noncarcinogenic effects for multiple contaminants can be calculated using the following two methods.

8.5.2.1 Carcinogenic Effects. Cancer risks will be summed across all carcinogens considered in the risk assessment using the following equation:

$$RISK_T = \Sigma RISK_i$$

where:

$RISK_T$ = the total cancer risk, expressed as a unitless probability
$RISK_i$ = the risk estimate for the ith substance

This equation is an approximation of the precise equation for combining risks to account for the probability of the same individual developing cancer as a consequence of exposure to two or more carcinogens. This risk summation assumes independence of action by the compounds involved. Several limitations are posed by using this approach as discussed in RAGS (EPA 1989b) For example, an attempt will be made to add carcinogenic risk across the three pertinent cancer classes

The potential for carcinogenic effect for nonradiological contaminants will be estimated by calculating excess lifetime cancer risks from the lifetime average exposure and cancer SF. IRIS SFs for radionuclides of concern will be used to estimate radiological risks from exposure for up to four pathways· inhalation, ingestion, air immersion, and external irradiations Calculations will be performed according to guidance provided by the EPA (1989c). The sum of risks from all radionuclides and pathways yields the lifetime risk from the overall exposure. Risks will be combined as appropriate, taking into consideration the plausibility of multiple exposures.

8.5.2.2 Noncarcinogenic Effects. HIs will be summed for those chemicals known to produce similar adverse effects in the same target organ using the following equation:

$$HI = \sum \frac{E_i}{RfD_i}$$

where:

HI	=	hazard index,
E_i	=	exposure level (intake) for the ith toxicant
RfD_i	=	reference dose for the ith toxicant

E and RfD are expressed in the same units and represent the same exposure period

Limitations on the application of this procedure are discussed in RAGS (EPA 1989b).

8.5.3 Combining Risks From All Pathways From All Contaminants

After reasonable exposure pathway combinations have been identified, the likelihood that the same individuals would consistently be exposed by more than one pathway will be evaluated. In some situations, it may be appropriate to combine one pathway's risks with other pathways' risk estimates If a reasonable exposure pathway combination is identified and consistent target organs and mechanisms of toxicity are present, then the cancer risks and HIs will be summed separately. Adjustments for absorption efficiency may be required for dermal routes of exposure. The adjustments include toxicity values (from administered to absorbed doses) and an adjustment for medium of exposure.

The HHRA will present the chemical and radiological risk estimates separately with discussion on the adaptivity potential for these risks.

8.5.4 Uncertainty Analysis in Risk Characterization

Uncertainties in toxicological measures and exposure assessment are greater than uncertainties in environmental analytical data and usually have a more significant effect on the uncertainty of the risk assessment (EPA 1990). A sensitivity analysis should be conducted to bound the results of the risk assessment. Combining probability distributions using Monte Carlo techniques is recommended by the SEAM (EPA 1988c). Risk assessment is a best estimate of potential (present and future) risk including the limitations or uncertainties for each estimate. Estimates of excess lifetime cancer risk and the potential for adverse noncarcinogenic effect in humans have limitations which need to be clearly stated

8.6 Uncertainty Analysis

The uncertainty analysis characterizes the propagated uncertainty in public health risk through the pathways and contaminants which dominate the risk in each credible scenario. These uncertainties are driven by uncertainty in the chemical monitoring data, the transport models used to estimate concentrations at receptor locations, receptor intake parameters, and the toxicity values used to characterize risk Additionally, uncertainties are introduced in the risk assessment when exposures to several substances across multiple pathways are summed.

The goal of the uncertainty analysis is to quantify the uncertainty in the final risk characterization estimates. Initially the key site-related variables and assumptions that contribute most to the uncertainty will be identified. The risk characterization used in site risk assessments may not be fully probablistic estimates of risk but conditional estimates given a considerable number of assumptions about exposure and toxicity. Where possible, quantitative techniques to estimate uncertainty will be applied (e.g., parameter imprecision

analyses to evaluate model predictions). Assumptions and uncertainties inherent in the risk assessment will be fully specified in order to place the risk estimates in the proper perspective. The goal will be to use and analyze site data in such a way that the results can be presented as estimated probability distributions. The overall uncertainty for the risk assessment will be estimated by the total resultant variance propagated through the pathways which dominate the risk.

The review and selection of appropriate uncertainty analysis methods will be focused on providing an overall approach that would provide a quantitative result To assess the uncertainty introduced into the risk assessment by each of the categories described above, methodologies or approaches for determining the uncertainty for each category will be selected.

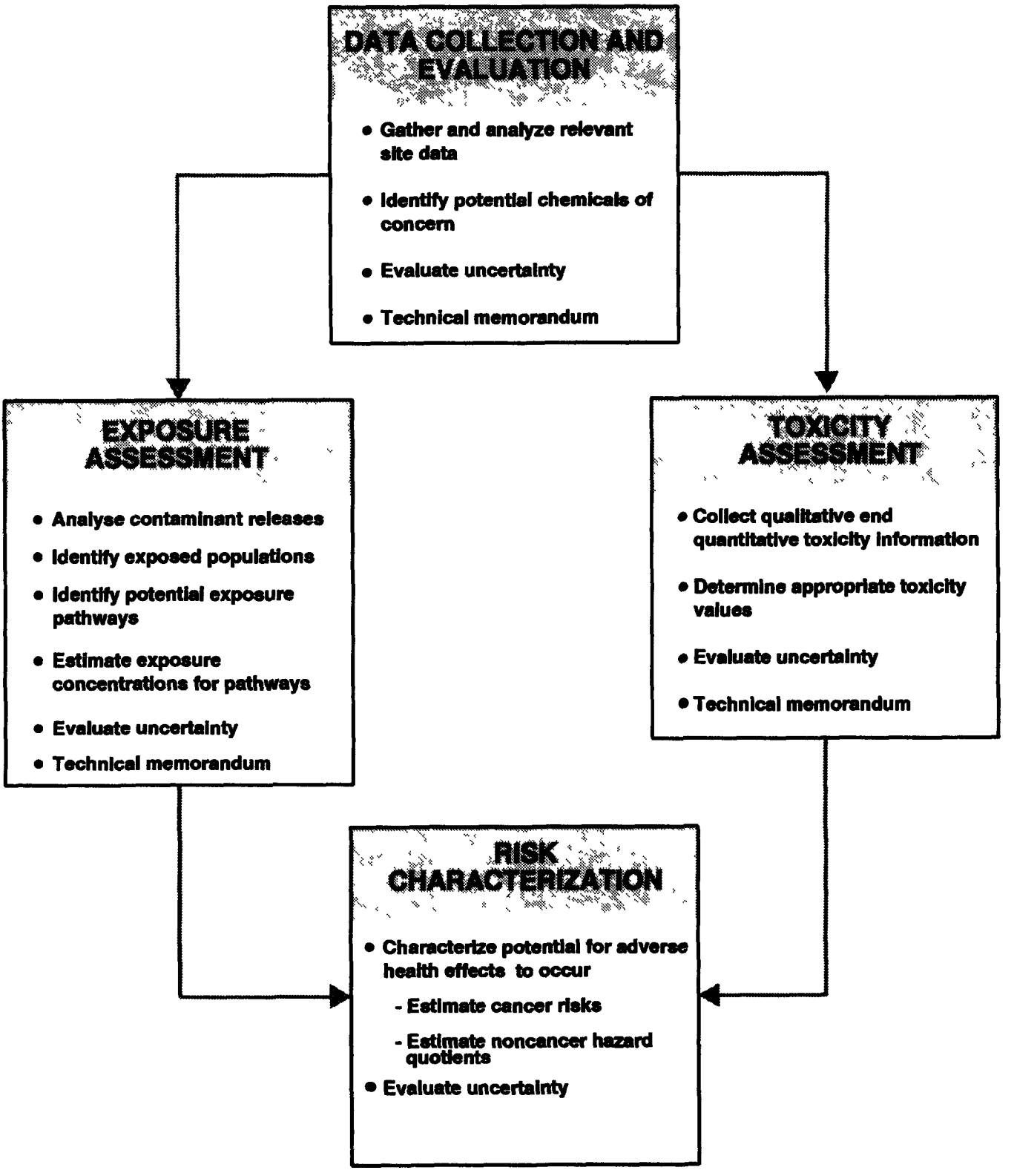
TABLE 8-1
MINIMUM REQUIREMENTS, IMPACTS, AND CORRECTIVE ACTIONS FOR DATA USEABILITY CRITERIA

Data Useability Criterion	Minimum Requirement	Impact on Risk Assessment	Corrective Action
Reports to Risk Assessor	• Site description • Sample design with sample locations • Analytical method and detection limit • Results on per-sample basis, qualified for analytical limitations • Sample-specific quantitation limits (SQLs) and detection limit for non-detects • Field conditions for media and environment • Preliminary reports	• Unable to perform quantitative risk assessment	• Request missing information • Perform qualitative risk assessment
Documentation	• Sample results related to geographic location (chain-of-custody records, SOPs, field and analytical records)	• Unable to assess exposure pathways • Unable to identify appropriate concentration for exposure areas	• Request locations identified • Resampling
Data Sources	• Analytical data results for one sample per medium per exposure pathway • Broad spectrum analysis for one sample per medium per exposure pathway • Field measurements data for media and environment	• Potential for false negatives and positives • Increased variability in exposure modeling	• Resampling or reanalysis for critical sample
Analytical Method and Detection Limit	• Routine methods used for critical samples and chemicals of potential concern • Detection limit less than 20% of concentration of concern	• Unquantified precision and accuracy • False negatives	• Reanalysis • Resampling and analysis for critical samples • Documented statements of limitation for non-critical samples

TABLE 8-1
MINIMUM REQUIREMENTS, IMPACT, AND CORRECTIVE ACTION FOR DATA USEABILITY CRITERIA
(continued)

Data Useability Criterion	Minimum Requirement	Impact on Risk Assessment	Corrective Action
Data Review	• Correctness of analytical results reviewed	• Potential for false negatives or false positives • Increased variability and bias due to analytical process, calculation or transcription errors	• Perform data review
Data Quality Indicators	• Sampling variability quantified for each analyte • QC samples required to identify and quantify precision and accuracy • Sampling and analytical precision and accuracy quantified	• Unable to quantify confidence levels for uncertainty • Potential for false negatives or false positives	• Resampling for critical samples • Perform qualitative risk assessment • Perform quantitative risk assessment for non-critical samples with documented discussion of potential limitations

Reference Guidance for Data Useability in Risk Assessment, Chapter 5, EPA/540/G-90/008, Directive 9285 7-05, 10/90



PREPARED FOR
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ROCKY FLATS PLANT
GOLDEN, COLORADO

FIGURE 8-1

PART A· BASELINE RISK ASSESSMENT

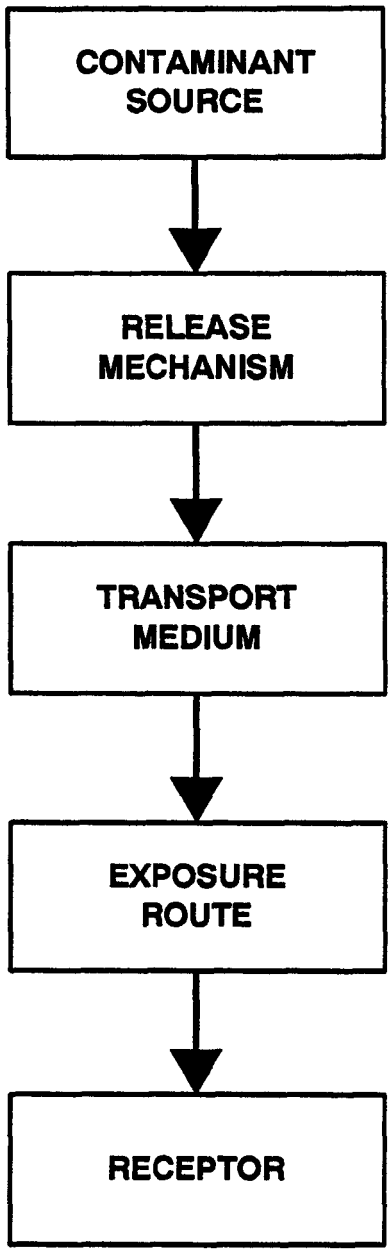

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FIGURE 8-2

COMPONENTS OF A COMPLETED EXPOSURE PATHWAY

Approved by

_____ / / _____ / /
Manager, Remediation Programs Project Manager

9.0 ENVIRONMENTAL EVALUATION WORK PLAN

9.1 Introduction

OU14 lies entirely within a RFP production area that consists of buildings, paved parking areas, roads, and hazardous substance sites. Because of extensive development, no viable ecosystems or natural habitat presently occur on the OU14 area The only vegetation within this area consists of landscaping that established scattered conifer trees and strips of grass near IHSSs 160 and 162; therefore, there are insufficient ecosystems, components, or functions on OU14 to require a comprehensive ecological risk assessment In addition, the area containing IHSSs in OU14 overlaps with other plant site OUs, and is contained within the OU9 preliminary study area. OU9 is composed of the OPWLs, a network that extends throughout much of the production area The OU9 EE work plan defines an ecological risk assessment within the production study area that is reduced in scope and is focused on requirements proportional to the depauperate ecosystems that occur on this site The objective of the OU14 EE is to address and characterize effects of contaminants on the ecological resources present, and then to determine if there is a risk of contamination of off-site biota by target taxa migrating from the study area.

Coordination of OU14 EE requirements with the OU9 EE is mandated by the overlapping study areas Habitat and biological surveys proposed for OU9 will cover the entire industrial area, and the results will apply to the OU14 study area The following text provides a brief description of the study components presently proposed for OU9, and how these studies relate to the OU14 EE. These sections are based on a preliminary draft of a technical memorandum for a revision to the EE proposed for OU9 (EG&G 1992a).

9.2 Biological and Habitat Site Characterization

Biota and habitat surveys proposed for OU9 will be adequate for the biological and habitat characterization of OU14 and will not be duplicated or repeated These surveys will provide the following information applicable to OU14

- Comprehensive survey and mapping of types and extent of habitats
- Presence and/or use of habitats by raptors and migratory birds, including waterfowl and passerine species
- Presence or absence of threatened and endangered species, or species of special concern
- Information on small (e g , mice), and large (e g., rabbits, hares) mammals, and resident bird populations that occur on the site or occur in close proximity to the site

This characterization will include a literature review, expert consultation, and field surveys to describe vegetation/habitats of the site, and identify species of special concern,

mammals, and birds which have potential to occur in the vicinity of the site This information will be provided in the three following reports

- Habitat survey report for compliance with acts and regulations protecting migratory birds
- Biological survey report for compliance with acts and regulations protecting threatened and endangered species
- A reporting of information on the tendency for mammals and birds to occur on the site, or in the vicinity of the site

9.3 Ecotoxicological Investigations

Since OU14 is a small interspersed area within OU9 study area, no target taxa populations would be expected to utilize OU14 habitats exclusively

If an ecotoxicological investigation is necessary, it would consist of the following procedures

- Developing a site-specific Conceptual Exposure model to identify potential pathways for exposure of on-site biota
- Developing a Conceptual Biota Transport model to identify potential pathways for off-site transport
- Selection of target taxa and target analytes (biologically active contaminants of concern)
- Direct measurement of target analytes within target taxa

A technical memorandum would be submitted for EPA and CDH review and approval, and for U S Fish and Wildlife Service (FWS) and the Colorado Division of Wildlife (CDW) review prior to initiating any work The procedures for conducting this type of investigation for the industrial area are presently under development for OU9, and would be adapted, if needed, for the much smaller and highly disturbed study area in OU14

The information developed by the ecotoxicological investigation would be used to assess the ecological risk posed by contaminant migration by contaminated target taxa Information on contaminant migration by target taxa to other OUs will be provided to those OU managers for use in conducting their EEs for identifying ecological risks This would be a quantitative estimate with the appropriate uncertainty analysis for model assumptions and estimates of parameters This information would also be coordinated with contaminant migration by physical or abiotic media developed during the site characterization and transport models

9.4 Environmental Evaluation Report

The environmental evaluation portion of the BRA in the Phase I RFI/RI report will consist of the habitat survey and species assessment information (raptors, migratory birds, threatened and/or endangered species; and mammals and resident bird species) discussed in Section 9.2 If an ecotoxicological investigation is conducted, the results would be included in the EE portion of the BRA in the Phase I RFI/RI report.

Approved by

_____ __/__/__ _____ __/__/__

Manager, Remediation Programs RFI Project Manager

10.0 QUALITY ASSURANCE ADDENDUM

This section consists of the QAA for Phase I investigations at Operable Unit No 14 (OU14) This QAA is a supplement only and must be used in conjunction with the "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/ Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities" (QAPjP) The QAA establishes the site-specific Quality Assurance (QA) controls applicable to the investigation activities described in the OU14 Work Plan.

OU14 is one of 16 operable units (OUs) identified for investigations under the Rocky Flats Plant (RFP) Interagency Agreement (IAG) OU14 contains 8 individual hazardous substance sites (IHSSs), which are described in Section 2 of the OU14 Work Plan. The OU14 Work Plan describes the Phase I characterization of potential sources of contamination and potentially affected soils at each of the OU14 IHSSs. The OU14 Work Plan was prepared in accordance with the requirements of the IAG, and federal, and State of Colorado regulations and guidance documents identified in the Introduction (Section 1.0).

10.1 Organization and Responsibilities

The overall organization of EG&G and the Environmental Management Department (EMD) and divisions involved in Environmental Restoration (ER) Program 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 to implement the field activities outlined in the OU14 Work Plan. The specific EMD personnel who will interface with the contractors and who will provide technical direction are shown in Figure 10-1

10.2 Quality Assurance Program

The QAPjP was written to address QA controls and requirements for implementing IAG-related activities. The content of the QAPjP was driven by Department of Energy (DOE) Order 5400.1, RFP Standard Operating Procedure (SOP) 5700.6B, and the IAG. DOE 5400.1 and SOP 5700.6B both require a QA program to be implemented based on American Society of Mechanical Engineers (ASME) NQA-1, "Quality Assurance Requirements for Nuclear Facilities " The IAG specifies development of a QAPjP in accordance with the Environmental Protection Agency (EPA) QAMS-005/80, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans." The 18-element format of NQA-1 was selected as the basis for both the QAPjP and subsequent QAAs with the applicable elements of QAMS-005/80 incorporated where appropriate Figure 2-1 of the QAPjP illustrates where the 16 QA elements of QAMS-005/80 are

integrated into the QAPjP and also into this QAA. Section 2.0 of the QAPjP also identifies other DOE orders and QA requirements documents to which the QAPjP and this QAA are responsive

The controls and requirements addressed in the QAPjP are applicable to OU14 Phase I activities, unless specified otherwise in this QAA. Where site-wide actions are applicable to OU14 activities, the applicable section of the QAPjP is referenced in this QAA. This QAA addresses additional and site-specific QA controls and requirements that are applicable to OU14 Phase I activities that may not have been addressed on a site-wide basis in the QAPjP. Many of the QA requirements specific to OU14 are addressed in the OU14 WP and are referenced in this QAA.

10.2.1 Training

The minimum personnel qualification and training requirements that are applicable to EG&G and subcontractor staff for RFP ER Program activities are addressed in Section 2.0 of the QAPjP

All EG&G and subcontractor staff working on OU14 Phase I investigations shall be trained in the EMD OPs or laboratory analytical procedures that are applicable to their assigned tasks Subcontractor Project Managers shall be trained by the EMD and shall be responsible for training subcontractor staff according to EMD Administrative Procedure 3-21000-ADM-02.01, Personnel Training, using EG&G-furnished lesson plans. All personnel training shall be documented according to procedure 3-21000-ADM-02.01

EG&G EMD and subcontractor personnel shall also meet the minimum qualification and training requirements specified in the OU14 WP, the EG&G HASP for OU14 (in preparation), the EMD Operating Procedures (OPS) identified in the OU14 WP, and the EG&G Environmental Management Radiological Guidelines (EMRGs) specified in the OU14 HASP and the OU14 Work Plan The EMD OPs (which may have been referred to as SOPs in the QAPjP and other sections of this OU14 WP) and the EMRGs that are applicable to OU14 Phase I activities are identified in Table 10-1

10.2.2 Quality Assurance Reports to Management

A QA summary report will be prepared annually or at the conclusion of these activities (whichever is more frequent) by the EMD Quality Assurance Project Manager (QAPM) or designee This report will include a summary of field operations and laboratory inspections, surveillance, and audits and a report on data verification/validation results

10.3 Design Control and Control of Scientific Investigations

10.3.1 Design Control

The OU14 Work Plan describes the investigation activities that will be implemented during Phase I. The work plan identifies the objectives of the investigations; specifies the sampling, analysis, and data generation requirements; and identifies applicable OPs that will provide controls for the investigations As such, the OU14 Work Plan is considered the investigation control plan for OU14 Phase I RFI/RI activities

10.3.2 Data Quality Objectives

The development of Data Quality Objectives (DQOs) for the OU14 Phase I investigations was presented in Section 4 0. The DQOs for OU14 were established in accordance with the 3-stage process described in EPA/540/G-87/003 (OSWER Directive 9335 0-7B), Data Quality Objectives for Remedial Response Activities, and Appendix A of the QAPjP. Identification of data quality needs includes defining specific investigation objectives, identifying data uses, and selecting the types of samples and data that need to be collected The primary objectives for the OU14 RFI/RI, specific data needs, data uses, sampling and analysis activities, analytical data levels, and DQOs were identified in Section 4 These are summarized in Table 4-1.

