

Science Applications International Corporation

008886

**CHARACTERIZATION PLAN
FOR
CERCLA INACTIVE DISPOSAL SITES**

August 26, 1987

Submitted to:

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Richland, Washington 99352**

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1.0 OVERVIEW

1.1. Introduction

This report presents the characterization plan developed in accordance with the methodology identified in the Task 3 Report. This report synthesizes information from a wide variety of sources to identify the current knowledge about each of the sites; and presents an evaluation of available data applicability to the site characterization process.

A primary objective of this task is the identification of where it might be possible to combine or aggregate sites to improve the cost effectiveness of the site characterization process. The information contained in this report will form the basis for the development of cost data in Task 6.

1.2 General Description of the Hanford Reservation

The semiarid Hanford Site, operated by Westinghouse Hanford Company for the DOE, occupies about 1,476 square kilometers (570 sq mi) of the southeastern part of Washington State north of where the Yakima River flows into the Columbia (see Figure 2.1). The Site lies about 320 kilometers (200 mi) east of Portland, Oregon, 270 kilometers (170 mi) southeast of Seattle, Washington, and 200 kilometers (125 mi) southwest of Spokane, Washington.

Established in 1943, the Hanford Site was originally designed, built, and operated to produce plutonium for nuclear weapons using production reactors and chemical reprocessing plants. Since then, waste management, energy research and development, isotope use, and other activities have been added to Hanford operations.

1.2.1 Historical and Current Operations at the Site

In 1943, after the Fermi experiment at the University of Chicago showed that nuclear fission could be controlled in a small reactor, the U.S. Army Corps of Engineers selected Hanford as one of the location to build larger versions of the Fermi reactor to produce plutonium for possible use in

military weapons. Construction started in 1943 on three reactor facilities and three chemical processing facilities. The first of the reactors went into operation about 18 months after the start of construction, and the first plutonium was available some 4 months later.

After World War II, five reactors similar to those built during the war were constructed. A total of eight graphite-moderated reactors used the Columbia River for once-through cooling (i.e., water circulated through the reactors only once before being released back to the river).

Early in the 1950s construction began on the research and development facilities known as the Hanford Laboratories. This marked the first diversification of Hanford from a purely defense-materials production facility to one heavily involved in peacetime uses of the atom.

In 1963 the N Reactor was built. The N Reactor is different from the other eight reactors in that it generates steam as a by-product of the plutonium production and does not use river water as a once-through coolant. Since 1966 the Washington Public Power Supply System has used the steam to generate electricity.

A presidential decision was made in early 1964 to begin shutting down the older Hanford reactors. This decision resulted in the closing down of all eight of the older reactors by the end of 1971, leaving the N Reactor as the only operational production reactor.

Historical practices and operational changes of particular interest to this study are as follows:

- o shutdown of the last of eight once-through cooled production reactors (adjacent to the Columbia River) in 1971
- o substitution of a bismuth phosphate precipitation process with solvent extraction chemical reprocessing in 1956 (and associated replacement of bismuth phosphate first- and second-cycle wastes with solvent wastes)

- o segregation of transuranic solid waste, stored for later shipment off site, beginning in 1970 by DOE Order
- o termination of routine liquid discharges containing transuranics to the soil column in 1973
- o consolidation of all radioactive solid-waste disposals in all Hanford areas to the 200 Areas and of all nonradioactive trash/chemicals to the Central Landfill (an area near the center of the site) in 1973.

As a result of these process changes and new DOE requirements, the sites of most interest to this study are those established early in the history of Hanford's waste-management operations. Current disposal practices at Hanford have not resulted in measurable public health impacts (Price et al. 1984, 1985; Price 1986; Cline et al. 1985).

1.2.2 General Description of Inactive Waste Disposal Sites

Discussions of site characteristics, waste inventories and sites selected for Phase II characterization are contained in Subsections 1.2.2.1, 1.2.2.2 and 1.2.2.3, respectively.

1.2.2.1 Site Characteristics

The operations at the Hanford Site have produced various low-level radioactive and chemical solid and liquid wastes. Most of the wastes have been stored on-site or disposed of on-site in the soil column. A total of 337 inactive waste disposal sites have been identified at the Hanford Site.

Twenty-one of the inactive sites (6%) were used to dispose of nonradioactive wastes only. Thirty-three more (10%) received predominantly water and radionuclides (100-Area reactor coolant and ruptured fuel effluents). The remainder of the Hanford waste-disposal sites (84%) contain a mixture of radionuclides and chemicals. Approximately three-quarters of Hanford's disposal sites were used to dispose of liquids.

The sites occupy surface areas ranging from 0.02 square meters (0.2 sq ft) to more than 15 hectares (37 acres) and were in service for periods ranging from a few days to 32 years. In total, the inactive waste-disposal sites occupy 1,416 hectares (3,500 acres), approximately 1% of Hanford's total area. The average depth to ground water from the surface of inactive waste-disposal sites varied from about 13 meters (43 ft) in the 300 Areas to 73 meters (240 ft) in the 200 Areas.

The Hanford Site is divided into 14 major operational areas. The nine 100 Operational Areas each contain one production reactor facility of which only one remains in operation. The nine 100 Operational Areas (Reactor) are all located along the Columbia River in the northern part of the Hanford Reservation. The two 200 Operational Areas contain reactor fuel processing, plutonium separation, and waste management facilities. Both 200 (Waste Management) Operational Areas are located near the center of the Hanford Reservation on the Central Plateau approximately 7 miles from the Columbia River. The 300 (Fuel Manufacturing) Operational Area contains reactor fuel manufacturing facilities. It is located along the Columbia River approximately 1 mile north of the Richland city limits. The 400 Operational Area contains an experimental reactor and associated support facilities. It is located in the southeast section of the Hanford Reservation approximately 4.5 miles from the Columbia River. The 600 Operational Area consist of the rest of the Hanford Reservation that is not located in the other operational areas. Figure 1-1 shows the general locations of the operational areas within the Hanford Reservation. More detailed maps of the 100, 200 and 300 areas are presented in Figures 1-2 through 1-10.

Approximately 67% of the inactive waste disposal sites are located within or just outside of the 200 Operational Areas (East and West). Approximately 25% of the inactive sites are located within or just outside of the nine 100 Operational Areas (B, C, D, DR, KE, KW, F, H and N). The remaining 8% of the sites are located in the remaining operational areas (3090, 400 and 600).

Radioactive and nonradioactive wastes are stored or disposed of in a variety of disposal structures. The most prevalent systems, by area serviced, include burial grounds (100 and 600 Areas), cribs (200 Areas), and liquid-waste trenches (300 Area).

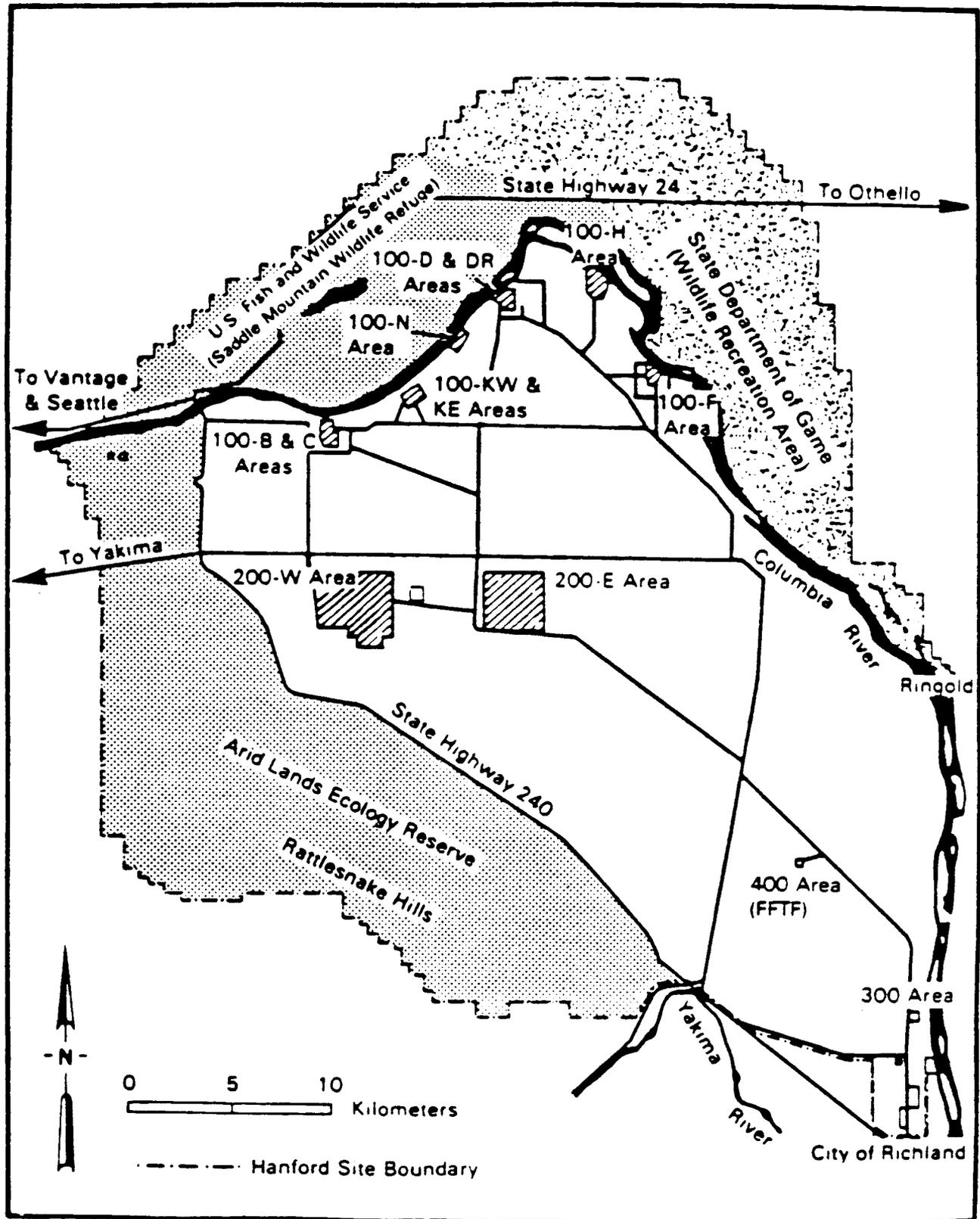
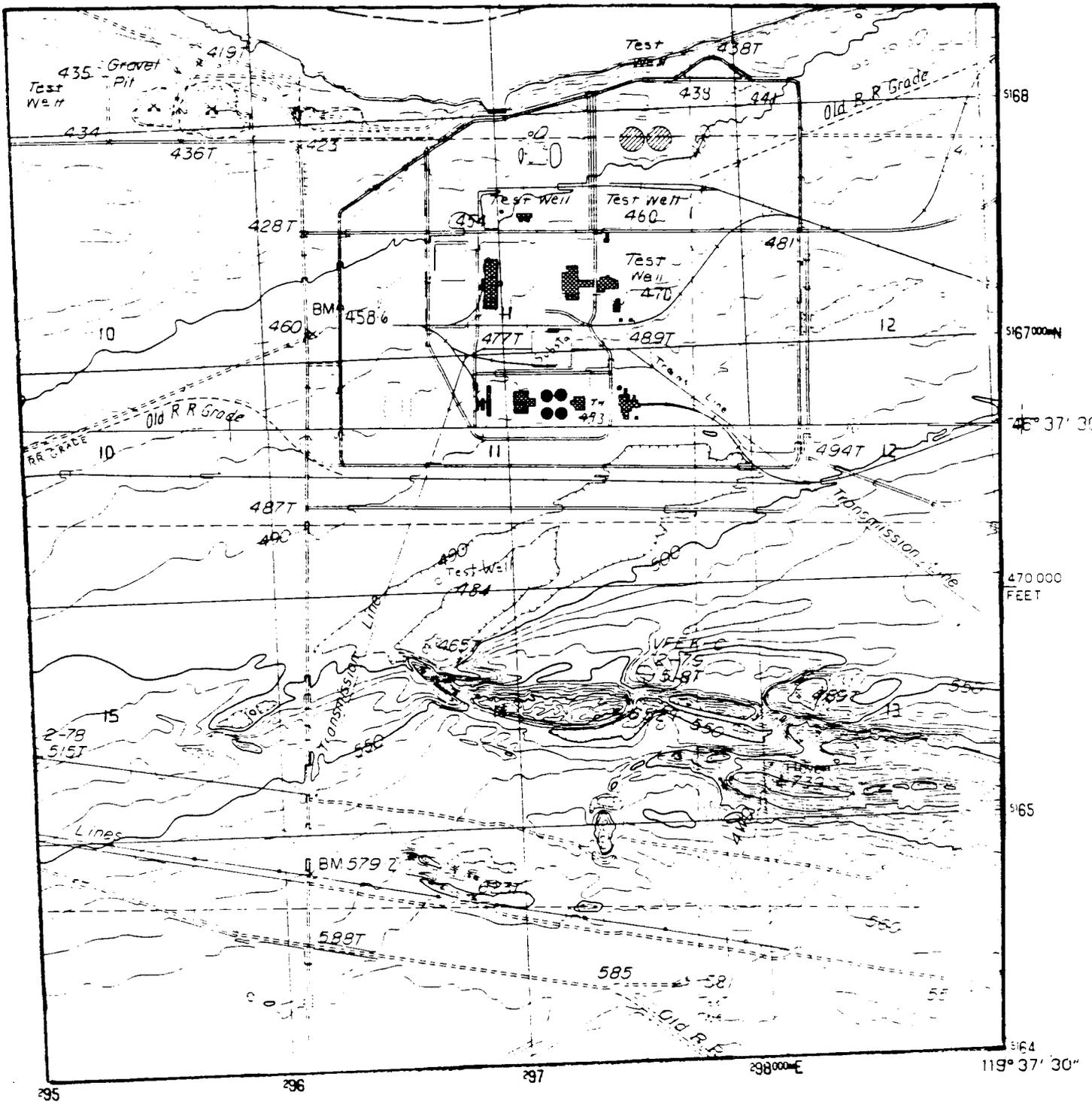
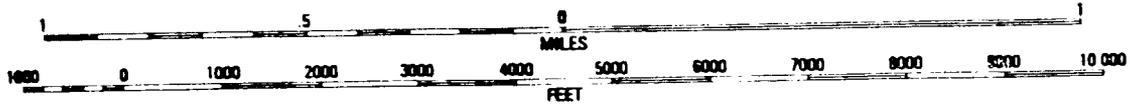


FIGURE 1-1. FEATURES OF THE HANFORD SITE.

