

NOTICE

All drawings located at the end of the document.

TECHNICAL MEMORANDUM 1

**REVISIONS TO FINAL
PHASE I RFI/RI WORK PLAN**

ROCKY FLATS PLANT

**WOMAN CREEK PRIORITY DRAINAGE
(Operable Unit No. 5)**

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

ENVIRONMENTAL RESTORATION PROGRAM



December 1991

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Technical Memorandum 1 (TM1) has been prepared in order to address comments submitted by the Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) on the Operable Unit No. 5 (OU 5) Final Phase I RFI/RI Work Plan. Because most of the comments address the Site Conceptual Model (Section 2.5) and the Field Sampling Plan (Section 7), these sections have been revised pursuant to EPA and CDH comments and are included in TM1 (all revisions made to the enclosed sections are shaded). The Final Work Plan together with TM1 represent RFI/RI planning documents for OU 5 that are consistent with the Inter-Agency Agreement (IAG) Statement of Work (SOW) for the Phase I investigation. TM1 provides the link between the Site Conceptual Model and the Field Sampling Plan to demonstrate that all potential exposure pathways were considered in the development of the work plan.

The characterization of all exposure pathways will not be performed for every IHSS within OU 5 during Phase I. The Phase I site characterization plan is designed to collect sufficient data at each IHSS to satisfy exposure pathway characterization needs commensurate with the likelihood that a contaminant source exists. For example, at the Original Landfill (a likely source of contamination), the characterization program is more extensive, and data collected for other IHSSs and for determining the overall extent of contamination within the Woman Creek drainage may allow characterization of most exposure pathways. In contrast, at the surface disturbed areas where the existence of a contamination source is less likely, sampling to simply verify the presence or absence of contamination in surface and subsurface soils is a logical size for a Phase I program. In either case, a Phase II RFI/RI may be required to better characterize a contaminant source or exposure pathway depending upon the Phase I results.

There were a few comments that were unrelated to the Site Conceptual Model and the Field Sampling Plan sections that are addressed below:

- (1) It will not be possible to analyze for solvent breakdown products 1,2 dichloroethane and vinyl chloride with a gas chromatograph (GC) for the soil gas survey because they co-elute with other compounds. Vinyl chloride co-elutes with freon compounds and 1,2 dichloroethane co-elutes with methyl ethyl ketone and dibromomethane.
- (2) The absence of historical air quality data in the work plan was noted by the regulatory agencies. Historical air quality data has been summarized and is included as Attachment 1 to TM1.

- (3) A concern was expressed that Section 2.1 does not discuss the current discharge system from the detention ponds on Woman Creek. This is discussed in some detail in Section 2.4 of the Final Work Plan.

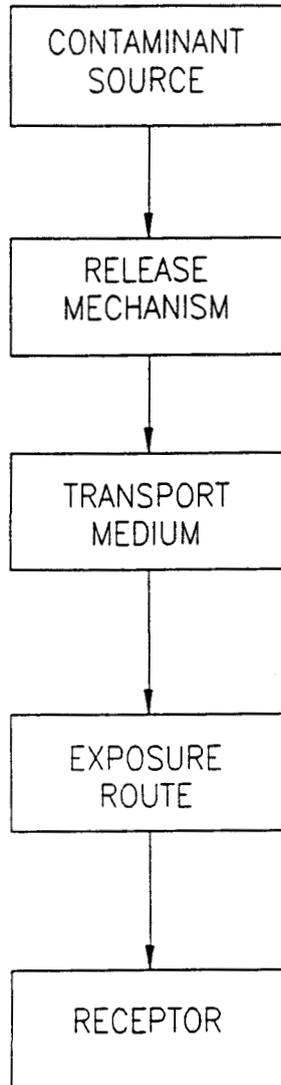
- (4) EPA requested that a bedrock hydrogeologic characterization be included in the Work Plan. Limited characterization of the bedrock hydrogeology will be performed as borings will be drilled 5 feet into the bedrock. This will allow identification of any subcropping sandstones and provide limited characterization of contaminant migration into bedrock, if present. Until it is determined that contaminated alluvial ground water is present at the IHSSs, it is premature to perform a comprehensive hydrogeological investigation during Phase I.

2.5 SITE CONCEPTUAL MODELS

A Site Conceptual Model of contaminant exposure pathways from the types of potential contaminant sources within OU 5 is presented in this section. This Site Conceptual Model identifies all elements of an exposure pathway (contaminant source, primary release mechanisms, transport media, secondary release mechanisms, and exposure route) that were considered in the development of the Phase I Field Sampling Plan. After Phase I data is collected, IHSS-specific conceptual models can be developed and provide the basis for Phase II RFI/RI activities and the Baseline Risk Assessment.

The primary purpose of the Site Conceptual Model is to aid in identifying exposure pathways by which populations may be exposed to contaminants from the IHSSs. The EPA defines an exposure pathway as "...a unique mechanism by which a population may be exposed to the chemicals at or originating from the site..." (EPA, 1989c). As shown in Figure 2-10, 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 the purposes of the OU 5 conceptual model, the contaminant sources are waste and/or contaminated media that may be present at each IHSS. These sources include buried wastes, and contaminated surface soils and sediments.
- **Release Mechanism:** Release mechanisms are physical and/or chemical processes by which contaminants are released from the source. The conceptual model for OU 5 identifies mechanisms which release contaminants directly from the source and those which release contaminants from transport media (i.e., secondary release mechanisms). Numerous potential release mechanisms and secondary release mechanisms for OU 5 are discussed in the conceptual model.
- **Transport Medium:** Transport media are the environmental media into which contaminants are released from the source and from which the contaminants are in turn released to a receptor (or to another transport medium by a secondary release mechanism). Potential transport media for OU 5 include, air, soils, sediment, surface water, groundwater, and biota (both flora and fauna).
- **Exposure Route:** Exposure routes are avenues through which contaminants are physiologically incorporated by a receptor. Exposure routes for receptors at OU 5 are inhalation, ingestion, dermal contact, and external exposure to radiation from radionuclides.
- **Receptor:** Receptors are human or environmental populations which are affected by the contamination released from a site. Environmental receptors include biota (both flora and fauna) indigenous to the OU 5 environs.



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COMPONENTS OF A
COMPLETED EXPOSURE
PATHWAY

FIGURE
2-10

2.5.1 Contaminant Source Descriptions

2.5.1.1 Original Landfill (IHSS 115)

Most of the limited data available for IHSS 115 suggests the possibility of a wide range of chemicals in the refuse in the landfill. In addition, depleted uranium is likely present in the landfill, and it is possible plutonium contaminated materials are present. Several radioactive "hot spots" have been identified at the perimeter of the landfill where it slopes down to the South Interceptor Ditch (SID). Non radioactive contaminants associated with the landfill likely include, volatile organics, semi-volatile organics and inorganic ions. The landfill is currently covered with a thin clay cap of presumably clean fill. However, there are several locations where the cover has slumped downslope and refuse is exposed.

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

The incinerator (IHSS 133.5) was used to burn general plant wastes between the 1950's and 1968. Depleted uranium is also believed to have been burned in the incinerator (Rockwell, 1988). Ashes from the incinerator were placed into the Ash pits (IHSS 133.1 through 133.4) or were pushed over the side of the hill into the Woman Creek drainage and/or onto the Concrete Wash Pad (IHSS 133.6). After the incinerator was closed in 1968, the ash pits were covered with fill. The Concrete Wash Pad appears to have been used to dispose of waste concrete and truck washdown water from construction activities at RFP. Results from sampling a monitoring well downgradient of the Ash Pits indicate elevated levels of metal and radionuclides. However, due to the limited characterization of the site, it is possible that other contaminants are present at this location.

2.5.1.3 Detention Ponds C-1 and C-2 (IHSS 142)

Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11) along the Woman Creek drainage and the SID are used primarily to capture and control surface water runoff. Pond C-1 receives water from Woman Creek, while Pond C-2 receives water from the SID which in turn collects surface water runoff from the southern part of the production facilities (see Section 2.4 of the RFI/RI Work Plan). Historically, water and sediment samples from these ponds have occasionally contained low concentrations of radionuclides, VOCs, base neutral compounds, pesticides and metals.

2.5.1.4 Surface Disturbances (IHSS 209)

The surface disturbances are thought to be old borrow pits to provide fill for other parts of the RFP. Although there is no information that indicates that hazardous wastes have been disposed in these locations, it is possible such activities occurred in the past.

2.5.1.5 Area South of OU 5 to the Property Boundary

The area south of OU 5 to the property boundary was deliberately excluded from the list of OUs and IHSSs in the IAG due to lack of known sources of contamination. Surface soil sampling for plutonium was previously conducted in this area. There were only two sampling locations with levels slightly in excess of the CDH Construction Standard of 0.9 picocuries/gram (Figure 2-11). Surface soil sampling for plutonium and other radionuclides may be performed in this area pending further data evaluation. This is discussed in Section 7.2.4.1. Until more detailed site characterization information is available, it is assumed that no significant exposure to contaminants occurs via this area.

2.5.2 Primary Release Mechanisms and Transport Media

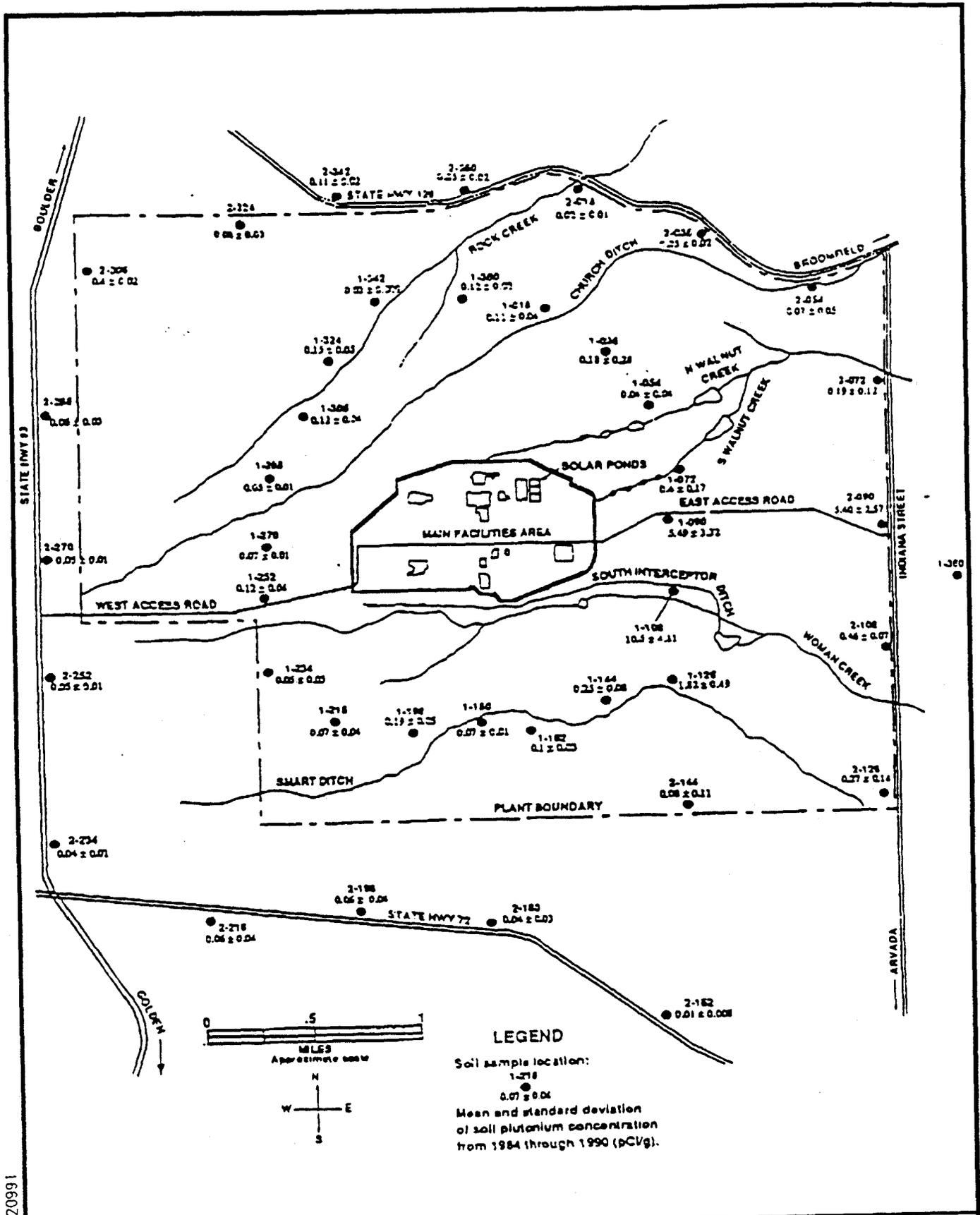
There are a number of mechanisms by which contaminants are released into environmental media. As shown in Figure 2-12, all primary release mechanisms apply to contaminated surface soils and sediments: fugitive dust wind erosion; surface runoff; volatilization; infiltration/percolation; biotic uptake; and tracking. With the exception of fugitive dust wind erosion, surface runoff and biotic uptake, these primary uptake mechanisms also apply to buried wastes.

Once contaminants are released from a source, they will enter an environmental medium where contaminants will be transported either to a point of exposure or be released (secondary release mechanism) to another environmental medium (and subsequently transported to a point of exposure). The transport medium a contaminant enters is determined by the primary release mechanism. For example, volatilization or fugitive dust wind erosion will result in contaminant release to the air. Surface runoff will transport contaminants to surface water while infiltration/percolation results in contaminant transport to ground water. Contaminants entering biota is simply due to biotic uptake.

The physical and chemical properties of a contaminant determine the tendency of a contaminant to be released from a source, and the fate and mobility in a transport medium once released. The following subsections provide a brief summary of these contaminant properties.

2.5.2.1 Organic Contaminants

Table 2-8 presents some of the relevant chemical/physical parameters that control the environmental fate and transport of representative organic chemicals. Because two IHSSs at OU 5 accepted a wide range of materials, further investigation may identify additional organic chemicals not present on this list.