Data quality is typically measured in terms of precision, accuracy, representativeness, comparability, and completeness (also referred to as PARCC parameters). Precision, accuracy, and completeness are quantitative measures of data quality, while representativeness and comparability are qualitative statements that express the degree to which sample data represent actual conditions and describe the confidence of one data set to another These parameters are defined in Appendix A of the QAPjP PARCC parameters will be determined for OU14 measurement data, as described in Appendix A of the QAPjP PARCC parameter objectives, that are established prior to initiating investigations, assist decision makers in determining if DQOs for measurement data have been met.

EG&G has established requirements for analytical chemistry services for environmental samples collected in support of the RFP ER Program These requirements are established in Parts A and B of the EG&G Rocky Flats General Radiochemistry and Routine

Analytical Services Protocol (referred to as the GRRASP) The GRRASP requires analyses of EPA's TCL organics and TAL metals to be analyzed using EPA CLP methods and procedures The GRRASP also requires analyses of all non-CLP and radiochemistry parameters to be modified such that the analyses parallel the QC requirements of CLP-type analyses Therefore, all organic and inorganic laboratory analytical data should meet the QC needs equivalent to analytical level IV data.

Historical measures of precision and accuracy for TCL volatile and semi-volatile organics and TAL metals have been established for CLP analyses. These historical measures of precision and accuracy are referenced in Appendix B of the QAPjP and represent the objectives for TCL organics and TA metals for OU14 Appendix B of the QAPjP also references the precision and accuracy measures for radionuclides that will be analyzed according to methods specified in Part B of the GRRASP. These measures represent the objectives that are applicable to the analysis of radionuclides for OU14 samples. The goal for completeness of laboratory analytical data is 100 percent with a minimum acceptable completeness of 90 percent

The quality of radiological and soil gas screening data will be controlled by adhering to field surveying, sampling, and analytical procedures that have been and are being developed This includes meeting instrument detection, efficiency, and calibration requirements specified in the procedures and manufacturers instructions

Representativeness and comparability were discussed in Section 4 of the OU14 Work Plan

10.3.3 Sampling Locations and Sampling Procedures

The Field Sampling Plan (FSP) for OU14 was presented in Section 6 0. The FSP consists of a 2-staged approach. During Stage 1, attempts will be made to locate areas of contamination and assess the nature of contamination Stage 2 will consist of assessing the extent of contamination present at the OU14 IHSSs Sampling activities will generally consist of performing surface radiological surveys, conducting soil gas surveys, collecting surface and near surface soil depth profile samples, collecting subsurface soil samples from boreholes, installation of tensiometers to monitor moisture matrix potentials in the vadose (unsaturated zone), installation of groundwater monitoring wells and groundwater sample collection The specific sampling plan for each of the eight IHSSs is described in Section 6 3 The field operating and sampling procedures that will be used to control field sampling activities are identified in Section 6 4. The applicable procedures are also listed here in Table 10-1

10.3.4 Analytical Procedures

The analytical program for the OU14 Phase I RFI/RI investigation is discussed in Section 6.5 The analytes of interest and the specified detection/quantitation limits are identified in Table 6-2 The analytical methods that shall be adhered to are those that are specified in Parts A and B of the GRRASP. These methods are referenced in Section 3.0 of the QAPjP. Specific analytical methods for each analyte identified in Section 7.5 are referenced in Appendix B of the QAPjP

10.3.5 Equipment Decontamination

Non-dedicated sampling equipment (i e., sampling equipment that is used at more than one location) 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

10.3.6 Air Quality

Air monitoring will be conducted 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 determine if OU14 RFI/RI activities are in compliance with the RFP Interim Plan for Prevention of Contaminant Dispersion Air monitoring will be conducted according to OPS-FO.01, Windblown Contaminant Dispersion Control.

10.3.7 Quality Control

To verify the quality of field sampling and laboratory analytical processes, the collection, preparation, and analysis of QC samples are incorporated into the sampling and analytical programs.

10.3.7.1 Field QC Samples Field QC samples and collection frequencies for OU14 are addressed in Section 6 7 and identified in Table 6-5. A specific sampling schedule will be prepared by the sampling subcontractor for approval by the EG&G Laboratory Analysis Task Leader (Figure 10-1) prior to sampling Equipment rinsate blanks, which are collected and analyzed to detect cross contamination of samples due to inadequate equipment decontamination, are considered acceptable (with no need for data qualification) if the concentration of analytes of interest is less than three times the required detection limit for each analyte as specified in Table 6-2 Field duplicate samples collected and analyzed to provide an indication of overall sampling and analytical precision shall agree within 30 percent relative percent difference for aqueous samples and 40 percent for homogenous, non-aqueous samples

Trip blanks and field blanks (for organics and inorganics, respectively) indicate possible field contamination when analytes are detected above the minimum detection limits The Laboratory Analysis Task Leader (Figure 10-1) is responsible for verifying these criteria and shall be responsible for checking to see if they are met and for qualifying data.

10.3.7.2 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 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)
- Qualifications of personnel
- 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 delegate (Figure 10-1) for review and verification.

10.3.8 Quality Assurance Monitoring

To assure the overall quality of the RFI/RI activities discussed in the OU14 WP, field inspections will be conducted daily, and audits and surveillance will be conducted at various intervals The intervals will be determined by the importance and complexity of each activity Intervals will also be based on the schedule contained in Section 7.0. At a minimum, each of the field sampling activities described in Sections 6.4 will be monitored by an independent surveillance team at least once during the sampling process EG&G will conduct audits of the laboratory contractor(s) as specified in the GRRASP, Parts A and B. The audits and surveillance, and activity Readiness Reviews are discussed further in Section 10 18

10.3.9 Data Reduction, Validation, and Reporting

Data management and reporting requirements for field and laboratory data are discussed in Section 6.6 Data reporting turnaround times, reduction, and validation requirements are as follows.

10.3.9.1 Analytical Reporting Turnaround Times. Analytical reporting turnaround times are as specified in Table 3-1 of Section 3 0 of the QAPjP

10.3.9.2 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 Attachments I in Parts A and B of the GRRASP The reduced data will be used in the data validation process to verify that the laboratory control and the overall system DQOs have been met

10.3.9.3 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 Section 8.0 of the QAPjP. The criteria for determining the validity of ER data at RFP are described in subsection 3.3 7 of Section 3 0 of the QAPjP

10.3.9.4 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 ER Department Data Assessment Summary reports. The

usability of data (the criteria of which is also described in subsection 3 3 7 of Section 3 0 of the QAPjP) shall also be addressed by the RFI Project Manager

10.4 Procurement Document Control

Procurement documents for items and services, including services for conducting field investigations and analytical laboratories, shall be prepared, handled, and controlled in accordance with the requirements and methods specified in Section 4.0 of the QAPjP Items and services used in support of OU14 Phase I RFI/RI activities will be procured according to instructions in EMD Administrative Procedure 3-21000-ADM-04 01, Procurement Document Control

10.5 Instructions, Procedures, and Drawings

The OU14 WP describes the activities to be performed. The OU14 WP will be reviewed and approved in accordance with the requirements for instructions, procedures, and drawings outlined in Section 5 0 of the QAPjP

EMD OPS approved for use and their applicability are identified in Table 10-1 OPs that are identified as being needed, but are not yet developed and/or approved, will be reviewed and approved as required in Section 5.0 of the QAPjP Any additional quality-affecting procedures proposed for use but not identified in Table 10-1 will also be developed and approved as required by Section 5 0 of the QAPjP prior to performing the affected activity

Changes and variances to approved OPs and the OU14 WP shall be documented through preparation of Document Change Notices (DCNs), which will be prepared, reviewed, and approved in accordance with requirements specified in Section 5 0 of the QAPjP (Note DCNs were referred to as Procedure Change Notices in Revision 0 of the QAPjP)

10.6 Document Control

The following documents will be controlled in accordance with Section 6.0 of the QAPjP

- "Phase I RFI/RI Work Plan for Radioactive Sites, Operable Unit No 14"
- "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities" (QAPjP)
- EMD Operating Procedures (all operating procedures specified in this OU14 WP and to-be-developed laboratory SOPs)

10.7 Control of Purchased Items and Services

Contractors that provide services to support the OU14 WP 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 OU14 investigations that have the ability to affect the quality of the data shall be inspected upon receipt

10.8 Identification and Control of Items, Samples, and Data

10.8.1 Sample Containers/Preservation

Appropriate volumes, containers, preservation requirements, and holding times for water and soil samples are presented in Tables 6-3

10.8.2 Sample Identification

RFI/RI samples shall be labeled and identified in accordance with Section 8 0 of the QAPjP and OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples 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

10.8.3 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

10.9 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 A process diagram is shown in Section 8 0 of the QAPjP

10.10 Inspection

Inspection of OU14 RFI/RI activities and items (including procured materials and construction items, such as borehole casing and groundwater monitoring wells) shall be inspected in accordance with the requirements for inspections specified in Section 10 0 of the QAPjP

10.11 Test Control

Test control requirements specified in Section 11.0 of the QAPjP are not applicable to any of the RFI/RI investigations described in the OU14 WP

10.12 Control of Measuring and Test Equipment (M&TE)

10.12.1 Field Equipment

Specific conductivity, temperature and pH of groundwater samples shall be measured in the field. Field measurements will be taken and the instruments calibrated as specified in

OPS-GW 05, Field Measurements of Surface Water Parameters Measurements shall be made using the equipment specified in the appropriate EMD OPS or approved procedure DCN

In addition to the field measurements for water quality, field measurements for radiation and soil gas 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 will be made by using both a FIDLER and a high purity germanium (HPGe) detector or equivalent. Use, calibration, and maintenance of the FIDLER will be according to EMD OPS-FO.16 Use, calibration, and maintenance of the HPGe detector will be according to an EMD OPS that is presently being developed Use and calibration of both types of instruments is based on manufacturer's instructions.

- Field readings for soil gas will be obtained using 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 serial number

- 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
- 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

10.12.2 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 the GRRASP This information will be supplied to EG&G as a laboratory SOP.

10.13 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 Table 8-1 of Section 8 0 of the QAPjP Sample handling and storage controls at the laboratory shall be provided as a laboratory SOP.

10.14 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.

10.15 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

10.16 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.

10.17 Quality Assurance Records

QA records will be controlled in accordance with OPS-FO.02, Field Document Control QA records to be generated during OU14 RFI/RI 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

10.18 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, Parts A and B 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 6 0

Examples of some specific tasks that will be monitored by the surveillance program are as follows

- 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 OU14 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 OU14 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.

10.19 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 OU14 WP activities Operating procedures applicable to the use of the database storing environmental data can be found in OPS-FO.14, Field Data Management.

FIGURE 10-1. PROJECT MANAGEMENT FOR OPERABLE UNIT 14 RADIOACTIVE SITES, PHASE I RFI/RI

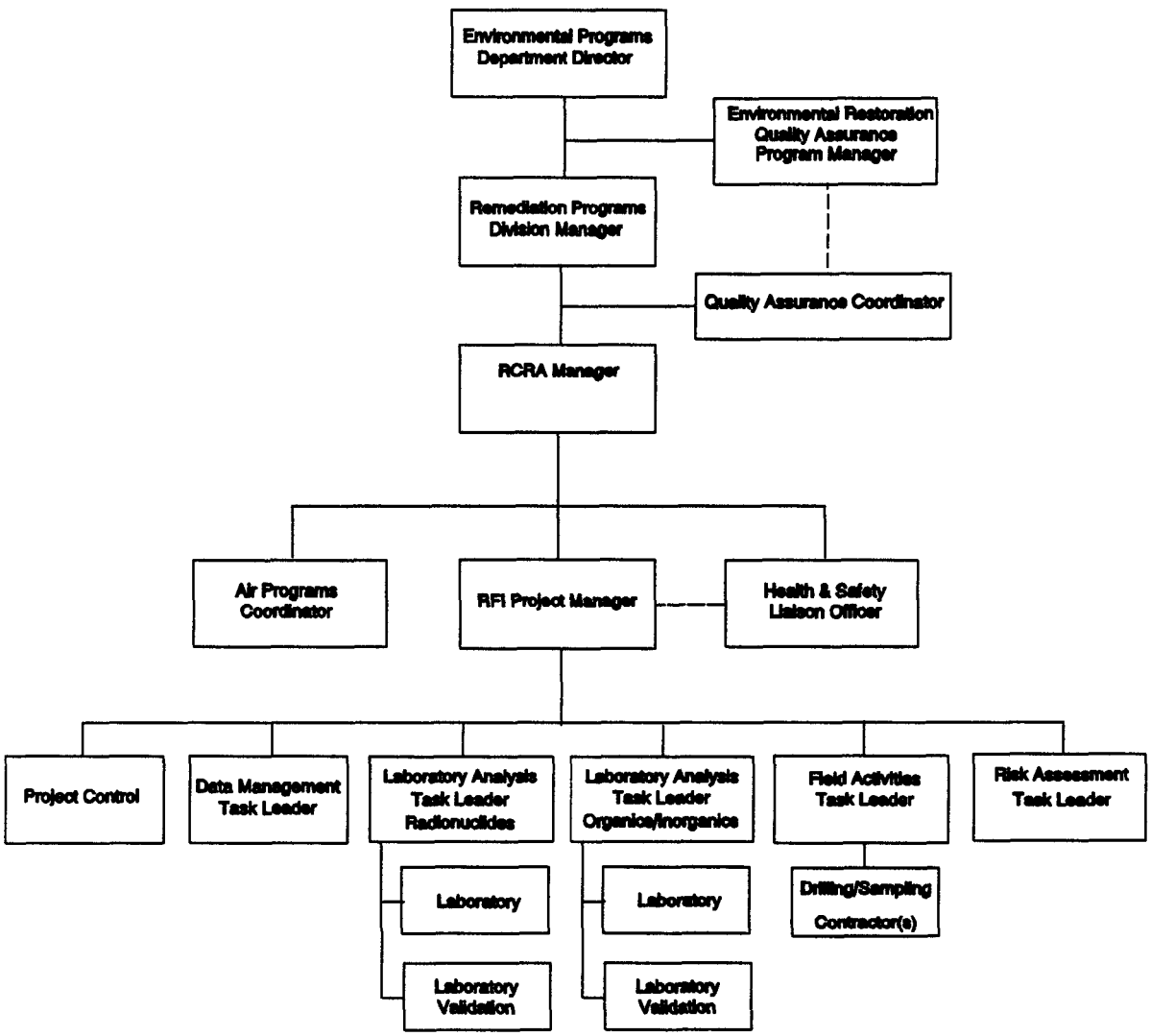

TABLE 10.1
EMD Operating Procedures and Field Activities for Which They are Applicable

Former SOP Reference Number	EMAD OPS Reference Number	Standard Operating Procedures	Soil-Gas Sampling	Radiological Surveys	Well Completion, Development	Ground-Water Sampling	Vadose Zone Monitoring	Surface Soil Sampling	Subsurface Soil Sampling	Asphalt & Concrete Sampling
1 1	FO 01	Wind Blown Contaminant Dispersion Control			●			●	●	●
1 2	FO 02	Field Document Control	●	●	●	●	●	●	●	●
1 3	FO 03	General Equipment Decontamination	●	●	●	●	●	●	●	●
1 4	FO 04	Heavy Equipment Decontamination			●	●	●	●	●	●
1 5	FO 05	Handling of Purge and Development Water			●	●				
1 6	FO 06	Handling of Personal Protective Equipment	●	●	●	●	●	●	●	●
1 7	FO 07	Handling of Decontamination Water & Wash Water	●	●	●	●	●	●	●	●
1 8	FO 08	Handling of Drilling Fluids & Cuttings			●				●	
1 9	FO 09	Handling of Residual Samples				●		●	●	●
1 10	FO 10	Receiving, Labeling, and Handling Waste Containers			●	●			●	●
1 11	FO 11	Field Communications	●	●	●	●	●	●	●	●
1 12	FO 12	Decontamination Facility Operations		●	●	●	●	●	●	●
1 13	FO.13	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples				●	●	●	●	●
1 14	FO.14	Field Data Management	●	●	●	●	●	●	●	●
1 15	FO 15	Use of PIDs and FIDs	●	x	x	x	x	x	x	x
1 16	FO 16	Field Radiological Measurements a) Walk-Over Surveys	x	●	x	x	x	x	x	x
New	FO 18	Environmental Sample Radioactivity Content Screening				●	●	●	●	●
2.1	GW 01	Water Level Measurements in Wells and Piezometers			●	●				
2.2	GW 02	Well Development			●					
2.5	GW 04	Measurements for Groundwater Field Parameters				●				
2.6	GW 05	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 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			●				●	

X - As required by H&S plan.

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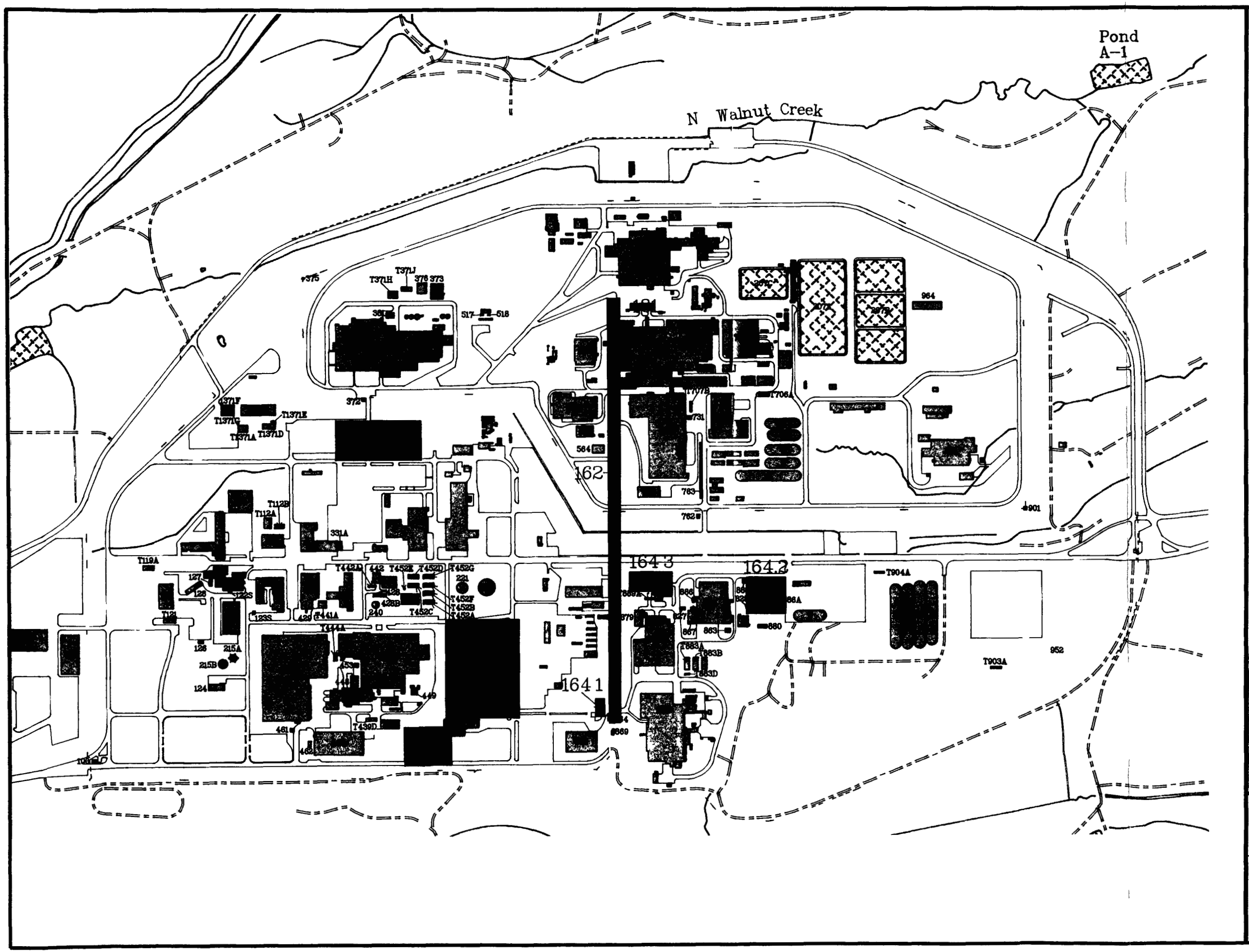

US Department of Energy

Rocky Flats Plant

Paved roads

Unimproved dirt roads

Streams ditches and other drainage features

Security fence

Ponds/lakes

Buildings or structures

Individual hazardous substance sites (IHSS)