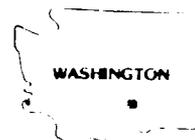


SCALE 1:24 000

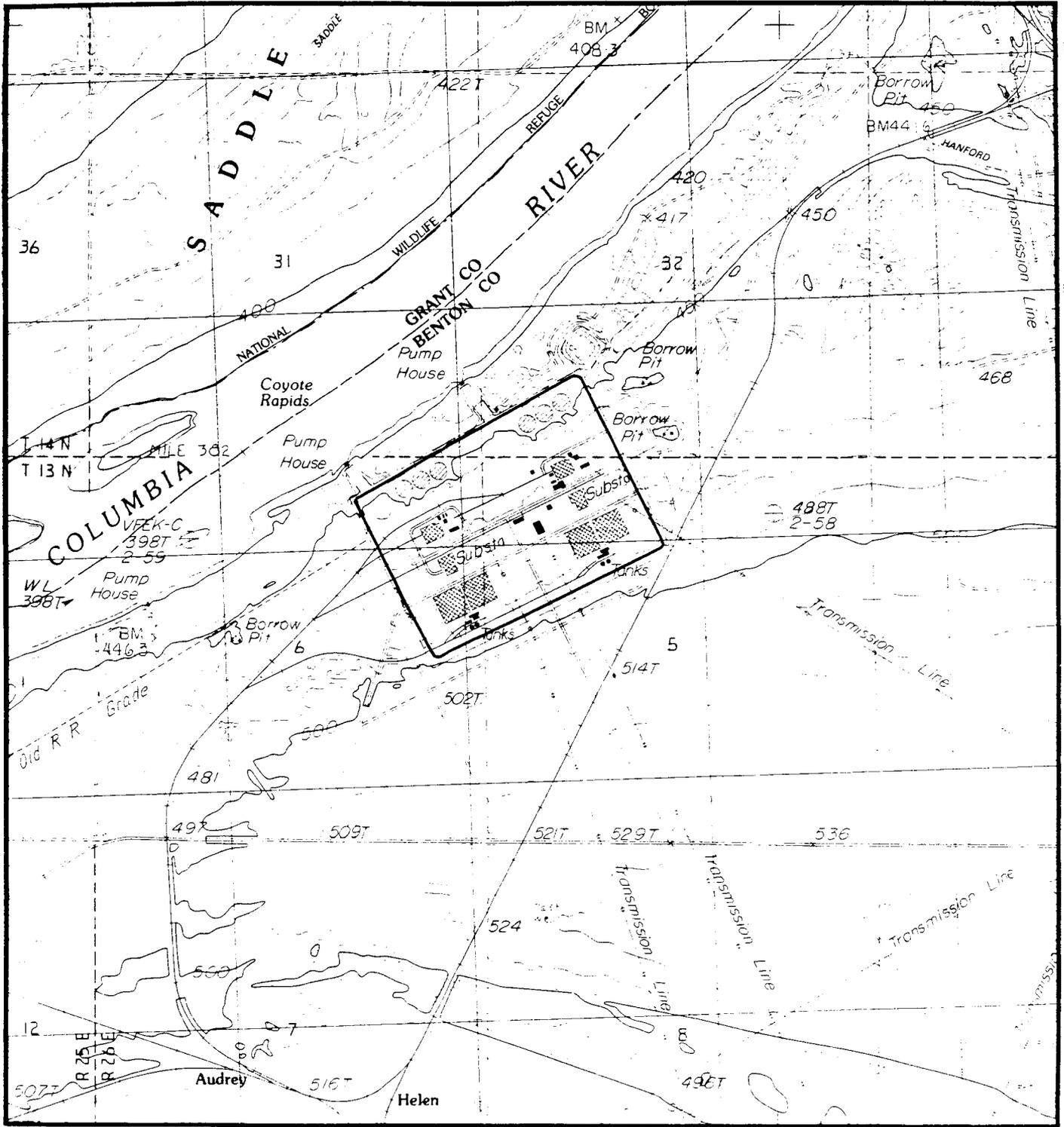


ROAD LEGEND

- Improved Road
- Unimproved Road
- Trail
- Interstate Route (Shield symbol)
- U.S. Route (Shield symbol)
- State Route (Circle symbol)



SOURCE: USGS, 1986
Vernita Bridge, WA
46119-F6-TF-1024



SCALE 1:24 000



ROAD LEGEND

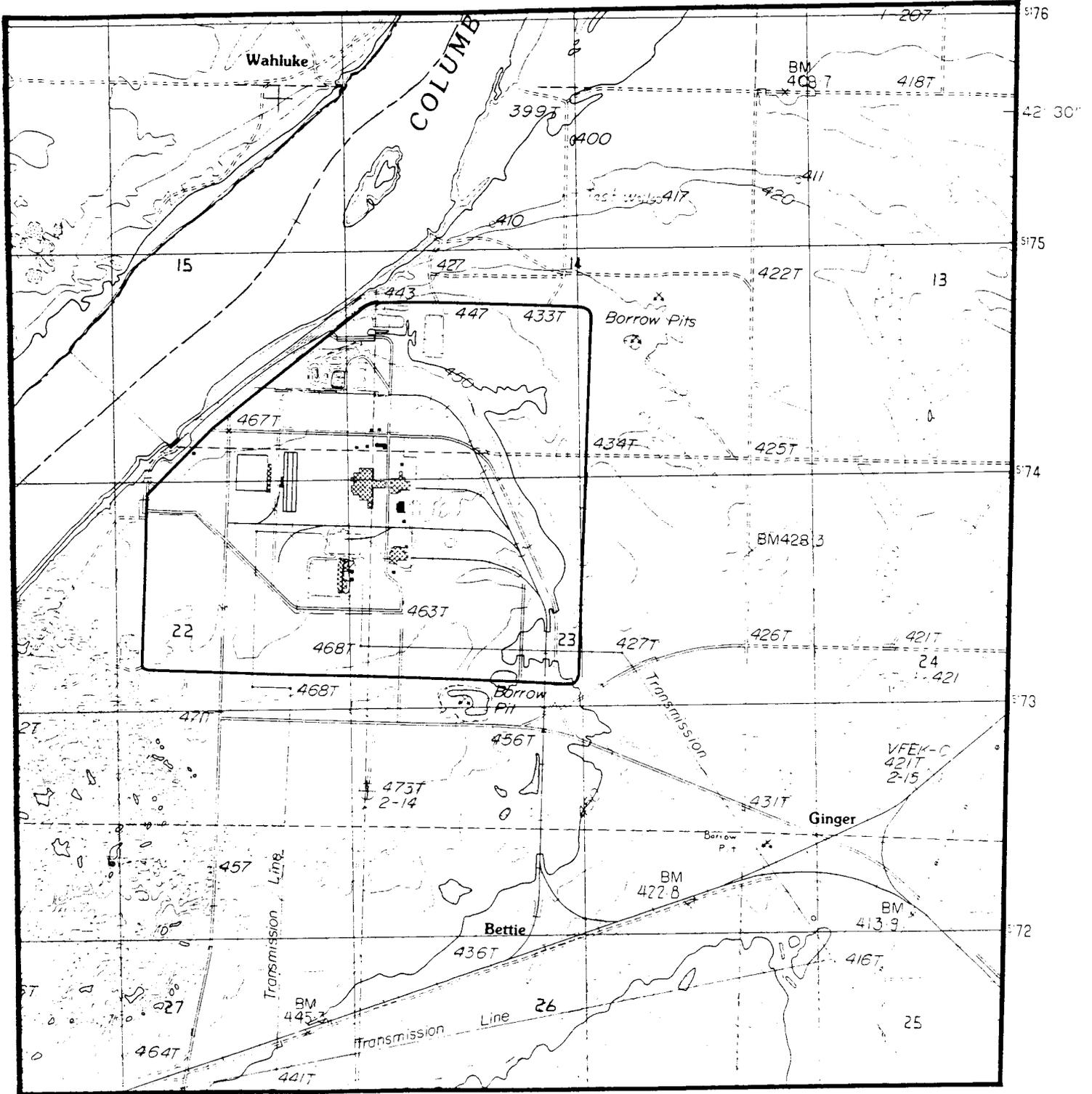
- Improved Road.....
- Unimproved Road.....
- Trail.....
- Interstate Route U.S. Route State Route

CONTOUR INTERVAL 10 FEET

WASHINGTON

SOURCE: USGS, 1986
 Coyote Rapids, WA
 46119-F5-TF-024
 Provisional Edition
 1986

FIGURE 1-3. 100 KE/KW AREA



SCALE 1:24 000



ROAD LEGEND

- Improved Road.....
- Unimproved Road.....
- Trail.....
- Interstate Route □ U.S. Route ○ State Route