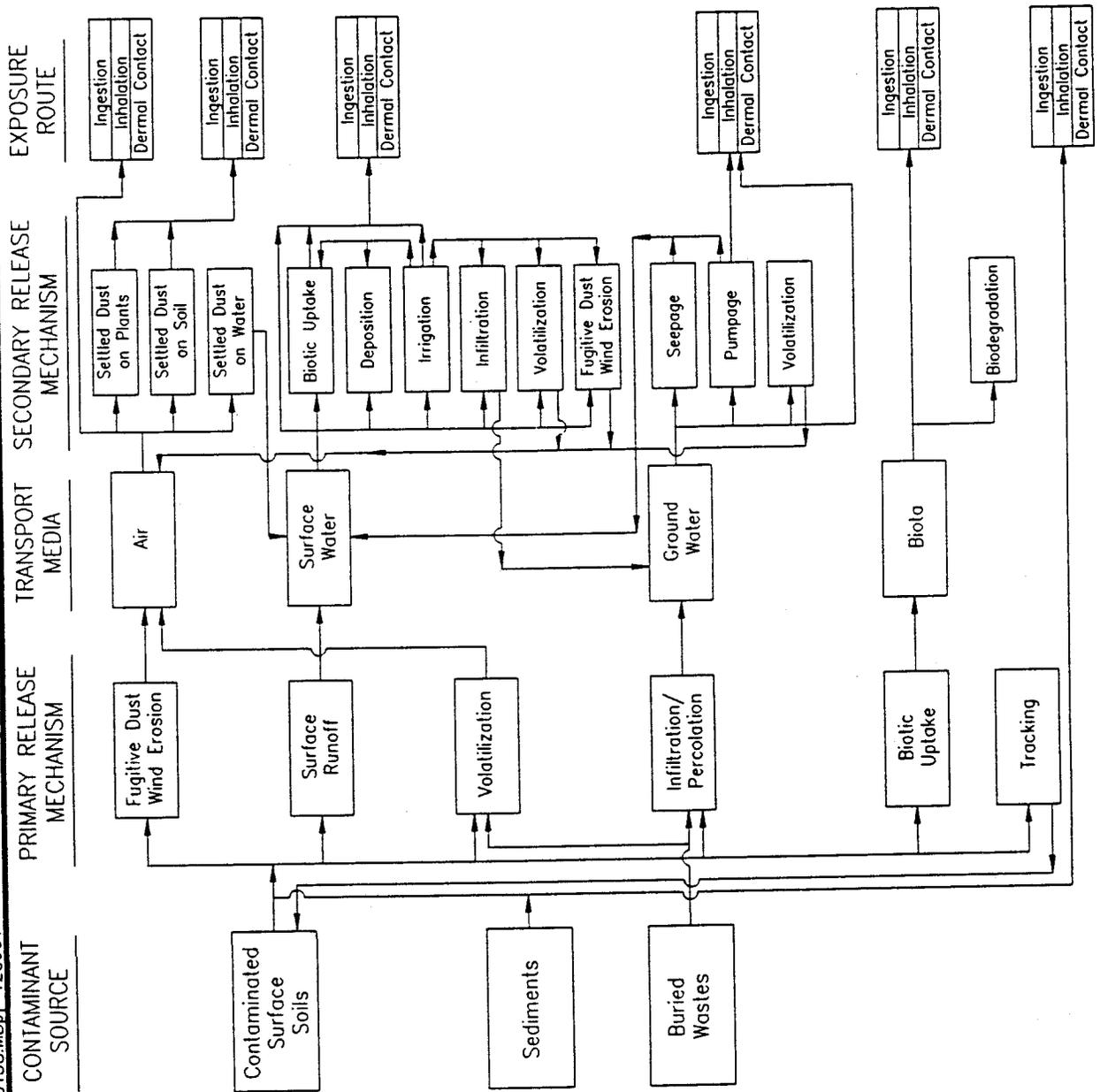
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 Golden, Colorado

SOIL SAMPLING
 LOCATIONS AT THE
 ROCKY FLATS PLANT IN 1990

FIGURE
 2-11

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OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

RISK ASSESSMENT
CONCEPTUAL MODEL

FIGURE 2-12

December, 1991

TABLE 2-8

CHEMICAL/PHYSICAL PARAMETERS AFFECTING
ENVIRONMENTAL FATE AND TRANSPORT
FOR ORGANICS

Chemical	Molecular Weight (g/mole)	Specific Gravity (g/cc)	Vapor Pressure (mmHg)	Henry's Constant (Dimensionless)	Water Solubility (mg/l)	Log K _{ow} (c/c)	Log K _{oc} (ml/g)	Saturated Zone Rd	Mobility Index MI	Env. Mobility
TCL VOLATILE ORGANICS										
Ketones & Aldehydes										
Acetone	58.1	0.1	270.00	0.013	60000.0	-0.24	-0.43	1.0	8	Extremely Mobile
Monocyclic Aromatics										
Benzene	78.1	0.8	76.00	0.182	1780.0	2.13	1.81	6.8	3	Very Mobile
Toluene	92.1	0.8	22.00	0.214	515.0	2.78	2.48	28.0	2	Very Mobile
Ethyl Benzene	106.2	0.8	7	0.286	152.0	3.34	3.04	100.0	-0	Slightly Mobile
Xylene	106.2	0.8	10	0.380	152.0	3.13	2.11	12.6	1	Very Mobile
Chlorinated Aliphatics										
Carbon Tetrachloride	153.8	1.6	80.00	0.980	785.0	2.98	2.64	40.5	2	Very Mobile
Trichloroethane	131.4	1.5	60.00	0.390	1100.0	2.42	2.10	12.3	3	Very Mobile
Chloroform	119.4	1.5	160.00	0.130	8000.0	1.97	1.64	4.9	4	Very Mobile
1,1,1,2-Tetrachloroethane	167.8	1.6	5.00	0.016	2800.0	2.38	2.07	11.8	2	Very Mobile
SEMIVOLATILE ORGANICS										
Acid Extractables (Phenolics)										
Phenol	94.1	1.1	0.20	1.2E-04	8200.0	1.48	1.15	2.3	2	Very Mobile
Pentachlorophenol	266.4	2.0	1.1E-0	1.1E-04	14.0	5.18	4.72	4771.3	-8	Immobile
2,4-Dinitrophenol	184.1	1.7	1.5E-05	2.7E-08	5600.0	1.54	1.22	2.5	-2	Slightly Immobile
2,4,6-Trichlorophenol	197.5	1.5	0.012	1.6E-04	800.0	3.81	3.30	181.0	-2	Slightly Immobile
Base-Neutral Extractables										
Bis(2-ethylhexyl)phthalate	391.1	1.0	2.7E-07	4.4E-06	1.3	8.61	8.30	1.8E+08	-16	Very Immobile
Chrysene	228.2	1.3	1.0E-11	8.9E-08	0.0	5.61	5.30	1.9E+04	-19	Very Immobile
1,2,4-Trichlorobenzene	181.5	1.5	0.29	9.6E-02	30	4.28	3.86	8.3E+02	-3	Slightly Immobile
1,3-Dichlorobenzene	147.0	1.3	2.28	1.6E-01	123	4.28	3.86	8.3E+02	-2	Slightly Immobile
Naphthalene	128.2	1.0	0.087	1.9E-02	31.7	3.29	2.97	8.6E+01	-3	Slightly Immobile
Benzol(a)pyrene	252.0	1.4	5.6E-09	2.0E-05	3.8E-05	6.08	6.74	5.0E+05	-17	Very Immobile

TABLE 2-8
 CHEMICAL/PHYSICAL PARAMETERS AFFECTING
 ENVIRONMENTAL FATE AND TRANSPORT
 FOR INORGANICS
 (Concluded)

Chemical	Molecular Weight (g/mole)	Specific Gravity (g/cc)	Vapor Pressure (mmHg)	Henry's Constant (Dimensionless)	Water Solubility (mg/l)	Log Kow (c/c)	Log Koc (ml/g)	Saturated Zone Rd	Mobility Index MI	Env. Mobility
PCBs AND PESTICIDES										
PCBs										
PCB-1248	298.5	1.4	4.8E-04	1.5E-01	0.054	5.76	5.44	24931.0	-10	Immobile
PCB-1254	328.4	1.5	7.7E-06	4.6E-02	0.0	6.03	6.72	47233.7	-11	Very Immobile
PCB-1280	376.7	1.6	4.1E-05	2.8E-01	0.0	7.15	6.82	594625.1	-14	Very Immobile
Chlorinated Pesticides										
Dieldrin	381.0	1.8	1.8E-07	1.9E-05	0.2	3.54	3.23	153.8	-11	Very Immobile
DDT	376.7	1.6	1.9E-07	7.1E-04	5.5E-03	6.91	6.59	350141.6	-16	Very Immobile
Heptachlor	376.0	1.6	3.0E-04	3.4E-02	0.18	4.4	4.1	1081.0	-8	Immobile
Lindane	291.0	1.6	2.5E-05	2.5E-04	1.6	3.9	3.6	343.0	-8	Immobile
Chlordane	408.8	1.6	1.0E-05	4.0E-03	0.058	5.5	5.1	12601.0	-11	Very Immobile
Toxaphene	414.0	1.6	0.3	1.4E+01	0.5	3.3	3.0	87.8	-4	

Source: EG&G, 1980e

TCL Volatiles

TCL volatiles are generally more mobile in the environment than other chemicals (Table 2-8). Volatiles are generally characterized by relatively high water solubility (greater than 100 mg/l) and volatility (vapor pressures greater than 1.0 mm Hg and Henry's Law Constants greater than 0.1). Volatiles can be expected to migrate through soils, sediment and groundwater in both liquid and vapor phase and to be transported in surface water and groundwater as neutral solutes. This is denoted by retardation factors (Rd) between 1 and 50 (Chemical migration velocity = water migration velocity/Rd). The Henry's Constants of volatiles suggest a tendency to volatilize from aqueous systems (including soil/water) to the atmosphere and, therefore, are unlikely to be detected in sediments and soils.

TCL Semivolatiles and Pesticides/PCBs

Semivolatile compounds and pesticides/PCBs typically are much less mobile than volatile compounds (Table 2-8). The retardation factors for semivolatiles and pesticides/PCBs range from approximately 100 to over 180,000,000 with the exception of the phenolic compounds. Phenols are relatively mobile because of their high water solubility. Semivolatiles and pesticides/PCBs exhibit low to negligible volatility as indicated by the low vapor pressures and Henry's Constants. This suggests a low propensity for volatilization of these compounds to the atmosphere from soil and surface water.

2.5.2.2 Radionuclides and Metals

Table 2-9 summarizes the distribution coefficients for radionuclides and inorganic elements. A distribution coefficient (K_d) is the ratio of the concentration of a compound in the solid phase to its concentration in solution at equilibrium. The distribution coefficients are considered empirical and are strongly influenced by the environmental conditions existing where the experiments are performed. Inorganic compounds differ from organic compounds in that they can be present in solution in a number of different forms or species. The form of an inorganic chemical is important in evaluating that chemical's mobility. Each species or complex may have different solubilities and the concentration of each can be related to several factors including pH and oxidation/reduction potential (E_h).

Radionuclides

The limited data available for OU 5 indicates that depleted uranium is a buried waste at two IHSSs, and plutonium contaminated wastes may also be present. Americium is also likely to occur either from *in situ* ingrowth from the plutonium or from direct disposal of americium contaminated material.

TABLE 2-9

**LITERATURE DISTRIBUTION COEFFICIENTS
FOR RADIONUCLIDES AND METALS ELEMENTS**

Chemical	Representative Value ¹	Summary Range	
		Low	Maximum
Radionuclide			
Americium-241	700	0 ⁴	47,230 ¹
Bismuth-214	200		
Cadmium-109	6.5	1.26 ¹	50 ³
Cesium-143	850	3.0 ⁴	300,000 ²
Cesium-137	1,000	1.3 ⁴	52,000 ¹
Cobalt-60	45	0.2 ¹	23,624 ⁴
Lead-212-Bismuth	900	4.5 ¹	7,640 ¹
Plutonium-238	4,500	0.4 ⁴	8.7E ⁴
Potassium-40	5.5	2.0 ¹	9.0 ¹
Radium-288	450	200 ¹	467 ⁴
Strontium-90	35	0.15 ¹	4,300 ⁴
Thorium-228	1,500	5 ⁴	1E ⁴
Uranium-234	1,500	0 ¹	4,400 ¹

¹U.S. Department of Energy, 1984, A Review and Analysis of Parameters for Assessing Transport of Environmental Released Radionuclides through Agriculture.

²U.S. Department of Energy, 1980, Determination of Distribution Coefficients for Plutonium, range of results for a variety of sediments in the Enewetak Lagoon using Lab and Field experiments; Transuranic Elements in the Environment, Technical Information Center.

³Couphrey, P.J. and Thorne, M.C., 1983, Radionuclide Distribution and Transport in Terrestrial and Aquatic Ecosystems, A Compendium of Data.

⁴ACS Symposium Series, 1979, Radioactive Waste in Geologic Storage (Abyssal Red Clay)

Conc = 1E3-1E8 mg/atom/ml in 0.68N NaCl Soil Distributed Coefficient for CS pH 2.7-8.0 Figure 1; for Cd pH 5.3 Figure 3; for Sr Phy. 1-73; for Ba pH 2.6-8.3 Figure 2; for Ce pH 5.8-8.0 Figure 4.

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TABLE 2-9

**LITERATURE DISTRIBUTION COEFFICIENTS
FOR RADIONUCLIDES AND METALS ELEMENTS
(Continued)**

Chemical	Representative Value ¹	Summary Range	
		Low	Maximum
Metals			
Aluminum	1,500	0 ⁴	122.8 ⁴
Antimony	45	1.0 ⁶	18 ⁶
Arsenic	200	5 ⁴	30,000 ⁴
Barium	60		
Beryllium	650		
Boron	3	1.26 ¹	50 ⁴
Cadmium	6.5		
Chromium	850	0.2 ¹	3,800 ¹
Cobalt	45	1.4 ¹	333 ¹
Copper	35	4.5 ¹	7,640 ¹
Lead	900	0.2 ¹	10,000 ¹
Manganese	65	30 ⁷	82,800 ⁷

¹U.S. Department of Energy, 1984, A Review and Analysis of Parameters for Assessing Transport of Environmental Released Radionuclides through Agriculture.

⁴Radionuclide Interactions with Soil and Rock Media Volume 1: Processes Influencing Radionuclide Mobility and Retention, Element Chemistry and Geochemistry, Conclusions and Evaluation, Battelle Pacific Northwest Labs, Richland, WA EPA No. 6078-007, August 1978.

⁶Dragun, 1988, The Soil Chemistry of Hazardous Materials, Dragun, 1988, Ranges of Kd for various Elements in Soils and Clays, Table 4.2, pg 158.

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TABLE 2-9
LITERATURE DISTRIBUTION COEFFICIENTS
FOR RADIONUCLIDES AND METALS ELEMENTS
(Continued)

Chemical	Representative Value ¹	Summary Range	
		Low	Maximum
Mercury	10	0.37 ¹	400 ¹
Molybdenum	20	200 ⁷	300,000 ⁷
Nickel	150		
Selenium	300		
Silicon	30	10 ¹	1,000 ¹
Silver	45		
Thallium	1,500		
Titanium	1,000		
Vanadium	1,000		
Zinc	40	0.1 ¹	8,000 ¹

¹U.S. Department of Energy, 1984, A Review and Analysis of Parameters for Assessing Transport of Environmental Released Radionuclides through Agriculture.

⁷EPRI, 1984, Chemical Attenuation Rates, Coefficients, and Constants in Leachate Migration Volume I. A Critical Review. Battelle Pacific Northwest Laboratories, Richland, WA. EPRI EA-3356, Kd for Ba in River Sediments; Kd for Me= pH=6.6 with Bentonite, Kd=82800 Ph-5.95 for Iron Oxide; Kd=200 for Ni in seawater with Clay pH=8; with Mn Oxide Kd=300,000 pH=8.

eg&glou6\tbl-2-9

The following discussions focus on characteristics of uranium and plutonium which may affect their fate and mobility in the environment (Table 2-9). Numerous studies of uranium and plutonium fate and mobility are incorporated by reference into the discussions. Much less information is available on the nature of americium in the environment. Americium has essentially the same characteristics in the environment as plutonium and is considered insoluble under typical environmental conditions.

Uranium

Uranium has 14 isotopes that decay to other elements at half-lives of minutes to 4.5 billion years. Natural uranium is comprised mainly of U-238 (99.27 percent) with some U-235 (0.72 percent) and minor amounts of U-234 (0.0057 percent) (Table 2-10). Enriched uranium contains a higher percentage of the fissile U-235 isotope. Depleted uranium, a potential contaminant at OU 5, contains less U-235 and U-234, and more U-238. Uranium-234 is a daughter product of uranium -238.

Thermodynamic data (Langmuir, 1978) indicates that most uranium in natural waters exists in the U(IV) or U(VI) oxidation state. Uranium in both oxidation states exhibits a strong affinity to complex with available anions in natural waters as either uranous (U^{4+}) or uranyl (UO_2^{+2}) ion. Because U(IV) species tend to precipitate as insoluble uraninite or coffinite (Langmuir, 1978), uranyl ion is the mobile species for most oxidizing groundwaters. More importantly, UO_2^{+2} is mobile over a relatively wide pH range. Depending on the ligands available and the pH, uranyl ion will form soluble complexes in oxidizing waters. Thus, uranyl will be soluble and hence mobile in most oxidizing groundwaters that contain common ligands. Oxidizing conditions probably exist in all alluvial/colluvial materials and extend at least into shallow bedrock as indicated by iron-oxidation staining in numerous drill logs. Therefore, uranium migration via surface water and ground water is likely given adequate leaching, and, therefore, uranium should be analyzed when characterizing these transport media.

Uranium has a lower K_d than plutonium or americium (Table 2-9). However, under reducing conditions (such as high-organic, fine-grained, bed sediments deposited in the deeper layers of sediments) uranium is immobilized and becomes part of the sediments.