0 200 400 800 FEET

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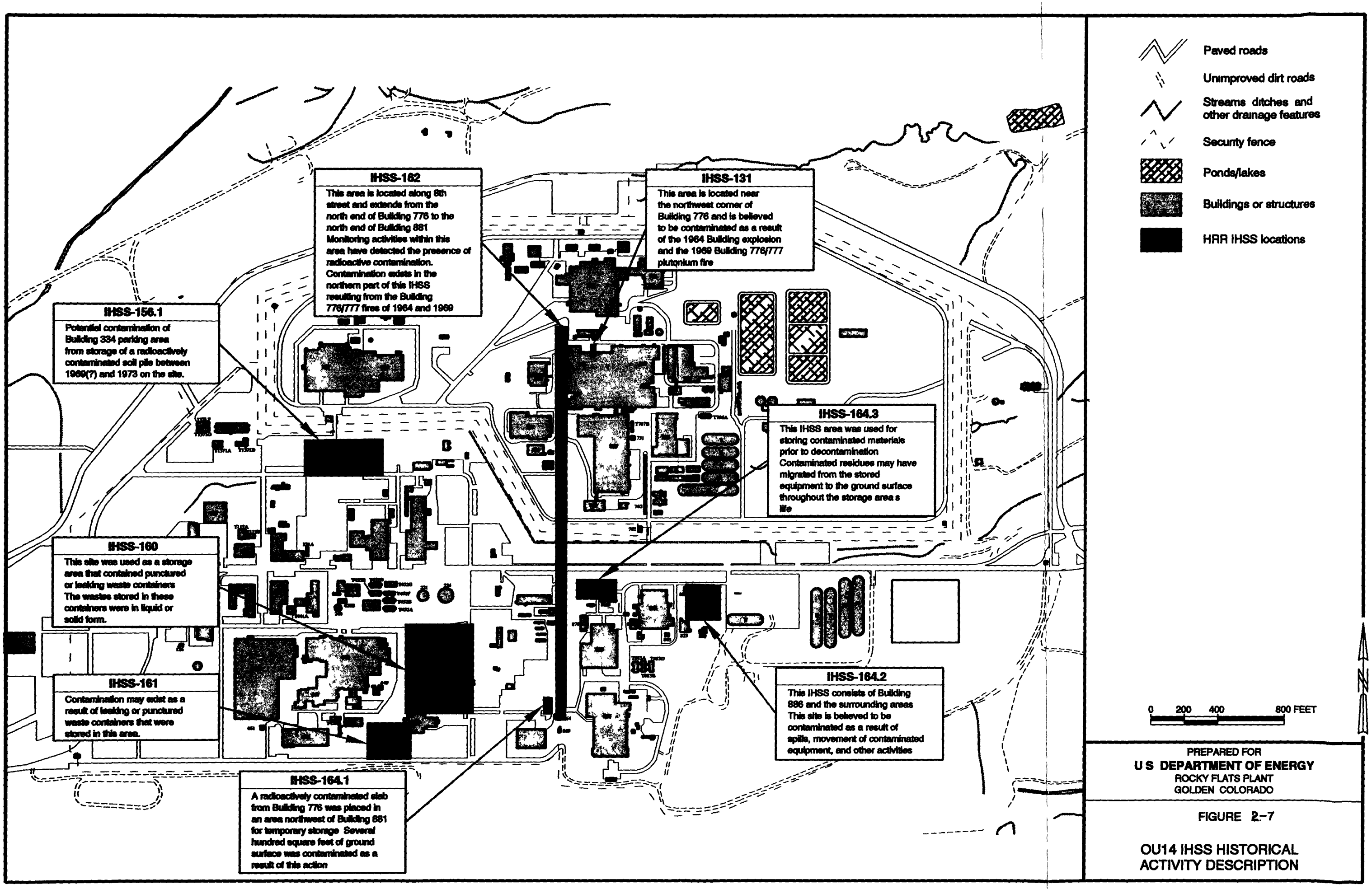
ROCKY FLATS PLANT
GOLDEN COLORADO

FIGURE 1-9

COMPREHENSIVE OVERVIEW OF THE OU14 SITE



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ROCKY FLATS PLANT
GOLDEN COLORADO

FIGURE 2-7

OU14 IHSS HISTORICAL ACTIVITY DESCRIPTION

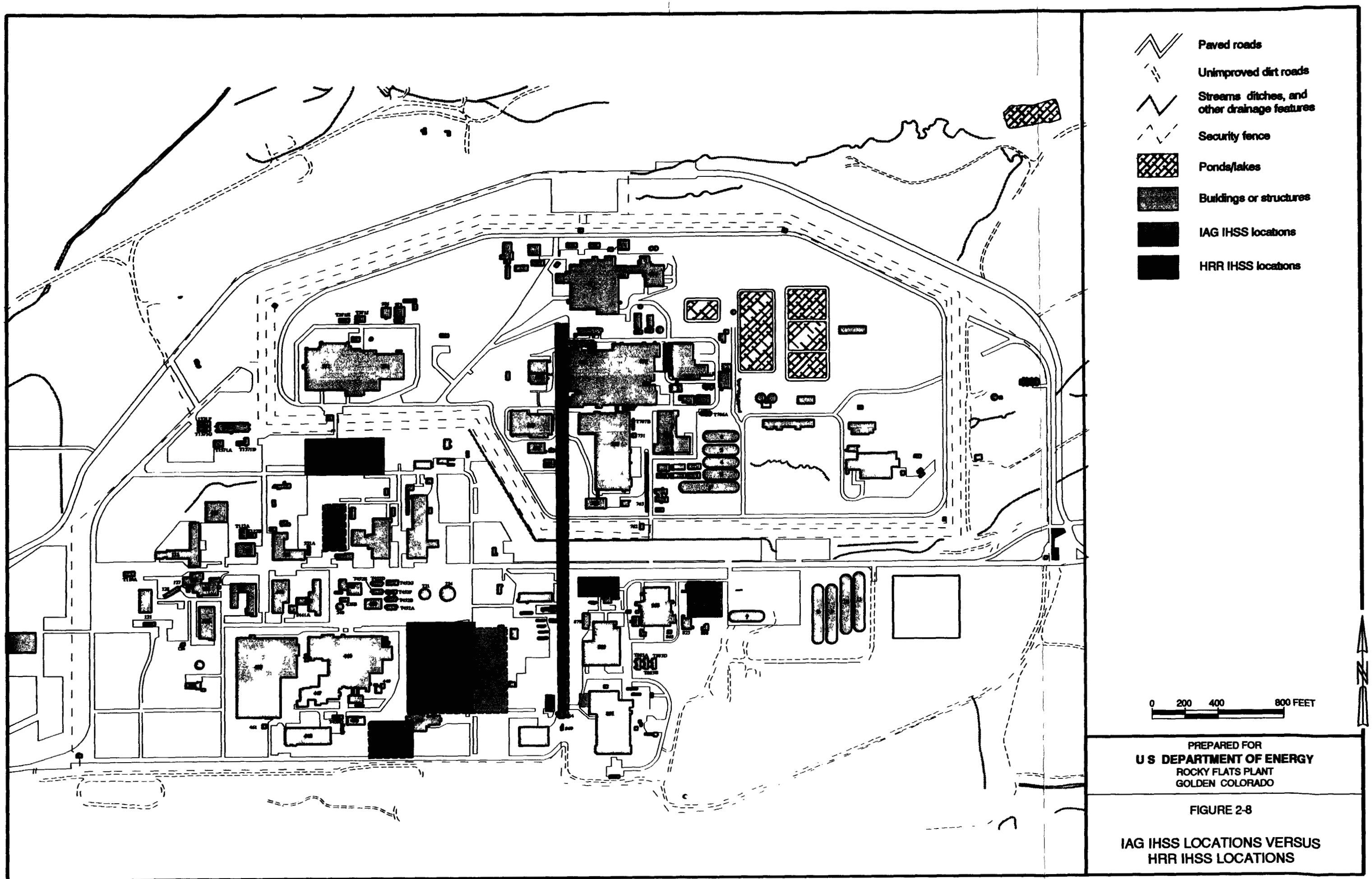


FIGURE 2-8

IAG IHSS LOCATIONS VERSUS HRR IHSS LOCATIONS

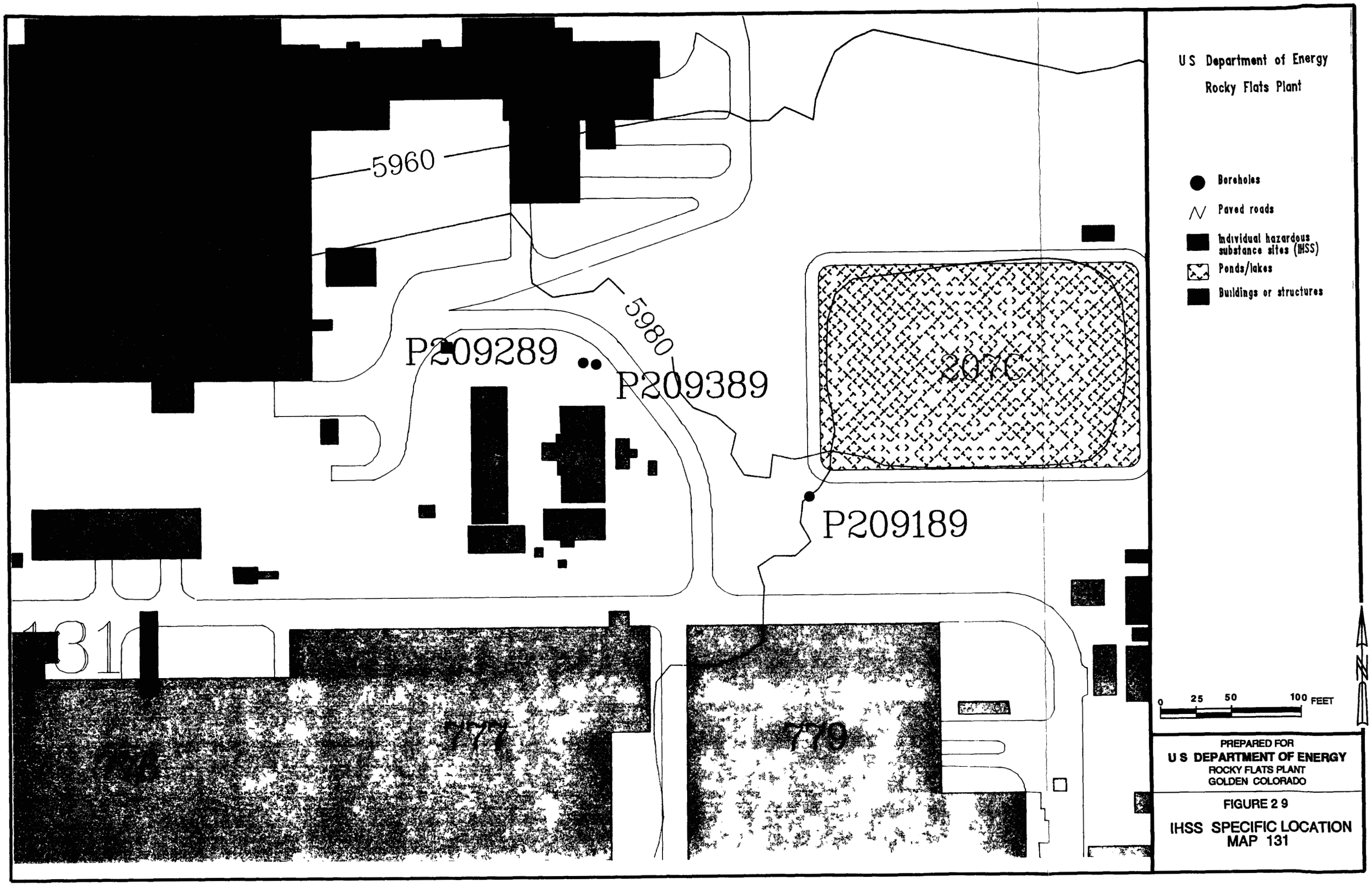
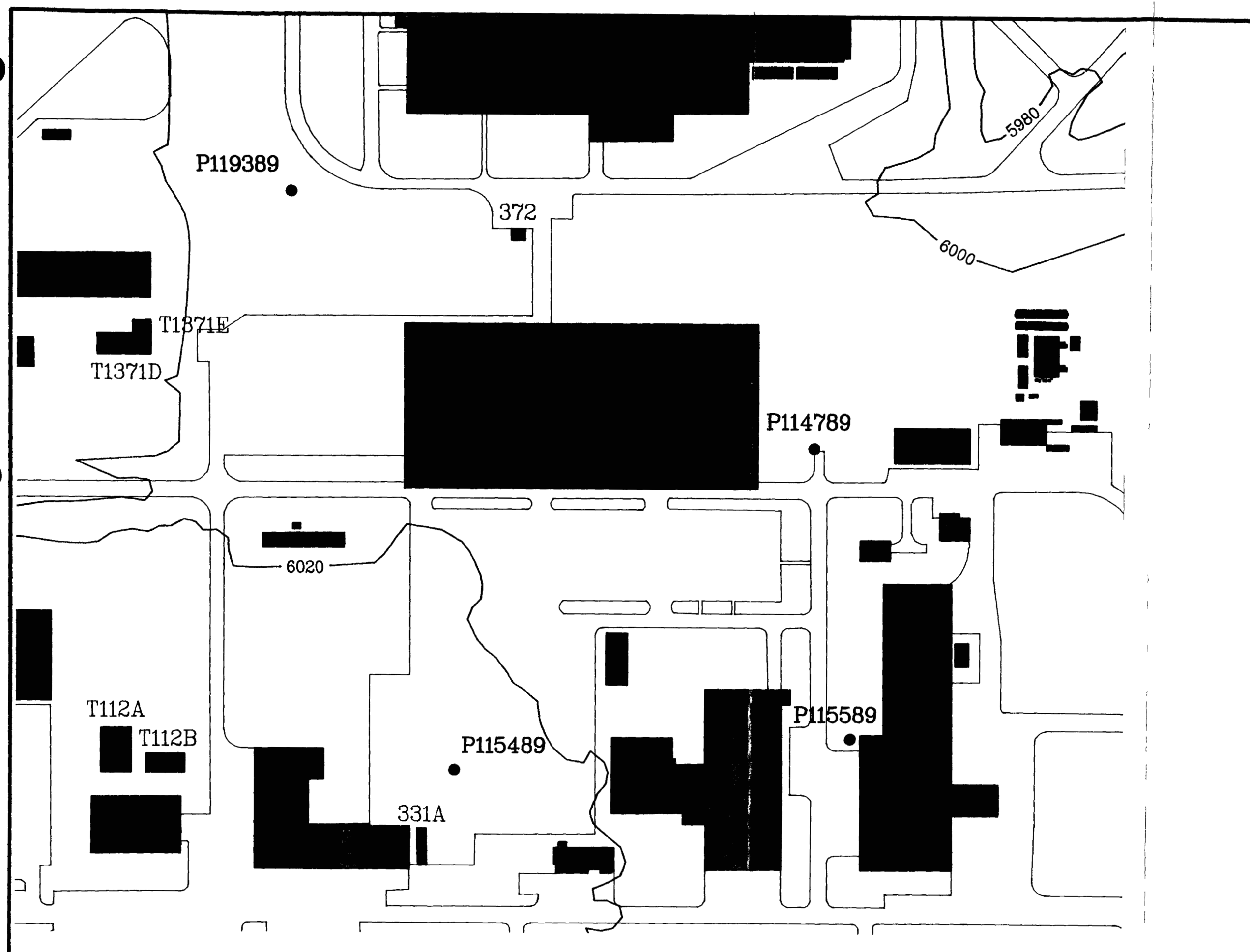


FIGURE 2 9

IHSS SPECIFIC LOCATION
MAP 131



US Department of Energy
Rocky Flats Plant

Boreholes
Paved roads
Individual hazardous substance sites (IHSS)
Buildings or structures

0 50 100 200 FEET

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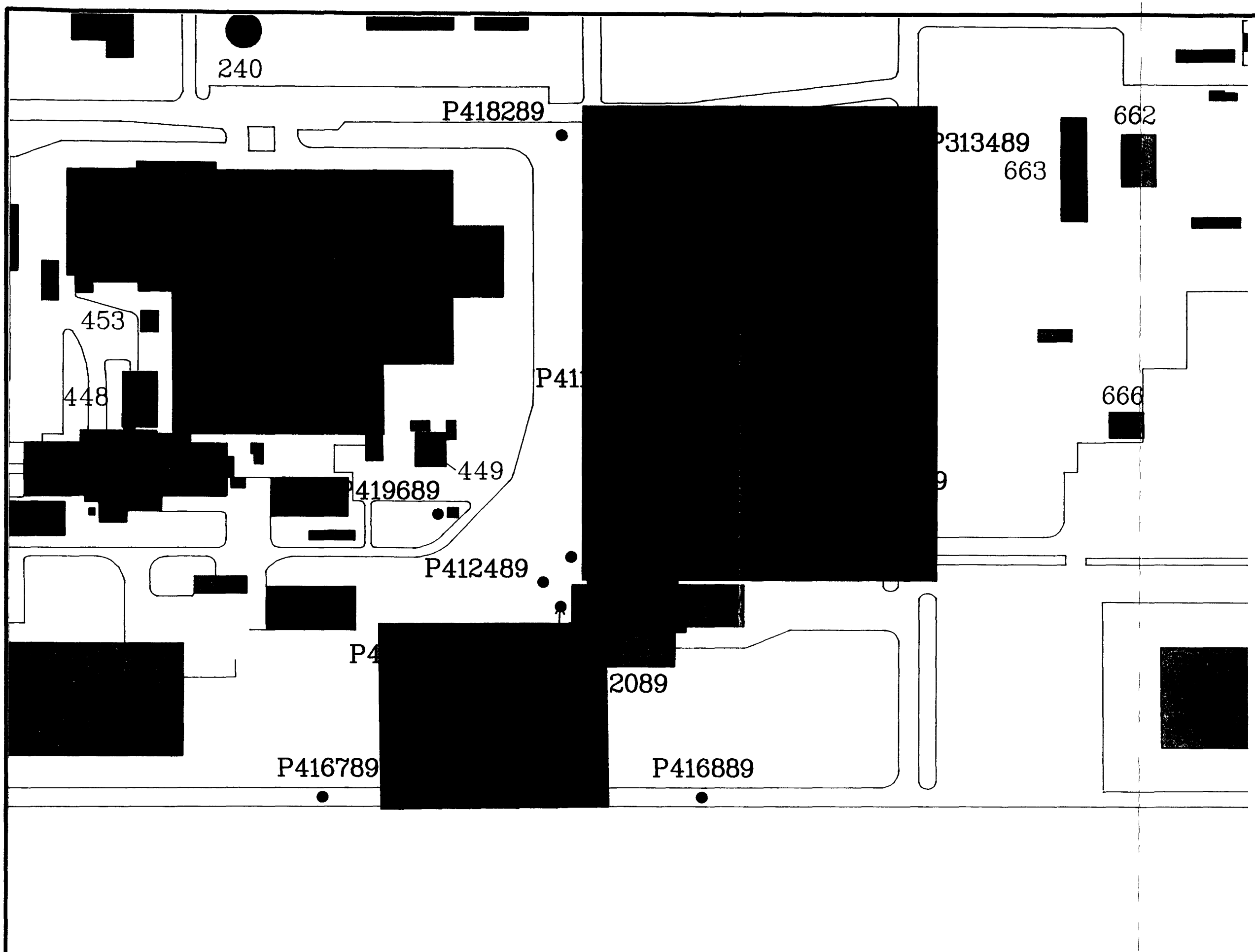
ROCKY FLATS PLANT
GOLDEN COLORADO

FIGURE 2 13
IHSS- SPECIFIC LOCATION
MAP 156 1



US Department of Energy
Rocky Flats Plant

Boreholes
Paved roads
Individual hazardous substance sites (IHSS)
Buildings or structures

0 38 75 150 FEET

N

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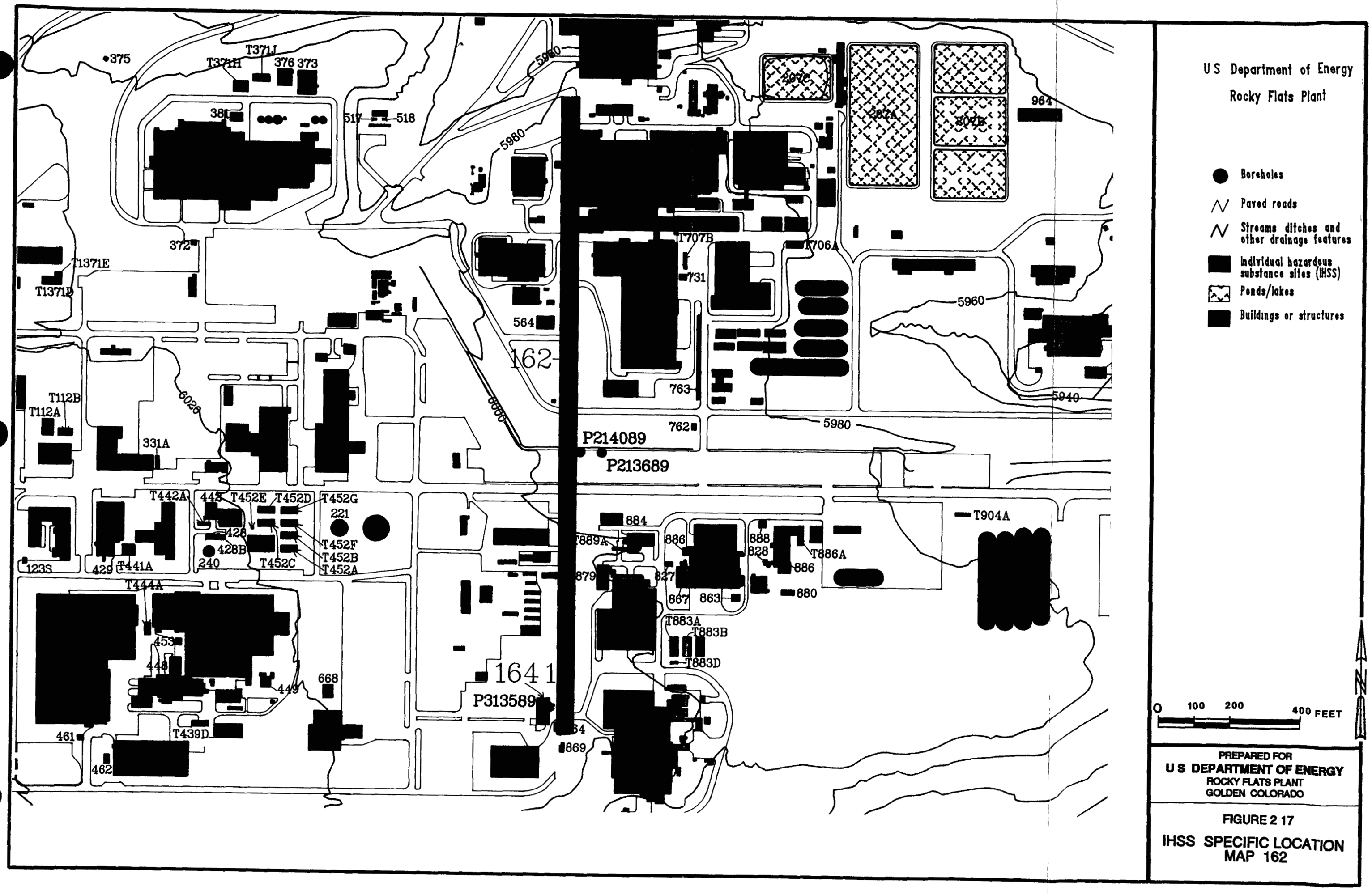
GOLDEN COLORADO