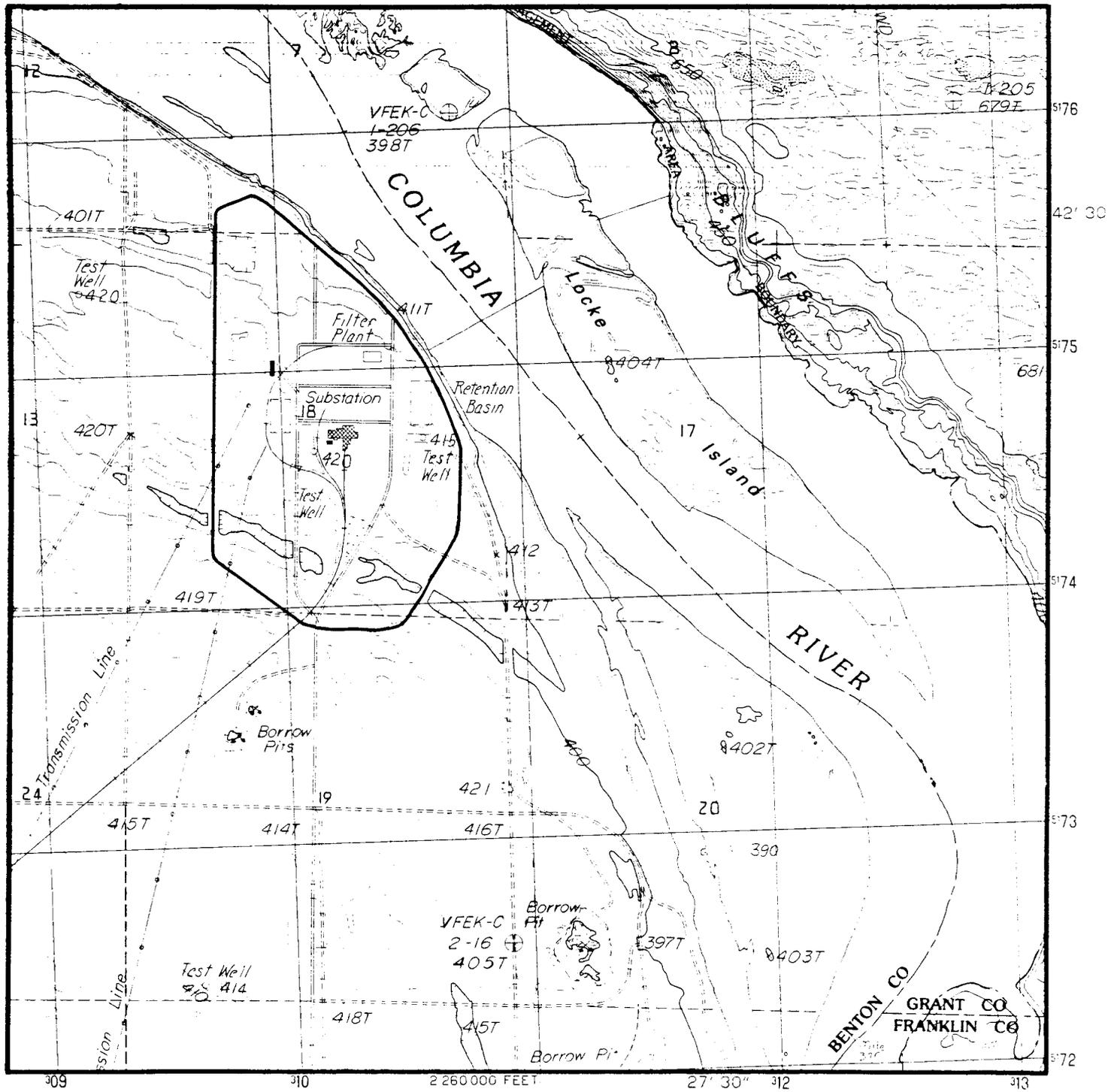
CONTOUR INTERVAL 10 FEET

1-9



SOURCE: USGS, 1986
Coyote Rapids, WA
46119-F5-TF-024

FIGURE 1-5. 100 D/DR AREA



SCALE 1:24 000



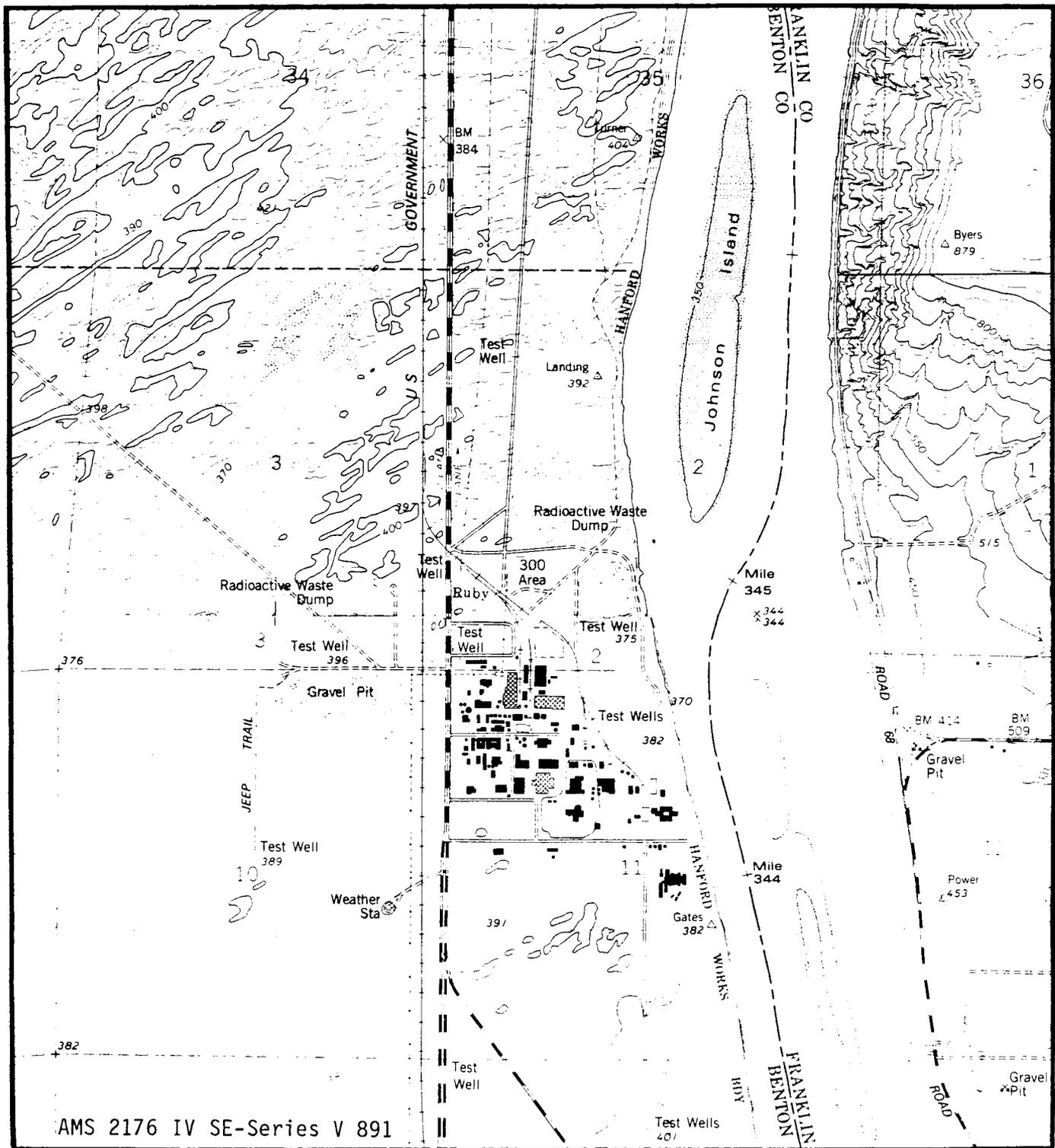
ROAD LEGEND

- Improved Road.....
- Unimproved Road.....
- Trail.....
- Interstate Route ○ U.S. Route ○ State Route

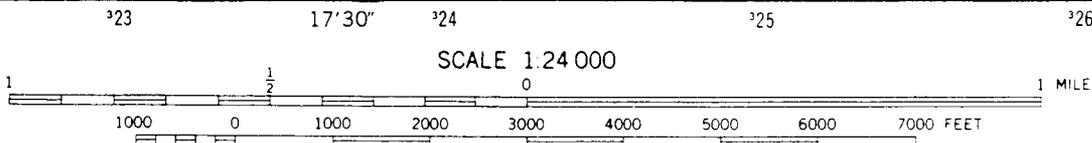
CONTOUR INTERVAL 10 FEET



SOURCE: USGS, 1986
 Locke Island, WA
 46119-F4-TF-024



AMS 2176 IV SE-Series V 891



CONTOUR INTERVAL 10 FEET

ROAD CLASSIFICATION

- | | | |
|---------------------------------|---|-------------|
| Primary highway, hard surface | Light-duty road, hard or improved surface | 1-14 |
| Secondary highway, hard surface | Unimproved road | |
| Interstate Route | U. S. Route | State Route |



SOURCE: USGS, 1978
 Wooded Island, WA N4622.5-W11915/7.5
 and Richland, WA N4615-W11915/7.5

FIGURE 1-10. 300 AREA

1.2.2.2 Waste Inventory

The inactive waste-disposal sites received an estimated 1.6 billion cubic meters (422 billion gallons) of aqueous wastes and 140,000 cubic meters 183,000 cubic yards) of solids, containing 75,000 metric tons of chemicals and 90,000 curies of radionuclides altogether. (The basis for these numbers is published literature and process estimates (Ref. 1). The associated uncertainty of the estimates is unknown.)

Although the quantity of chemicals disposed of in solid-waste disposal sites is unknown, it is estimated that the following contaminants and quantities were disposed of in liquid-waste disposal sites during routine plant operations (Ref. 1):

| <u>Contaminant</u> | <u>Quantity (metric tons)</u> | <u>Quantity (tons)</u> |
|--------------------|-----------------------------------|----------------------------|
| Nitrate | 63,000 | 69,445 |
| Phosphate | 4,400 | 4,850 |
| Sulfate | 3,000 | 3,307 |
| Nitrite | 2,200 | 2,425 |
| Fluoride | 970 | 1,069 |
| Organic carbon | 760 | 837 |
| Chromium (VI) | 260 | 287 |

A variety of radionuclides are also stored or disposed of in both solid- and liquid-waste disposal sites. The most significant quantities (decayed to current values) of radionuclides include:

| <u>Radionuclide</u> | <u>Quantity (curies)</u> |
|---------------------|------------------------------|
| ^{239}Pu | 29,900 |
| ^{137}Cs | 28,000 |
| ^{90}Sr | 23,700 |
| ^{240}Pu | 8,000 |
| ^{238}U | 200 |

These inventories were obtained through a combination of records search and estimates based on knowledge of the processes used. The uncertainty associated with these estimates is unknown but may be significant.

1.2.2.3 Selection of Sites for Phase II Characterization

Very little direct evidence exists to indicate if inactive waste sites have contaminated groundwater or surface waters. Application in Phase I of EPA's Hazard Ranking System (HRS) and the DOE's modified Hazard Ranking System (mHRS) to Hanford's 337 inactive waste-disposal sites resulted in 81 sites receiving scores greater than 28.5 and 256 sites with scores less than 28.5. (The score of 28.5 out of a possible 100 is an arbitrary cutoff established by EPA as the point at which further action for potential CERCLA sites may be required.) The 81 Hanford inactive waste-disposal sites ranking greater than 28.5 will all be characterized in Phase II. The sites had all received liquids containing radionuclides and/or chemicals. They were ranked high because they were suspected of having had releases to ground water and surface waters in the past. Most of these sites were designed and first operated in the 1940s and 1950s. Most of the sites received and transferred to the soil column large volumes of liquid waste.

1.3 Contaminant Migration From CERCLA Sites

The observed releases from CERCLA sites are the cause of concern for potential contamination of water supplies tapping the groundwater or having surface water intakes in the path of contaminant plumes originating in the vicinity of the inactive waste sites. The principal concern in the 100 area is the remobilization of cobalt-60 in the sediments of the Columbia River; and the movement of chromium, iodine-129, cobalt-60, and strontium-90 through the groundwater into the surface water of the Columbia River. In the 200 Area, there are observed elevations of nitrates, tritium, iodine-129, carbon tetrachloride, cyanide, and uranium. In the 300 area, the observed releases of uranium, chromium, fluoride, TCE, and 1-2-DCE to groundwater, as well as release of copper to surface water, are of concern.

2. SITE CHARACTERIZATION PLANS

2.1 Overview

Information to characterize CERCLA sites fall into four general categories:

1. Environmental Setting - These data characterize the regional aspects of the area that impact the movement of contaminants from the site and the potential of exposure to them. They include topography, regional hydrologic characteristics, meteorology, biota, soil type, among others. Secondary data sources contain sufficient information to define the environmental setting of the Hanford site.
2. Hazardous and Radioactive Substances - These data characterize the wastes disposed at the sites and include chemical constituents, concentrations, and the nature of the depositories. Secondary data sources provide some of this information at Hanford.
3. Environmental Concentrations - These data define the extent, direction, and rate of migration of contaminants in the ground, water, and air. Extensive sampling will be needed to develop a sufficient data base of environmental concentrations at the Hanford site.
4. Potential Impacts on Receptions - These data describe the human population likely to be exposed to contaminants and the pathways through which the exposure is likely to occur. Available demographic information and the findings from the environmental sampling activities will provide the basis for making these assessments at Hanford.

The information developed during the site characterization is used to help in identifying applicable and feasible remedial actions. As indicated above, most of the effort to fully characterize the Hanford site will be concentrated in the tasks to collect and analyze the environmental samples

taken in and around the ponds, ditches, trenches, cribs, french drains, and reverse wells used to dispose of the wastes.

This section of the Task 4 report is divided into three parts. First, the degree and extent of the environmental problems are briefly discussed and the pathways of likely exposure identified. Second, the adequacy of the available data in the four categories of information needed to characterize the site is evaluated. Third, a plan is presented for gathering the additional data needed to fully define and evaluate the environmental setting, hazardous substances, environmental concentrations and receptor impacts at the Hanford site. This section also includes a schedule for conducting the site characterization.

2.2 Problem Identification

Existing information indicates that contamination of the surface and subsurface environments at the Hanford Reservation site poses a potential threat to human population (in the 300 Area and in Richland, Washington). During operation of the 100, 200 and 300 Areas of the Hanford Reservation, liquid hazardous waste and radioactive waste were deposited at a variety of disposal facilities which included trenches, ponds, cribs, ditches, and reverse wells. Many of the trenches, ponds, and ditch facilities were unlined and remained uncovered after they were retired. Because of the general permeability and porosity of the underlying sediments, contaminants have migrated into the groundwater and plumes have begun to be identified. Current well log data may show evidence of the spreading of contamination plumes.

2.3 Adequacy of the Existing Data

The extent and completeness of the available data to characterize the site is discussed below:

2.3.1 Environmental Setting

The information needed to understand the environmental setting of the Hanford Reservation and the surrounding area is assessed in this subsection.

The information required for the environmental setting must be sufficient to allow an understanding of the factors impacting the source of contamination to the potential receptor; and the movement of the contaminant through the environment. The documents listed below and a few supplemental reports are sufficient to define the environmental setting. (It should be noted that information for the 200 Area is more extensive than for the other Hanford Reservation areas.)

Regional geology is essential to a discussion of the environmental setting. This includes information on the stratigraphy and structure of the area along with information regarding seismicity and tectonics. Also included should be information about geomorphology, geochemistry and soils.

Another important aspect of the regional setting is geohydrologic and hydrologic conditions. This discussion should address surface water conditions and characteristics, groundwater flow, pathways and bedrock structures and sources of drinking water including information dealing with confined and unconfined aquifers and vadose zone characteristics.