Yang and Edwards (1984) documented the fate and transport of uranium and its daughter product, radium-226, in dissolved form, and in both suspended and bed sediments, from above the Schwartzwalder (uranium) Mine adjacent to Ralston Creek several miles southwest of the RFP. Uranium is present in dissolved and solid phases. Concentrations range from 4 micrograms per liter ($\mu g/l$) dissolved in the creek water above the mine to 100 $\mu g/l$ in Ralston reservoir below the mine. Uranium occurred as both a discrete mineral and as partially entrapped colloidal iron and manganese coatings on suspended and bed sediments.

TABLE 2-10

ISOTOPIC COMPOSITION OF ROCKY FLATS URANIUM

Isotopic	Relative Weight (Percent)		Relative Activity* (pCi/ μ g)	
	Natural Uranium	Depleted Uranium	Natural Uranium	Depleted Uranium
U-232	0	Trace	0	Trace
U-233	0	Trace	0	Trace
U-234	0.0057	0.002	0.35	.124
U-235	0.72	0.3	0.015	.006
U-236	0	0.0003	0	.0002
U-238	99.27	99.7	0.33	.332

* Relative activity is obtained by multiplying the percentage by weight by the specific activity.

Plutonium

There are 15 known isotopes of plutonium that decay into other elements at half-lives ranging from hours to 387,000 years (Ames and Rai, 1978). At the RFP, plutonium exists primarily as plutonium -239 and -240 (Table 2-11).

Plutonium specification in the environment is heavily influenced by hydrogen ion concentration (pH) and oxidation-reduction capacity (Eh). Typical environmental conditions are pH in the range of 5 to 8 and a positive Eh (greater than 0.05 volts) (Brownlow, 1979). Under these conditions, plutonium species will most likely be found in the following order of occurrence: $\text{Pu}^{+4} > \text{PuO}_2 > \text{Pu}^{+3} > \text{PuO}^{+1}$ (Ames and Rai, 1978).

As shown above, the most probable species in the environment is the plus 4 valence (oxidation state) species, which will exist either as plutonium dioxide (PuO_2) or as a solid hydroxide $\text{Pu}(\text{OH})_4$ (Brookins, 1984; Dragun, 1988). The assertion is based on the assumption that the pH of the environmental system is near neutral and that the system is in an oxidative state ($\text{Eh} > 0$).

Plutonium shows a very strong tendency to adsorb to clays, metal dioxides, and organic matter in soils and thus has a very low migration potential in the environment (CSU, 1974; Brookins, 1984). The distribution coefficient (K_d), for plutonium is 10^3 - 10^5 (Allard and Rydberg, 1983), meaning that the ratio of plutonium bound to soil to plutonium dissolved in water would be expected to vary from 1000:1 to 100,000:1. The EPA (1990b) gives a K_d of 2×10^3 for plutonium. At a minimum, analysis of surface water samples should include total plutonium because plutonium may be present in the suspended fraction. Although plutonium is not expected to migrate readily in ground water, its ubiquitous occurrence together with the lack of initial data suggest the Phase I RFI/RI include plutonium analysis for ground water samples.

Metals and Major Ions

In general, the solubility of metals and major ions in natural water situations are very sensitive to pH and Eh conditions as are the radionuclides. Based on their physical properties (Table 2-6), they can form complexes and potentially move relatively rapidly within the hydrosphere. There is also a tendency for the ions to be incorporated into new minerals, to be adsorbed on to mineral surfaces, ion exchange or to be coprecipitated. Because initial data on source characterization is limited, the Phase I RFI/RI should include metals analysis in waste, soils, and water.

TABLE 2-11

ISOTOPIC COMPOSITION OF ROCKY FLATS PLUTONIUM

Isotopic	Relative Weight (percent)	Specific Alpha Activity (Curies/gram)	Specific Beta Activity (Curies/gram)	Relative* Activity (Curies/gram)
Pu-238	0.01	17.1	—	0.00171
Pu-239	93.79	0.0622	—	0.056834
Pu-240	5.80	0.228	—	0.01322
Pu-241	0.36	—	103.5	0.37260
Pu-242	0.03	0.00393	—	1.18×10^{-6}
Am-241	— ^b	3.42	—	—

Source: Rockwell, 1985b.

*Relative activity is obtained by multiplying the percent by weight by the specific activity.

Total activity for the plutonium isotopes is:

Alpha 0.0732 curries/gram
Alpha plus Beta 0.446 curries/gram

^bAm-241 daughter from decay of Pu-241.

2.5.3 Secondary Release Mechanisms and Exposure Routes

As shown in Figure 2-12, there are numerous secondary release mechanisms and exposure routes for contaminants that may be released from OU 5 sources. This figure shows all potential pathways; however, the actual pathways of significance will be determined during the risk assessment.

2.5.4 Receptors

The point of exposure includes the source material or any point within a transport media that is contaminated. Whether the human receptor is a resident or visitor there is the potential for direct exposure through multiple pathways. Biota may also be present and be potential receptors. The potential for exposure and the magnitude of risk will be assessed during the risk assessment.

2.5.5 Exposure Pathway Characterization

The elements of the Site Conceptual Model described above are cross referenced to the Field Sampling Plan for characterization details in Table 2-12 through 2-15 for each IHSS. Site sampling based upon the site conceptual model will improve the characterization of contaminant pathways for each IHSS. As additional information is obtained, the overall model and specific portion of the model may be refined or expanded to address the issues of concern.

TABLE 2-12

OU 5 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS:
ORIGINAL LANDFILL (IHSS 115)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Buried Waste Table 7-1 (1,2,3,4,5,6,8,10,13,14)	Fugitive Dust Wind Erosion	Air Section 7.2.5	Settled Dust on Plants - Phase II
	Section 7.2.5 Air Sampling Table 7-1, (7)	Surface Water Table 7-1, (13-15) Table 7-4 Table 7-4, (2-4)	Settled Dust on Soil Section 7.2.5 Table 7-1, (7) Table 7-4, (2,3,4)
			Settled Dust on Water Table 7-1, (15) Table 7-4, (2,3,4)
Contaminated Surface Soil Table 7-1, (2,6,7) Table 7-4	Surface Runoff Table 7-1, (15) Table 7-4 (2-4)	Groundwater Table 7-1, (3,4,5,9,10,11,12)	Deposition Table 7-1, (15) Table 7-4, (2-4)
	Volatilization Table 7-1, (15)	Biota Section 9	Irrigation OU 3 Work Plan Infiltration Table 7-1, (9-11) Table 7-4, (2-4)
	Infiltration Percolation Table 7-1, (3,4,5,9,10,11,12)		Volatilization Table 7-1, (7); 7-4, (2-4)
	Biotic Uptake Section 9.0		Fugitive Dust Wind Erosion Table 7-1, (15); 7-4, (2-4)
	Tracking Section 9.0		Seepage Table 7-1 (10-12)
			Pumpage Table 7-1; OU 3 Work Plan
			Volatilization Table 7-1, (7,11), 7-4, (2-4)
		Biodegradation-Phase II	

TABLE 2-13

OU 5 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS:
INCINERATOR, ASH PITS AND CONCRETE WASH PAD (IHSS 133)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Buried Waste Table 7-1 (1,2,3,4,5,6,7,8)	Fugitive Dust	Air	Settled Dust on Plants - Phase II
	Wind Erosion	Section 7.2.5	
	Section 7.2.5	Surface Water	Settled Dust on Soil
	Air Sampling Table 7-2, (6)	Table 7-2, (6) Table 7-4, (1)	Section 7.2.5 Table 7-2, (6) Table 7-4, (1)
			Settled Dust on Water Table 7-2, (6) Table 7-4, (1)
			Biotic Uptake Section 9
Contaminated Surface Soil Table 7-2; (2,3,4,5,6) Table 7-4 (1)	Surface Runoff	Groundwater	Deposition
	Table 7-2, (6)	Table 7-2,	Table 7-2, (6)
	Table 7-4 (1)		Table 7-4, (1)
	Volatilization	Biota	Irrigation OU 3 Work Plan
	Table 7-2, (15)	Section 9	Infiltration
	Infiltration		Table 7-2, (3-8)
	Percolation		Volatilization
	Table 7-2, (3,4,5,7,8)		Table 7-2, (6), 7-4, (1)
	Biotic Uptake		Fugitive Dust Wind
	Section 9.0		Erosion
Tracking		Table 7-2, (6), 7-4, (1)	
Section 9.0		Sec. 7.2.5	
			Seepage, Table 7-2, Table 7-2, (5,7,8)
			Pumpage OU 3 Work Plan
			Volatilization Table 7-2, (6); 7-4, (1)
			Biodegradation-Phase II

TABLE 2-14

OU 5 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS:
C-SERIES DETENTION PONDS (IHSS 142.10-11)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Buried Waste Table 7-5, (1,2,3,5,6)	Fugitive Dust Wind Erosion	Air Section 7.2.5	Settled Dust on Plants - Phase II
	Section 7.2.5 Air Sampling Table 7-5, (6-8)	Surface Water Table 7-5, (4)	Settled Dust on Soil Section 7.2.5 Table 7-5, (6-8)
			Settled Dust on Water Table 7-5, (4)
			Biotic Uptake Section 9
Contaminated Surface Soil Table 7-5, (1,2,3,4,6,7,8)	Surface Runoff Table 7-5, (4,5,7,8) Table 7-4, (1-4)	Groundwater Phase II	Deposition Table 7-5, (4, 6-8)
	Volatilization Table 7-5, (6-8)	Biota Section 9	Irrigation OU 3 Work Plan Infiltration Table 7-5, (5)
	Infiltration Percolation Table 7-5, (6-8)		Volatilization Table 7-5, (4, 6-8)
	Biotic Uptake Section 9.0		Fugitive Dust Wind Erosion Table 7-5, (4, 6-8) Sec. 7.2.5
	Tracking Section 9.0		Seepage, Table 7-5, (5) Phase II
			Pumpage Table 7-6; OU 3 Work Plan
			Volatilization Table 7-5, (4, 6-8)
			Biodegradation-Phase II

TABLE 2-15

OU 5 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS:
C-SERIES DETENTION PONDS (IHSS 142.10-11)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Buried Waste Table 7-3, (1-5)	Fugitive Dust Wind Erosion	Air Section 7.2.5	Settled Dust on Plants - Phase II
	Section 7.2.5 Air Sampling	Surface Water Table 7-3, (1) Table 7-4, (3-6)	Settled Dust on Soil Section 7.2.5 Table 7-3, (1) Table 7-4, (3-6)
			Settled Dust on Water Table 7-3, (1-4) Table 7-4, (1-4)
			Biotic Uptake Section 9
Sediment and Surface Water Table 7-3, (1-4) Table 7-4, (3-6)	Surface Deposition Table 7-3, (1-4) Table 7-4, (3-6)	Groundwater Phase II	Table 7-3, (1-4) Table 7-4 (3-6)
	Volatilization Table 7-3, (1-4)	Biota Section 9	Phase II
	Infiltration Percolation Table 7-3, (5)		Infiltration Table 7-3, (5)
	Biotic Uptake Section 9.0		Volatilization Table 7-3, (1-4), 7-4, (3-6)
	Tracking Section 9.0		Fugitive Dust Wind Erosion Table 7-3, (1-4), 7-4, (3-6) Sec. 7.2.5
			Seepage, Table 7-3, (5) Phase II
			Pumpage Phase II
			Volatilization Table 7-3, (1-4); 7-4, (3-6)
			Biodegradation-Phase II

7.1 BACKGROUND AND SAMPLING RATIONALE

7.1.1 Background

The objectives of the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) are:

- To characterize the physical and hydrogeologic setting of the Individual Hazardous Substance Sites (IHSSs)
- To assess the presence or absence of contamination at each site
- To characterize the nature and extent of contamination at the sites, if present
- To support the Phase I Baseline Risk Assessment and Environmental Evaluation

Within these broad objectives, site-specific data needs have been identified in Section 4.0. The purpose of this section of the work plan is to provide a Field Sampling Plan (FSP) that will address data needs and data quality objectives. The FSP developed in this section is based on the requirements of the IAG Statement of Work for OU5, and the data needs developed in Section 4.0. It is important to recognize that additional phases of investigation and risk assessment may be required at some IHSSs prior to feasibility studies.

Generally, only limited information is available concerning the IHSSs in Operable Unit Number 5 (OU5) since there have been no previous field investigations of these sites. Available information includes aerial photographs, site histories, and some analytical data for samples collected near the IHSSs. Little information exists specific to the physical characteristics of the sites or to the nature and extent of the contamination, if present.

One of the objectives of the RFI/RI is to assess the presence or absence of contamination in the groundwater, surface water, and soils at the sites. A multi-staged approach is outlined in the IAG and will be used in Phase I to achieve this objective. This approach uses an iterative process involving continuing reassessment of the site conditions as data are obtained. Based on this process, the subsequent field sampling program may be modified to collect more representative data for each IHSS. This FSP describes this staged process.

Based on the previous investigations and historical data presented in Section 2.0 of this report, the primary potential contaminants of concern are metals and radioactive materials. Insufficient data exists to confirm or deny the presence of organic compounds in IHSSs within OU5.

7.1.2 Sampling Rationale

As discussed above, a **staged** approach will be used for the sampling program. There are four **stages** which may be completed at any site.

- **Stage 1** consists of a review of existing data, including aerial photographs and site records. Data from ongoing or other operable unit investigations that have become available since preparation of this Phase I work plan will be compiled and evaluated. These data will be validated as appropriate for incorporation into the OU5 site characterization. This review of existing information has already been partially performed during preparation of this Phase I work plan.
- **Stage 2** involves screening activities, including **electromagnetic (EM)** radiation and **cone penetrometer** surveys, magnetometer surveys, and a soil gas survey at the Original Landfill area and the Ash Pits. These activities are designed to provide Phase I screening-level data concerning the presence or absence of contaminants at the sites.
- **Stage 3** consists of Phase I sampling activities for soil, sediment, and surface water. Soil borings will be completed at some IHSSs to collect samples at depth and to characterize the IHSS. Some of the sampling locations may be selected to investigate anomalies identified in the Stage 2 screening surveys. This stage will provide confirmation of the Phase I screening data as well as aid in Phase I geologic and hydrogeologic characterization of the sites.
- **Stage 4** is monitoring well installation and sampling, which will follow Stage 3 Phase I characterization and sampling. Groundwater monitoring wells will be installed to characterize the hydrogeologic setting of each site and to monitor alluvial groundwater conditions within or downgradient of several sites. These wells will be sampled after completion and development, and the results will be included in the Phase I RFI/RI Report.

7.1.3 Modifications to the IAG Plan

Several sampling and analytical activities described in the Interagency Agreement (IAG) have been modified in this FSP. These modifications, listed below, have been made so that each IHSS can be better evaluated during the Phase I investigation. Modifications to the Phase I sampling program are presented first followed by modifications to the Phase I analytical program.

Phase I Sampling Program Modifications

- 1) Radiation surveys and limited soil sampling (including surface soil samples and soil borings) will be conducted at the Surface Disturbance areas. The purpose of these activities is to assess the presence or absence of contaminants at these sites. The rationale for this sampling is that if contamination is not found, the surface disturbances can be removed from further phases of the RFI/RI process.
- 2) An investigation of a second surface disturbance (south of the Ash Pits) has been added to the Phase I investigation. This is an area where unknown activities have taken place at excavation and fill areas. The investigation of this area will include a review of the aerial photos, a radiation survey, surface soil sampling, and nine soil borings. Details of this program are contained in subsection 7.2.4.
- 3) An investigation of a third surface disturbance west of IHSS 209 has been added to the Phase I investigation. The investigation of this area, which appears to have been a radio tower installation, will include a review of the aerial photos, a radiation survey, and surface soil sampling and soil borings. Details of this program are contained in subsection 7.2.4.
- 4) No FIDLER radiation survey will be conducted at the Original Landfill (IHSS 115). This survey has been deleted from the Phase I investigation because a more comprehensive gamma radiation survey using a germanium detector was completed in the fall of 1990. In addition, a gamma radiation survey using a germanium detector will be used at the Ash Pits (IHSS 133) instead of the radiation surveys specified in the IAG.
- 5) Two-foot composite samples will not be used for volatile organics analysis at the Original Landfill (IHSS 115). Instead, discrete samples will be collected at two-foot increments for analysis. Composite samples are not appropriate for analysis of volatile organic compounds, since a significant portion of the volatiles present in a sample can be volatilized during compositing of a sample.
- 6) Five sediment samples are to be collected from both Ponds C-1 and C-2 (IHSSs 142.10 and 142.11), as proposed in the IAG. However, three of the five locations have been changed so that more representative samples of the pond sediment can be obtained. The five locations proposed in this Phase I FSP are:
 - In the deepest portion of the pond,
 - In the pond, five feet from the inlet, and
 - At three randomly selected locations within the pond.