FIGURE 2 14

IHSS- SPECIFIC LOCATION
MAP 160 AND 161


U S Department of Energy
Rocky Flats Plant
Boreholes
Paved roads
Streams ditches and other drainage features
Individual hazardous substance sites (IHSS)
Ponds/lakes
Buildings or structures
0 100 200 400 FEET
N
PREPARED FOR
U S DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN COLORADO
FIGURE 2 17
IHSS SPECIFIC LOCATION
MAP 162
375
T371J
T371H
376
373
381
517
518
5980
207C
207A
207B
964
372
T1371E
T1371D
T707B
T706A
731
5960
564
162
763
5940
T112B
T112A
6020
6000
762
5980
331A
P214089
P213689
T442A
443
T452E
T452D
T452G
221
428
428B
240
T452F
T452B
T452A
T452C
123S
429
T441A
T444A
453
448
449
668
461
T439D
462
1641
P313589
869
884
T889A
886
888
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T886A
886
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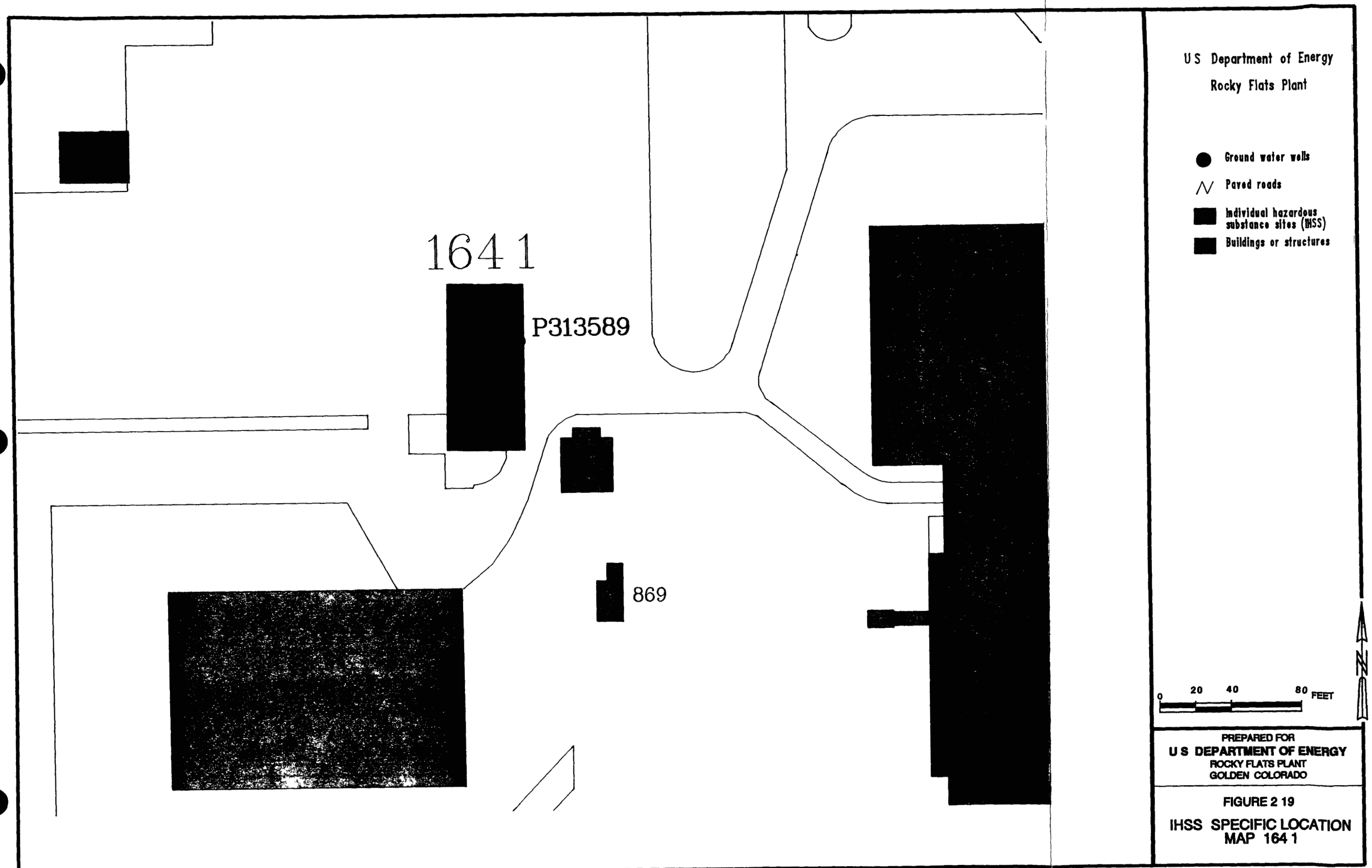
827
867
863
T883A
T883B
T883D
T904A


1641
P313589
869
US Department of Energy
Rocky Flats Plant
Ground water wells
Paved roads
Individual hazardous substance sites (IHSS)
Buildings or structures
0
20
40
80
FEET
N
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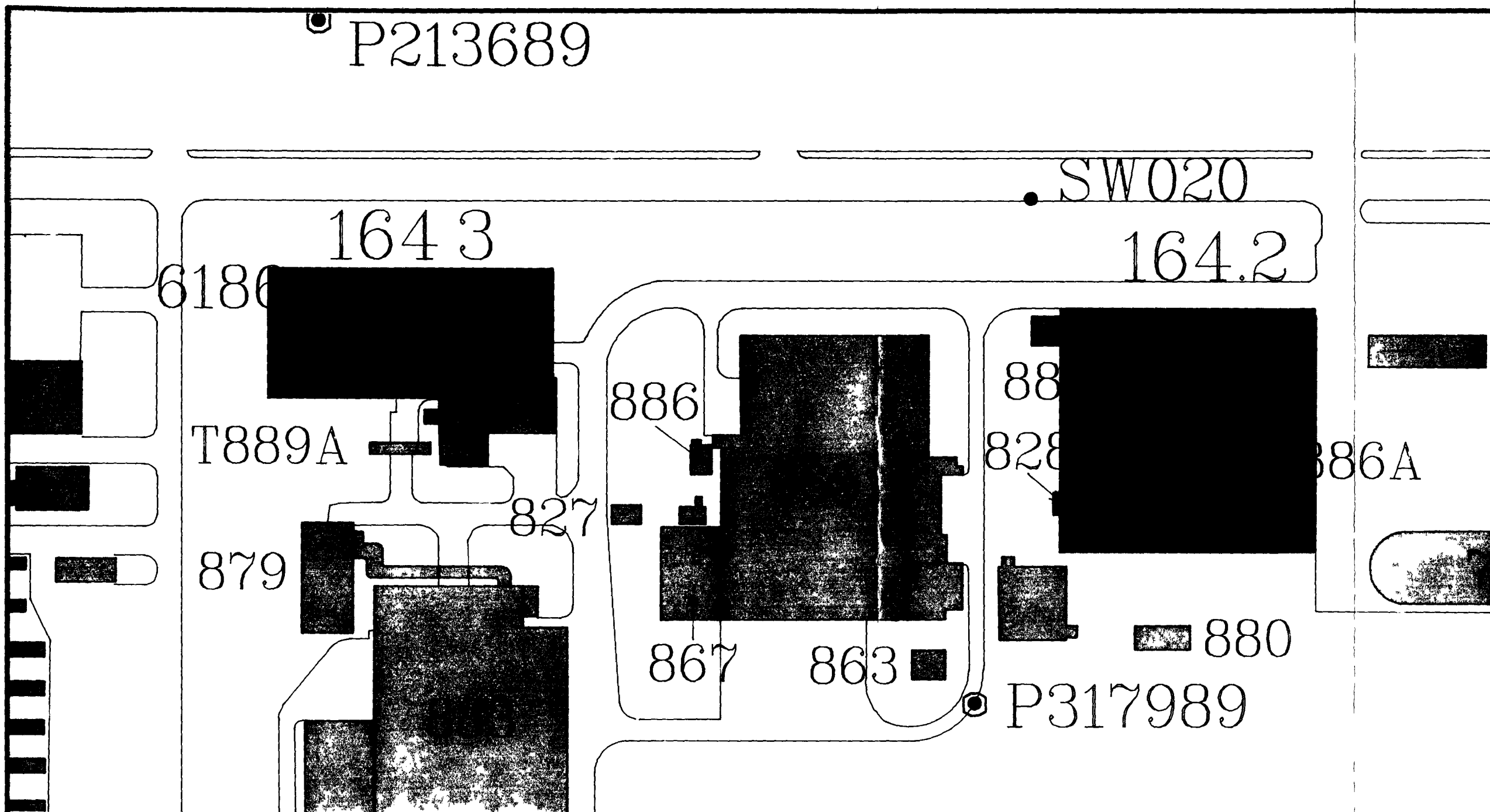
ROCKY FLATS PLANT
GOLDEN COLORADO
FIGURE 2 19
IHSS SPECIFIC LOCATION
MAP 164 1



US Department of Energy
Rocky Flats Plant

- Ground water wells
- Routine sitewide surface water sampling stations
- Boreholes
- Paved roads
- Individual hazardous substance sites (IHSS)
- Buildings or structures

0 50 100 FEET

N

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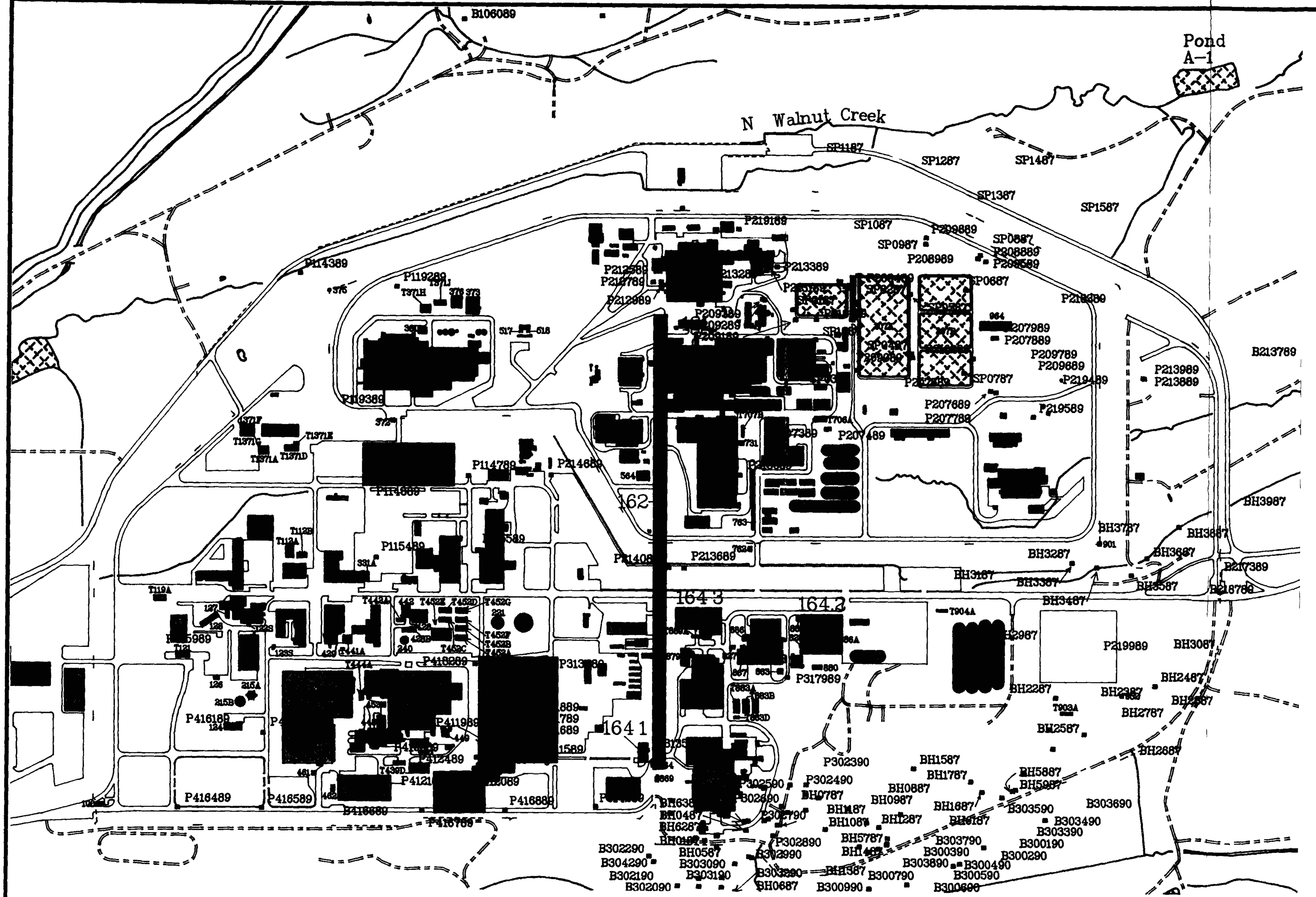
GOLDEN COLORADO

FIGURE 2 21

IHSS- SPECIFIC LOCATION MAP 164 2 AND 164 3



US Department of Energy

Rocky Flats Plant

Boreholes

Paved roads

Unimproved dirt roads

Streams ditches and other drainage features

Security fence

Ponds/lakes

Buildings or structures

Individual hazardous substance sites (IHSS)

0 200 400 800 FEET

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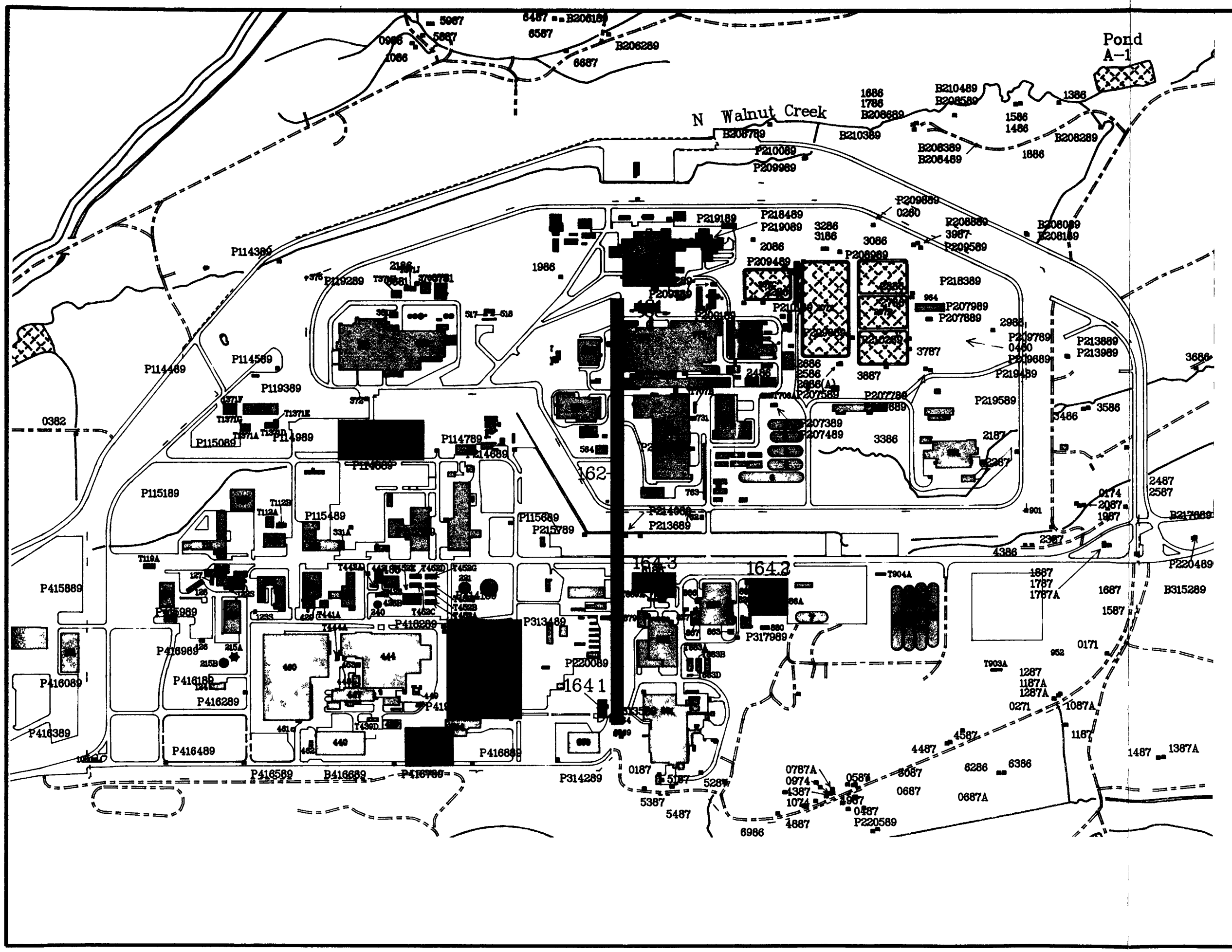
GOLDEN COLORADO

FIGURE 2 26

BOREHOLES LOCATION IN THE VICINITY OF OU14 IHSS



US Department of Energy

Rocky Flats Plant

Ground water wells

Paved roads

Unimproved dirt roads

Streams ditches and other drainage features

Security fence

Ponds/lakes

Buildings or structures

Individual hazardous substance sites (IHSS)

0 200 400 800 FEET

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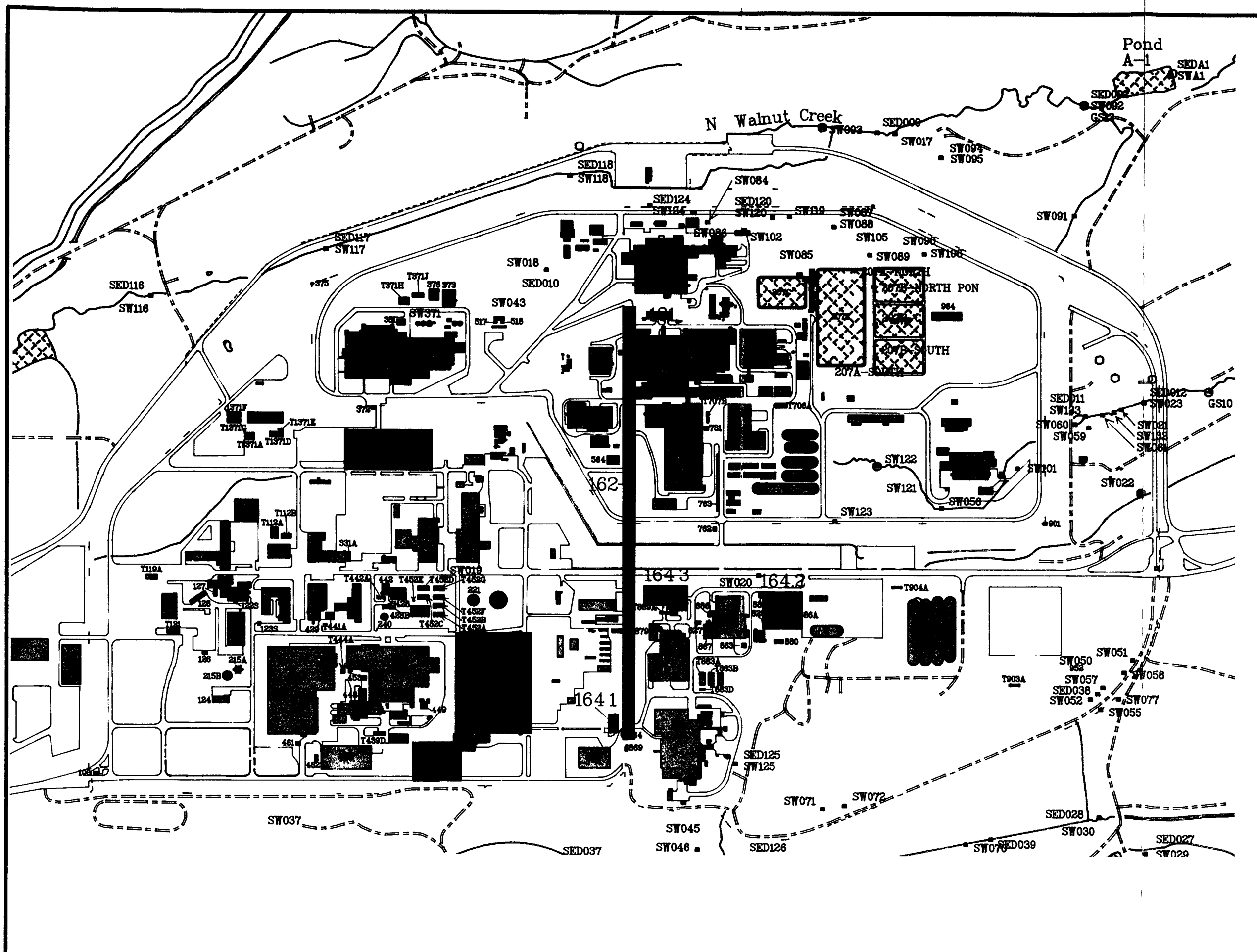
ROCKY FLATS PLANT