Information on meteorological and air quality conditions are also key elements of this section of the site characterization. Within this section wind direction and speed should be addressed along with the ranges of temperature and humidity, precipitation and dispersion conditions. Terrestrial and aquatic ecosystems also have a role in the regional discussion. These include environmental quality, agricultural and other land use, vegetation and radiological conditions. Discussion should also include area mammals, birds, reptiles, insects, amphibians, and all threatened and endangered species.

Additionally, a discussion of natural resources such as archaeological, cultural and historical resources should be included. A discussion of population density and distribution and possible socioeconomic conditions may also be included.

For the Hanford Reservation and the surrounding area, information of the kind described above can be found in four documents.

- o U.S. Department of Energy (U.S. DOE). Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford. Volume I. Methods and Analysis. Washington, D.C. July 1986.
- o United States Energy Research and Development Administration. Final Environmental Statement - Waste Management Operations Hanford - Reservation, Richland, Washington. ERDA-1538 UC70. December 1975.
- o U.S. Department of Energy. Environmental Assessment Reference Repository Location Hanford Site Washington. Volume I of 3. DOE/RW-0070. Washington, D.C. May 1986.
- o U.S. Department of Energy. Environmental Assessment Reference Repository Location Hanford Site Washington. Volume II of 3. DOE/RW-0070. Washington, D.C. May 1986.

2.3.2 Hazardous and Radioactive Substances

Chemical and radioactive waste disposal inventories from documented sources are available for each source within the 100, 200 and 300 Areas. There are indications, however, that undocumented release to the sites also took place. Key constituents and concentrations of the chemicals and radionuclides are given in these documented inventories. Volumes of liquid waste disposed of at the disposal sites are listed along with the nature of the disposal site. Radioactive materials releases and unplanned releases (i.e., spills, etc.) information is present in the documents that were reviewed under this task. In addition, well logs are needed for existing wells. The availability of this information could not be determined.

The following documents contain chemical and radionuclide inventories:

- o U.S. Department of Energy (U.S. DOE). Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford. Volume I. Methods and Analysis. Washington, D.C. July 1986.

- o U.S. Department of Energy (U.S. DOE). Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford. Volume II. HISS Data base. Washington, D.C. July 1986.
- o United States Energy Research and Development Administration. Final Environmental Statement - Waste Management Operations Hanford - Reservation, Richland, Washington. ERDA-1538 UC70. December 1975.

The 200 Areas of the Hanford Reservation are better documented than either the 100 or the 300 Areas.

2.3.3 Environmental Concentrations

Table 2-1 lists the data needed to determine the type and extent of contamination at the Hanford site. The table also evaluates the utility of the environmental data available from past studies to make these determinations. The evaluations are based on a thorough examination of the environmental data reported in the various studies conducted to date. The evaluations assess whether:

- 1) Little or no data is available and a complete sampling effort is needed
- 2) Sampling is needed to supplement the existing data base
- 3) Enough quality data is already available and no further sampling is needed.

This evaluation provides a basis for developing in the following section the sampling recommendations for generating the additional information to fully characterize the environmental condition of the sites.

2.3.4 Potential Impacts on Receptors

A quantitative risk assessment requires environmental, toxicological and exposure information. This information is used to assess the degree of

TABLE 2-1. ADEQUACY OF PATHWAY CHARACTERISTICS DATA

| GENERAL PATHWAY CHARACTERISTICS | DATA ADEQUACY | | | PURPOSE OR RATIONALE |
|--|---------------|----------|----------|--|
| | 100 Area | 200 Area | 300 Area | |
| Groundwater | | | | |
| Unconfined Aquifer | | | | |
| Boundaries and Location | 3 | 3 | 3 | Determine quantity of subsurface water, extent of aquifer confinement |
| Aquifer Hydraulics | 2 | 2 | 1 | Identify flow rate and direction and contaminant pathway and rate |
| Hydrochemistry | 1 | 2 | 2 | Determine contaminant plume to remediate |
| Contaminants | 2 | 2 | 2 | Determine the aquifers geometry, aquifer recharge and discharge; ground-water quality, movement, productivity and occurrence |
| Stratigraphy | 1 | 3 | 2 | Determine barriers or controls on the natural flow |
| Structure | 3 | 3 | 1 | Determine gains and losses of water into the aquifer's total quantity of water |
| Recharge/Discharge | 1 | 3 | 2 | Determine aquifer properties for the ease of movement, to store water and to access remediation and detect the spatial extent of contamination. |
| Well Data | 2 | 2 | 2 | |
| Confined Aquifer | | | | |
| Boundary and Location | 2 | 3 | 2 | |
| Aquifer Hydraulics | 1 | 1 | 2 | |
| Hydrochemistry | 1 | 1 | 3 | |
| Contaminant | 2 | 2 | 1 | |
| Stratigraphy | 2 | 2 | 2 | |
| Structure | 3 | 3 | 3 | |
| Recharge/Discharge | 1 | 1 | 1 | |
| Well Data | 2 | 2 | 1 | |
| Surface Soils | | | | |
| Spatial Distribution | 3 | 3 | 1 | Determine spatial extent of contaminant resulting from infiltration of transported contaminant resulting from precipitation, spills, airborne particulates or overload flows |
| Hydraulics | 1 | 2 | 1 | Surface soil is the first soil horizon to vadose zone (see vadose zone for similarities) |
| Chemistry | 1 | 2 | 1 | |
| Pedology | 1 | 2 | 2 | |
| Biology | 1 | 1 | 1 | |
| Contaminants in Surface Soil Environment | 2 | 2 | 1 | |

TABLE 2-1. ADEQUACY OF PATHWAY CHARACTERISTICS DATA (Continued)

| GENERAL PATHWAY CHARACTERISTICS | DATA ADEQUACY | | | PURPOSE OR RATIONALE |
|--|---------------|----------|----------|--|
| | 100 Area | 200 Area | 300 Area | |
| Vadose Zone | | | | |
| Unsaturated Hydraulics | 1 | 1 | 1 | Estimate the transport of contaminant through soil matrix |
| Unsaturated Zone Chemistry | 1 | 1 | 1 | Predict mobility of contaminant through the soil and determine environmental setting for chemical degradation for by-products |
| Podology | 2 | 2 | 1 | Determine the effects of physical properties on infiltration, retardation and attenuation of contaminant species |
| Biology | 1 | 1 | 1 | Understand the biological degradation by-products |
| Soil Gas Contaminants | 1 | 1 | 1 | |
| | 2 | 2 | 1 | Determine path of migration and contaminant type. |
| Air | | | | |
| Meteorological Parameters | 2 | 2 | 2 | Determine contributions from other dispersion of contaminants from other sources, weather variation and outcome on remediation, defining recharge and evapotranspiration |
| Weather Extremes | 2 | 2 | 2 | |
| Surface Water | | | | |
| River | | | | |
| Hydraulics/Geometry | 1 | - | 1 | Determine the degree of contaminant transport and quantity of contaminants |
| Chemistry | 1 | - | 1 | |
| Ground Water - Surface Water Relationships | 1 | 1 | 1 | Evaluate for contaminant pathway cycling |
| Location/Quantities | 1 | 1 | 1 | Determine water/sediment partitioning and capacity for water to assimilate contaminant |
| Chemistry | 1 | 1 | 1 | |
| Drainage | 2 | 2 | 2 | Determine if chemical flow or overload flow will remove contaminants offsite or on. |
| Location/Quantities | | | | |
| Sediments | | | | |
| Physical Characteristics | 1 | 1 | 1 | |
| Chemistry | 1 | 1 | 1 | Determine water/sediment partitioning of contaminants. |
| Mineralogy | 1 | 1 | 1 | |
| Contaminants | 1 | 1 | 1 | |

Footnotes

- (1) Complete sampling effort required resulting from an absence of information.
- (2) Moderate sampling effort required to supplement the existing data.
- (3) No further sampling effort required because sufficient data exists that is diagnostically useful.

(0) = 3

degradation in environmental quality and to determine the potential risk to receptors in the environment.

Some information is available to help make these assessments. This information shows that potential receptors may eventually be impacted by contaminants from Hanford and a comprehensive risk assessment will probably be required.

The following documents contain the most extensive data:

- o U.S. Department of Energy (U.S. DOE). Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford. Volume I. Methods and Analysis. Washington, D.C. July 1986.
- o U.S. Department of Energy (U.S. DOE), Richland Operations Office. Hanford Environmental Management Program Plan. Richland, Washington. November 1986.
- o United States Energy Research and Development Administration. Final Environmental Statement - Waste Management Operations Hanford - Reservation, Richland, Washington. ERDA-1538 UC70. December 1975.
- o U.S. Department of Energy. Environmental Assessment Reference Repository Location Hanford Site Washington. Volume I of 3. DOE/RW-0070. Washington, D.C. May 1986.
- o U.S. Department of Energy. Environmental Assessment Reference Repository Location Hanford Site Washington. Volume II of 3. DOE/RW-0070. Washington, D.C. May 1986.

This information, plus the results from the sampling activities should provide sufficient data to conduct a quantitative risk assessment of the 100, 200 and 300 Areas.

2.4 Plan for Conducting the Site Characterization

The characterization plan is designed to identify contaminants and determine the migration rates through the eight pathways; groundwater, vadose zone, surface soils, air, surface water, sediments, direct contact plant uptake, and animal uptake. Of these, the vadose zone and the groundwater are generally the priority concerns for most of the CERCLA sites. In characterizing these pathways, the following nature of the contamination should be addressed:

- o Confirmation of releases of contaminants and evaluation of potential for future releases
- o Delineation of the horizontal and vertical extent of contaminant plumes and effects of the media characteristics on contaminant migration
- o Determination of existing surface and groundwater quality and characterization of chemical nature of contaminant plume
- o Determination of the direction and rate of contaminant movement.

A separate characterization plan has been developed for each of the three areas (100, 200, and 300 Areas). Each plan specifies a sampling program for the CERCLA sources in the area (81 sources in total). A highly structured sampling program is being proposed to address each of the environmental pathways for each source. The characterization plans are designed to be implemented in a series of stages, with a maximum of five stages possible within an area. The main objective of this approach is to systematically build a data base for each site. These five stages are:

- o Stage I: Review Existing Measurements Data
- o Stage II: Conduct Proximity Contaminant Survey and Evaluation for the Unconfined Aquifer
- o Stage III: Conduct Distal Contaminant Survey and Evaluation for the Unconfined Aquifer

- o Stage IV: Conduct Confined Aquifer Survey and Evaluation
- o Stage V: Conduct Sampling of Surface Water and Sediments and Final Data Evaluation

Stage I: Review Existing Data

The first stage reviews and evaluates existing environmental measurements data not available to SAIC at the time that this characterization plan was prepared.

Stages II and III: Proximity and Distal Surveys

The second and third stages provide the basis to verify and understand the types of chemicals and radionuclides resulting from the liquid waste disposal at the sites in the uppermost aquifer. The second stage directs its efforts toward identifying contaminants residing in the immediate proximity of the source. The third stage addresses the lateral and horizontal extent of contamination and determines which contaminants have migrated. Stages II and III tasks are designed to investigate the geological and hydrogeological (including soil and vadose zone) conditions.

Geologic Investigations

The main purpose of the geologic investigation is to describe the geologic conditions that govern the movement of contaminants from the disposal sites. These goals will be met by reviewing and reevaluating available geologic data previously developed for the Hanford site complimented by detailed geological and geophysical logging of monitoring wells boreholes. A surface geophysical assessment around the site will also be made. This assessment will aid in the locating of new monitoring wells and in the definition of the contaminant plumes.

The review and reevaluation of previously developed geologic data will be included. These data, along with site construction records, will be used to confirm the accuracy of existing site geologic maps, construct appropriate cross-sections and fence diagrams, and to correlate data between

separate site investigations. These efforts are expected to reveal the geologic conditions or other factors most likely to be responsible for current or future contaminant releases.

The review and reevaluation effort discussed above will help guide both the geophysical investigation and the final site selection for new borings for monitoring well installation. These investigative efforts are expected to identify the geologic factors governing the movement of contaminants from the sites into and through the groundwater and soil pathways.

Hydrogeologic and Chemical Investigations

In conjunction with the geologic investigations, hydrogeologic and hydrochemical investigations will be conducted. These investigations focus on groundwater movement and contaminant migration within the unconfined and confined aquifers. This process will begin with a thorough review of existing hydrogeologic and groundwater monitoring data. Validated monitoring data will be computerized and organized into data management basis. This will allow rapid evaluation of the data and development of a thorough evaluation of the pathway and evaluation of existing and historic potentiometric surface maps, and isocontours of geophysical and hydrochemical data. The results of this effort will be used to finalize the number and locations of new monitoring wells. Samples from all wells will undergo a complete chemical characterization.

Stage IV: Conduct Confined Aquifer Survey

Stage IV's objective is to assess the viability of vertical migration of contaminants into the confined aquifer and the interbeds. Although extensive examination of the Saddle Mountain basalts has been conducted by the Department of Energy and Rockwell, no information exists on contamination migration directly under the areas on which the sites source units exist. The tasks under this stage are similar to the media investigations discussed in Stages II and III.