The samples to be collected at the three random locations are the locations which have been changed from those specified in the IAG. These random samples will provide pond sediment data that can be statistically averaged, while the samples collected from the deepest part of the ponds are likely to provide worst case concentrations. These average and worst case concentrations can then be used to better characterize the extent and nature of any contamination in the ponds and provide more useful data for the Phase I baseline risk assessment. The three original sampling locations specified in the IAG would provide non-random data that cannot be used in statistical analyses.

- 7) Sediment samples from Woman Creek and the SID will be collected to characterize the drainage where existing data is currently lacking. These samples will be placed just downstream of the impact area (area where surface runoff from an IHSS reaches Woman Creek) for each IHSS along Woman Creek and along stream segments that need further characterization. Based on a review of the data collected at the existing 18 sediment sample locations, there exists a significant amount of information about the sediment in many parts of the OU5 drainages (see Section 2.0). Based on this approach, two additional sampling locations have been placed downstream of the Ash Pits, four downstream of the Old Landfill, one between the Old Landfill and Pond C-1, one between Ponds C-1 and C-2, and four downgradient of Pond C-2. These proposed sampling locations in combination with the existing 18 sampling locations should be sufficient to characterize the Woman Creek and SID sediment.
- 8) Seven borings will be drilled and sampled in the Original Landfill (IHSS 115) area. One boring will be drilled at the location of each of the former ponds and six borings will be drilled in the disturbed area east of the landfill. The borings will be drilled 6 feet into weathered bedrock. Samples will be analyzed for the same constituents as other soil samples from the landfill (as presented in Table 7-7). There have been no previous investigations in either the area of the former pond or the disturbance east of the landfill. These borings will provide Phase I data concerning the presence or absence of contamination at these locations.
- 9) One additional well will be installed downgradient of the Old Landfill (IHSS 115). The well will be located between existing wells 5786 and 7086 south of the SID. The well will be completed in the alluvial materials.
- 10) A magnetometer survey, an EM geophysical survey and screening sampling with a cone penetrometer will be conducted at the Old Landfill (IHSS 115) and Ash Pits (IHSS 133). The magnetometer survey will be used to evaluate the presence of ferrous materials in the units. The EM survey will determine differences in the conductivity of subsurface materials which may allow evaluation of the IHSS boundaries and/or the presence of saturated material. The cone penetrometer will be used to identify saturated subsurface material for subsequent soil water sampling between the landfill and the SID, and

between the SID and Woman Creek. The information gathered from the cone penetrometer will be used to define the best locations and depths for groundwater monitoring wells or if appropriate, vadose zone sampling using the BAT sampler.

- 11) Surface soil sampling for plutonium and other radionuclides may be performed at the RFP site between Woman Creek and the southern boundary pending further data evaluation. This is discussed in Section 7.2.4.1. Sediment and surface water sampling in this area is also discussed in this section.

Phase I Analytical Program Modifications

- 1) All the Phase I soil samples collected from the Ash Pits area (IHSSs 133.1-133.6) will be analyzed for TAL metals as well as for uranium, plutonium, americium, gross alpha, and gross beta. This should provide a more representative analysis of the wastes thought to be present in these pits. This is also appropriate, since the groundwater monitoring program calls for analysis of metals in wells downgradient of this IHSS. Details of this analytical program are summarized in subsection 7.3.2.
- 2) A gamma radiation scan will be conducted by EG&G or its contractor on each of the sediment samples collected from the location at the deepest portion of Ponds C-1 and C-2 (IHSSs 142.10 and 142.11). Sediment samples at these locations will be collected from the sediment core at five-centimeter intervals. The rationale behind including this analysis is to evaluate whether contamination may exist in thinly stratified layers and to provide additional data to characterize pond sediment.
- 3) The IAG specifies that water and sediment samples be analyzed for soluble and insoluble radionuclides and metals. For the purposes of this Phase I investigation, each of the water samples will be filtered, and both the filtered and an unfiltered aliquot will be analyzed for the specified metals and radionuclides. The filtered sample will provide data on the dissolved constituents and the unfiltered sample will provide data on the total constituent concentrations. Also, water (both filtered and unfiltered) and sediments will be analyzed for both plutonium isotopes (239/240). This is consistent with the existing Rocky Flats analytical methods.
- 4) Several analyses have been added to the Phase I analytical program to address chemicals of interest in the Environmental Evaluation. Groundwater samples from wells installed at the Original Landfill (IHSS 115) and some of the sediment samples collected in Woman Creek will be analyzed for TCL pesticides/PCBs. All surface (0-2 inches) soil samples taken in OU5 and sediment samples collected in Woman Creek will be analyzed for total organic carbon (TOC).

- 5) **The two sediment samples downgradient of the Ash Pits will not be analyzed for TCL volatiles and semi-volatiles. These organic compounds are unlikely to be present in the ash disposed of in these IHSSs and organics have not been detected in the data collected from existing sediment locations in and adjacent to Woman Creek near the Ash Pits.** Radionuclides and TAL metals are the suspected contaminants at the Ash Pits and the sediment analytical program downgradient of these areas will focus on these analytes.

7.2 PHASE I INVESTIGATION PROGRAM

This section describes the Phase I investigation program for the IHSSs within OU5. For each IHSS, the tasks listed are generally divided into office activities prior to field sampling (Stage 1), field screening activities prior to sampling (Stage 2), field sampling activities (Stage 3), and groundwater monitoring well installation and sampling (Stage 4). As part of the field sampling program, data from site-wide monitoring programs and investigations at other OUs will be used as appropriate to add to, or substitute for, the data collected during the Phase I investigation. The sites included within OU5 are IHSS 115 - Original Landfill; IHSS 133 - Ash Pits 1-4, the Incinerator, and the Concrete Wash Pad; IHSS 142.10 and 142.11 - C-Series Detention Ponds, and IHSS 209 - Surface Disturbance southeast of Building 881 and two additional surface disturbances. The area south of OU5 to the property boundary will be investigated if warranted. These are the surface disturbance west of IHSS 209 and the surface disturbances south of the Ash Pits. The area south at OU5 to the property boundary will be investigated if warranted. For reference, the Phase I investigation programs for each IHSS are summarized below. A number of standard operating procedures (SOPs) will be used during the investigation. The SOPs are cited in this section and discussed further in Section 11.0 of this Phase I work plan.

7.2.1 IHSS 115 - Original Landfill

Stage 1 - Review Aerial Photographs

Aerial photographs taken during operation of the Original Landfill will be reviewed to identify the extent of the Original Landfill and the disturbed area located to the east of the Original Landfill. The areas to be studied during later steps of this investigation, including the location of former ponds, will be delineated from the aerial photographs and surveyed in on the ground as needed to define their locations for the Phase I field work. Additional studies conducted at the Landfill after preparation of this Phase I work plan will be evaluated during Stage 1 (see Table 7-1). Also as part of this stage, the gamma radiation survey conducted at the Original Landfill using a germanium detector (Appendix B) may be further reviewed as needed.

Stage 2 - Soil Gas, EM, Magnetometer and Cone Penetrometer Surveys

TABLE 7-1

PHASE I INVESTIGATION
IHSS 115 - ORIGINAL LANDFILL

Activity	Purpose	Location	Sample Number
1. Review Aerial Photographs	Identify extent and area east of Landfill	Entire site and eastward	NA
2. Review Radiation Survey	Identify areas of anomalous radiation readings		NA
3. EM Survey	Locate ferrous objects, and IHSS boundaries	Entire site - 25 ft. grid	NA
4. Cone Penetrometer	Characterize subsurface conditions and contamination	Downgradient of Landfill	NA
5. Magnetometer Survey	Locate ferrous objects	Entire site - 25 ft. grid	2, 490
6. Soil Gas Survey	Locate plumes of volatile organics	Entire site and eastward - 100 ft. grid	69
7. Soil Cores	Verify presence or non-presence of volatiles identified during soil gas survey	Random basis, 1 sample every 15 to 20 soil gas samples, at the depth of the soil gas probe	4
8. Soil Borings	Characterize subsurface conditions and contamination	One in each area of the former ponds, six in the disturbance east of the Landfill. Borings will be drilled at least 3 feet into weathered bedrock.	8
9. Soil Borings (if plumes are identified)	Transect plumes identified by soil gas survey, if identified	Three borings transecting three highest soil gas locations. Borings will be placed at point of highest reading and two locations downslope of the point. Borings will be drilled at least 6 ft. into weathered bedrock.	Maximum of 9
10. Complete wells in borings (if plumes are identified)	Monitor alluvial groundwater in plume, if identified	In borings at the points of highest readings	Maximum of 3
11. Vadose Zone Sampling (if required)	Monitor vadose zone	As needed	NA
12. Install wells	Monitor alluvial groundwater downgradient of the unit	See Figure 7-1	4
13. Review plant plans, conduct sewer snake survey	Confirm interconnections of two pipes daylighting in the Landfill	Two pipes in Landfill	NA

TABLE 7-1 (Continued)

Activity	Purpose	Location	Sample Number
14. Sample effluent (if present)	Characterize effluent from the pipes	Pipe outfalls	2
15. Sample sediment and surface water	Characterize sediment and surface water downgradient of the unit	Two and three locations along SID and Woman Creek for sediment and surface water, respectively	4 sediment and 6 surface water

NA - Not Applicable

A real-time soil gas survey will be conducted over the Original Landfill and the disturbed area located to the east of the Landfill (Figure 7-1) to identify areas of volatile organic contamination. As specified in the IAG, the soil gas samples will be taken on a 100-foot grid according to the procedures described in SOP GT.9. To further improve the sampling coverage, the grid will be reduced to 25 foot spacing at the perimeter of the landfill and at areas of suspected buried metallic materials based on the magnetometer survey. In addition, if volatiles are found during the soil gas survey the grid will also be reduced to 25 feet to improve the sampling coverage in these areas. This approach should better characterize the area of likely contamination. A probe will be driven approximately 5 feet into the soil to collect the soil gas. The soil gas samples will be analyzed for 1,1,1-trichloroethane (TCA), dichloromethane, benzene, carbon tetrachloride, tetrachloroethene (PCE), and trichloroethene (TCE) using a portable gas chromatograph (GC). Analytical peaks of compounds for which the GC is not calibrated will be noted. It will not be possible to analyze for solvent breakdown products like 1,2 dichloroethane and vinyl chloride with a GC because they co-elute with other compounds. Vinyl chloride co-elutes with freon compounds, and 1,2 dichloroethane co-elutes with methyl ethyl ketone and dibromomethane. The analytical program for the soil gas survey is discussed in subsection 7.3.2.

A magnetometer survey will be performed over and downgradient of the Old Landfill and the disturbed area to the east. This survey will be conducted on a 25-foot grid in the area outlined for the radiation survey in Figure 7-2. The survey will be completed according to the magnetic locator procedure in SOP GT.10. Resulting anomalies will be mapped and contoured.

An EM geophysical survey will be performed over the Old Landfill on the 25 foot grid established for the magnetometer survey. The survey will be completed according to the EM Geophysical procedures in SOP GT.18.

A cone penetrometer will be used to identify saturated subsurface material for subsequent soil water sampling downgradient of the Old Landfill. Two lines of cone penetrometer surveys will be established; one between the landfill and SID, and one between the SID and Woman Creek.

Stage 3 - Surface Soil, Soil Cores, Soil Borings, Surface Water, and Sediment Samples

Four randomly selected grab samples of surface soils will be collected to characterize the landfill cover material.

Soil cores will be collected on a random basis to verify the soil gas survey and other screening methods. Depending upon the results of the radiation screening, additional surface soil samples may be required at identified areas with above-background radiation. One soil core (grab sample) will be collected for every 15

to 20 soil gas samples at the same depth as the soil gas samples. Based on the number of soil gas sampling locations, it is estimated that four soil cores will be collected.

One soil boring will be drilled in the location of each of the two former ponds. Six soil borings will be drilled in the disturbed area east of the landfill. Three borings will be placed at up to three areas where plumes have been identified by the soil gas. This will result in a maximum of nine soil borings being drilled at the three plume areas. At each plume area, one soil boring will be placed at the point of the highest soil gas reading, and two borings will be located downslope of that point within the plume identified by the soil gas survey. Each soil boring will be drilled at least 6 feet below the base of the alluvial material according to the procedures described in SOP GT.2. Samples will be taken continuously in these borings. Discrete samples will be collected from every 2-foot increment and analyzed for the Target Compound List (TCL) volatile organic compounds. Samples will be composited from every 6-foot interval and analyzed for the TCL semivolatile organic compounds, the Target Analyte List (TAL) metals, and radionuclides. As specified in the SOP, samples will not be collected for chemical analysis from the saturated alluvium. The analytical program for those samples is presented in subsection 7.3.

During sampling a soil classification survey will be completed at the Original Landfill for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

The two corrugated metal pipes protruding from the Landfill (Figure 7-1) will also be investigated in this FSP. Plant plans will be reviewed and a sewer snake survey will be conducted to attempt to identify the open length of the pipes and the sources of water. This survey may use a traceable electronic or magnetic source attached to the snake such that surface instruments can be used to follow the path of the pipe. Other methods for locating pipes may also be used if the sewer snake survey is inconclusive. If water is found to be flowing through either of the corrugated pipes during this Phase I investigation, the effluent will be sampled according to SOP SW.3. Results of the sampling will be reported in the Phase I RI Report.

The sediments and surface water of the South Interceptor Ditch (SID) and Woman Creek will be sampled immediately downgradient of the Original Landfill. These locations are shown in Figure 7-2, which is a map of all the proposed surface water and sediment sampling locations for OU5. Surface water samples will be collected at three locations along the SID and three locations on Woman Creek (total of six samples) according to the procedures specified in SOPs SW.2 and SW.3 for surface water. Sediment samples will be collected at two locations along the SID and two locations on Woman Creek (total of four samples) according to procedures specified in SOP SW.6 (see Section 7.2.3). The sediment samples will be collected in areas of the creek or ditch that are conducive to sediment accumulation. The analyses to be performed on these samples are listed in subsection 7.3.

Stage 4 – Monitoring Wells

Based on information from the soil gas survey, monitoring wells will be installed in locations with the highest volatile readings. It is possible due to the limited saturated thickness of the alluvium that there may be locations where there is no water or times of the year when the saturated thickness is zero. If this is the case, it may be necessary to relocate the wells or possibly install a vadose zone sampling device such as the BAT sampler to characterize the contaminant plumes in zones of limited water. It may also be necessary to install bedrock wells beneath zones of contaminated alluvial ground water or if a subcropping sandstone is encountered. At this time it is proposed that a maximum of three monitoring wells will be installed in these borings. As specified in the IAG, all of these wells will be installed in the alluvium just above the bedrock according to SOP GT.6.

In addition to the above wells, four monitoring wells and/or vadose zone samplers will be installed in the alluvium downgradient of the Original Landfill depending upon the results of the cone penetrometer and other screening survey methods. At least three wells will need to be installed between the Landfill and the SID and one well will be installed between the SID and Woman Creek (Figure 7-1). The first well will be placed approximately between the western leg of the Landfill and the SID. The second well will be placed in the alluvium in the surface drainage north of Well 5786 between the Landfill and the SID within the area of the old embankment. The third well will be placed in the alluvium between the southeastern corner of the boundary of IHSS 115 and the SID, downgradient of the outfall identified on the east side of the Landfill. The fourth well will be placed between existing wells 5786 and 7086. These locations may be modified slightly depending upon the results of the screening surveys. If a water-bearing sandstone unit is found to be the first bedrock unit underlying the alluvium in a boring, then the well will be completed in the sandstone at that location. These wells should monitor the principal groundwater migration pathway downgradient of the Original Landfill.