GOLDEN COLORADO

FIGURE 2 27

GROUND WATER WELLS IN THE VICINITY OF OU14 IHSS



US Department of Energy

Rocky Flats Plant

- Routine sitewide surface water sampling station
- Routine sitewide sediment sampling station
- Gaging and sampling station for storm event monitoring
- Routine surveillance surface water sampling site
- Paved roads
- Unimproved dirt roads
- Streams ditches and other drainage features
- Security fence
- Ponds/lakes
- Buildings or structures
- Individual hazardous substance sites (IHSS)

0 200 400 800 FEET

N

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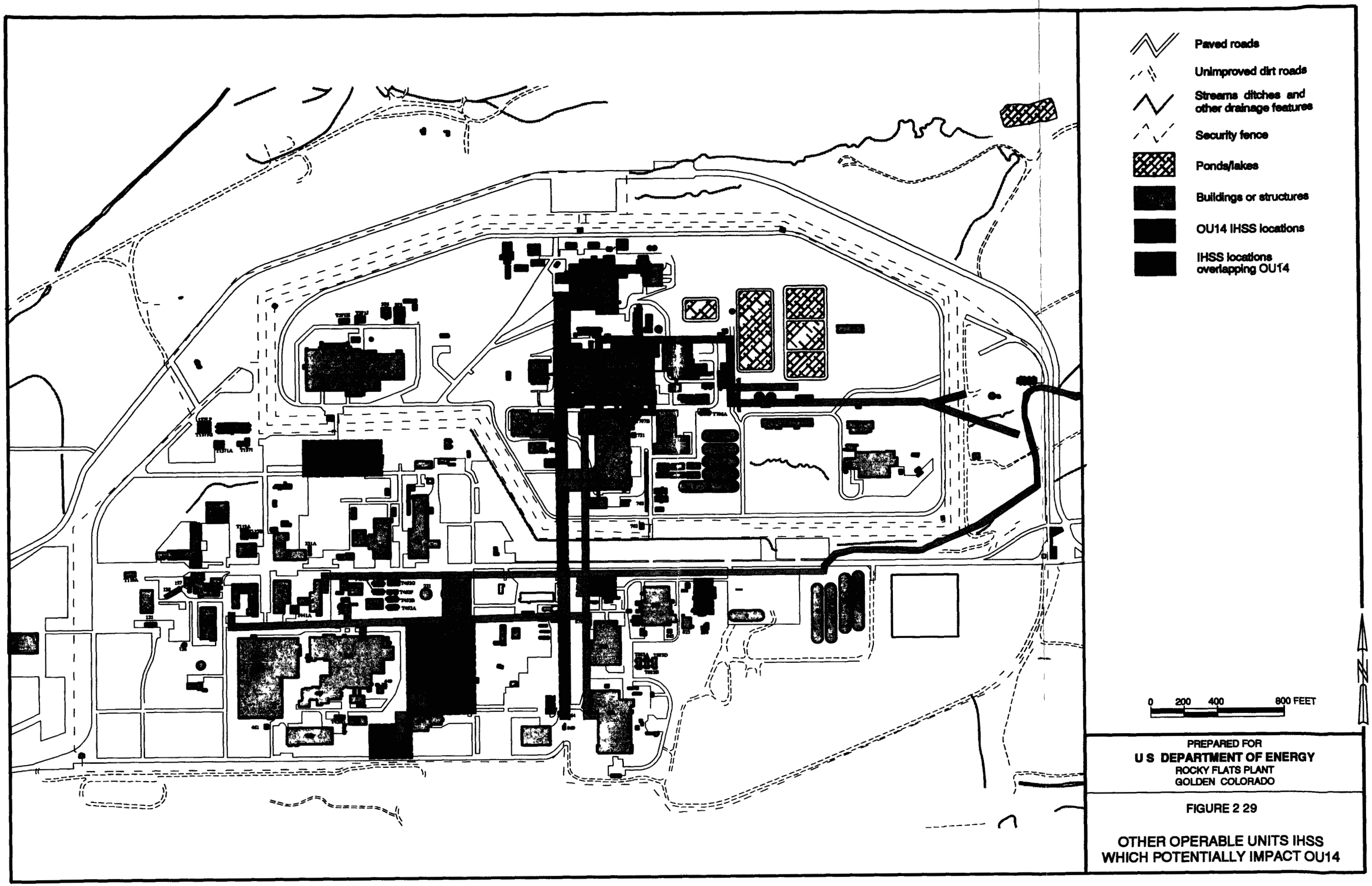
ROCKY FLATS PLANT
GOLDEN COLORADO

FIGURE 2 28

SAMPLING STATIONS IN THE VICINITY OF OU14 IHSS


Paved roads
Unimproved dirt roads
Streams ditches and other drainage features
Security fence
Ponds/lakes
Buildings or structures
OU14 IHSS locations
IHSS locations overlapping OU14
0 200 400 800 FEET
N
PREPARED FOR
U S DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN COLORADO
FIGURE 2 29
OTHER OPERABLE UNITS IHSS WHICH POTENTIALLY IMPACT OU14

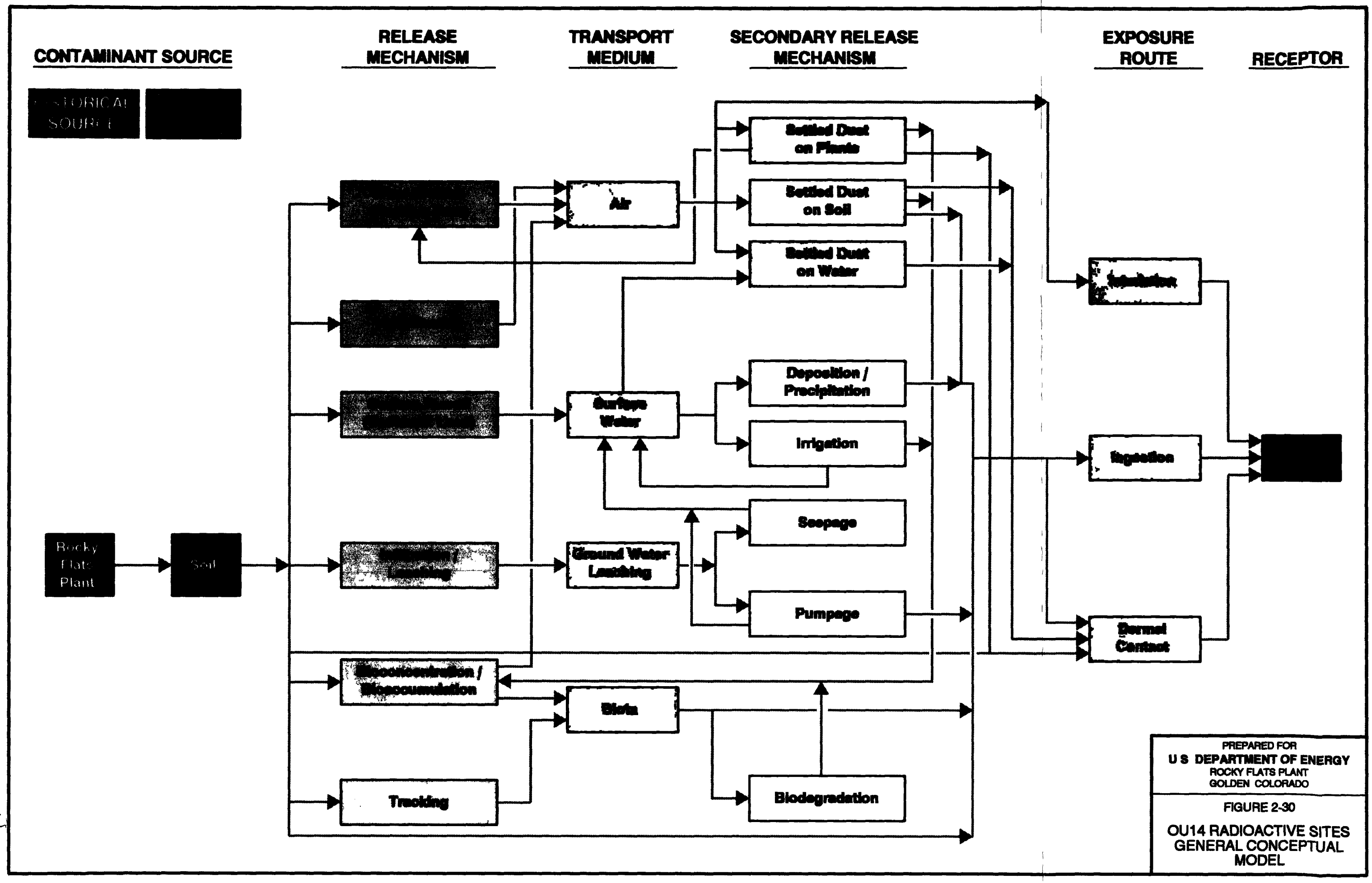
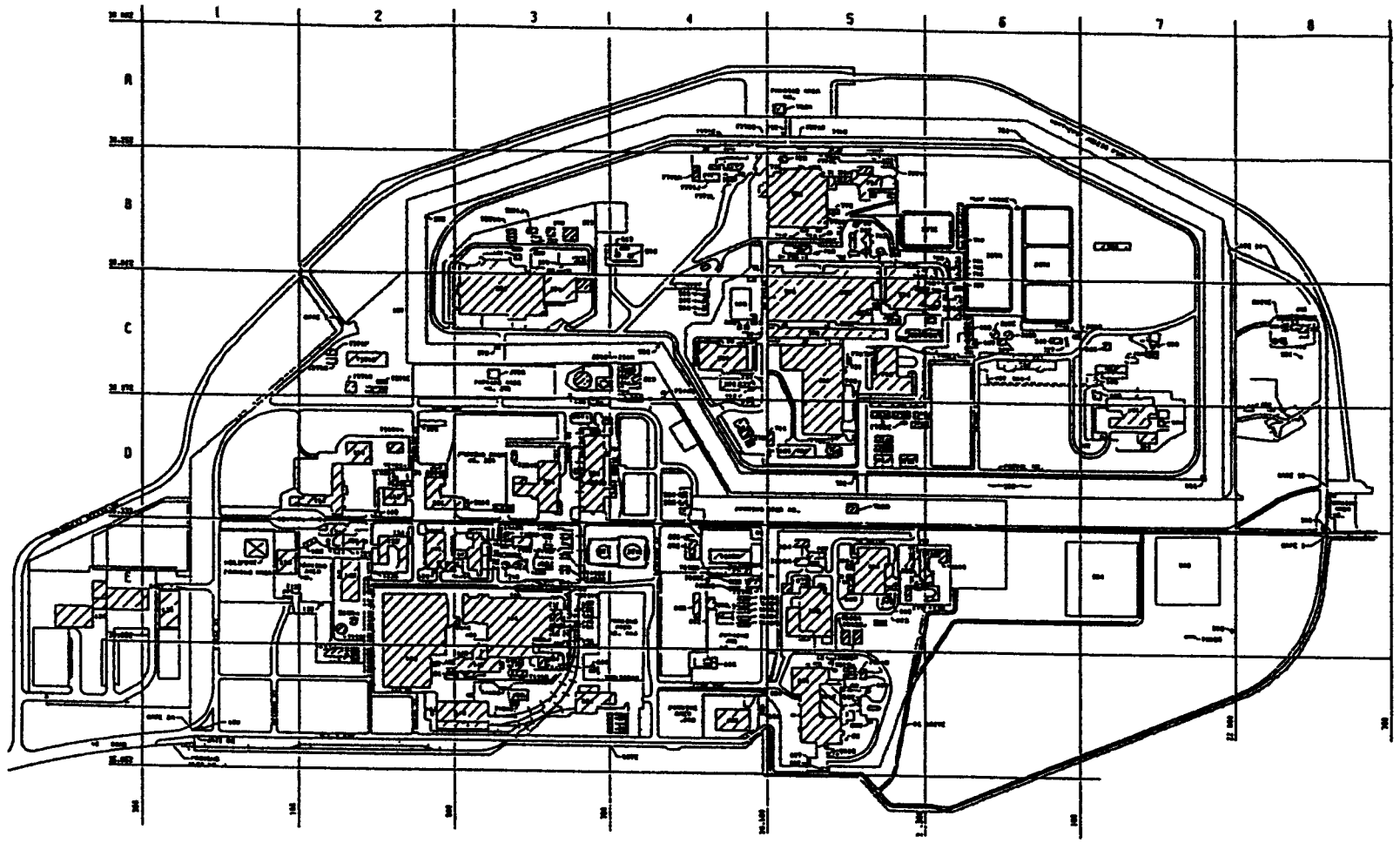


FIGURE 2-30

OU14 RADIOACTIVE SITES GENERAL CONCEPTUAL MODEL



KEY TO DRAWINGS OF AREA PLOT PLAN

			A 3 15501 3	A 4 15501 4	A 5 15501 5	A 6 15501 6	A 7 15501 7			
		B 2 15501 10	B 3 15501 11	B 4 15501 12	B 5 15501 13	B 6 15501 14	B 7 15501 15	B 8 15501 16		
	C 1 15501 17	C 2 15501 18	C 3 15501 19	C 4 15501 20	C 5 15501 21	C 6 15 01 22	C 7 15501 23	C 8 15501 24		
	D W1 15 01 25	D 1 15501 26	D 2 15501 27	D 3 15501 28	D 4 15 01 9	D 5 15501 30	D 6 15501 31	D 7 15 01 32	D 8 15501 3	D 16 15501 34
	E W1 15501 38	E 1 1 501 39	E 2 15501 40	E 3 15501 41	4 15501 42	5 15501 43	E 6 15501 44	E 7 15501 45	8 15501 46	
	F W1 15501 49	F 1 15501 50	F 2 15501 51	F 3 15501 52	F 4 15501 53	F 5 15501 54	F 6 15501 55	F 7 15501 56	F 8 15501 57	
G W8 15501 59										

LEGEND

SYMBOL	DESCRIPTION
	BUILDING OR STRUCTURE
	PAVED AREA
—X—	FENCE
—+—+—	RAILROAD TRACK
—	UNDERGROUND STRUCTURE

DWG 15501 74
DWG 15501 75

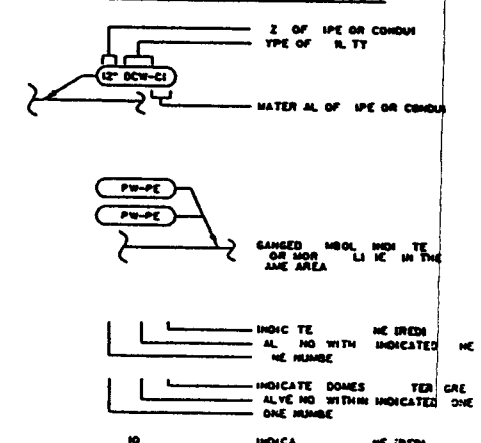
QUADRANT A 15501 70	QUADRANT B 15501 71
QUADRANT C 15501 72	QUADRANT D 15501 73

RFAO PLANT VICINITY
UTILITIES DRAINAGE &
QUADRANTS A B C D

REFERENCE DRAWINGS

255 -1 UND D GE AN
300 E O LAN W BE C MARKS
300 3 BUF ER ZO E O O R E
55 0 CK FL T (GR D S TE)
2 2 3 E CESS RD T ND
7 9-1 AI T TY & DR E
E 9 BOUNDR L NES M NUME T T (U ARM E)
2 W TER L NE R UMP HG ST O ER
RE TMENT P AN
2720 EN O WE ST DY LO T O S & Z E
DES G T S
2 DWG SER ES FO W TER S
E1 7 9 6 E EST E T
5 3 WE T WER LO P
5 2 TO D 37

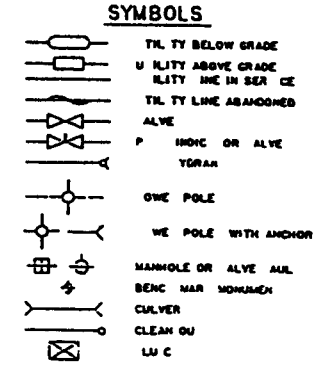
UTILITY INDENTIFICATION



ABREVIATIONS

BDN	ABANDONED
ABN	ALARM AND METERING
A	ANGEN
A	ALARM TEN 0" DEEP
BD	BL DOWN
BM	BENCH MARK ALSO BAM
BS	BOTTOM OF DUC
B	BOTTOM OF PIPE
	BREATHING AIR
CC OR CAP	CEMEN ASBESTO PE
CA	CA ON ASBM
	CARBON TETRACHLORIDE
	CONDUI
	CAST IRON PIPE
	CORRUGATED ME AL IPE
	CONDUIT FUGA ATELAN
	CONCRETE TED M R ACKO
	CONCRETE
	COLD W TER NO PO ABLE
	COOLING WATER RE JAN
	COOLING WATER SUPPL
	COPPER PIPE
	CLEAN OU
	DOMESTIC COLD WA ER
	DOMESTI COLD ER-FIRE -0" -0" DEEP
	DUC IRON PIPE
	DUC PLASTIC TRANSITE OR TEEL I CONC.
	ELECTRICAL -0 DEEP
	ELE THOM
	ELE TRICAL MANHOLE
	OW PRESSURE ALARM
	GASOLINE OR IN
	IESEL S P PE
	ME TORAN
	FUEL OIL
	GLASS LINED IPE
	GAS LIQUID PETROLEUM
	GAS, NATURAL -0" DEEP
	GROUNDI ACKO
	AND HOLE
	HONEYWELL ALAR TEM
	VALVEL
	PO AS NUM TOR XHOE
	INSTRUMENT AIR
	LAUNDR ASTE
	MANHOLE
	NITROGEN
	OX GEN -0" 4'-0 DEEP
	OUTFALL SEWER
	PLAN
	PULL BO
	POL ETHYLENE IPE
	PROCES OIL WASTE
	POLYVINYL CHLORIDE IPE
	PROCES ASTE
	PROCE WASTE-FORCED
	PROCE ASTE A LIN -0" TO - DEEP
	OCESS ASTE SUPPL
	HIGH TEFLON PE
	AW TEN
	ORM DRAIN
	AIN AR EWER
	SAN AR EWER FORCED
	S NKLESS TEEL PIP -0" TO 8'-0" DEE
	TEAM (S S.I. & AS VO)
	TEEL PIP
	TELEPHONE -0" TO -0" DEEP
	TELEPHONE MANHOL
	TOWER ER RETUR
	TOWER W TER SUPPL
	UNDERGROUND CABLE-CLASS -6 -0 DEEP
	UNDERGROUND CABLE-CLASS
	VITRIFIED CLA PE
	ALVE AULT
	SEWAGE EFFLUENT
	EWER SE SIMO FEED
	REVER E SIMO RODUC TER
	CO ILTER ACA AS
	P ER EVERSE MOS ME
	CONDAR EVERSE SMO EM
	DR ING BED I TR TE

SYMBOLS



KEYWORDS
S E
2 TLTES
3 AB YEGROUND
NDERGROUND
5
BLDG/FACILI T
S TE
DRAWING
CA CODE /FCAL NO

N | ADDED MAS R S AMP
M | UPDATED

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DR WN	KELLOUGH	7 20 83	
CHECKED	TRUWILLO	8 23 83	
AP VE	TERXUN	8 24 83	
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APPROVED BO			