Stage V: Surface Water and Sediment Sampling

Stage V evaluates the surface water, sediments, and animal contamination pathways. These are accomplished by collecting water and sediment samples from the Columbia River and conducting bioassays of resident species from the 100 Area to three miles below the 300 Area contaminant plume. A complete water quality sampling would follow the completion of the entire area's monitoring well installations.

Existing river monitoring stations and new river and river sediment sampling stations will be established and used to characterize the point of contaminant existence and contaminant migration down the river. Characterization of all potential contaminants in the surface water and bottom sediments will be conducted. Results of these analyses will show if the sites are contributing to surface water contamination and if contamination is found, will be compared to the results of groundwater analyses to give an indication of the likely route being followed by the contaminants.

The climate of this region of Washington State places some constraints on evaluating this potential contaminant pathway since stream flow in the vicinity of the Hanford site is ephemeral. Nonetheless, nonflowing artificial and natural stream channels, gullies, and flowing seep will be located for sampling. An attempt will also be made to establish site-specific and local drainage patterns across the surface of the Hanford site.

As part of the technical approach in characterizing potential contaminants in the surface water and stream sediments, a revised water balance will be conducted for the site area to examine the interrelationships between groundwater and surface water. This water balance will allow for a determination of potential for the site affecting surface water quality.

Proposed Sampling Program

Tables 2-2 through 2-5 are matrices summarizing the sampling needs in the proposed characterization plans. Each matrix organization relates each area's sources to the pathways by means of a stage activated sampling

regime. Tables 2-2, 2-3, and 2-4 discuss the unconfined aquifer's sampling efforts and Table 2-5 discusses the confined aquifer's sampling efforts.

These three tables demonstrate how the evaluation of staged sampling will provide the information to eliminate the deficiencies identified in Table 2-1. These matrices provide the groundwork to prepare the cost estimates and scheduling on a source(s) basis. With this in mind, Table 2-6 compiles the staged sampling needs for the 100, 200, and 300 Areas on an area basis.

Tables 2-2 through 2-4 are tables which identify by area the individual sampling needs. Their needs include the number of samples, soil borings, lysimeters, and monitoring wells along with the types of monitoring wells and samples to be taken for the 100, 200, and 300 Areas of the Hanford Reservation.

Table 2-6 is a summary table which identifies the number of monitoring wells samples, grab samples, lysimeter samples, soil boring samples, and random sediment and river sediment samples for each of the three CERCLA areas of the Hanford Reservation. This table is derived from Tables 2-2, 2-3, and 2-4.

Table 2-5 is a Stage IV summary table for well monitoring of the confined aquifer for the three CERCLA areas of the Hanford Reservation.

Table 2-2

Summary of Sampling Needs for the 100 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| Pathway | 100 H Area | | | | | | | |
|---------|---|--------------|---|-----|-----------|---|--------------|---------------|
| | Groundwater | Surface Soil | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake |
| 116-H-1 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 10 sampled every 5 feet to water level. 84 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | Stage V Ephemeral overflows 4 random samples Stage V Seepage 4 random samples | | |
| 116-H-2 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 10 sampled every 5 feet to water level. 84 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | Stage V Ephemeral overflows 4 random samples Stage V Seepage 4 random samples | | |
| 116-H-3 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 sampled every 5 feet to water level. 67 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | Stage V Ephemeral overflows 4 random samples Stage V Seepage 4 random samples | | |

Table 2-2

Summary of

Summary of Sampling Needs for the 100 Area Sources

Notes A and B to this table define chronologic

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| | | | 100 D/DR Area | | | | | | | | |
|---------|------------------|------------|---------------|------------------|--------------|---------------------|-----|-----------|---------------|--------------|---------------|
| Pathway | Sources | | Pathway | Groundwater | Surface Soil | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake |
| 116-F-1 | Stage II & III | Ins | 116-DR-1 | Stage II & III | 5 | 1 | --- | --- | --- | --- | --- |
| | Installation of | 2 | | Installation of | | | | | | | |
| 116-F-2 | Stage II & III | Ins | 116-DR-2 | Stage II & III | 5 | 1 | --- | --- | --- | --- | --- |
| | Installation of | 1 | | Installation of | | | | | | | |
| 116-F-3 | Stage II & III | Ins | 116-DR-1B | Stage II & III | 5 | 1 | --- | --- | --- | --- | --- |
| | Installation of | 1 | | Installation of | | | | | | | |
| | 5 | clustering | | 5 | clustering | 1 | --- | --- | --- | --- | --- |
| | monitoring wells | lys | | monitoring wells | lys | lysimeter | | | | | |
| | Stage V | Soil | | Stage V | Soil | Soil Borings | | | | | |
| | Water Quality | Vol | | Water Quality | Vol | 10 borings | | | | | |
| | 23 | Com | | 23 | Com | sam | | | | | |
| | Samples | 50 | | Samples | 50 | to | | | | | |
| | | | | | | water level. | | | | | |
| | | | | | | 166 samples | | | | | |
| | | | | | | --- | | | | | |
| | | | | | | Soil Gas Survey for | | | | | |
| | | | | | | Volatile Organic | | | | | |
| | | | | | | Compounds | | | | | |
| | | | | | | 50 ft. grids | | | | | |

Table 2-2

Summary of Sampling Needs for the 100 Area Sources

| Pathway Source | 100 D/DR Area | | | | | | | | |
|-------------------|---|-----------------|---|-----|-----------|---|---|------------------|--|
| | Groundwater | Surface Soil | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake | |
| 116-DR-6 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 133 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | Stage V Ephemeral overflows 4 random samples samples | Stage V Seepage 4 random samples | | |
| 116-DR-7 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 133 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | Stage V Ephemeral overflows 4 random samples samples | Stage V Seepage 4 random samples | | |

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

Table 2-2

Summary of Sampling Needs for the 100 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| | | 100 F Area | | | | | | | |
|---------|---|-------------|--------------|--|-----|--------------------------------------|--------------------------|--------------|---------------|
| Pathway | | Groundwater | Surface Soil | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake |
| 116-F-1 | Stage II & III | | | Stage II & III | | Stage V | Stage V | | |
| | Installation of 5 cluster (3 depths) monitoring wells | | | Installation 2 cluster (3 depths) lysimeters | | Ephemeral overflows 4 random samples | Seepage 4 random samples | | |
| | Stage V Water Quality 23 Samples | | | Soil Borings 40 borings sampled every 5 feet to water level. 400 samples | | | | | |
| | | | | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| 116-F-2 | Stage II & III | | | Stage II & III | | Stage V | Stage V | | |
| | Installation of 5 cluster (3 depths) monitoring wells | | | Installation 1 cluster (3 depths) lysimeter | | Ephemeral overflows 4 random samples | Seepage 4 random samples | | |
| | Stage V Water Quality 23 Samples | | | Soil Borings 13 borings sampled every 5 feet to water level. 130 samples | | | | | |
| | | | | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| 116-F-3 | Stage II & III | | | Stage II & III | | Stage V | Stage V | | |
| | Installation of 5 cluster (3 depths) monitoring wells | | | Installation 1 cluster (3 depths) lysimeter | | Ephemeral overflows 4 random samples | Seepage 4 random samples | | |
| | Stage V Water Quality 23 Samples | | | Soil Borings 10 borings sampled every 5 feet to water level. 100 samples | | | | | |
| | | | | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Table 2-2

Summary of Sampling Needs for the 100 Area Sources

| | | 100 F Area | | | | | | | |
|---|--|-------------|---------|---|-----|-----------|--|---|--------|
| Pathway | * | Groundwater | Surface | Vadose | Air | Sediments | Surface | Plant | Animal |
| Sources | | | Soil | Zone | | | Water | Uptake | Uptake |
| I (2 sources) 116-F-6 116-F-10 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | | Stage II & III Installation 2 cluster (3 depths) lysimeter --- | | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | |
| | Stage V Water Quality 23 Samples | | | Soil Borings 13 borings sampled every 5 feet to water level. 130 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| 116-F-9 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | |
| | Stage V Water Quality 23 Samples | | | Soil Borings 18 borings sampled every 5 feet to water level. 180 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

Table 2-2

Summary of Sampling Needs for the 100 Area Sources

| 100 KE/KW Area | | | | | | | | |
|--|--|---------|---|-----|-----------|--|---|--------|
| Pathway | Groundwater | Surface | Vadose | Air | Sediments | Surface | Plant | Animal |
| Source | | Soil | Zone | | | Water | Uptake | Uptake |
| I (2 sources) 100-KW*1 100-KW*2 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | |
| | Stage V Water Quality 23 Samples | | Soil Borings 10 sampled every 5 feet to water level. 144 samples --- | | | | | |
| | | | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | |
| | Stage V Water Quality 23 Samples | | Soil Borings 8 sampled every 5 feet to water level. 115 samples --- | | | | | |
| | | | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | |
| | Stage V Water Quality 23 Samples | | Soil Borings 8 sampled every 5 feet to water level. 115 samples --- | | | | | |
| | | | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

Table 2-2

Summary of Sampling Needs for the 100 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| 100 KE/KW Area | | | | | | | | | |
|----------------|---|--------------|--|-----|-----------|---|--------------|---------------|--|
| Pathway | Groundwater | Surface Soil | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake | |
| 116-K-2 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 sampled every 5 feet to water level. 115 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | Stage V Ephemeral overflows 4 random samples Stage V Seepage 4 random samples | | | |
| 116-KE-2 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 10 sampled every 5 feet to water level. 144 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | Stage V Ephemeral overflows 4 random samples Stage V Seepage 4 random samples | | | |

Table 2-2

Summary of Sampling Needs for the 100 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| | | 100 B/C Area | | | | | | | | |
|---------|---------|---|---------------|--|-----|-----------|--|---|---------------|--|
| Pathway | | Groundwater | Surface Soils | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake | |
| | Source | | | | | | | | | |
| | 116-B-1 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 10 borings sampled every 5 feet to water level. 188 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | | |
| | 116-B-4 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 150 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | | |
| | 116-C-1 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 150 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | | |

Table 2-2

Summary of Sampling Needs for the 100 Area Sources

| | | 100 B/C Area | | | | | | | |
|---------|--|--------------|---------|---|-----|--|---|--------|--------|
| Pathway | | Groundwater | Surface | Vadose | Air | Sediments | Surface | Plant | Animal |
| Source | | | Soils | Zone | | | Water | Uptake | Uptake |
| 116-C-2 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | | |
| | Stage V Water Quality 23 Samples | | | Soil Borings 20 borings sampled every 5 feet to water level. 376 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

Table 2-3

Summary of Sampling Needs for the 200 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| 200 E Area | | | | | | | | | |
|--|---|--|---|---|--|---|--|---------------|--|
| Pathway | Groundwater | Surface Soils | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake | |
| I (7 sources) 216-B-43 216-B-44 216-B-45 216-B-46 216-B-48 216-B-49 216-B-50 | Stage II & III Installation of 13 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | Soil Borings 10 borings sampled every 5 feet to water level. | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 20 Samples | | 676 samples --- | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| | Stage II & III Installation of 5 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | Soil Borings 8 borings sampled every 5 feet to water level. | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | II (1 source) 216-B-7A&B | Stage V Water Quality 8 Samples | | 541 samples --- | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | |
| | Stage II & III Installation of 5 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | Soil Borings 8 borings sampled every 5 feet to water level. | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | III (1 source) 216-B-2-2 | Stage V Water Quality 8 Samples | | 541 samples --- | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | |

Table 2-3

Summary of Sampling Needs for the 200 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| 200 E Area | | | | | | | | |
|---|--|---------|---|-----|--|--|--------|--------|
| Pathway | Groundwater | Surface | Vadose | Air | Sediments | Surface | Plant | Animal |
| Source | | Soils | Zone | | | Water | Uptake | Uptake |
| IV (1 source) 216-B-5 | Stage II & III Installation of 6 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 9 Samples | | Soil Borings 6 borings sampled every 5 feet to water level. 406 samples --- | | | | | |
| V (2 sources) 216-B-10-A 216-B-6 | Stage II & III Installation of 7 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 11 Samples | | Soil Borings 10 borings sampled every 5 feet to water level. 676 samples --- | | | | | |
| VI (2 sources) 216-C-1 216-C-10 | Stage II & III Installation of 5 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 8 Samples | | Soil Borings 12 borings sampled every 5 feet to water level. 811 samples --- | | | | | |
| | | | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Table 2-3

Summary of Sampling Needs for the 200 Area Sources

| 200 E Area | | | | | | | | |
|--------------------------------|--|---------------|---|-----|--|--|--------------|---------------|
| Pathway | Groundwater | Surface Soils | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake |
| Source | | | | | | | | |
| VII (1 source) 216-B-16 | Stage II & III Installation of 5 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 8 Samples | | Soil Borings 8 borings sampled every 5 feet to water level. 541 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| VIII (1 source) 216-A-40 | Stage II & III Installation of 5 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 8 Samples | | Soil Borings 8 borings sampled every 5 feet to water level. 541 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| IX (1 source) 216-A-24 | Stage II & III Installation of 5 monitoring wells | | Stage II & III Installation 2 cluster (3 depths) lysimeters --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 8 Samples | | Soil Borings 12 borings sampled every 5 feet to water level. 811 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