The four proposed groundwater monitoring wells will be drilled according to SOP GT.2 and installed according to SOP GT.6. All wells will be developed according to SOP GW.2. Following development, wells will be sampled according to SOPs GW.5 and GW.6. The analyses to be performed on these samples are listed in subsection 7.3. The results of the first round of sampling will be reported in the Phase I RI Report. The four monitoring wells downgradient of the Landfill will be sampled quarterly for a minimum one year.

7.2.2 IHSS 133 - Ash Pits 1-4, Incinerator, and Concrete Wash Pad

Stage 1 – Review Aerial Photographs

Aerial photographs from 1953, 1955, 1964, 1969, and 1978 through 1988 will be reviewed to identify the extent of the disposal areas for these sites including an area north of the west access road and possible waste disposal areas beyond the boundaries of Ash Pit 1 and the Concrete Wash Pad (see Section 2.0). The dimensions of each pit, determined from the aerial photographs, will be used to assist in planning the Phase I drilling program and for defining the area of the radiation survey (see Table 7-2).

Stage 2 – Radiation, EM Geophysical, Cone Penetrometer and Magnetometer Survey

A ground based radiation survey employing a high purity germanium gamma-ray sensor will be performed over the four Ash Pits, the Concrete Wash Pad, and the Incinerator. The area to be surveyed for IHSS 133 is shown on Figure 7-2 and extends from the western boundary of the previously surveyed area over the Original Landfill (Appendix B) to approximately 600 feet west of the Concrete Wash Pad. The sodium iodide sensors employed for this survey will be spaced such that there is overlapping coverage between stations to guarantee that there is 100% coverage. The gamma emitting radionuclides that are detected will be analyzed to identify the isotopes that may be present. An SOP is currently being developed for performing this survey. If areas of anomalous radiation readings are detected, they will be surveyed sufficiently to define their lateral extent. The results will be plotted and contoured on a map and will also be presented in tabular form.

A magnetometer and an EM Geophysical survey will be performed over the Ash Pits in the same area as outlined for the radiation survey on Figure 7-2. This survey will be conducted on a 25-foot grid according to the magnetic locator procedure described in SOP GT.10 and according to the EM Geophysical procedure described in SOP GT.18. Resulting anomalies will be mapped and contoured.

Stage 3 – Surface Soil Sampling and Soil Borings

Surface soil samples will be collected at 4 randomly selected locations to characterize the ash pit cover material. In addition, surface soil samples will be collected at the central location of all areas identified by the radiation survey as having above-background radiation levels. These soil samples will be collected according to the sampling procedures specified in SOP GT.8.

Borings will be drilled during the Phase I investigation to collect samples for analysis and to further characterize the pits and pads. As specified in the IAG, these borings will be placed on 25-foot centers along the long axis of each pit or pad, as identified in Stage 1 (see Figure 7-3). Borings will also be placed along the short axis

TABLE 7-3

PHASE I INVESTIGATION
IHSS 142.10-11 - C-SERIES DETENTION PONDS

Activity	Purpose	Location	Sample Number
1. Collect surface water samples	Characterize surface water contamination	5 locations in each pond and from each vertically stratified zone at the deepest point in the pond	16
2. Collect sediment samples in ponds	Characterize sediments in ponds and contamination	5 locations in each pond. Samples will also be taken from each 5 centimeter interval of sediment from the deepest part of each pond.	10
3. Collect sediment samples in other locations on Woman Creek	Characterize Woman Creek sediments and contamination	See Figure 7-2 and text	10
4. Collect sediment samples in the South Interceptor Ditch	Characterize South Interceptor Ditch sediments and contamination	See Figure 7-2 and text	2
5. Install wells	Monitor alluvial groundwater downgradient of the ponds	Below ponds C-1 and C-2 dams (2 each)	4

TABLE 7-2

PHASE I INVESTIGATION
IHSS 133 - ASH PITS 1-4, INCINERATOR,
AND CONCRETE WASH PAD

Activity	Purpose	Location	Sample Number
1. Review Aerial Photographs	Identify extent of the areas, including areas beyond the boundaries of the units	Entire site and north of road	NA
2. Radiation Survey	Locate areas of anomalous radiation readings	IHSS areas, areas between pits, and area between Ash Pits and Landfill	NA
3. EM Survey	Locate metallic objects and contaminant plumes	IHSS areas, areas between pits, and area between Ash Pits and Landfill	NA
4. Magnetometer Survey	Locate metallic objects	Same as radiation survey	4, 864
5. Cone Penetrometer	Characterize subsurface contamination	As needed	NA
6. Surface Soil Sampling	Characterize radiation hotspots	Central location of areas of radiation above background	Unknown
7. Soil borings	Characterize subsurface conditions and contamination	On 25-foot centers and over hotspots. Borings will be drilled 5 ft. into weathered bedrock.	85
8. Install wells	Monitor alluvial groundwater downgradient of the unit	See Figure 7-3	3

NA - Not Applicable

of each pit to aid characterization efforts. Soil borings will also be placed over areas of anomalous radiation readings detected during the radiation survey. Based on the present size of the Ash Pits, Incinerator, and Wash Pad, it is estimated that approximately 85 borings on 25-foot centers will be drilled in the area. Each boring will be drilled 5 feet into weathered bedrock and will be drilled and sampled according to procedures contained in SOP GT.2. Samples will be taken continuously in these borings. Samples will be composited from every 2-foot interval and analyzed for metals, total uranium, plutonium, americium, chromium, gross alpha, and gross beta (see subsection 7.3).

During sampling a soil classification survey will be completed at the Ash Pits for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

Stage 4 – Monitoring Wells

Three monitoring wells will be installed downgradient of the Ash Pits between IHSS 133 and Woman Creek (preliminary locations are shown on Figure 7-3). Locations for the wells will be selected following the Stage 3 activities and after a review of the geologic characteristics of the site. The locations will be proposed to the Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) prior to well installation. The wells will be drilled according to SOP GT.2, installed according to SOP GT.6, and developed according to SOP GW.2. The wells will be screened to monitor the saturated section of the alluvium. If a water-bearing sandstone unit is found to be the first bedrock unit underlying the alluvium in a boring, then the well will be completed in the sandstone unit at that location. It is possible due to the limited saturated thickness of the alluvium that there may be locations where there is no water or times of the year when the saturated thickness is zero. If this is the case it may be necessary to relocate the wells or possibly install a vadose zone sampling device such as the BAT sampler to characterize the contaminant plumes in zones of limited water. It may also be necessary to install bedrock wells beneath zones of contaminated alluvial ground water or in a subcropping sandstone, if encountered. Following development, the wells will be sampled according to SOP GW.5 and GW.6. The Phase I analytical program for samples collected from these wells is contained in subsection 7.3. The results of the first round of sampling will be reported in the Phase I RI Report. The wells will be sampled quarterly for a minimum of one year.

7.2.3 IHSS - 142.10-11 - C-Series Detention Ponds

Stage 1 – Review of Existing Data

Surface water and sediment samples are currently being collected at locations in the Woman Creek drainage as part of ongoing monitoring activities at the Rocky Flats Plant. The sampling locations, methodology,

analytical parameters, and results from this monitoring will be reviewed prior to the Phase I field investigation to assess the potential overlap between the programs. Data collected during the ongoing monitoring may satisfy the requirements of this OU5 program and will be utilized, if appropriate. Also, as specified in the IAG, the 1986 report "Trends in the Rocky Flats Surface Water Monitoring" (U.S. DOE 1986a) and other data pertaining to these ponds will be submitted to the EPA and the CDH.

Stage 2 – Surface Water and Sediment Samples

Five surface water samples will be collected from each of the two C-Series Detention Ponds (Table 7-3). At least one of the five water samples at each pond will be taken from the deepest part of the pond. As specified in the IAG, during the collection of this sample, the presence of stratification in the pond water will be evaluated. Stratification of the water column will be identified through temperature and/or dissolved oxygen measurements taken according to SOP SW.8. If stratification of the pond is identified at this location, grab water samples will be taken from each vertically stratified zone. The second surface water sample from each pond will be collected within 5 feet of the inlet to the pond. The third surface water sample for each pond will be collected within 5 feet of the pond spillway. The two remaining sampling locations will be selected at random based on the size of the pond at the time of sample collection. The surface water sample collected at each location will consist of a composite sample from the entire vertical water column, except for the grab samples at the deepest sampling location (described above). Samples will be collected according to SOPs SW.1, SW.2, and SW.8 as they apply to pond water sampling.

Five sediment samples will be collected from each of the two C-Series Detention Ponds (Figure 7-4). One of the five sediment samples will be taken within the pond 5 feet from the inlet. A second sediment sample will be collected from the deepest part of each pond. The other three samples will be taken from random locations within the pond as it exists at the time of sampling. All sediment samples will represent the entire vertical column of sediment present at each location. If the sediment depth is greater than 2 feet, 2-foot composite samples will be collected. Sediment samples will be geologically logged according to SOP GT.1.

In addition to the above samples, grab sediment samples will be collected from discrete vertical intervals in the sediment core taken from the deepest part of the pond. These sediment samples will consist of composite samples collected at 2-inch intervals in this core. Each of these samples will be analyzed by a gamma radiation scan.

Sediment samples will also be collected along Woman Creek from the Concrete Wash Pad (IHSS 133.6) to Indiana Street and along the SID (Figure 7-2). There already exists data on the sediments in the OU5 area (see Section 2.0). In developing the OU5 sediment sampling program, the areas where each IHSS would impact this drainage have been estimated so that the additional field sampling locations can be positioned downstream

of these impact areas (Figure 7-5). These impact areas have been estimated by defining the area where surface water runoff from each IHSS intercept the drainage.

Based on these impact areas, additional field sampling locations have been positioned downgradient of each IHSS where there was a lack of existing data (Figure 7-5). Table 7-4 lists these additional sediment sampling locations proposed for OU5 and their purposes, along with what existing sediment locations will be used to characterize each area. The sediment samples collected from each pond are not included on Table 7-4. Generally, additional sampling locations are placed downstream of each IHSS and along each stream segment where existing data is lacking to characterize the stream sediment (Table 7-4 and Figure 7-5). Data from these additional sampling locations along with the sediment data that has already been collected will be used to evaluate Woman Creek and the SID in OU5 for the Phase I RI Investigation.

The sediment samples from Woman Creek and the SID will be collected within the creek or ditch at points that are conducive to the collection of sediment. The sample at each location will consist of 2-foot composite samples taken to the depth of the first gravel layer below the sediment. If the sediment is thicker than two feet then additional two-foot composite samples will be collected.

All sediment samples will be collected according to SOP SW.6 and the SOP Addendum (SOPA) to SOP SW.6 in Section 11.0 of this document. The chemical analyses that will be performed on these samples is presented in subsection 7.3.

Stage 3 and 4 -- Monitoring Wells

Two monitoring wells will be installed immediately downgradient of each dam at Detention Ponds C-1 and C-2, thus providing a total of four monitoring wells in this area (Figure 7-4). The wells will be constructed within the original stream channel according to SOP GT.6 and will monitor the saturated alluvium. If a water-bearing sandstone unit is found to be the first bedrock unit underlying the alluvium in a boring, then the well will be completed in the sandstone at that location. Following development of the wells according to SOP GW.2, the wells will be sampled according to SOPs GW.5 and GW.6. Results of the first round of well sampling will be reported in the Phase I RI Report. These wells will be sampled quarterly for one year. The chemical analyses that will be performed on these samples are discussed in subsection 7.3.

7.2.4 IHSS 209 - Surface Disturbance Southeast of Building 881 and Other Surface Disturbances

There are three surface disturbances that will be evaluated during the Phase I investigation: IHSS 209, the surface disturbance west of IHSS 209, and the surface disturbances south of the Ash Pits (Figures 7-3 and 7-4).

TABLE 7-4

PROPOSED SEDIMENT SAMPLING PROGRAM¹

IHSS or Stream Segment	Proposed Locations	Existing Locations	Purpose
1. Ash Pits, Concrete Wash Pad, and Incinerator (Woman Creek)	2	SED-14 and SED-17	Characterize Woman Creek sediment downstream of IHSS 133.
2. Original landfill (Woman Creek and SID)	4	0	Characterize sediments downstream of landfill in both SID and Woman Creek
3. Between IHSS 115 and Pond C-1	1	SED-126	Characterize sediments in SID and Woman Creek
4. SID Between Pond C-1 and C-2	0	SED-28, SED-31, SED-29, and SED-30	Characterize SID
5. Woman Creek between C-1 and C-2	1	SED-27, SED-26, and SED-25	Characterize Woman Creek between ponds
6. Woman Creek between C-2 and Indiana Street	4	SED-1, SED-2, and SED-24	Characterize Woman Creek and Unnamed Ditch

¹ The 5 sediment samples for each pond are not included in this table.

The Phase I field sampling programs for these areas are similar and are described below. Table 7-5 summarizes the proposed program for these areas.

Stage 1 – Review Aerial Photographs

Available aerial photographs, including those from 1964, 1969, 1971, and 1983, will be reviewed to evaluate the nature and use of IHSS 209, the surface disturbance west of IHSS 209, and the surface disturbance south of the Ash Pits (see Table 7-5). These photos will help to determine if there are any specific areas within each of these surface disturbances that should be investigated more fully. In addition, the features that appears to be a pond at IHSS 209 in a 1983 and 1988 aerial photo will be evaluated.

Stage 2 – Visual Inspection and Radiation Survey

A visual inspection will be conducted over the three surface disturbances to identify any stained soil and anomalous surface areas. A FIDLER radiation survey will also be performed at the areas according to SOP FO.16. This survey will be conducted randomly over each surface disturbance. If areas of anomalous radiation readings are detected, the survey will be adjusted to pinpoint the radiation source. The results of the surveys will be plotted on a map and contoured, if appropriate. The radiation surveys will be conducted using a side-shielded FIDLER and a shielded G-M pancake-type detector. If appropriate, the Stage 3 field sampling program will be adjusted to investigate anomalies identified from the Stage 2 visual inspection and radiation survey.

Stage 3 – Soil, Surface Water, and Sediment Samples

A sediment sample and surface water sample (if present) will be collected from the deepest part of both pond-like depressions at IHSS 209 according to SOPs SW.1, SW.2, SW.3, and SW.6 (Figure 7-4).

A total of 18 boreholes will be drilled and sampled in the surface disturbance areas. In response to a regulatory agency comment that each disturbed area include both surface and subsurface sampling, a borehole will be drilled at the borehole locations and surface soil sampling locations identified on Figure 7-3 and 7-4. The surface soil sample will consist of a 0 to 6 inch composite from the borehole.

The borings will be drilled to a depth of 12 feet and will be drilled and sampled according to SOP GT.2. The borings will be logged according to SOP GT.1. Samples will be taken continuously. Except for the surface 0 to 6 inch sample, discrete samples will be collected from every 2-foot increment and analyzed for the TCL volatile organic compounds. The surface 0 to 6 inch sample as well as two 6-foot composites will be analyzed for the TCL semivolatile organic compounds, the TAL metals, and radionuclides.

TABLE 7-5
PHASE I INVESTIGATION
IHSS 209 - SURFACE DISTURBANCE SOUTHEAST OF BUILDING 881, THE SURFACE DISTURBANCE WEST OF IHSS 209
AND THE SURFACE DISTURBANCES SOUTH OF THE ASH PITS

Activity	Purpose	Location	Sample Number
1. Review Aerial Photographs	Evaluate nature and use of sites and nature of the ponds at IHSS 209	IHSS 209, surface disturbance west of IHSS 209 and surface disturbances south of the Ash Pits	NA
2. Visual Inspection	Identify stained soil areas	IHSS 209, surface disturbance west of IHSS 209 and surface disturbances south of the Ash Pits	NA
3. Radiation Survey	Locate areas of anomalous radiation readings	Random survey over area	NA
4. Sample Sediment and Surface Water	Characterize the two ponds on IHSS 209	From the center of the ponds at IHSS 209	2 each sediment and surface water
5. Soil Borings including 0-6" surface sample	Evaluate surface disturbances	IHSS 209 - 1 boring in each of the 3 former excavations; for the surface disturbance west of IHSS 209 1 boring in each of the five disturbed areas; for the disturbance south of Ash Pits 1 in the north-south; 2 in each of the parallel excavations, 4 in west fill area, and 1 in east fill area.	162

NA - Not Applicable

In addition, surface soil and subsurface samples from soil borings will be collected at any areas of anomalous radiation readings or stained areas identified from the visual inspection and radiation surveys of these disturbed areas.