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UTILITY LAYOUT
LEGEND SHEET

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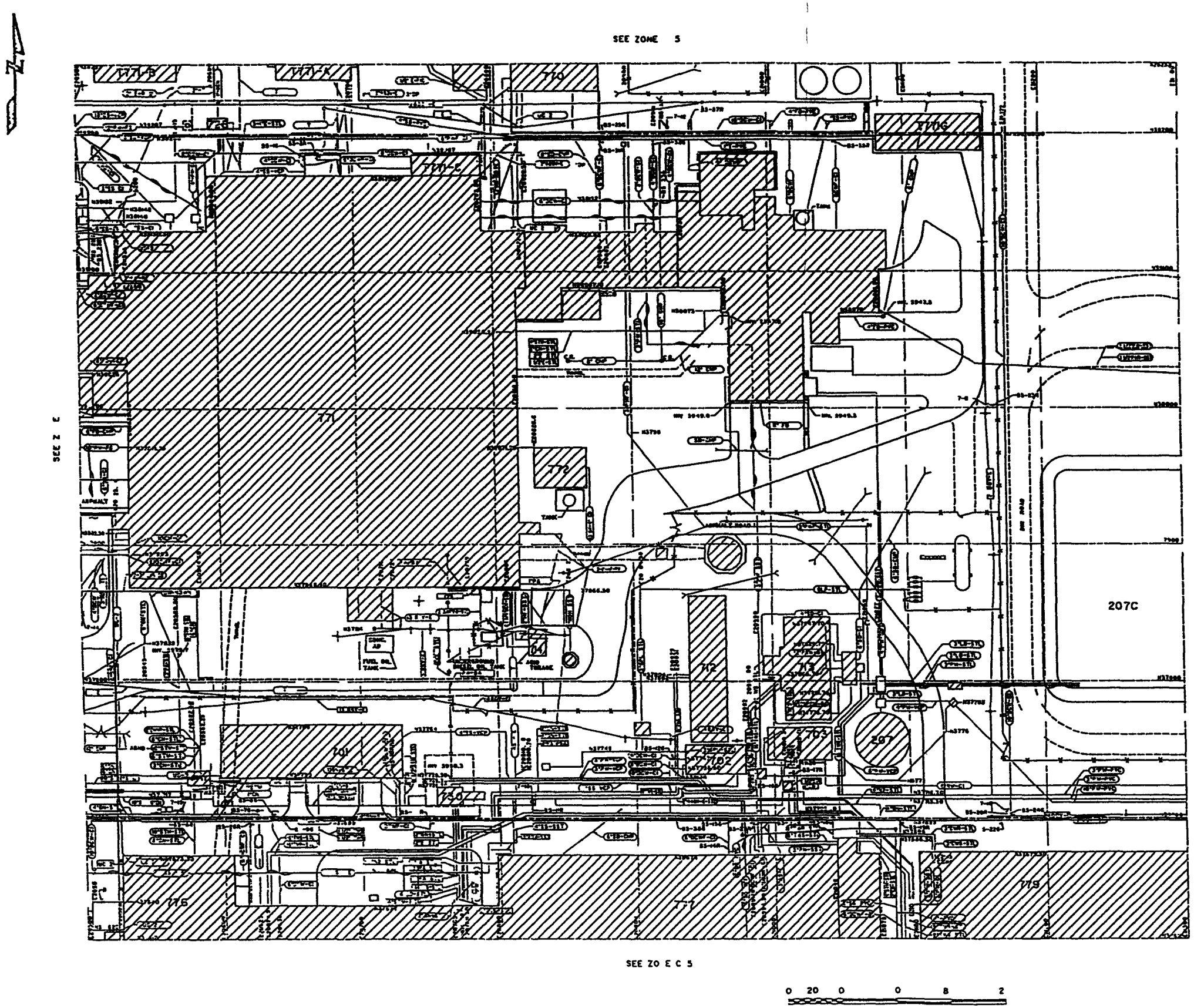

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KEYWORDS
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U DE ARTME T ER
OCK L OF CE OLDEN, COLORADO

SITE UTILITY PL NS

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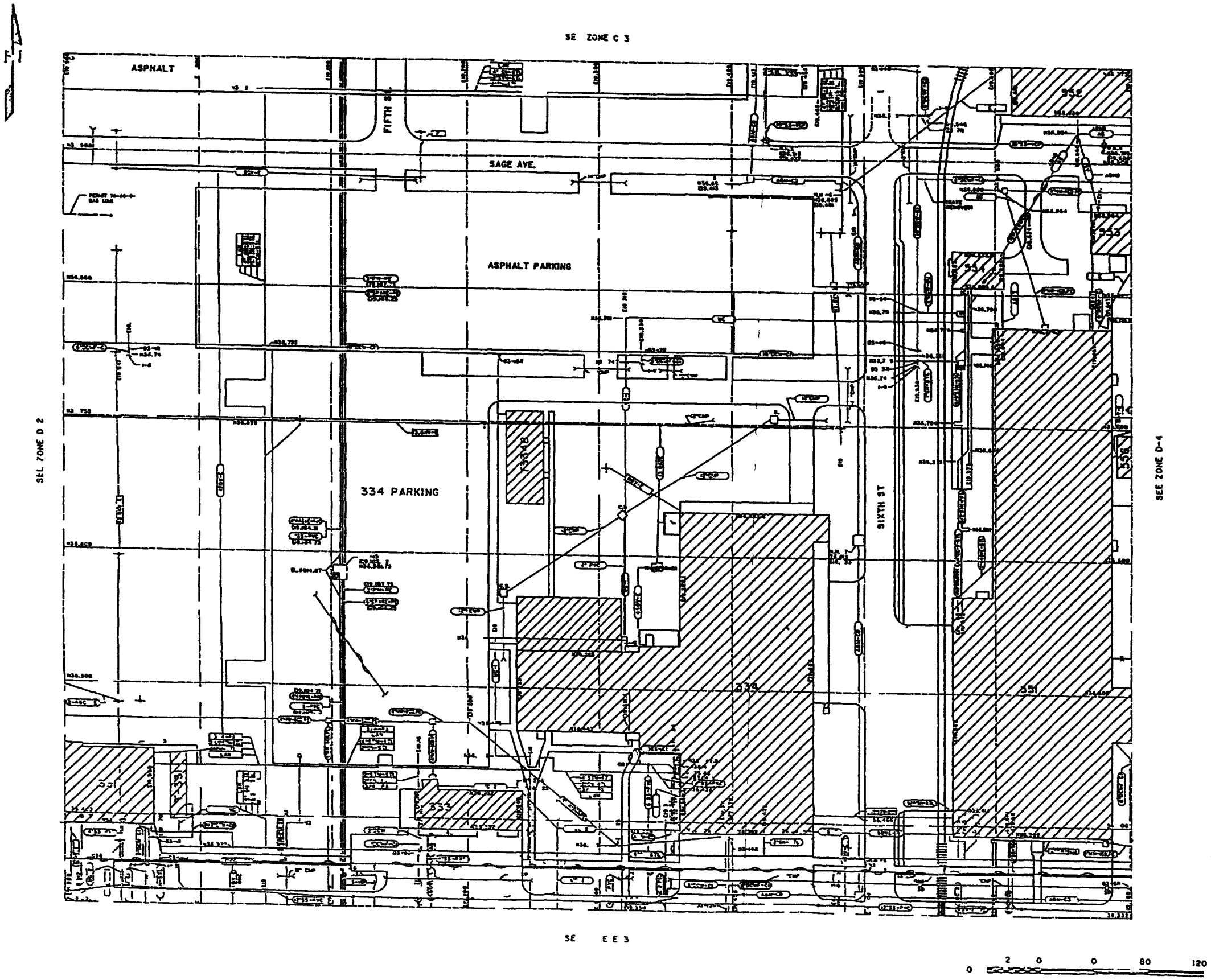

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SITE UTILITY PLANS

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D 15501-28-M P D-3

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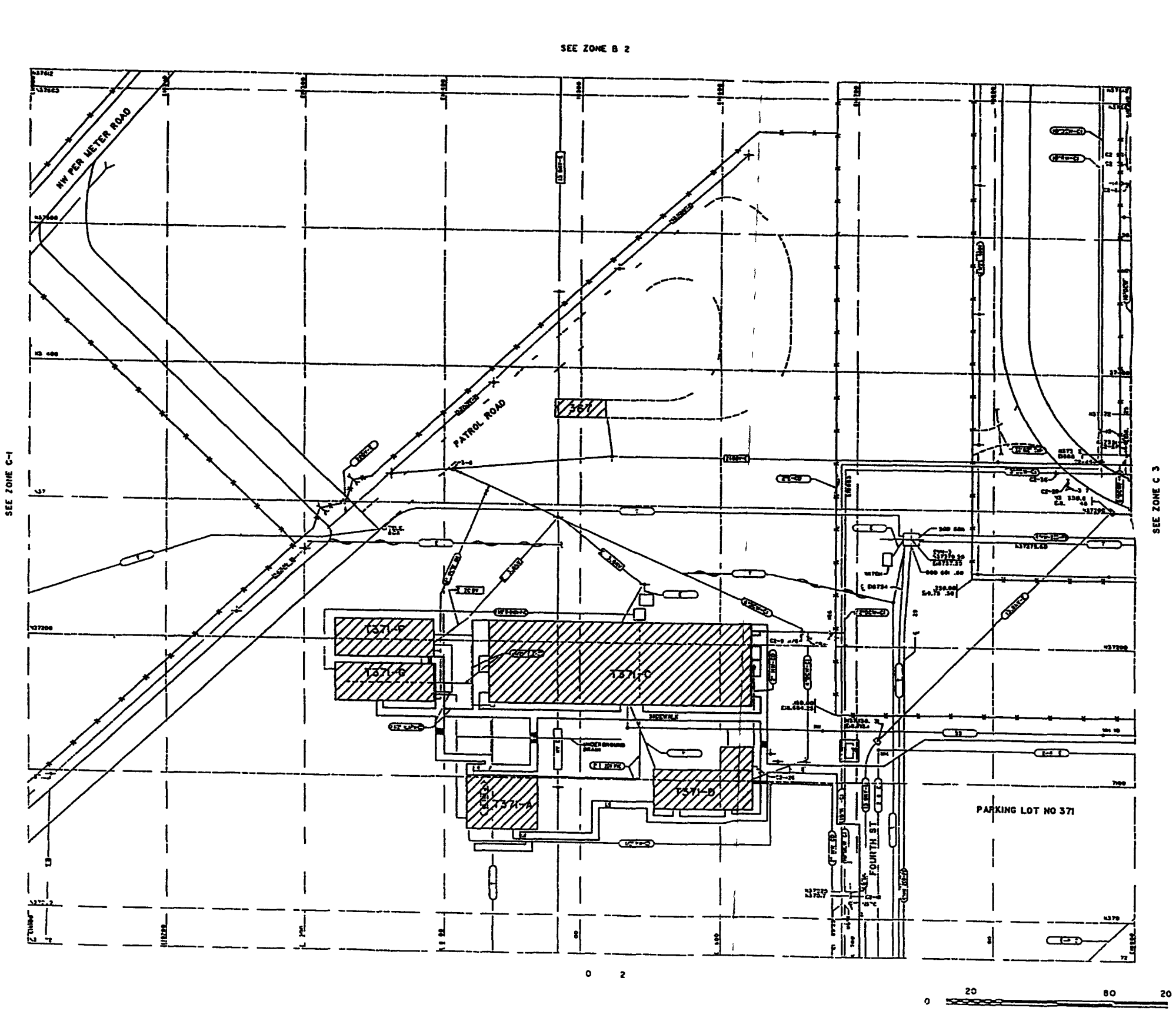

IHSS 156 1 (HRR)

KEYWORDS	H UPDATED		6-14-90
T T	G UPDATED		7
NO GROUND			
3 PLA			
S TE			
5 VEG OUTP			
S TE			
	DR WN	KELLOUGH	20
	CHECKED		
	APPROVED	T KU	6 7 8

MASTER DRAWING

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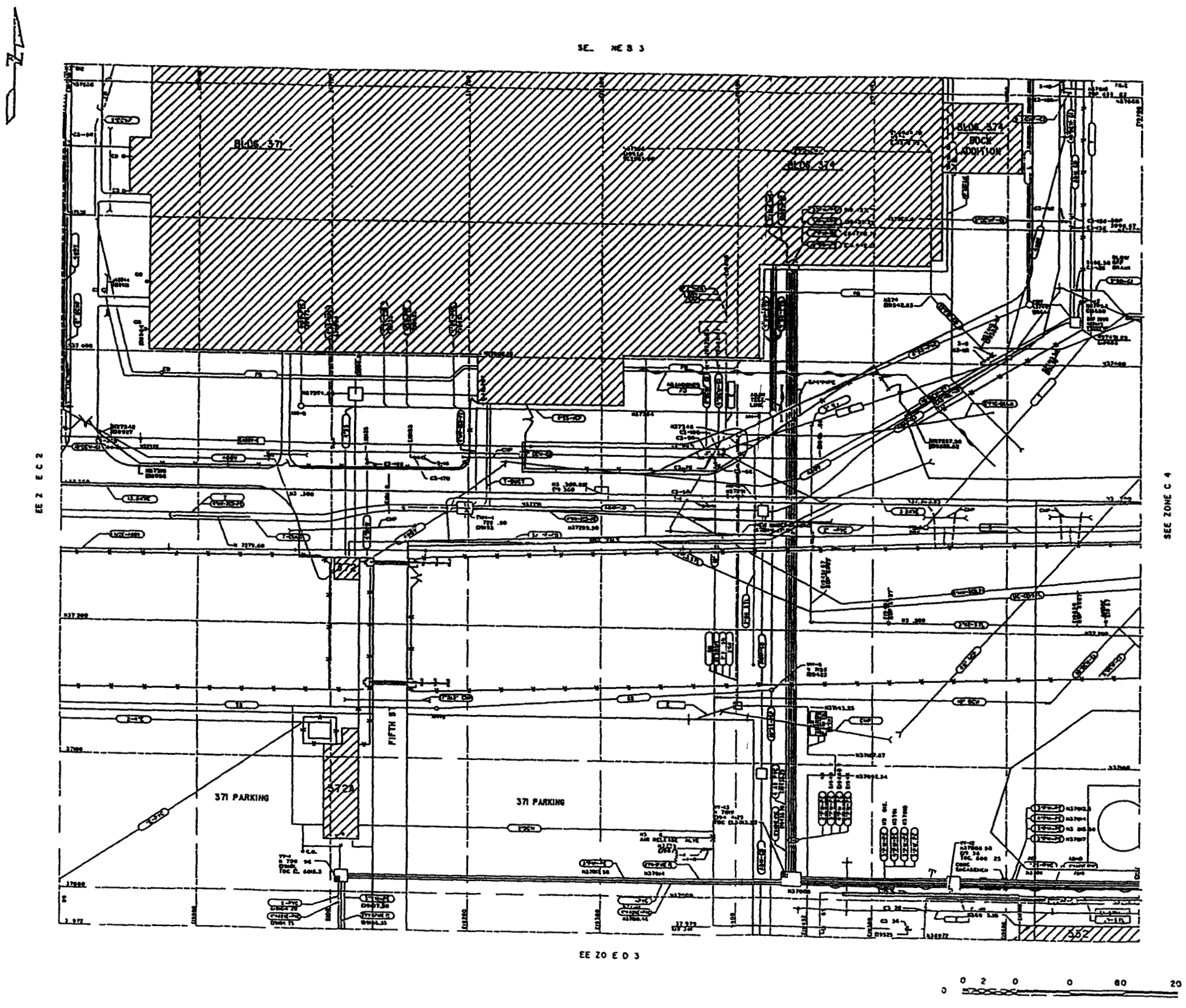


IHSS 156 1 (HRR)

P	ADDED MAS STAMP	7-20-1		900
N	CONTROLLED DRAWING	1-17 87	WC	DLG 47 E

KEYW RDS
L T
2 NDERGROUND
3 A
S TE
B 'E.R UND
T
ROOM/AREA
CA CODE/FEDL NO

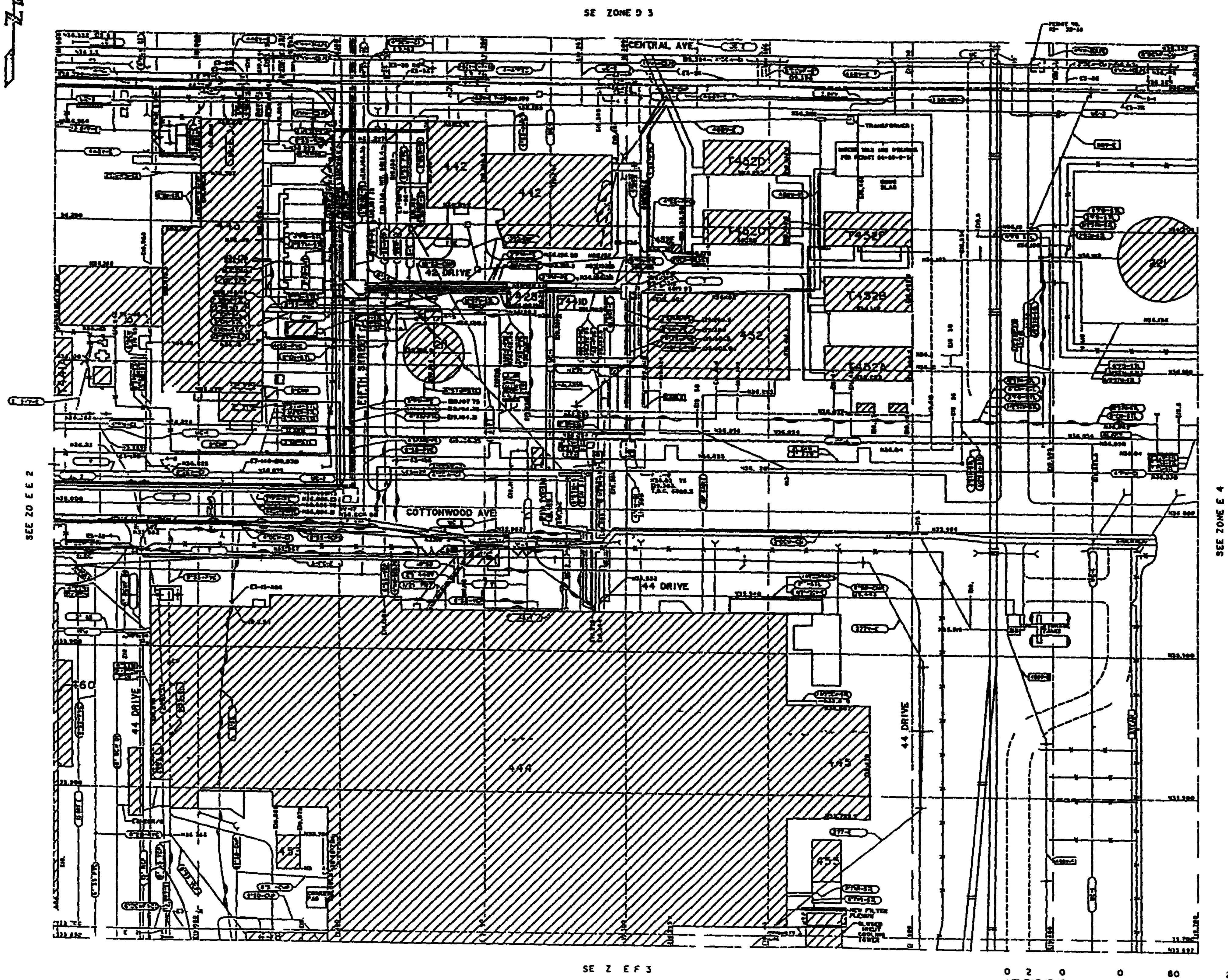
DE GNED	—	—
DR WN	KELLOUGH	8
CHECKED	—	—
AP VE	TERKU I	6 7 6