Table 2-3

Summary of Sampling Needs for the 200 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| 200 E Area | | | | | | | | |
|-------------------------------|--|---------|---|-----|--|--|--------|--------|
| Pathway | Groundwater | Surface | Vadose | Air | Sediments | Surface | Plant | Animal |
| Source | | Soils | Zone | | | Water | Uptake | Uptake |
| X (1 source) 216-A-9 | Stage II & III Installation of 5 monitoring wells | | Stage II & III Installation 2 cluster (3 depths) lysimeters --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 8 Samples | | Soil Borings 12 borings sampled every 5 feet to water level. 811 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| XI (1 source) 216-A-7 | Stage II & III Installation of 5 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 8 Samples | | Soil Borings 4 borings sampled every 5 feet to water level. 270 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| XII (1 source) 216-A-28 | Stage II & III Installation of 5 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 8 Samples | | Soil Borings 4 borings sampled every 5 feet to water level. 270 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Table 2-3

Summary of Sampling Needs for the 200 Area Sources

| 200 E Area | | | | | | | | | |
|---------------------|---|--|--|--|-----------|---|---|--|--|
| Pathway | Groundwater | Surface Soils | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake | |
| XIII (5 sources) | Stage II & III Installation of 10 monitoring wells | | Stage II & III Installation 2 cluster (3 depths) lysimeters --- | | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | 216-A-4 216-A-21 216-A-27 216-A-5 216-A-36A | Stage V Water Quality 15 Samples | 32 borings sampled every 5 feet to water level. 2163 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | | |
| | XIV (1 source) | Stage II & III Installation of 5 monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | |
| | | 216-A-6 | Stage V Water Quality 8 Samples | 8 borings sampled every 5 feet to water level. 541 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

Table 2-3

Summary of Sampling Needs for the 200 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| 200 W Area | | | | | | | | | |
|--|---|---------------|--|-----|--|---|--------------|---------------|--|
| Pathway | Groundwater | Surface Soils | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake | |
| I (5 sources) 216-S-5 216-S-6 216-S-17 216-S-16P 216-S-16D | Stage II & III Installation of 6 cluster (3 depths) monitoring wells Stage V Water Quality 27 Samples | | Stage II & III Installation 2 cluster (3 depths) lysimeters --- Soil Borings 40 borings sampled every 5 feet to water level. 2064 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | | |
| II (4 sources) 216-S-1&2 216-S-7 216-S-3 216-S-9 | Stage II & III Installation of 8 cluster (3 depths) monitoring wells Stage V Water Quality 36 Samples | | Stage II & III Installation 2 cluster (3 depths) lysimeters --- Soil Borings 32 borings sampled every 5 feet to water level. 1651 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | | |
| III (1 source) 216-S-20 | Stage II & III Installation of 8 cluster (3 depths) monitoring wells Stage V Water Quality 36 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 413 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | | |

Table 2-3

Summary of Sampling Needs for the 200 Area Sources

| 200 W Area | | | | | | | | |
|--|--|---|---|--|--|---|--------------|---------------|
| Pathway | Groundwater | Surface Soils | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake |
| Source | | | | | | | | |
| IV (2 sources) 216-S-4 216-S-21 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | Stage II & III Installation 2 cluster (3 depths) lysimeters --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 23 Samples | | Soil Borings 16 borings sampled every 5 feet to water level. 826 samples --- | | | | | |
| | | | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | V (1 source) 216-U-11 | Stage V Water Quality 23 Samples | | Soil Borings 8 borings sampled every 5 feet to water level. 413 samples --- | | | | |
| | | | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | VI (1 source) 216-U-3 | Stage V Water Quality 23 Samples | | Soil Borings 8 borings sampled every 5 feet to water level. 413 samples --- | | | | |
| | | | Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

Table 2-3

Summary of Sampling Needs for the 200 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| 200 W Area | | | | | | | | | |
|--|---|---------|--|-----|--|---|--------|--------|--|
| Pathway | Groundwater | Surface | Vadose | Air | Sediments | Surface | Plant | Animal | |
| Source | | Soils | Zone | | | Water | Uptake | Uptake | |
| VII (1 source) 216-Z-1&2 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 413 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | | |
| VIII (1 source) 216-U-1&2 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 413 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | | |
| IX (3 sources) 216-U-4 216-U-4A 216-U-4B | Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 12 borings sampled every 5 feet to water level. 619 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | | |

| 200 W Area | | | | | | | | |
|---|--|---------------|---|-----|--|---|--------------|---------------|
| Pathway | Groundwater | Surface Soils | Vadose Zone | Air | Sediments | Surface Water | Plant Uptake | Animal Uptake |
| X (2 sources) 216-Z-7 216-Z-10 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 413 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 23 Samples | | | | | | | |
| XI (1 source) 216-T-19 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 413 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 23 Samples | | | | | | | |
| XII (1 source) 216-T-7 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 413 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 23 Samples | | | | | | | |

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

Table 2-3

Summary of Sampling Needs for the 200 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| 200 W Area | | | | | | | | |
|---|--|---------|---|-----|--|---|--------|--------|
| Pathway | Groundwater | Surface | Vadose | Air | Sediments | Surface | Plant | Animal |
| Source | | Soils | Zone | | | Water | Uptake | Uptake |
| XIII (1 source) 216-T-28 | Stage II & III Installation of 5 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 23 Samples | | Soil Borings 8 borings sampled every 5 feet to water level. 413 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| XIV (1 source) 216-T-3 | Stage II & III Installation of 6 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 27 Samples | | Soil Borings 8 borings sampled every 5 feet to water level. 413 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| XV (2 sources) 216-T-2 216-T-8 | Stage II & III Installation of 6 cluster (3 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 6 random samples | Stage V Seepage 6 random samples | | |
| | Stage V Water Quality 27 Samples | | Soil Borings 12 borings sampled every 5 feet to water level. 619 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Table 2-4

Summary of Sampling Needs for the 300 Area Sources

Notes A and B to this table define chronological stage implementation and source characterization activity rationale.

| 300 Area | | | | | | | | |
|----------|--|---------|---|-----|--|---|--------|--------|
| Pathway | Groundwater | Surface | Vadose | Air | Sediments | Surface | Plant | Animal |
| Source | | Soils | Zone | | | Water | Uptake | Uptake |
| 316-1 | Stage II & III Installation of 8 cluster (2 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | | |
| | Stage V Water Quality 24 Samples | | Soil Borings 12 borings sampled every 5 feet to water level. 103 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| 316-2 | Stage II & III Installation of 8 cluster (2 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | | |
| | Stage V Water Quality 24 Samples | | Soil Borings 14 borings sampled every 5 feet to water level. 120 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |
| 316-3 | Stage II & III Installation of 6 cluster (2 depths) monitoring wells | | Stage II & III Installation 1 cluster (3 depths) lysimeter --- | | Stage V Ephemeral overflows 4 random samples | Stage V Seepage 4 random samples | | |
| | Stage V Water Quality 18 Samples | | Soil Borings 12 borings sampled every 5 feet to water level. 103 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids | | | | | |

Table 2-5

Stage IV Confined Aquifer Drilling

| AREA | Pathway Groundwater |
|-----------|---|
| 100 B/C | Installation of one monitoring well to interbedded zone depth |
| 100 KE/KW | Installation of one monitoring well to interbedded zone depth |
| 100 D/DR | Installation of one monitoring well to interbedded zone depth |
| 100 H | Installation of one monitoring well to interbedded zone depth |
| 100 F | Installation of one monitoring well to interbedded zone depth |
| 200 East | Installation of one monitoring well to interbedded zone depth |
| 200 West | Installation of one monitoring well to interbedded zone depth |
| 300 | Installation of one monitoring well to interbedded zone depth |

Table 2-6 Summary of the Complete Sampling Needs of the 100, 200 & 300 Areas

| STAGE | | 100 Area | 200 Area | 300 Area |
|----------------------|---------------|------------------------------------|------------------------------------|------------------------------------|
| Stage I | | No Sampling required at this stage | No Sampling required at this stage | No Sampling required at this stage |
| Stage II & Stage III | Groundwater | 110 clusters | 175 clusters | 22 clusters |
| | Vadose Zone | 24 clusters | 36 clusters | 3 clusters |
| | Soil Borings | 255 soil borings | 342 soil borings | 38 soil borings |
| Stage IV | Groundwater | 5 monitoring wells | 2 monitoring wells | 1 monitoring well |
| Stage V | Sediments | 88 random samples | 180 random samples | 12 random samples |
| | Surface Water | 88 samples | 180 samples | 12 random samples |

NOTE A. CHRONOLOGY OF IMPLEMENTATION FOR SOURCE CHARACTERIZATION STAGES

A brief overview of the proposal CERCLA source characterization activity stages was presented in the Task 4 Report. The stages involved include: Stage I - Literature Review and Source Characterization Work Plan; Stage II - Characterization Activities in Proximity to the Source; Stage III - Characterization Activities to Determine Areal Extent of Source Impacts; Stage IV - Basalt/Confined Aquifer Impact Evaluations; Stage V - Sampling Activities and Source Characterization (Remedial Investigations) Report. In reality, these stages are performed non-sequentially and in segments in the source characterization process. The following table is presented to better depict the chronological sequence of events in a typical source characterization effort.

| <u>Stage</u> | <u>Chronological Activity</u> |
|--------------|---|
| I | <ul style="list-style-type: none">o Literature Search.o Work, Health and Safety, QA/QC Plans. |
| II, III | <ul style="list-style-type: none">o Soil Gas, Surface Geophysics - both initially focus on immediate source area (Stage II), and expand outward in vicinity of the source (Stage III) if contaminants are indicated to delineate areal extent of those contaminants. |
| II | <ul style="list-style-type: none">o Soil Borings, Monitoring Well and Lysimeter Installation in proximity to source. |
| V | <ul style="list-style-type: none">o Stage V, Round 1 Sampling - to include Stage II monitoring wells, ephemeral sources.o Laboratory Analysis of Samples.o Analytical Data Review.<ul style="list-style-type: none">- If <u>no</u> contaminants identified or if contaminants have been adequately identified/quantified at this point, proceed to Stage V Remedial Investigation Report preparation (below). |

NOTE A. CHRONOLOGY OF IMPLEMENTATION FOR SOURCE CHARACTERIZATION STAGES
(Continued)

| <u>Stage</u> | <u>Chronological Activity</u> |
|--------------|---|
| V | <ul style="list-style-type: none">o Analytical Data Review (continued)<ul style="list-style-type: none">- If additional data is required to quantify contaminants, scope Stage III requirements/activities. |
| III | <ul style="list-style-type: none">o Soil Borings, Monitoring Well Installation - to evaluate contaminant migration. |
| V | <ul style="list-style-type: none">o Stage V, Round 2 Sampling - to include Stage II <u>and</u> Stage III monitoring wells, with analysis for a reduced list of analytical parameters based upon evaluation of Stage II findings.o Laboratory Analysis of Samples.o Analytical Data Reviewo Source Characterization (Remedial Investigation) Report preparation. |
| IV | <ul style="list-style-type: none">o Stage IV activities include installation of basalt/confined aquifer monitoring wells, sampling of these wells, analysis of samples. Stage IV has been projected to include one deep monitoring well <u>per area</u>, and would be scoped/implemented only after a sufficient number of unconfined (surficial) aquifer source/contaminant characterizations have been completed in a given area. |

NOTE B. RATIONALE FOR SOURCE CHARACTERIZATION FIELD ACTIVITIES (Continued)

| Pathway Sampling Method | Criteria | Purpose/Rationale for Criteria |
|------------------------------|--|---|
| Soil Gas Survey | Stage II & III | |
| | <ul style="list-style-type: none">o Area surveyed is 4 times the source's (site's) physical size on 50 foot grid centers. | <ul style="list-style-type: none">o Determine the areal extent of volatile organic compounds. |
| Confined Aquifer | Stage IV | |
| | <ul style="list-style-type: none">o 1 well per Area | <ul style="list-style-type: none">o These well installations are in the basalt/confined aquifer. The wells investigate interaquifer communication of contaminants and the degree of lateral contamination in the interbeds. |
| Surface Sediment and Seepage | Stage V | |
| | <ul style="list-style-type: none">o The number of random samples were restricted because of the lack of existing data. | <ul style="list-style-type: none">o Determine surficial pathways of contaminant migration. |
| Groundwater Sampling | Stage V - Round 1 | |
| | <ul style="list-style-type: none">o Sample Stage II wells for a complete suite of parameters which include organics, pesticides, inorganics, and radionuclides. | <ul style="list-style-type: none">o Verify the species of contaminants existing in the proximity of the source. |
| | Stage V - Round 2 | |
| | <ul style="list-style-type: none">o Sample Stage II and Stage III wells for a reduced list of parameters. This sampling will provide a single time line for analytical data. | <ul style="list-style-type: none">o Verify the lateral and areal extent of contaminant species beyond the immediate source area. |

3.0 ACCEPTABILITY OF SAMPLING/ANALYTICAL METHODS

The principal environmental regulations governing the site characterization methods are contained in the Federal and State regulations implementing the Resource Conservation and Recovery Act (RCRA) and those implementing the Safe Drinking Water Act (SDWA). In cases where the air pathway is of principal concern, the Clean Air Act regulations are important regulatory guides for CERCLA sites.