During sampling a soil classification survey will be completed at the Surface Disturbances for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

7.2.4.1 Area South of OU 5 to the Property Boundary

Surface soils in the area south of the OU5 to the property boundary will be sampled for plutonium, americium, and uranium as part of OUs 1, 2, and 3 RFI/RI's.

The background and site-wide sampling programs for the RFP will provide coverage for the area south of OU5 to the property boundary. The background sampling includes sediment and surface water stations (Sed 18 and 19, and SW 80, 104, and 130) for the Antelope Springs area and on Smart Ditch at the western boundary of the Plant. The site-wide monitoring activities will include sediment and surface water sampling in Pond D-1 and surface water sampling near Indiana Avenue. The exact station locations have not been finalized. The background program and site-wide monitoring programs use the same sampling protocols and QA/QC procedures as the OU programs. Therefore, the data will be comparable.

If the work done for OUs 1-3, the background or site-wide sampling activities detect any contaminants at significant levels (as defined above by acceptable risk range when considering additivity, above background or above a potential ARAR) further investigation of this area will be covered under the OU5 investigation.

7.2.5 Ambient Air Monitoring Program

Three Hi-Vol air sampling devices will be installed near the Woman Creek drainage to monitor the air pathway from this Operable Unit (Figure 7-2). One will be located northwest of the Ash Pits (IHSS 133) and the Old Landfill (IHSS 115) to provide background data. The second air monitoring station will be placed between the Ash Pits and the Old Landfill, with the third southeast of the Old Landfill.

The data obtained from these stations, as well as the existing nearby air stations, will be used to evaluate the air emissions from this area. There are currently seven air monitoring stations (S-10, S-11, S-13, S-14, S-23, S-37, and S-38) near the Woman Creek drainage (Figure 7-2). The three proposed monitoring stations will be sampled in accordance with the Site-Wide Ambient Air Monitoring Program currently being conducted by EG&G at the Rocky Flats Plant. Briefly, the operation and sampling procedures are described below.

Air coming in contact with the Hi-Vol Ambient Air samples is forced through a filter material, trapping radioactive particulates and other airborne matter for subsequent analysis. Performance data from these RAAMP air samplers are collected by Environmental Monitoring and Assessment Technologists (EMAT) on a weekly basis, and air filters are replaced every 2 weeks. Once a month, the two filters collected from each air monitoring station are composited, and one sample from each air monitoring station is sent to Radiological Health Labs (Building 123) at the Plant for analysis. Detailed procedures describing the air sampler operations, filter exchange, filter preparation for analysis, RAAMP documentation, and reporting requirements are contained in SOP AP.13. These air samples will be analyzed according to the procedures outlined in the GRRASP. The samples will be analyzed for the same analytes as are analyzed in the site-wide program (which is currently plutonium). The analytical program for the site-wide Ambient Air Program is expected to be expanded in the near future to include other radionuclides, at which time the analytical program for the three proposed OU5 air stations will also be increased.

7.3 SAMPLE ANALYSIS

This section describes the sample handling procedures and analytical program for samples collected from the Phase I investigation. In this section, sample designations, analytical requirements, sample containers and preservation, and sample handling and documentation requirements will be discussed.

7.3.1 Sample Designations

All sample designations generated for this RFI/RI will conform to the input requirements of the Rocky Flats Environmental Database System (RFEDS). Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media sampled (e.g., "SB" for soil borings, "SS" for stream sediments), a unique five-digit number, and a two-letter suffix identifying the contractor (e.g., "WC" for Woodward-Clyde). One sample number will be required for each sample generated, including Quality Assurance (QA)/Quality Control (QC) samples. In this manner, 99,999 unique sample numbers are available for each contractor that contributes sample data to the database. A block of numbers will be reserved for the Phase I RFI/RI sampling of OU5. Boring numbers will be developed independently of the sample numbers from a boring. Specific sample location numbers are not assigned at this time, pending the results of the aerial photograph analysis and review of existing data.

7.3.2 Analytical Requirements

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

- Nitrate
- TAL metals
- Uranium 233/234, 235, and 238
- Transuranic elements (plutonium and americium)
- Cesium 137 and strontium 89/90
- Gross alpha and gross beta
- Tritium
- Total dissolved chromium (water only)
- Beryllium
- TCL volatile organics
- TCL semivolatile organics
- Total organic carbon (TOC)
- TCL pesticides/PCBs
- CO₃, HCO₃, Cl, SO₄, NO₃ (water only)

The specific analytes in the groups listed above and their detection/quantitation limits are contained in Table 7-6. Table 3-1 lists the analytical methods that will be used for each analyte. The specific Phase I analytical programs for each IHSS are contained in Table 7-7. Both filtered and unfiltered surface water and groundwater samples will be analyzed at each location.

The analytical program for each media at every IHSS is summarized in Table 7-7. The analytical program for each IHSS was developed in the IAG based on the type of waste suspected to be present at each site. The specific analytes and detection/quantitation limits are specified in the IAG by reference to CLP (Contract Laboratory Program) analyses. The General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G 1990f) provides a listing of CLP analytes and limits that will be used for this Phase I RFI/RI. These analytes and limits are presented in Table 7-6. The program shown in Table 7-7 should address the bulk of chemicals and compounds that were handled or are suspected to be present at OU5 and enable detection of soil, sediment, surface water, and groundwater contamination, if present.

Nitrates are included because low-level radioactive wastes with high nitrate concentrations may be present in Woman Creek or the SID. Metals were probably disposed of at OU5; however, details are not well known. Therefore, all of the TAL metals have been selected for Phase I analysis.

TABLE 7-6

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET ANALYTE LIST - METALS	DETECTION LIMITS*	
	Water ($\mu\text{g/l}$)	Soil/Sediment (mg/kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1.0
Cadmium	5	1.0
Calcium	5000	2000
Cesium	1000	200
Chromium	10	2.0
Cobalt	50	10
Copper	25	5.0
Cyanide	10	10
Iron	100	20
Lead	5	1.0
Lithium	100	20
Magnesium	5000	2000
Manganese	15	3.0
Mercury	0.2	0.2
Molybdenum	200	40
Nickel	40	8.0
Potassium	5000	2000
Selenium	5	1.0
Silver	10	2.0
Sodium	5000	2000
Strontium	200	40
Thallium	10	2.0
Tin	200	40
Vanadium	50	10.0
Zinc	20	4.0
TOTAL ORGANIC CARBON	1	1
TARGET COMPOUNDS LIST - VOLATILES	QUANTITATION LIMITS*	
	Water ($\mu\text{g/l}$)	Soil/Sediment ($\mu\text{g/kg}$)
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

TABLE 7-6
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUNDS LIST - VOLATILES (Continued)	QUANTITATION LIMITS*	
	Water ($\mu\text{g/l}$)	Soil/Sediment ($\mu\text{g/kg}$)
total 1,2-Dichloroethene	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinyl Acetate	10	10
Bromodichloromethane	5	5
1,1,2,2-Tetrachloroethane	5	5
1,2-Dichloropropane	5	5
trans-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
cis-1,3-Dichloropropene	5	5
Bromoform	5	5
2-Hexanone	10	10
4-Methyl-2-pentanone	10	10
Tetrachloroethene	5	5
Toluene	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Total Xylenes		

TARGET COMPOUNDS LIST - SEMIVOLATILES	QUANTITATION LIMITS*	
	Water ($\mu\text{g/l}$)	Soil/Sediment ($\mu\text{g/kg}$)
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-dipropylamine	10	330
Hexachloroethane	10	330

TABLE 7-6
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUND LIST - SEMIVOLATILES (Continued)	QUANTITATION LIMITS*	
	Water ($\mu\text{g/l}$)	Soil/Sediment ($\mu\text{g/kg}$)
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-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethylphthalate	10	330
Acenaphthylene	10	330
2,6-Dinitrotoluene	10	330
3-Nitroaniline	50	1600
Acenaphthene	10	330
2,4-Dinitrophenol	50	1600
4-Nitrophenol	50	1600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenyl Phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600
N-nitrosodiphenylamine	10	330
4-Bromophenyl Phenylether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	50	1600
Phenanthrene	10	330
Anthracene	10	330
Di-n-butylphthalate	10	330
Fluoranthene	10	330
Pyrene	10	330
Butylbenzylphthalate	10	330

TABLE 7-6
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUND LIST - SEMIVOLATILES (Continued)	Water ($\mu\text{g/l}$)	Soil/Sediment ($\mu\text{g/kg}$)
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	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

TARGET COMPOUND LIST - PESTICIDES/PCBS

QUANTITATION LIMITS*

	Water $\mu\text{g/l}$	Soil/Sediment $\mu\text{g/kg}$
alpha-BHC	0.05	8.0
beta-BHC	0.05	8.0
delta-BHC	0.05	8.0
gamma-BHC (Lindane)	0.05	8.0
Heptachlor	0.05	8.0
Aldrin	0.05	8.0
Heptachlor epoxide	0.05	8.0
Endosulfan I	0.05	8.0
Dieldrin	0.10	16.0
4,4'-DDD	0.10	16.0
Endrin	0.10	16.0
Endosulfan II	0.10	16.0
4,4'-DDD	0.10	16.0
Endosulfan sulfate	0.10	16.0
4,4'-DDT	0.10	16.0
Methoxychlor	0.5	80.0
Endrin ketone	0.10	16.0
alpha-Chlordane	0.5	80.0
gamma-Chlordane	0.5	80.0
Toxaphene	1.0	160.0
Aroclor-1016	0.5	80.0
Aroclor-1221	0.5	80.0
Aroclor-1232	0.5	80.0
Aroclor-1242	0.5	80.0
Aroclor-1248	0.5	80.0
Aroclor-1254	1.0	160.0
Aroclor-1260	1.0	160.0

TABLE 7-6
(Concluded)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

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

<u>Parameters Exclusively for Groundwater Samples</u>	DETECTION LIMITS*
	<u>Water (mg/l)</u>
ANIONS	
Carbonate	10
Bicarbonate	10
Chloride	5
Sulfate	5
Nitrate as N	5
FIELD PARAMETERS	
pH	0.1 pH unit
Specific Conductance	1
Temperature	
Dissolved Oxygen	0.5
Barometric Pressure	
INDICATORS	
Total Dissolved Solids	5

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

TABLE 7-7
PHASE I ANALYTICAL PROGRAM

IHSS	Location	Media	Total		Nitrate	Gross α	Gross β	U 233/234	U 235	U 238	Pu 239/240	Am 241	Cs 137	Sr 89/90
			U	Cr										
115	Borings to confirm soil gas	Soil				X	X							
	Borings transecting plumes grabs from 2' intervals 6' composites	Soil						X	X	X	X	X	X	X
		Soil									X	X		
	Wells downgradient of unit	Water	X		X	X					X	X		
	Effluent from pipes	Water			X	X					X	X		
	Sediments in SID and Woman Creek	Seds.	X		X	X					X	X		
		Water	X		X	X					X	X		
	Water in SID and Woman Creek	Water	X		X	X					X	X		
	4 randomly selected surface soil samples	Soil	X		X	X					X	X		
	Surface Soil "hot spots"	Soil	X		X	X					X	X		X
133	Borings on 25' centers	Soil	X		X	X				X	X		X	
	4 randomly collected surface samples	Soil	X		X	X				X	X		X	
	Surface soil "hot spots"	Soil	X		X	X				X	X		X	
	Sediment samples downstream of ash pits	Seds.			X	X					X	X		
	Wells downgradient of unit	Water	X		X	X					X	X		X
142	Sediment samples in Woman Creek, SID and ponds	Seds.			X	X					X	X		X
	Water samples from ponds	Water	X		X	X				X	X		X	X
	Wells downgradient of C-1 and C-2	Water	X		X	X				X	X		X	X
	Sediment in former ponds	Seds.	X		X	X					X	X		X
209	Water in former ponds	Water	X		X	X				X	X		X	X
	Soil in small depressions	Soil	X		X	X				X	X		X	X
	Borings in area 0-6" 2' intervals 6' composites	Soil	X		X	X				X	X		X	X
		Soil	X		X	X				X	X		X	X
	Surface Soils	Soil	X		X	X				X	X		X	X

Uranium is likely to have been a constituent of the wastes at OU5. The isotopes U-233, U-234, U-235, and U-238 have been selected for analysis in Phase I. Plutonium is the only transuranic element that is used on the site. However, americium is a daughter product of plutonium and is found at the Rocky Flats Plant. Therefore, plutonium and americium have also been selected as Phase I radionuclide parameters. Gross alpha and gross beta are included as screening parameters because they are useful indicators of radionuclides. Tritium, strontium, and cesium are also included in the analytical program.

Volatile and semivolatile organics may have been handled at OU5 in small quantities probably only at the Original Landfill. The specific compounds used are unknown; therefore, all of the TCL volatile and semivolatile organics will be included in the Phase I analyses for some samples.

TCL pesticides/PCBs and TOC have been included for some samples to provide data for the environmental evaluation. For the sediment samples collected from Woman Creek and the SID, TCL pesticides will be analyzed in the samples collected from the detention ponds and at the location just downgradient from the Original Landfill. The other sediment samples collected from Woman Creek and the SID will not be analyzed for TCL pesticides as no pesticides have been detected to date from the extensive sampling already performed (see Section 2.0). In addition, the two proposed sediment sampling locations just downstream of the Ash Pit will not be analyzed for TCL volatiles and semi-volatiles since incineration would probably have destroyed these organics.

The analytical parameters for the soil gas survey at IHSS 115 are 1,1,1-trichloroethane (TCA), dichloromethane, benzene, carbon tetrachloride, tetrachloroethene (PCE), and trichloroethene (TCE). Detection limits proposed for these parameters during the soil gas survey are listed in Table 7-8.

7.3.3 Sample Containers and Preservation

Sample volume requirements, preservation techniques, holding times, and container material requirements are dictated by the media being sampled and by the analyses to be performed. The soil matrices to be analyzed will include soils and sediments. The water matrices for analysis will include surface water and groundwater. Tables 7-9 and 7-10 list analytical parameters of interest in OU5 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 SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.

**TABLE 7-8
PHASE I INVESTIGATION
SOIL GAS PARAMETERS AND
PROPOSED DETECTION LIMITS**

IHSS-115 Original Landfill

Volatiles	Detection Limit
1,1,1 TCA	1 $\mu\text{g}/\ell$
Dichloromethane	1 $\mu\text{g}/\ell$
Benzene	1 $\mu\text{g}/\ell$
Carbon Tetrachloride	1 $\mu\text{g}/\ell$
PCE	1 $\mu\text{g}/\ell$
TCE	1 $\mu\text{g}/\ell$

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

TABLE 7-9

**SAMPLE CONTAINERS, SAMPLE PRESERVATION,
AND SAMPLE HOLDING TIMES FOR WATER SAMPLES**

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

^a Add 0.008% sodium thiosulfate (Na₂S₂O₃) in the presence of residual chlorine

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

^c Holding time for mercury is 28 days.

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

TABLE 7-10

**SAMPLE CONTAINERS, SAMPLE PRESERVATION,
AND SAMPLE HOLDING TIMES FOR SOIL SAMPLES**

Parameter	Container	Preservative	Holding Time
<u>Soil or Sediment Samples - Low to Medium Concentration</u>			
Organic Compounds:			
Purgeable Organics (VOCs)	1 x 4-oz wide-mouth teflon-lined glass vials	Cool, 4°C	14 days
Extractable Organics (BNAs), Pesticides and PCBs	1 x 8-oz wide-mouth teflon-lined glass vials	Cool, 4°C	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 8-oz wide-mouth glass jar	Cool, 4°C	180 days ¹
Cyanide	1 x 8-oz wide-mouth glass jar	Cool, 4°C	14 days
Sulfide	1 x 8-oz wide-mouth glass jar	Cool, 4°C	28 days
Nitrate	1 x 8-oz wide-mouth glass jar	Cool, 4°C	48 hours
Radionuclides	1 x 1-l wide-mouth glass jar	None	45 days

¹Holding time for mercury is 28 days.