TIME E
ROCK FLAT OF ICE GOLDEN, COLORADO

SIT UTILITY PLA IS

MASTER DRAWING
MAINTAIN AS BUILT PER DES 8
E GROUP RE PONS LE CSE

D 15501-19-M P C-



IHSS 160

KEYWORDS	R	ADDED MASTER STAMP	7/24/9	KU	QU		C	9G04
S TE	P	CONTROLLED DR WING	1-17 87	—	"C	— RYJ	DLG	470601

2. T ES — 3. VEGROUND / HOERGROUND

DR WN: KEL OUGH 7 20 85
APP VED: TERKUN 6 27 86

SIT UTILIT P IS

MASTER DRAWING
MAINTAIN AS BUILT PER DES 8
FE GROUP R PONS BLE SE

D|15501-41-M|R|E-3

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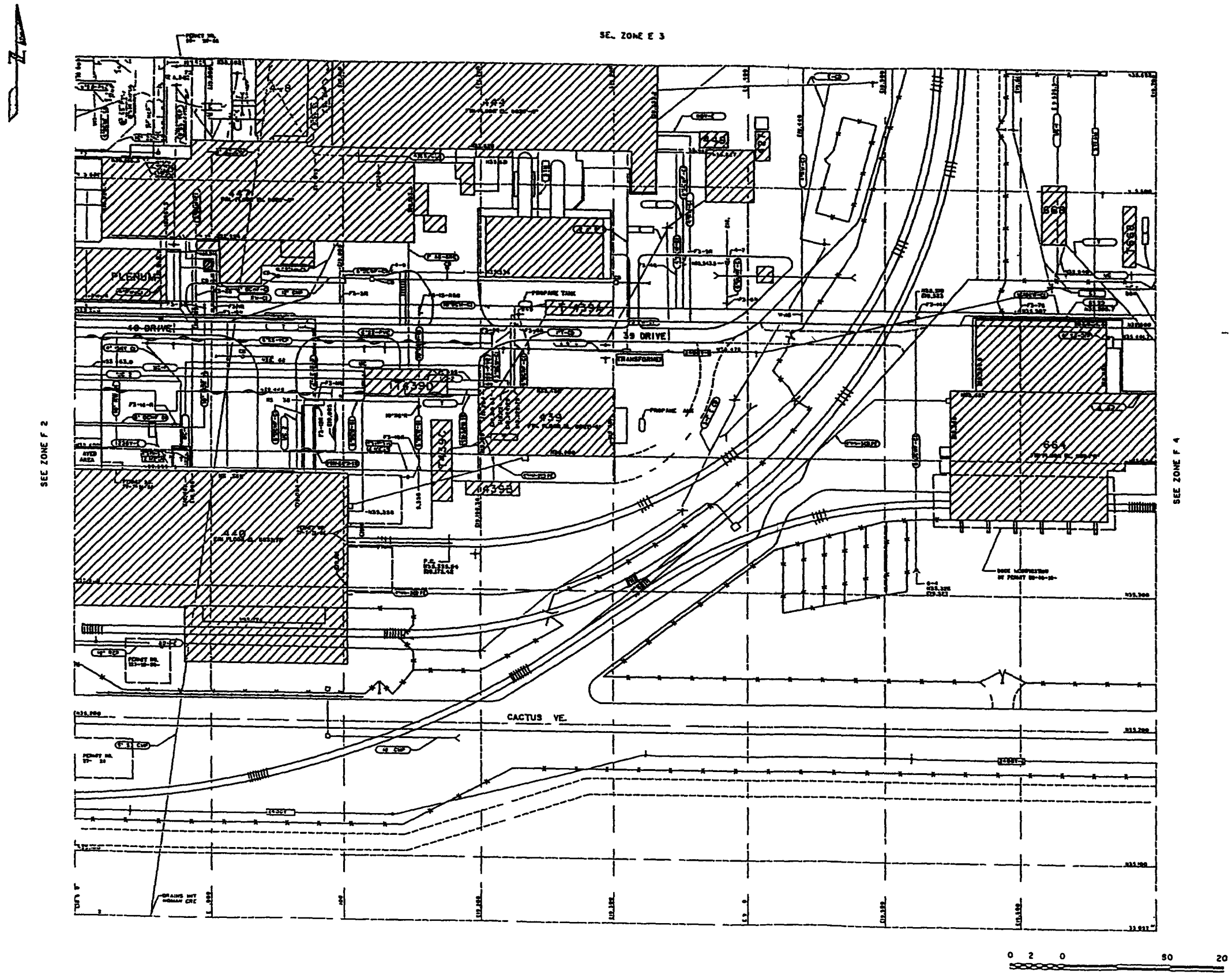


IHSS 160/161

P	ADDED MASTER STAMP	7/20/90	KM	OU	9004 E
N	CONTROLLED DRAWING	1-17 87	WC	P K	DLG 470601

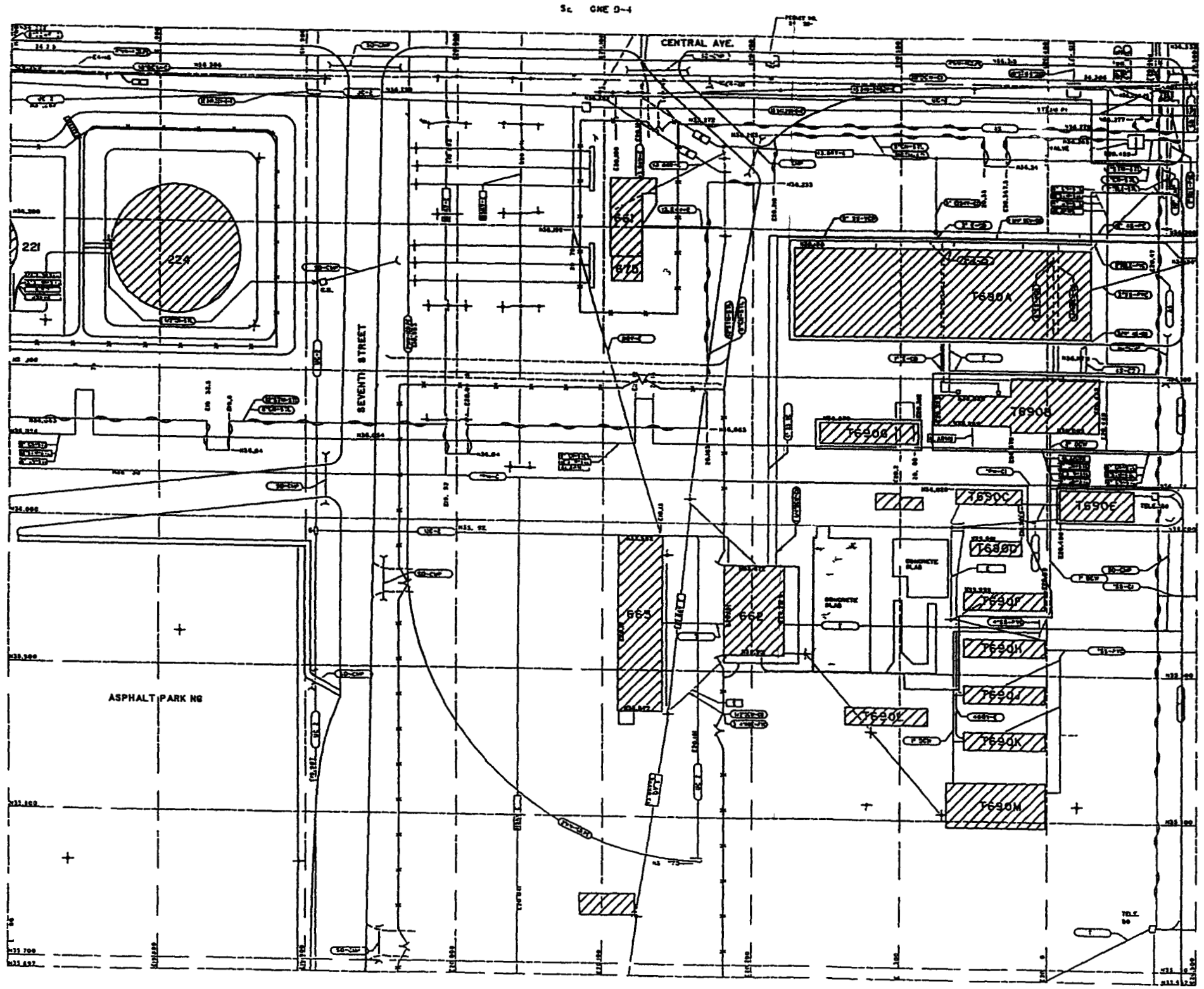
KEYWORDS
S TE
2 T L T ES
3 ABOVEGROUND
NDERGROUND
TE

DES GNED	—	—
DR WN	KELLOUGH	7 2 8
CH CKED	—	—
APP VED	TERKUN	6 27 86

SITE J ILI / PLANS

MASTER DRAWING

D 15501-52-M P F-3



IHSS 160/162

P	ADDED MAS ER STAMP	7/20/9	KJ	OU	9004 9
N	UPDATED OLD DWG NO 15501 5	7 1 86	DM	VT	DLG 4 0031

KEYWORDS
TE
2 U L T ES
3 YEGR UND
NDERGROUND
5
S TE

		DATE
DESIGNED	—	—
DR WN	KELLOUGH	20 8
CHECKE	—	—
AP VE	TERKUN	6 27 86

D TM E
OCK FLA OF IC GOLDEN, COLORADO

SITE UTILITY PLANS

MASTER DRAWING
MAINTAIN S BUILT PER DES 8
FE GROUP RE PONSIBL SE

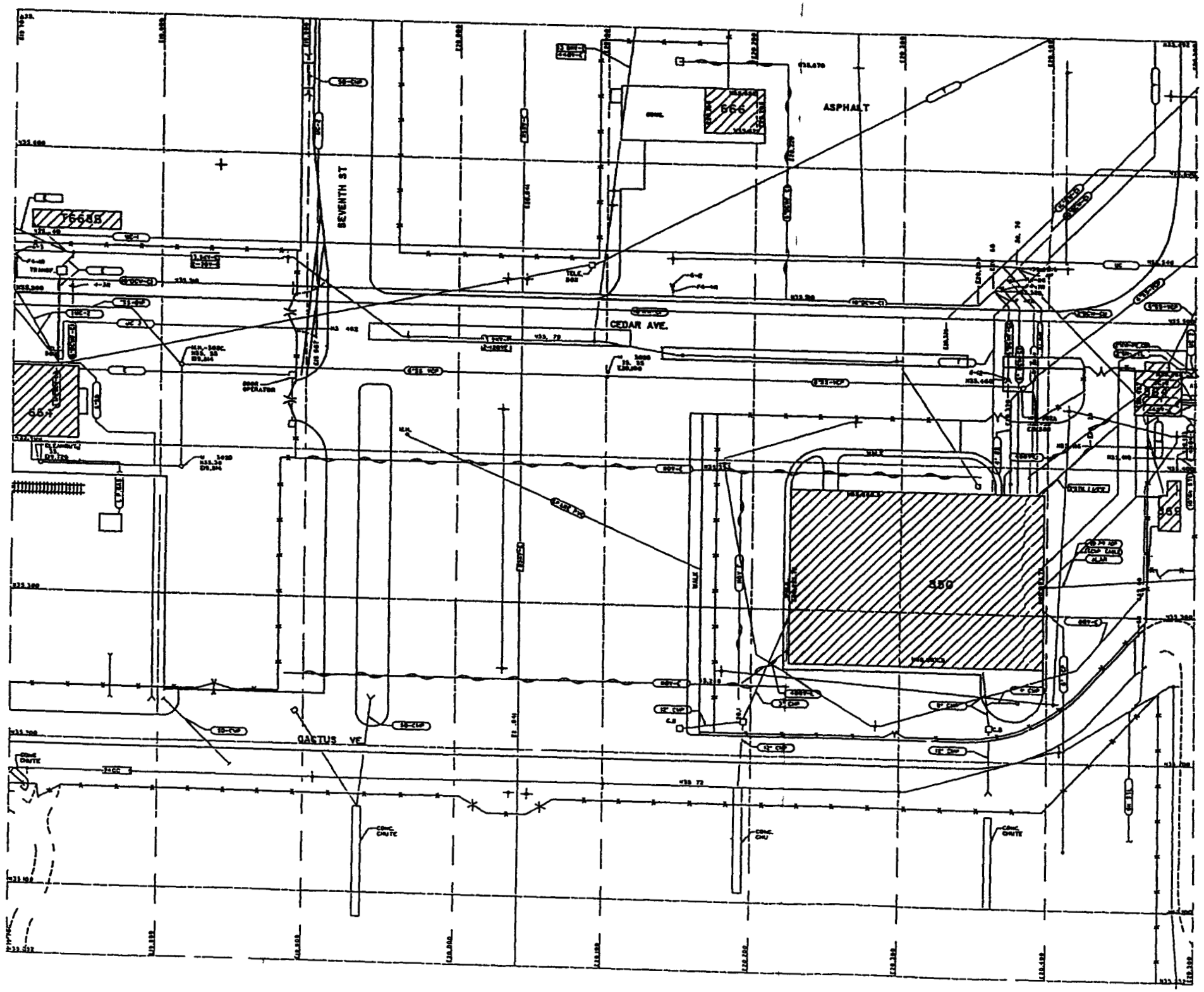
D 15501-42-M P E 4

COMPUTER GENERATED

SEE ZONE E

SEE ZONE F 3

SEE ZONE F 5



IHSS 160/162/164 1

R	ADDED MASTER STAMP	2/24/1	KM	OU	900458
P	CONTROLLED DRAWING	1 17 87	WC	RKJ	DLG 470601

KEYWORDS
S TE
2 T L TIES
3 AB VEGROUND
NDERGROUND

DES GNED
DR WN KEL OUGH 20 8
CHECKED
APP VED TERKUN 6 27 86

TM T E
ROCKY FLAT OFF CE GOLDEN, COLORADO

SITE UTILITY PLANS

D 15501-53-M R F

MASTER DRAWING
MAINTAIN AS BUILT PER DES 8
FE GROUP RESPONSIBLE PCSE

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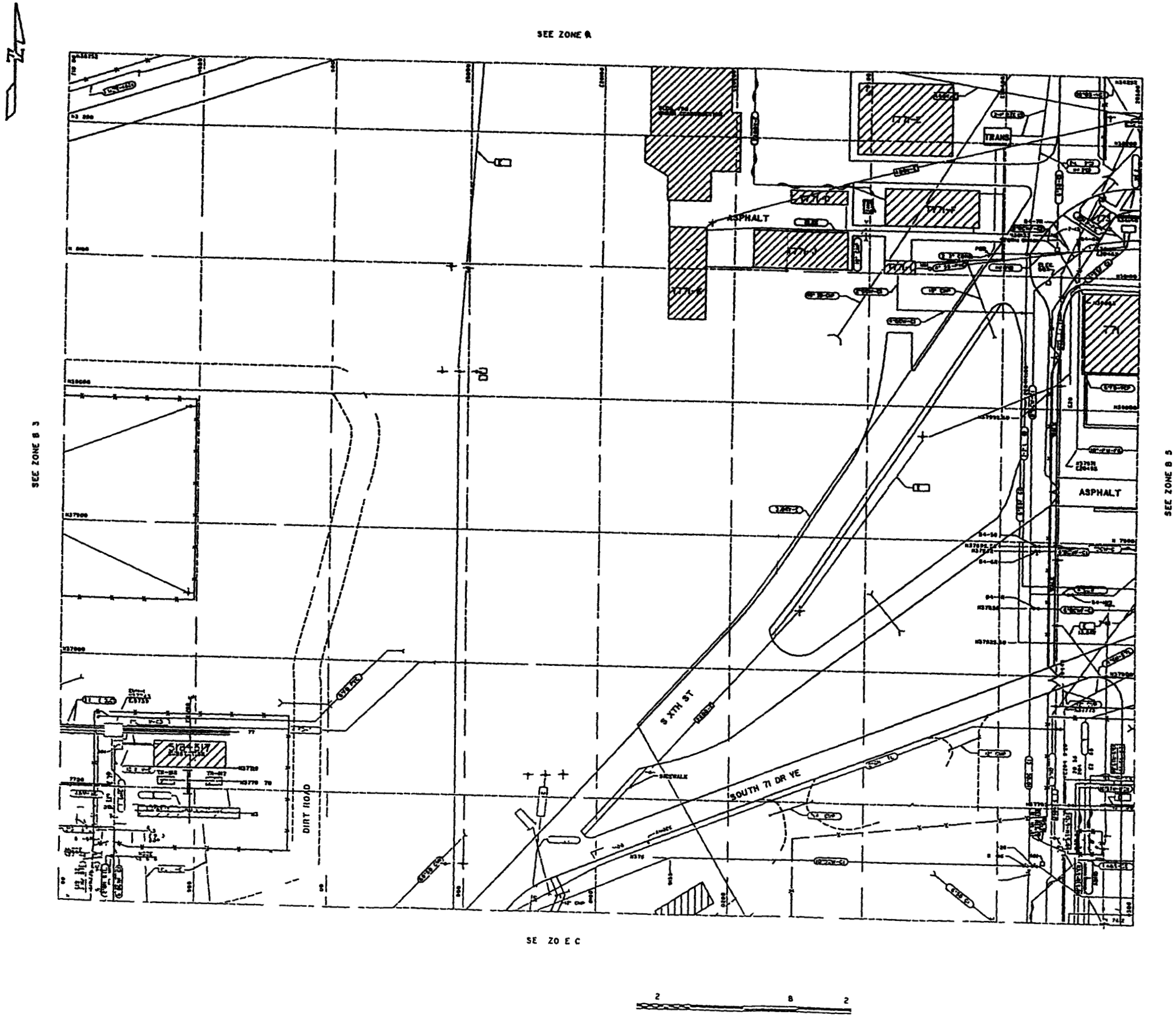


IHSS 162

AR	QUAN	DESCRIPTION	TEP

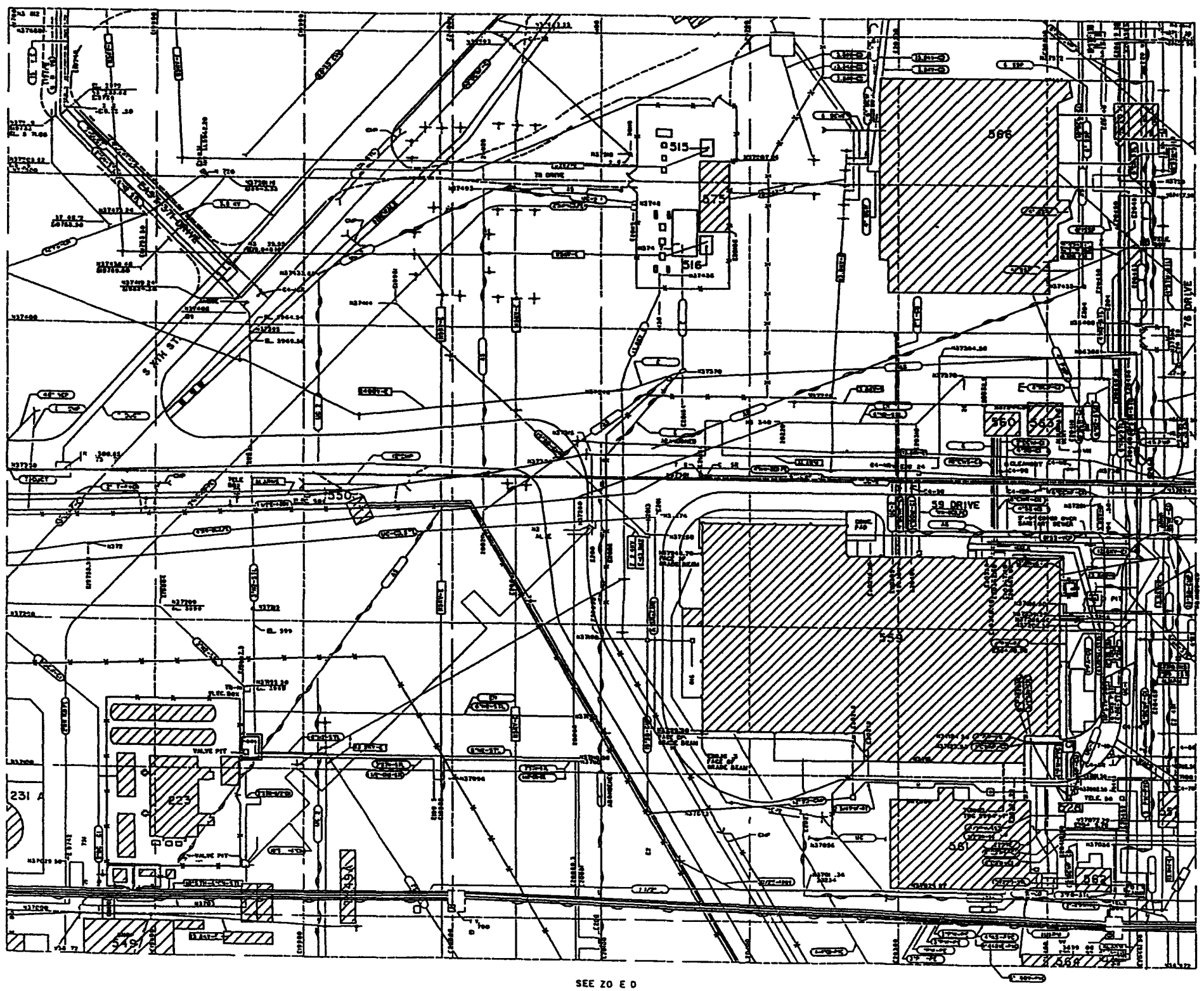
KEYWORDS	N	UPDA D	6-14 9
T L T	M	UPDATED	-1 86
2. UNDERGROUND		DE C PTION	
3			
S TE			
ABOVEGR UND			