3.1 Verification of Compliance of Characterization Methods With Environmental Regulations.

The characterization methods outlined in this document are based on Guidance on Remedial Investigations and Feasibility Studies Under CERCLA (EPA/540/G-85/002 and 003). These methods must enable the determination of the nature and extent of the contamination, and provide information necessary to aid in the evaluation of a remedial alternative.

The levels of contamination which trigger the need for possible remediation are determined from the applicable or relevant and appropriate regulatory requirements (ARARS). These requirements are summarized in Tables 3-1 and 3-2. The type and frequency of sampling is given in 40 CFR 264.90 and 40 CFR 141. The regulatory limits are included in the Washington Annotated Code as Washington Department of Ecology Regulations.

The analysis of the samples collected as part of the characterization must be analyzed using acceptable techniques and methods. Table 3-3 identifies accepted methods for analysis of the samples.

Since the characterization has been based on the EPA guidance for CERCLA sites, and is consistent with the applicable and appropriate relevant regulations, the characterization methods are in compliance with the regulatory requirements.

TABLE 3-1. SELECTED APPLICABLE OR RELEVANT AND APPROPRIATE AMBIENT REQUIREMENTS

| Chemical | Safe Drinking Water Act MCLs <u>b/</u> (mg/1) | Safe Drinking Water Act MCLGs <u>c/</u> (mg/1) | Clean Air Act NAAQS (ug/m ³) |
|--|---|--|--|
| Arsenic | 0.05 | | |
| Barium | 1.0 | | |
| Benzene | | 0 | |
| Cadmium | 0.01 | | |
| Carbon monoxide | | | 40,000 (1-hour) <u>d/</u> 10,000 (8-hour) <u>d/</u> |
| Carbon tetrachloride | | 0 | |
| Chlorophenoxy | | | |
| 2,4-Dichlorophenoxyacetic acid (2,4-D) | 0.1 | | |
| 2,4,5-Trichlorophenoxy-propionic acid (2,4,5-TP) | 0.01 | | |
| Chromium VI (hexavalent) | 0.05 | | |
| p-Dichlorobenzene | | 0.75 | |
| 1,2-Dichloroethane | | 0 | |
| 1,1-Dichloroethylene | | 0.007 | |
| Endrin | 0.0002 | | |
| Fluoride | 1.4-2.4 | | |
| Lindane (99% gamma-HCCH) | 0.004 | | |
| Hydrocarbons (non-methane) | | | 160 (3-hour) <u>d/</u> 1.5 (90-day) <u>e/</u> |
| Lead | 0.05 | | |
| Mercury | 0.002 | | |
| Methoxychlor | 0.1 | | |
| Nitrate (as N) | 10.0 | | |
| Nitrogen dioxide | | | 100 (1-year) <u>f/</u> |
| Ozone | | | 235 (1-hour) <u>d/</u> |
| Particulate Matter | | | 260 (24-hour) <u>d/</u> 75 (1-year) <u>g/</u> |
| Radionuclides | | | |
| Radium-226 and 228 | 5 pCi/l | | |
| Gross alpha activity | 15 pCi/l | | |
| Tritium | 20,000 pCi/l | | |
| Strontium-90 | 8 pCi/l | | |
| Other man-made radionuclides | <u>h/</u> | | |
| Selenium | 0.01 | | |
| Silver | 0.05 | | |
| Sulfur oxides | | | 365 (24-hour) <u>d/</u> 80 (1-year) <u>f/</u> |
| Toxaphene | 0.005 | | |
| 1,1,1-Trichloroethane | | 0.2 | |

TABLE 3-1. SELECTED APPLICABLE OR RELEVANT AND APPROPRIATE AMBIENT REQUIREMENTS (Continued)

| Chemical | Safe Drinking Water Act MCLs <u>b/</u> (mg/l) | Safe Drinking Water Act MCLGs <u>c/</u> (mg/l) | Clean Air Act NAAQS (ug/m3) |
|-----------------------------------|---|--|-----------------------------------|
| Trichloroethylene | | 0 | |
| Trihalomethanes (total) <u>i/</u> | 0.1 | | |
| Vinyl chloride | | 0 | |

a/ Federal ambient water quality criteria (see Exhibit 4-6) and state environmental standards are also ARARS.

b/ EPA has also proposed MCLS for eight volatile organic chemicals: trichloroethylene, carbon tetrachloride, 1,1,1-trichloroethane, vinyl chloride, 1,2-dichloroethane, benzene, 1,1-dichloroethylene, and p-dichlorobenzene (50 Federal Register 46902-46933, November 13, 1985).

c/ EPA has also proposed MCLGs for 40 additional chemicals. Refer to Exhibit 4-7 for the proposed MCLG values.

d/ Maximum concentration not to be exceeded more than once per year.

e/ Three-month ^b arithmetic mean concentration.

f/ Annual arithmetic mean concentration.

g/ Annual geometric mean concentration.

h/ Radionuclides in drinking water are limited to activity levels corresponding to a total body or any internal organ dose of 4 millirem/year, summed over all radionuclides present.

i/ Total trihalomethanes refers to the sum concentration of chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

TABLE 3-2. EPA AMBIENT WATER QUALITY (WQC) FOR PROTECTION OF HUMAN HEALTH

| Chemical | WQC (Concentrations in Parentheses Correspond to Midpoint of Risk Range for Potential Carcinogens Only) <u>a/</u> | |
|-----------------------------|---|---|
| | Aquatic Organisms and Drinking Water | Adjusted for Drinking Water Only <u>b/</u> |
| Acenaphthene | 20 ug/1 (Organoleptic) <u>c/</u> | 20 ug/1 (Organoleptic) |
| Acrolein | 320 ug/1 | 540 ug/1 |
| Acrylonitrile* | 0 (58 ng/1) | 0 (63 ng/1) |
| Aldrin* | 0 (0.074 ng/1) | 0 (1.2 ng/1) |
| Antimony* | 146 ug/1 | 146 ug/1 |
| Arsenic* | 0 (2.2 ng/1) | (25 ng/1) |
| Asbestos | 0 (30,000 fibers/1) | (30,000 fibers/1) |
| Benzene* | 0 (0.66 ug/1) | 0 (0.67 ug/1) |
| Benzidine* | 0 (0.12 ng/1) | 0 (0.15 ng/1) |
| Beryllium* | 0 (3.7 ng/1) | 0 (3.9 ng/1) |
| Cadmium* | 10 ug/1 | 10 ug/1 |
| Carbon tetrachloride* | 0 (0.4 ug/1) | 0 (0.42 ug/1) |
| Chlordane* | 0 (0.46 ng/1) | 0 (22 ng/1) |
| Chlorinated benzenes | | |
| Hexachlorobenzene* | 0 (0.72 ng/1) | 0 (21 ng/1) |
| 1,2,4,5-Tetrachlorobenzene* | 38 ug/1 | 180 ug/1 |
| Pentachlorobenzene* | 74 ug/1 | 570 ug/1 |
| Trichlorobenzene* | Insufficient data | Insufficient data |
| Monochlorobenzene* | 488 ug/1 | 488 ug/1 |
| Chlorinated ethanes | | |
| 1,2-Dichloroethane* | 0 (0.94 ug/1) | 0 (0.94 ug/1) |
| 1,1,1-Trichloroethane* | 18.4 mg/1 | 19 mg/1 |
| 1,1,2-Trichloroethane* | 0 (0.6 ug/1) | 0 (0.6 ug/1) |
| 1,1,2,2-Tetrachloroethane* | 0 (0.17 ug/1) | 0 (0.17 ug/1) |
| Hexachloroethane* | 0 (1.9 ug/1) | 0 (2.4 ug/1) |

TABLE 3-2. EPA AMBIENT WATER QUALITY (WQC) FOR PROTECTION OF HUMAN HEALTH
(CONTINUED)

| Chemical | WQC (Concentrations in Parentheses Correspond to Midpoint of Risk Range for Potential Carcinogens Only) <u>a/</u> | |
|-------------------------------|---|---|
| | Aquatic Organisms and Drinking Water | Adjusted for Drinking Water Only <u>b/</u> |
| Monochloroethane* | Insufficient data | Insufficient data |
| 1,1-Dichloroethane* | Insufficient data | Insufficient data |
| 1,1,1,2-Tetrachloroethane | Insufficient data | Insufficient data |
| Pentachloroethane | Insufficient data | Insufficient data |
| Chlorinated naphthalenes | Insufficient data | Insufficient data |
| Chlorinated phenols | | |
| 3-Monochlorophenol | 0.1 ug/1 (Organoleptic) | 0.1 ug/1 (Organoleptic) |
| 4-Monochlorophenol | 0.1 ug/1 (Organoleptic) | 0.1 ug/1 (Organoleptic) |
| 2,3-Dichlorophenol | 0.04 ug/1 (Organoleptic) | 0.04 ug/1 (Organoleptic) |
| 2,5-Dichlorophenol | 0.5 ug/1 (Organoleptic) | 0.5 ug/1 (Organoleptic) |
| 2,6-Dichlorophenol | 0.2 ug/1 (Organoleptic) | 0.2 ug/1 (Organoleptic) |
| 3,4-Dichlorophenol | 0.3 ug/1 (Organoleptic) | 0.3 ug/1 (Organoleptic) |
| 2,3,4,6-Tetrachlorophenol* | 1.0 ug/1 (Organoleptic) | 1.0 ug/1 (Organoleptic) |
| 2,4,5-Trichlorophenol* | 2600 ug/1 | 2600 ug/1 |
| 2,4,6-Trichlorophenol* | 0 (1.2 ug/1) | 0 (1.8 ug/1) |
| 2-Methyl-4-chlorophenol | 1800 ug/1 (Organoleptic) | 1800 ug/1 (Organoleptic) |
| 3-Methyl-4-chlorophenol | 3000 ug/1 (Organoleptic) | 3000 ug/1 (Organoleptic) |
| 3-Methyl-6-chlorophenol | 20 ug/1 (Organoleptic) | 20 ug/1 (Organoleptic) |
| Chloroalkyl ethers | | |
| bis-(Chloromethyl) ether* | 0 (0.0038 ng/1) | 0 (0.0039 ng/1) |
| bis-(2-Chloroethyl) ether* | 0 (30 ng/1) | 0 (30 ng/1) |
| bis-(2-Chloroisopropyl) ether | 34.7 ug/1 | 34.7 ug/1 |
| Chloroform* | 0 (0.19 ug/1) | 0 (0.19 ug/1) |
| 2-Chlorophenol | 0.1 ug/1 (Organoleptic) | 0.1 ug/1 (Organoleptic) |

TABLE 3-2. EPA AMBIENT WATER QUALITY (WQC) FOR PROTECTION OF HUMAN HEALTH
(CONTINUED)

| Chemical | WQC (Concentrations in Parentheses Correspond to Midpoint of Risk Range for Potential Carcinogens Only) <u>a/</u> | |
|-----------------------------------|---|---|
| | Aquatic Organisms and Drinking Water | Adjusted for Drinking Water Only <u>b/</u> |
| Chromium Cr+6* | 50 ug/1 | 50 ug/1 |
| Cr+3* | 170 mg/1 | 179 mg/1 |
| Copper* | 1 mg/1 (Organoleptic) | |
| Cyanide* | 200 ug/1 | 200 ug/1 |
| DDT* | 0 (0.024 ng/1) | 0 (> 1.2 ng/1) |
| Dichlorobenzenes* (all isomers) | 400 ug/1 | 470 ug/1 |
| Dichlorobenzidines | 0 (10.3 ng/1) | 0 (20.7 ng/1) |
| Dichloroethylenes | | |
| 1,1-Dichloroethylene* | 0 (33 ng/1) | 0 (33 ng/1) |
| 1,2-Dichloroethylene | Insufficient data | Insufficient data |
| Dichloromethane* | See Halomethanes | See Halomethanes |
| 2,4-Dichlorophenol* | 3.09 mg/1 | 3.09 mg/1 |
| Dichloropropanes/Dichloropropenes | | |
| Dichloropropanes | Insufficient data | Insufficient data |
| Dichloropropenes | 87 ug/1 | 87 ug/1 |
| Dieldrin* | 0 (0.071 ng/1) | 0 (1.1 ng/1) |
| 2,4-Dimethylphenol | 400 ug/1 (Organoleptic) | 400 ug/1 (Organoleptic) |
| 2,4-Dinitrotoluene* | 0 (0.11 ug/1) | 0 (0.11 ug/1) |
| 1,2-Diphenylhydrazine* | 0 (42 ng/1) | 0 (46 ng/1) |
| Endosulfan* | 74 ug/1 | 138 ug/1 |
| Endrin | 1 ug/1 | 1 ug/1 |
| Ethylbenzene* | 1.4 mg/1 | 2.4 mg/1 |
| Fluoranthene | 42 ug/1 | 188 ug/1 |
| Haloethers | Insufficient data | Insufficient data |
| Halomethanes | 0 (0.19 ug/1) | 0 (0.19 ug/1) |