7.3.4 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance defining the necessary sample control, identification, and chain-of-custody documentation is discussed in SOP FO.14.

7.3.5 Data Reporting Requirements

Field data will be input into the RFEDS environmental database using a remote data entry module supplied by EG&G. Data will be entered on a timely basis and a 3.5-inch diskette will be delivered to EG&G. A hard copy report will be generated from the module for contractor use. The data will be put through a prescribed QC process based on Standard Operating Procedure SOP FO.14 to be generated by EG&G.

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 the timely reporting of the information. This data will also be delivered to EG&G on 3.5-inch diskettes.

Computer hardware and software requirements for contractors using government supplied equipment will be supplied by EG&G. Computer and data security will also follow acceptable procedures outlined by EG&G.

7.4 FIELD QC PROCEDURES

Sample duplicates, field preservation blanks, and equipment rinsate blanks will be prepared. Trip blanks will be obtained from the laboratory. The analytical results obtained for these samples will be used by the Environmental Restoration (ER) Project Manager to assess the quality of the field sampling effort. The types of field QC samples to be collected and their application are discussed below. The frequency for QC samples to be collected and analyzed is provided in Table 7-11.

Duplicate samples will be collected by the sampling team and will be used 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, the same equipment, and in the same types of containers as required for the samples. They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field preservation blanks of distilled water, preserved according to the preservation requirements (subsection 7.3.3), will be prepared by the sampling team and will be used to provide an indication of any contamination

TABLE 7-11
FIELD QC SAMPLE FREQUENCY

Sample Type	Type of Analysis	Media	
		Solids	Liquids
Duplicates	Organics	1/10	1/10
	Inorganics	1/10	1/10
	Radionuclides	1/10	1/10
Field Preservation Blanks	Organics	NA	NA
	Inorganics	NA	1/20
	Radionuclides	NA	1/20
Equipment Rinsate Blanks	Organics	1/20	1/20
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Trip Blanks	Organics (Volatiles)	NR	1/20
	Inorganics	NR	NR
	Radionuclides	NR	NR

NA = Not Applicable
NR = Not Required

a final decontamination rinse to evaluate the success of the field sampling team's decontamination efforts on nondedicated 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 container. Equipment rinsate blanks are applicable to all analyses for water and soil samples as indicated in Table 7-11.

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

Procedures for monitoring field QC are given in the site-wide Quality Assurance Project Plan (QAPjP).

ADDITIONAL REFERENCES

-
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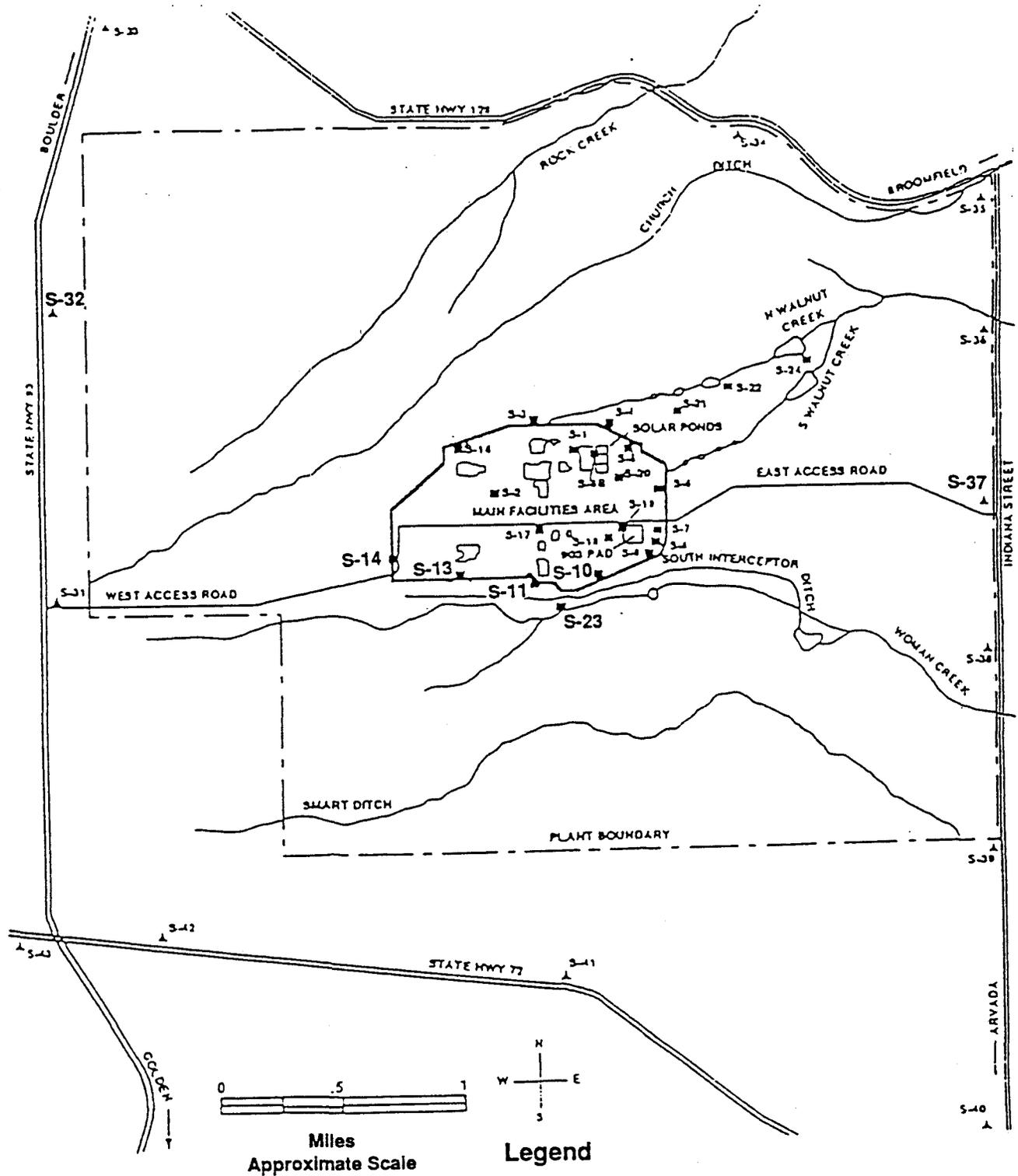
ATTACHMENT 1
HISTORICAL AIR QUALITY DATA FOR OU5

RAAMP Data for OU-5

OU-5 PLUTONIUM 239 CONCENTRATIONS PRESENTED IN pCi/m ³									
1990									
	Station-10	Station-11	Station-13	Station-14	Station-23	Station-32	Station-37		
JANUARY	0.00002	0.00006	0.00003	0.00001	0.00001	0.00000	0.00003		
FEBRUARY	0.00007	0.00005	0.00001	0.00002	0.00003	0.00001	0.00002		
MARCH	0.00016	0.00008	0.00004	0.00003	0.00005	0.00001	0.00002		
APRIL	0.00004	0.00004	0.00005	0.00001	0.00002	0.00002	0.00002		
MAY	0.00005	0.00006	0.00008	0.00001	0.00003	0.00002	0.00007		
JUNE	0.00008	0.00004	0.00002	0.00002	0.00003	0.00002	0.00004		
JULY	0.00007	0.00007	0.00008	0.00002	0.00003	0.00000	0.00002		
AUGUST	0.00005	0.00007	0.00002	0.00003	0.00005	0.00000	0.00000		
SEPTEMBER	0.00005	0.00007	0.00002	0.00002	0.00006	0.00003	0.00001		
OCTOBER	0.00003	0.00001	0.00001	0.00004	0.00001	0.00002	0.00002		
NOVEMBER	0.00004	0.00003	0.00007	0.00006	0.00002	0.00002	0.00005		
DECEMBER	0.00002	0.00000	0.00001	0.00000	0.00003	0.00001	0.00003		
Annual Ave.	0.00006	0.00005	0.00004	0.00002	0.00003	0.00001	0.00003		
Max. Value	0.00016	0.00008	0.00008	0.00006	0.00006	0.00003	0.00007		

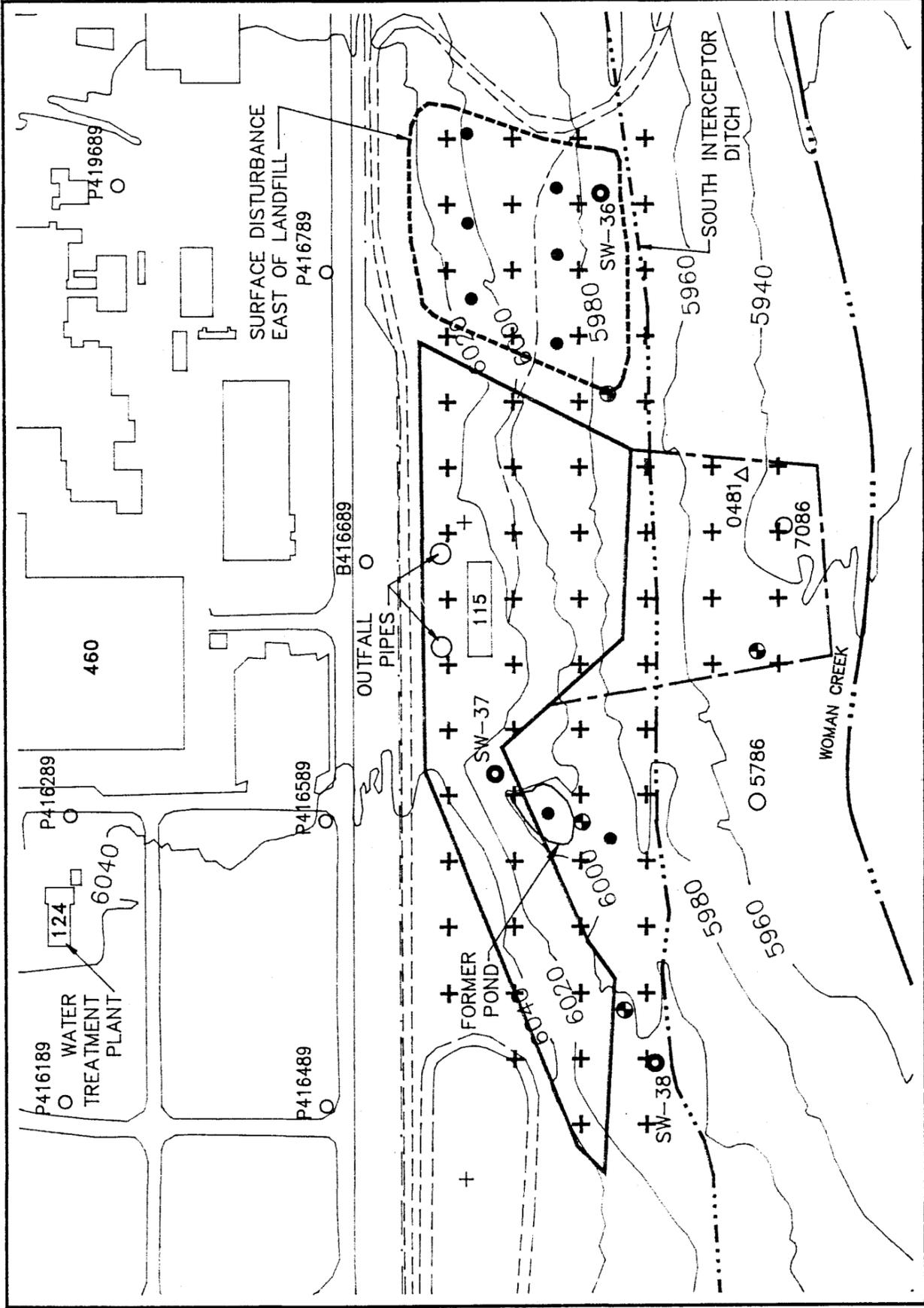
Prior to January 1990 the biweekly filters from most onsite samplers (including the ones designated for OU-5 support) were analyzed for total long-lived alpha activity only. If results exceeded the Rocky Flats Plant (RFP) guideline of 10×10^{-15} $\mu\text{Ci}/\text{ml}$, specific plutonium analysis was performed. Data collected at ambient stations 10, 11, 13, 14, 23, 32, and 37 during 1986 through 1989 did not exceed this screening value, therefore; no plutonium specific analysis for performed.

**FIGURE AP.13-3
ONSITE AND PERIMETER SAMPLER LOCATIONS**



Note: all samplers analyzed for Pu

- Onsite Air Samplers
- ▲ Perimeter Air Samplers within 2 to 4 miles of RFP



EXPLANATION

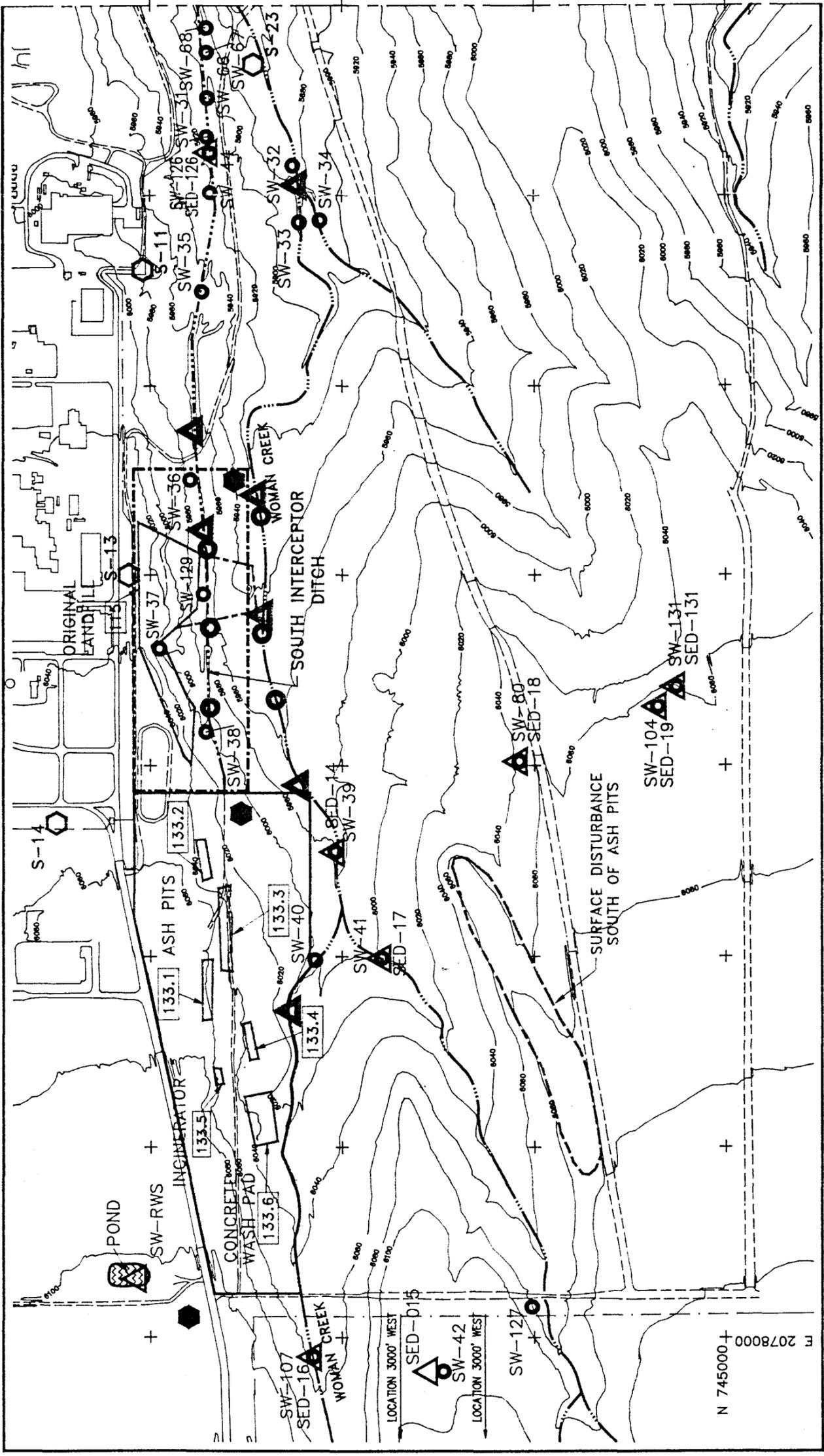
- 115 INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SW-1 ● EXISTING SURFACE WATER SAMPLING LOCATION
- 5786 ○ EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
- 0481 △ PRE-1986 MONITORING WELL
- · · · — INTERMITTENT STREAM
- — — — — DIRT ROAD
- 124 ROCKY FLATS BLDG. NO.
- - - - - PRELIMINARY EXTENSION OF THE LANDFILL BASED ON A SITE RECONNAISSANCE
- PROPOSED WELL LOCATION*
- PROPOSED SOIL BORING LOCATION*
- + PROPOSED SOIL GAS SAMPLES*
- *ALL PROPOSED LOCATIONS ARE APPROXIMATE