		DATE
DE SHED	—	—
DR WN	KELLOUGH	7 0 83
CHECKE	—	—
AP	Y T AKUN	6 7

EP RTM E

MASTER DRAWING

AINTAIN S BUILT P R D 8



IHSS 162

20 20

R	ADDED MASTER STAMP	7/ /4	— LCB OU	004
P	CONTROLLED DRAWING	1 17 87	WC — RKJ	DL 4706

KEYWORDS
T TY
2 NOE GROUND
3 A
S TE
5 AB VEGRO NO
S E
MAREA
CR CODRD/COL NO

DE GNED	—	—
DR WN	KELLOUGH	2
CHECKE	—	—
AP VE	RKUH	-17 86

S E M T E E
OCKY FL TS OFFICE GOLDEN, COLORADO

R

SITE UTILITY PLAN

DR WING NUMB

D 15501-20-M P C

MASTER DRAWING
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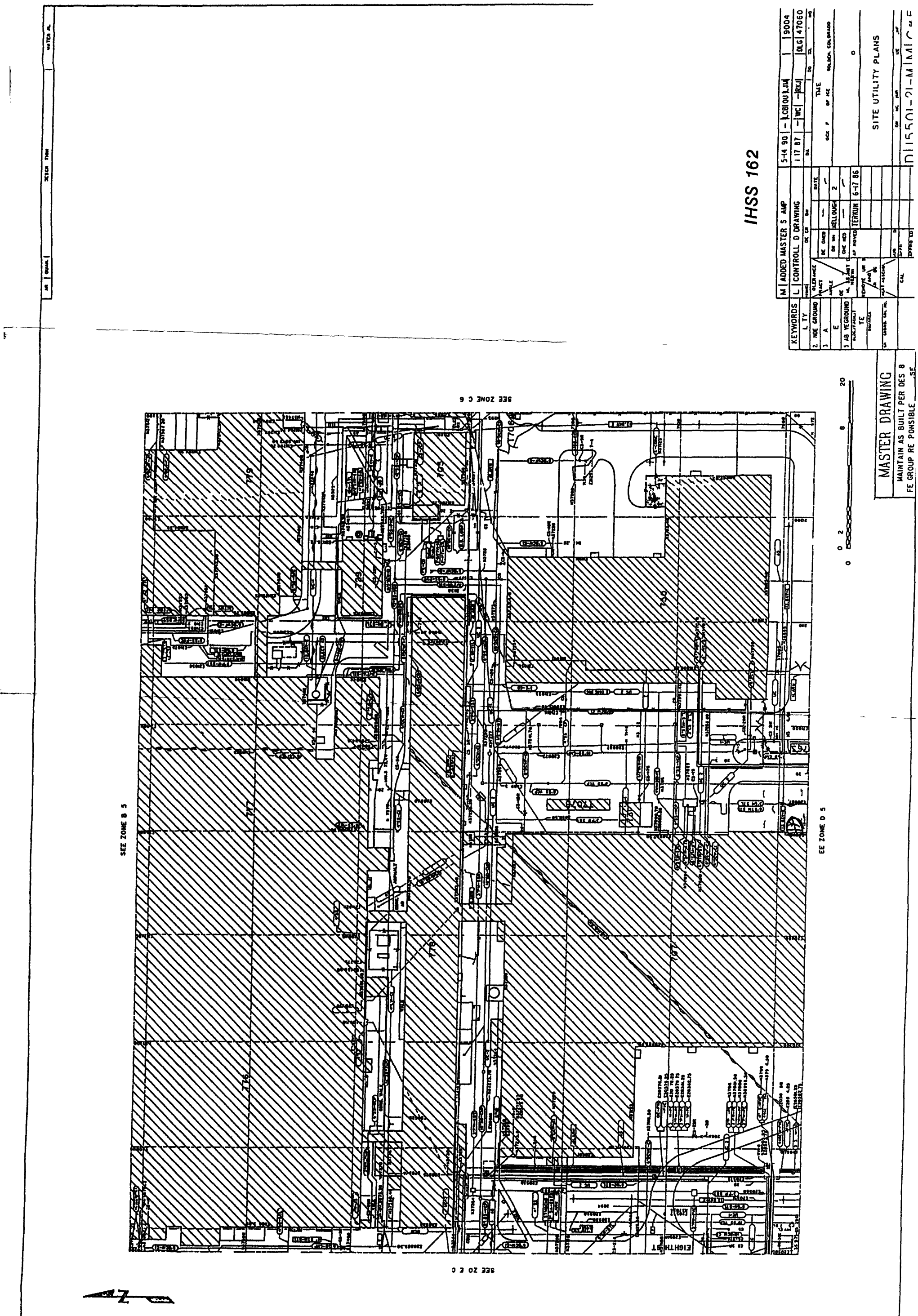
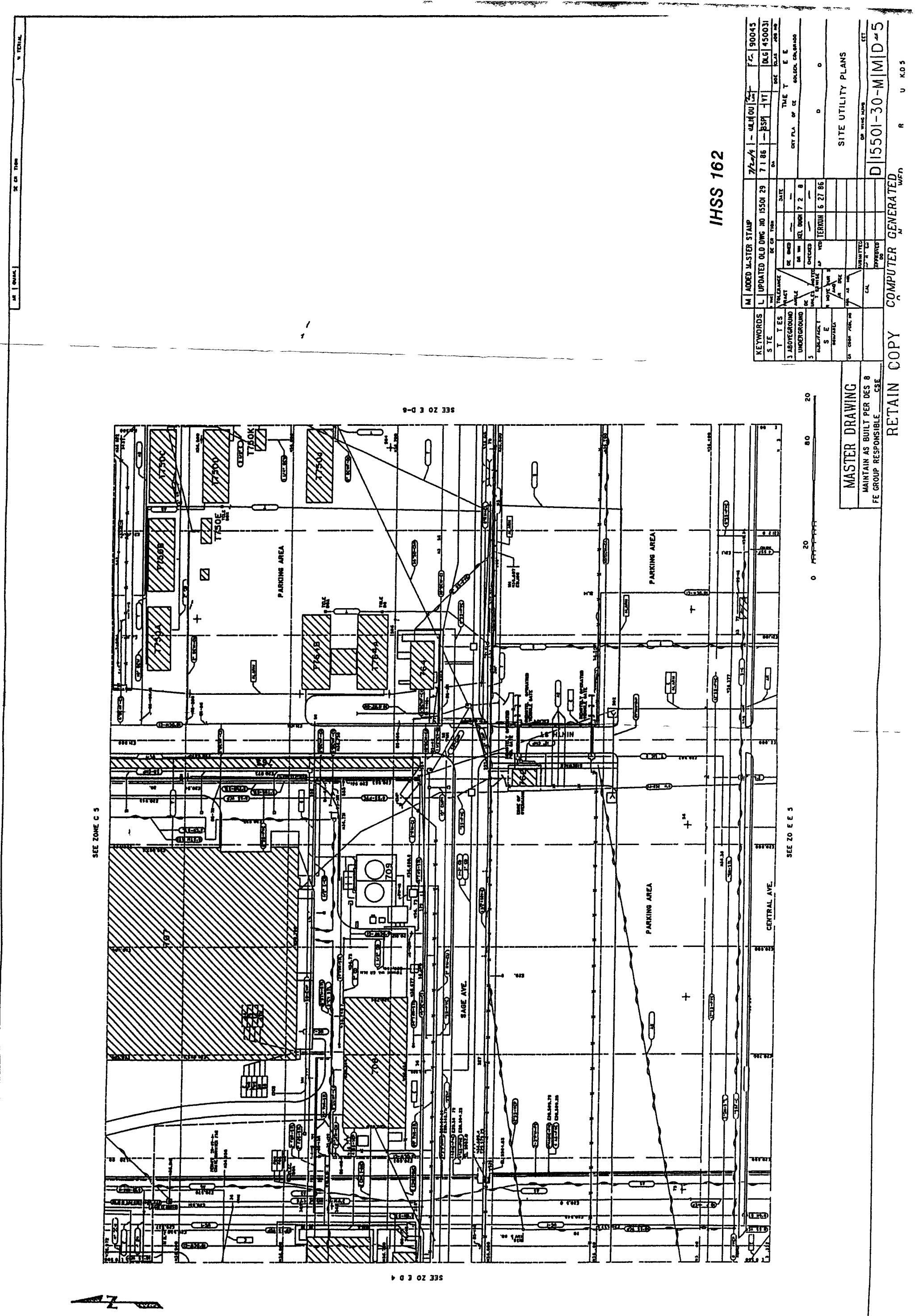
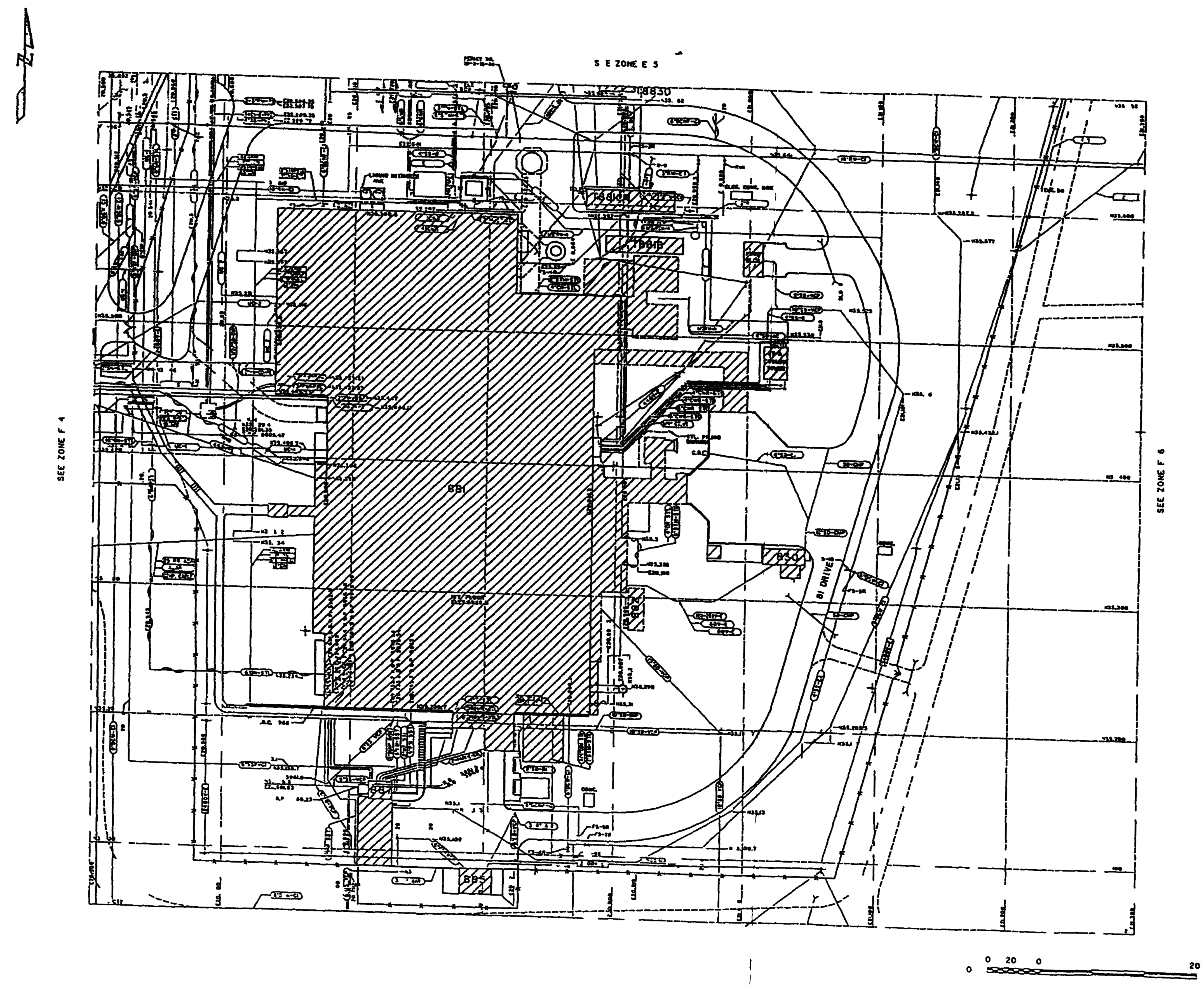
FE GROUP RESPONSIBLE PSCE


IHSS 162
SITE UTILITY PLANS
MASTER DRAWING
MAINTAIN AS BUILT PER DES 8
FE GROUP RE PONSIBLE
SEE ZONE C 6
SEE ZONE B 5
SEE ZONE D 5
SEE ZO E C
EIGHTH ST
KEYWORDS
L TY
2 NOE GROUND
3 A
E
5 AB YEGROUND
TE
M ADDED MASTER S AMP
L CONTROLL D DRAWING
5-14 90
1 17 87
9004
47060
DLG
TERKUN
6-17 86
KELLOUGH
2
0 2 8 20


IHSS 162
SITE UTILITY PLANS
D 15501-30-M M D-5
MASTER DRAWING
MAINTAIN AS BUILT PER DES 8
FE GROUP RESPONSIBLE CSE
RETAIN COPY
COMPUTER GENERATED
SEE ZONE C 5
SEE ZO E E 5
SEE ZO E D-6
SEE ZO E D 4
PARKING AREA
SAGE AVE.
CENTRAL AVE.
T750A
T750B
T750C
T750D
T750E
T750K
T764A
T764B
764
709
708
707
0
20
80
20



IHSS 162

KEYWORDS	R	..DED ..ASTER S		
S TE	P	CONTROLLED DRAWING		
T ES				
B YEGROUND			ELLOUGH	
NDERGR UND			TERKUH	7 86

SITE UTILITY PL S

MASTER DRAWING

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FE ROUP RE PO SIBLE ___

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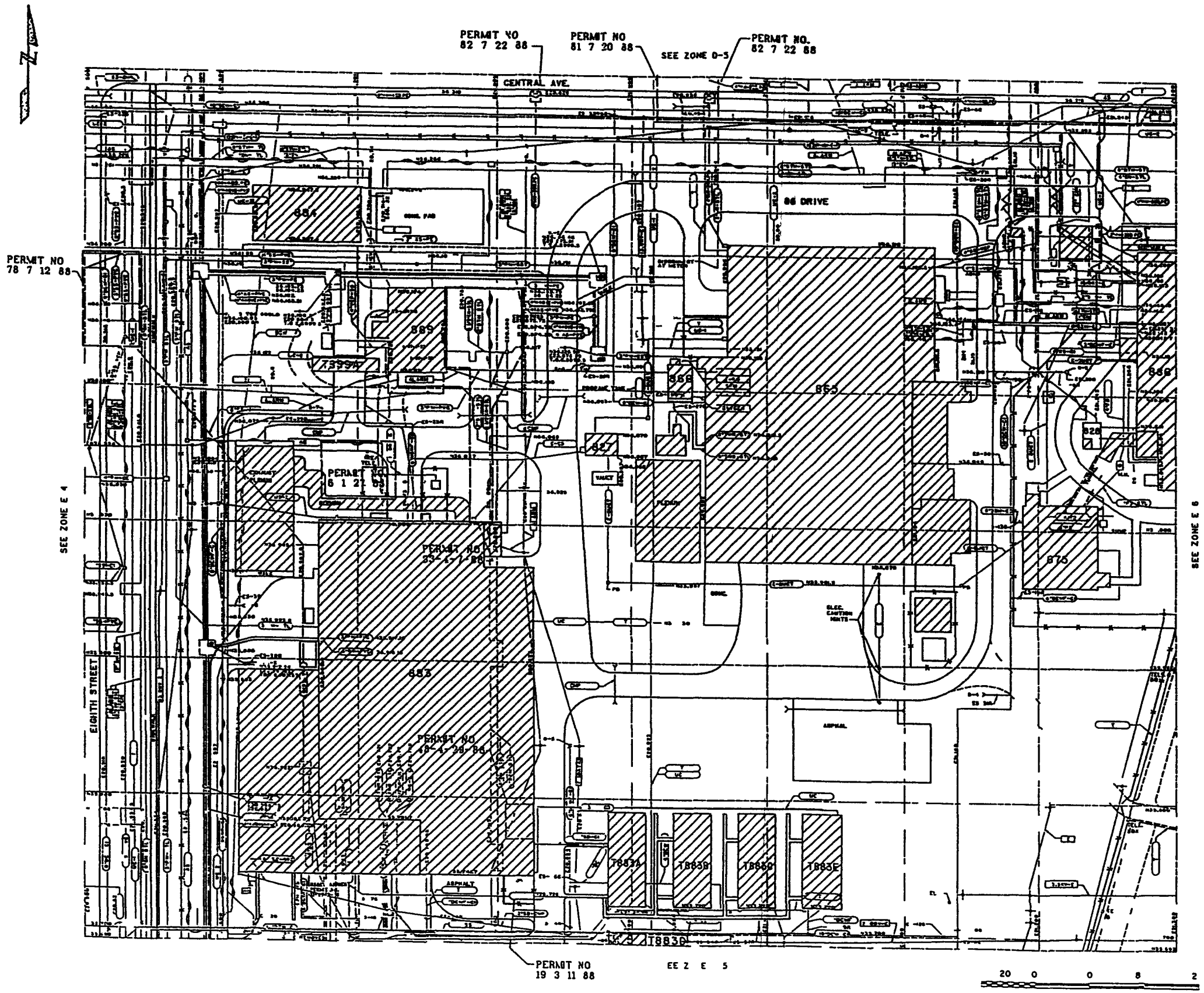


IHSS 162/164 2/164 3

P	ADDED MAS ER ST-MP	7/29/4	K-10U	0045
N	CONTROLLED DRAWING	1 17 87	JC	DLG 47060

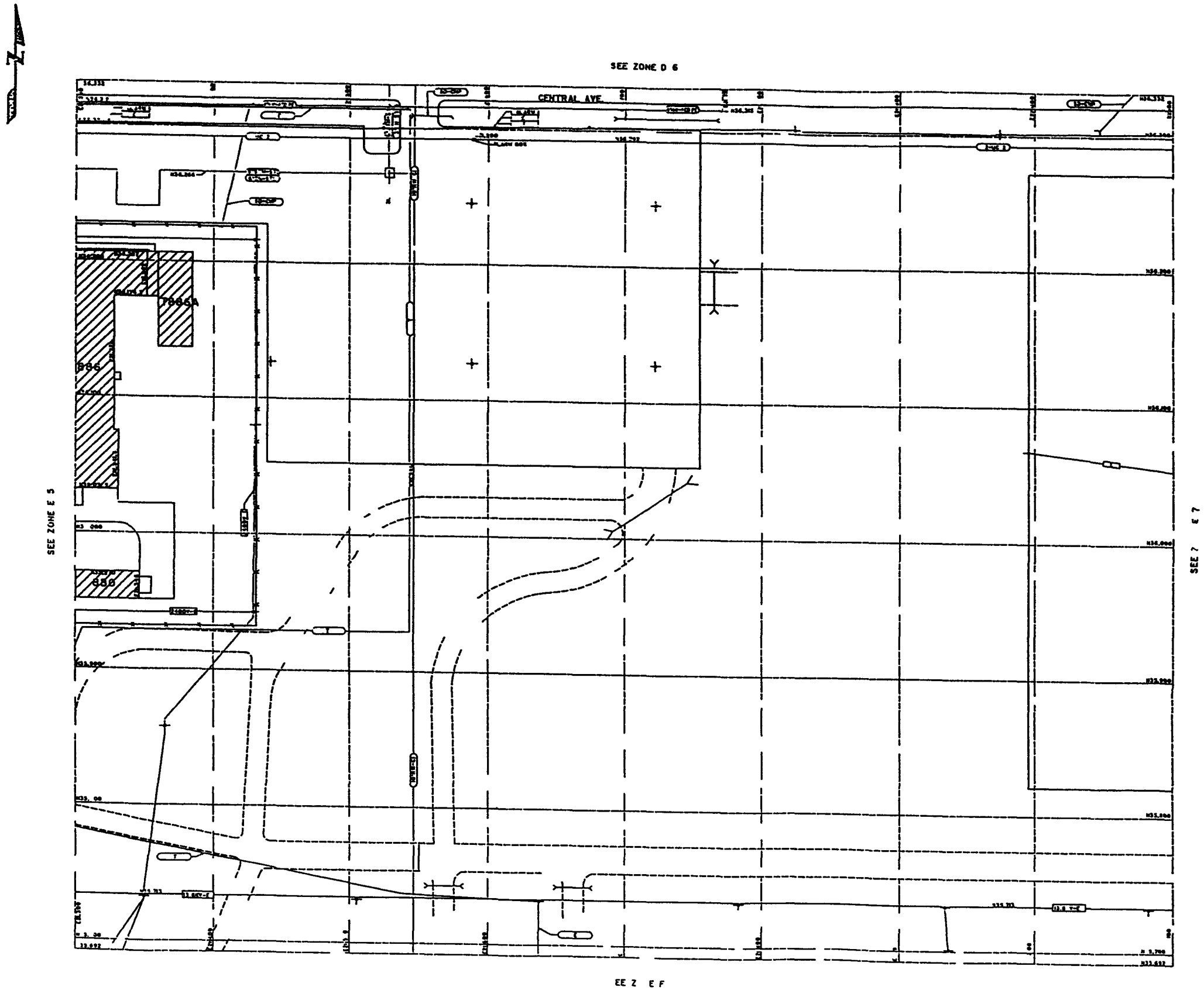
KEYWORDS
E
2 L T ES
NDERGROUND
AB VEGROUND
5
S TE

DES GNED		
DR WN	KELL UGH	2
CHECKED		
AP VE	TERKUN	6 27 86

SITE UTILI Y PLA S

MASTER DRAWING
AINTAI AS BUILT PER DES 8
FE ROJP SPONSIBLE SE

D 15501-4 -1 P E-5



IHSS 164 2

M	ADDED MASTER STAMP	7/20/90	MC	QU		900458
L	UPDATED OLD DWG NO 15501 6	7 1-86	BP	YT	DLG	450031

KEYWORDS
TE
2 T L T ES
3 ABOVEGROUND
NDERGROUND
S TE

		DATE
DES GNED	—	—
DR WN	KELLOUGH	7 20 83
CHECKED	—	—
APP OVED	TERKUH	6 27 86

A TME E
OCKY FL OF CE GOLDEN, COLORADO

SITE UTILITY PLANS

D 15501-44-M M E of 6

MASTER DRAWING
MAINTAIN AS BUILT PER DES 8
FE GROUP RESPONSIBLE CSE

RETAIN COPY

COMPUTER GENERATED R MST104 U KJKE 6