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

OPERABLE UNIT 5
 PHASE I RF/RI WORK PLAN

PROPOSED SAMPLING AND
 WELL LOCATIONS
 IHSS 115
 ORIGINAL LANDFILL

FIGURE 7-1



MATCHLINE
(SEE FIGURE 7-2 [2 OF 2])



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

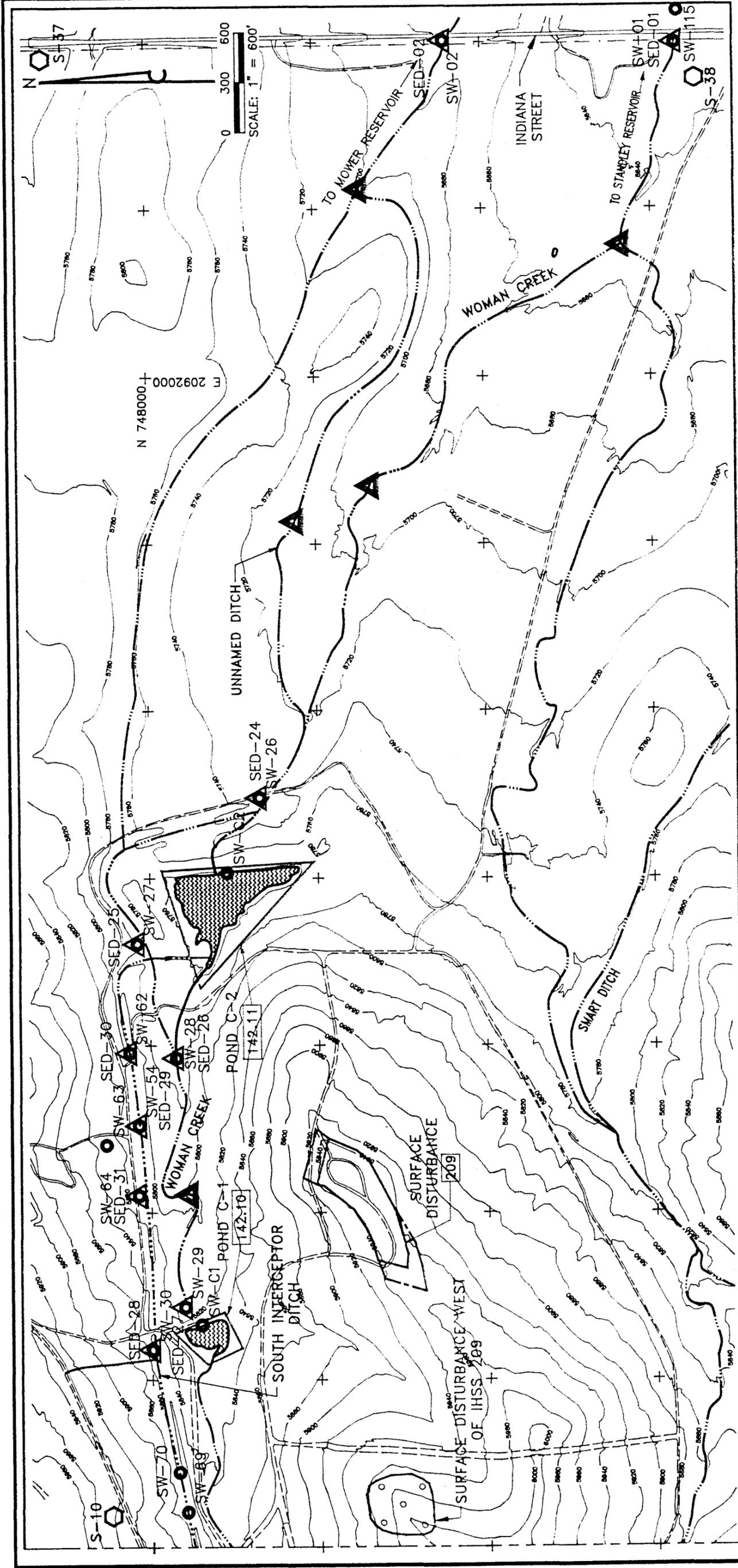
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

**SEDIMENT & SURFACE WATER
SAMPLING SITES & AIR MONITORING
STATIONS ALONG WOMAN CREEK AND
THE SOUTH INTERCEPTOR DITCH**

REV. AUGUST 1991
MARCH 1991

EXPLANATION	
[115]	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER LOCATION
SED-1	EXISTING SEDIMENT SAMPLING LOCATION
---	INTERMITTENT STREAM
---	DIRT ROAD
---	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
S-23	EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION
▲	PROPOSED SEDIMENT SAMPLE LOCATION
●	PROPOSED RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION
○	PROPOSED SURFACE WATER LOCATION
---	PROPOSED GERMANIUM SURVEY FOR ASH PIT AREA
---	1990 GERMANIUM SURVEY BOUNDARY AROUND OLD LANDFILL

R33M054.120291/600



U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado
 OPERABLE UNIT 5
 PHASE 1 RFI/RI WORK PLAN
 SEDIMENT & SURFACE WATER
 SAMPLING SITES & AIR MONITORING
 STATIONS ALONG WOMAN CREEK AND
 THE SOUTH INTERCEPTOR DITCH

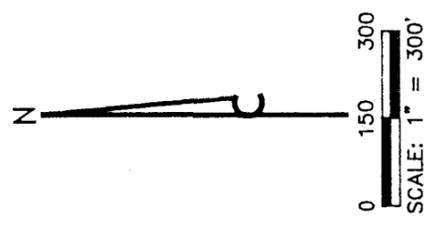
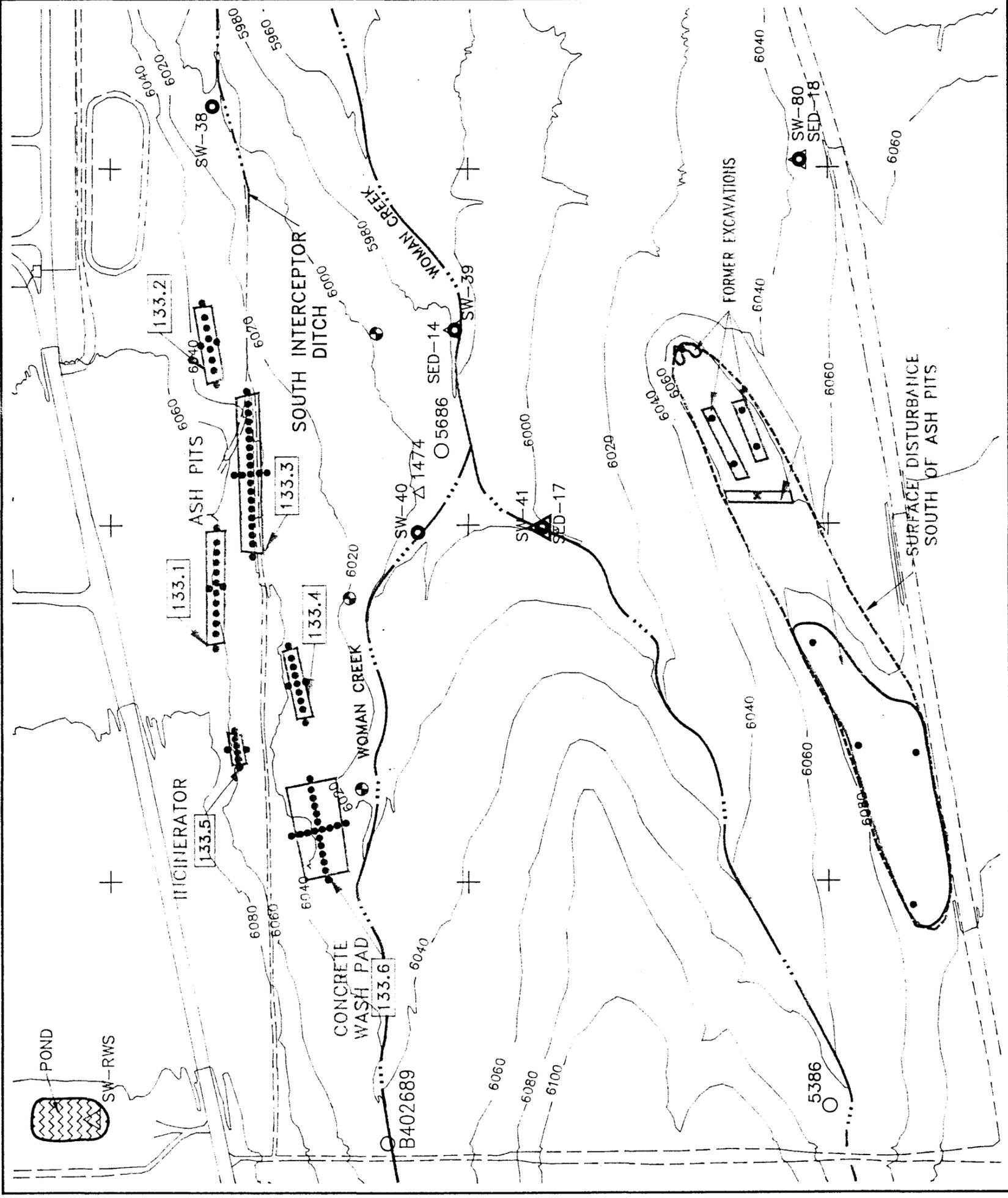
EXPLANATION

[115]	INDIVIDUAL HAZARDOUS SUBSTANCE SITE	S-23	EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION
SW-1	EXISTING SURFACE WATER LOCATION	▲	PROPOSED SEDIMENT SAMPLE LOCATION
SED-1	EXISTING SEDIMENT SAMPLING LOCATION	—	INTERMITTENT STREAM
—	DIRT ROAD	- - -	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
—	ORIGINAL STREAM CHANNEL NEAR POND C-2		

— MATCHLINE
 (SEE FIGURE 7-2 [1 OF 2])

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 FIGURE 7-2 (2 OF 2)

R33M055.120391/200



EXPLANATION

- 115 INDIVIDUAL HAZARDOUS SUBSTANCE SITE
 - SW-1 ● EXISTING SURFACE WATER SAMPLING LOCATION
 - 5786 ○ EXISTING ALLUVAL GROUNDWATER MONITORING WELL
 - SED-17 △ EXISTING SEDIMENT SAMPLING LOCATION
 - 1474 △ PRE-1986 MONITORING WELL
 - PROPOSED SOIL BORING LOCATION 1
 - ⊙ PROPOSED WELL LOCATION
 - ⊗ PROPOSED SURFACE SAMPLING LOCATION
 - · · · · · INTERMITTENT STREAM
 - - - - - DIRT ROAD
- *ALL PROPOSED LOCATIONS ARE APPROXIMATE

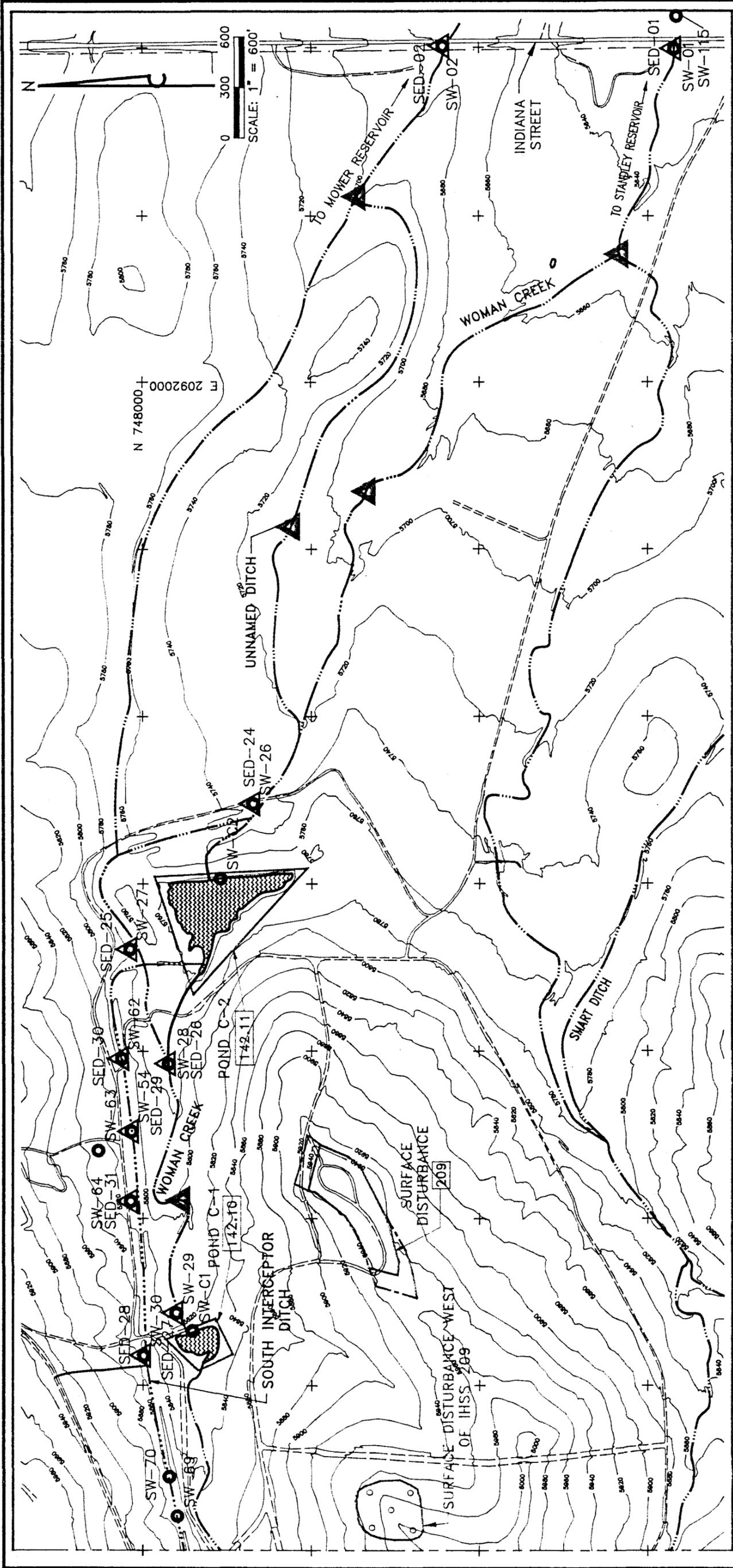
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PROPOSED SAMPLING & WELL LOCATIONS,
ASH PITS 1-4, INCINERATOR,
CONCRETE WASH PAD (IHSS 133.1-6),
AND ADDITIONAL SURFACE DISTURBANCE

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FIGURE 7-3



MATCHLINE
(SEE FIGURE 7-5 [1 OF 2])

EXPLANATION	
[115]	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER LOCATION
SED-1	EXISTING SEDIMENT SAMPLING LOCATION
---	INTERMITTENT STREAM
---	DIRT ROAD
---	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON RECONNAISSANCE
---	ORIGINAL STREAM CHANNEL NEAR POND C-2
▲	PROPOSED SEDIMENT SAMPLE LOCATION

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OPERABLE UNIT 5
PHASE 1 RFI/RI WORK PLAN
SEDIMENT SAMPLING SITES AND
IHSS IMPACT AREAS ALONG THE
SOUTH INTERCEPTOR DITCH
AND NEARBY TRIBUTARIES

REV. AUGUST 1991
MARCH 1991
FIGURE 7-5 (2 OF 2)