TABLE 3-2. EPA AMBIENT WATER QUALITY (WQC) FOR PROTECTION OF HUMAN HEALTH
(CONTINUED)

| Chemical | WQC (Concentrations in Parentheses Correspond to Midpoint of Risk Range for Potential Carcinogens Only) <u>a/</u> | |
|-------------------------------|---|---|
| | Aquatic Organisms and Drinking Water | Adjusted for Drinking Water Only <u>b/</u> |
| Heptachlor* | 0 (0.28 ng/l) | 0 (11 ng/l) |
| Hexachlorobutadiene* | 0 (0.45 ug/l) | 0 (0.45 ug/l) |
| Hexachlorocyclohexanes (HCCH) | | |
| alpha-HCCH* | 0 (9.2 ng/l) | 0 (13 ng/l) |
| beta-HCCH* | 0 (16.3 ng/l) | 0 (23.2 ng/l) |
| gamma-HCCH* | 0 12.3 ng/l) | 0 (17.4 ng/l) |
| delta-HCCH | Insufficient data | Insufficient data |
| epsilon-HCCH | Insufficient data | Insufficient data |
| Technical-HCCH | 0 (5.2 ng/l) | 0 (7.4 ng/l) |
| Hexachlorocyclopentadiene* | 206 ug/l | 206 ud/l |
| Isophorone* | 5.2 mg/l | 5.2 mg/l |
| Lead* | 50 ug/l | 50 ug/l |
| Mercury* | 144 ng/l | 10 ug/l |
| Naphthalene | Insufficient data | Insufficient data |
| Nickel* | 13.4 ug/l | 15.4 ug/l |
| Nitrobenzene* | 19.8 mg/l | 19.8 mg/l |
| Nitrophenols | | |
| 2,4-Dinitro-o-cresol | 13.4 ug/l | 13.6 ug/l |
| Dinitrophenol* | 70 ug/l | 70 ug/l |
| Mononitrophenol | Insufficient Data | Insufficient Data |
| Trinitrophenol | Insufficient data | Insufficient data |
| Nitrosamines | | |
| n-Nitrosodimethylamine* | 0 (1.4 ng/l) | 0 (1.4 ng/l) |
| n-Nitrosodiethylamine* | 0 (0.8 ng/l) | 0 (0.8 ng/l) |
| n-Nitrosodi-n-butylamine* | 0 (6.4 ng/l) | 0 (6.4 ng/l) |

TABLE 3-2. EPA AMBIENT WATER QUALITY (WQC) FOR PROTECTION OF HUMAN HEALTH
(CONTINUED)

| Chemical | WQC (Concentrations in Parentheses Correspond to Midpoint of Risk Range for Potential Carcinogens Only) <u>a/</u> | |
|--|---|---|
| | Aquatic Organisms and Drinking Water | Adjusted for Drinking Water Only <u>b/</u> |
| n-Nitrosodiphenylamine | 0 (4.9 ug/l) | 0 (7.0 ug/l) |
| n-Nitrosopyrrolidine* | 0 (16 ng/l) | 0 (16 ng/l) |
| Pentachlorophenol* | 1.01 mg/l | 1.01 mg/l |
| Phenol* | 3.5 mg/l | 3.5 mg/l |
| Phthalate esters | | |
| Dimethylphthalate | 313 mg/l | 350 mg/l |
| Diethylphthalate* | 350 mg/l | 434 mg/l |
| Dibutylphthalate* | 34 mg/l | 44 mg/l |
| Di-2-ethylhexylphthalate* | 15 mg/l | 21 mg/l |
| Polychlorinated biphenyls (PCBs)* | 0 (0.079 ng/l) | 0 (> 12.6 ng/l) |
| Polynuclear aromatic hydrocarbons (PAHs)* | 0 (2.8 ng/l) | 0 (3.1 ng/l) |
| Selenium* | 10 ug/l | 10 ug/l |
| Silver* | 50 ug/l | 50 ug/l |
| 2,3,7,8-TCDD* | 0 (0.00013 ng/l) | 0 (0.00018 ng/l) |
| Tetrachloroethylene* | 0 (0.8 ug/l) | 0 (0.88 ug/l) |
| Thallium* | 13 ug/l | 17.8 ug/l |
| Toluene* | 14.3 mg/l | 15 mg/l |
| Toxaphene* | 0 (0.71 ng/l) | 0 (26 ng/l) |
| Trichloroethylene* | 0 (2.7 ug/l) | 0 (2.8 ug/l) |
| Vinyl chloride* | 0 (2.0 ug/l) | 0 (2.0 ug/l) |
| Zinc* | 5 mg/l (Organoleptic) | 5 mg/l (Organoleptic) |

* Toxicity values necessary for risk characterization are given in Appendix A.

a/ The criterion value, which is zero for all potential carcinogens, is listed for all chemicals in the table. The concentration value given in parentheses for potential carcinogens corresponds to a risk of 10^{-6} , which is the midpoint of the range of 10^{-5} to 10^{-7} given in water quality criteria documents. To obtain concentrations corresponding to risks of 10^{-5} , the 10^{-6} concentrations should be multiplied by 10. To obtain concentrations corresponding to risks of 10^{-7} , the 10^{-6} concentrations should be divided by 10.

b/ These adjusted criteria, for drinking water ingestion only, were derived from published EPA ambient water quality criteria (45 Federal Register 79318-79379, November 28, 1980) for combined fish and drinking water ingestion and for fish ingestion alone. The adjusted values are not official EPA ambient water quality criteria, but may be appropriate for Superfund sites with contaminated ground water. In the derivation of these values, intake was assumed to be 2 liters/day for drinking water and 6.5 grams/day for fish, and human body weight was assumed to be 70 kilograms. Values for bioconcentration factor, carcinogenic potency, and acceptable daily intake were those used for water quality criteria development.

c/ Criteria designated as organoleptic are based on taste and odor effects, not human health effects. Health-based water quality criteria are not available for these chemicals.

TABLE 3-3. ACCEPTED METHODS FOR ANALYSIS OF SAMPLES

| Type of Sample | Method of Analysis |
|----------------|--|
| Groundwater | Method listed in Appendix IX to 40 CFR 264.98 and to 40 CFR 264.99 (52 FR 25946) |
| Surface Water | Methods listed in Appendix A to 40 CFR 136.3 |
| Air | Methods listed in Appendix B to 40 CFR 61 |

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APPENDIX A

GENERIC MONITORING PLAN

THIS GENERIC MONITORING PLAN WAS ADAPTED FROM DOE.
COMPREHENSIVE ENVIRONMENTAL ASSESSMENT AND RESPONSE
PROGRAM PHASE 2 GENERIC MONITORING PLAN. WORKING DRAFT,
JULY 1986. ALBERQUERQUE OPERATIONS OFFICE.

GENERIC MONITORING PLAN

1. INTRODUCTION

The Generic Monitoring Plan (GMP) Sampling Plan provides guidance for the development and execution of installation and site-specific sampling plans necessary for CERCLA site characterizations. The intent of the GMP is to describe those methods and materials sufficient to address most sampling situations that could occur while conducting Site Characterizations. The GMP will provide specific guidelines relevant to the geologic, hydrologic, and environmental setting and facility operations unique to each installation, and the Site-Specific Monitoring Plan (SSMP) will provide the following basic components:

- o objectives and goals of the investigation
- o sampling methods to be used, including equipment needs, procedures, sample containment, and preservation
- o justification for selected methods and procedures
- o sample locations, as well as number and types of samples to be collected
- o transportation and shipping information
- o additional site-specific information requirements.

The SSMP serves to guide the site characterization process, which provides data to support the evaluation of alternative candidate response or remedial actions at the site or grouping of similar sites in close proximity. The SSMP is initially developed on the basis of available information and is subsequently developed in stages so that knowledge gained during the course of site characterization can be used to guide

sampling/measurement activities. This will ensure that appropriate and sufficient data are collected to support the Technological Assessment (EPA CERCLA Feasibility Study) and decision making process.

The site characterization process involves both collection and synthesis of data to develop a conceptual model of the site and associated contamination problems. This information is then used to develop a contaminant transport model for describing the current conditions and evaluating the environmental and health impacts of alternative remedial actions, including the no action alternative. The level and sophistication of the data collection and synthesis process leading to model development depend on the complexity of the site, the scope of the contamination problem, and the degree of precision needed to screen and evaluate remedial alternatives.

1.2 OBJECTIVES

The basic objective of any sampling/measurement program is to produce a defensible set of samples/measurements representative of the source under investigation and suitable for subsequent analysis. The objective of sampling hazardous waste is to acquire information that will (1) assist investigators in identifying unknown compounds present in the environment, (2) assess the extent to which these compounds have migrated into the surrounding environment, (3) document conclusions regarding environmental impact, and (4) provide documentation for reporting requirements.

The objectives of SSMP activities are to:

- o verify and characterize contaminant sources
- o determine the present areal and vertical extent of contamination
- o estimate the potential for contaminant migration (including rate and direction) to support risk assessment studies

- o support the identification and technology assessment (feasibility study) of alternative response actions.

1.3 SAMPLING LOGISTICS

1.3.1 Scheduling

Prior to initiating site characterization, the probable duration (including contingency) and sequence of activities will be forecast so that the critical path of these activities may be scheduled. The sequence of other subtasks and constraints (e.g., funding, weather, installation restrictions) will be identified so that reasonable start/finish dates may be established.

1.3.2. Site Access

Site access arrangements for site characterization personnel will be made with each installation. Field activities will be scheduled with responsible reservation staff with as much lead time as possible. Arrival schedules will be confirmed by telephone 24-48 hours before staff and/or contractors are expected to arrive.

Installation security clearance badge and/or noncleared visitor badge arrangements will be made with the reservation security office.

2. SITE SURVEY AND MAPPING

Survey and mapping techniques will be employed to delineate boundaries of sites to be studied and illustrate the extent of contamination. To facilitate presentation and comparison of data generated during the investigation, maps at common (or readily interchangeable) scales with a fixed coordinate system will be used. Establishing map standards and coordinate systems provides a foundation from which to reference spatially distributed information. The resulting common frames of reference permit development of base maps assuring that subsequent maps, site physical features, and data monitoring or collection locations all correspond. The

two primary means for presenting coordinate systems are (1) the base map, consisting of a topographic surface compiled as elevation contours or digitized elevations recorded in a regular grid pattern; and (2) the boundary survey, portraying the polygonal region of a designated area with benchmarks reflecting coordinate values.

The level and sophistication of survey and mapping depend on the complexity of the site, the scope of the contamination problem, and the degree of precision needed to screen and evaluate remedial alternatives. For each site, existing surveys and maps will be reviewed and updated as required to conduct related activities. Where there may be a need to develop an aerial photographic display base that will support terrain analysis and overlay mapping, a program will be implemented to obtain the necessary survey control and photographic imagery.

3. SAMPLE COLLECTION

Sample collection is a critical component of the site characterization process. The quality of the samples collected will directly influence the value of the site characterization data. Therefore, collecting a representative portion of the media of interest and preserving it in an uncontaminated state until analyses are performed is extremely important. The collection of representative samples requires careful selection of a sampling strategy and strict adherence to sampling protocols/methods.

Because the sampling strategy and procedures will depend on the conditions at a specific site, a range of procedures and general guidelines are provided in the GMP selection and implemented in the SSMP plans. Site-specific factors to be considered in the SSMP sampling plans include: (1) the type, size, and topography of the site; (2) the type, quantity, and mobility of the waste/contaminants; and (3) the type and homogeneity of the medium to be sampled.

3.1 SAMPLING PLAN DESIGN

A sample must be a representative part of the object to be analyzed. To be a representative sample, the sample must have the same qualities as the material under consideration. The chemical parameters of interest and the nature of the material to be sampled (i.e., homogenous or heterogenous) dictate the number, frequency, and distribution of samples required. For example, if a material is known to be truly homogeneous, a single sample might suffice to define its quality. However, if a sample is heterogenous, a number of samples collected at specified time intervals or distances may be necessary to define the characteristics of the subject materials.

The number of samples collected at a site will also depend on the anticipated use of the data, the degree of accuracy (level of confidence) desired, and the cost of collecting and analyzing the samples. Statistical methods and formulas are available to estimate the appropriate number of samples required to obtain representative data within a specified level of confidence. The methods take into account sample variability and the degree of accuracy desired to derive a statistically valid sample number. Basically, the smaller the sample variability, the fewer samples required for a given level of accuracy. Conversely, the larger the sample variance and/or the greater the accuracy desired, the greater the sample size required.

3.1.1 Sample Types

There are basically six major types of samples that may be used in the site characterization effort. These sample types are briefly summarized below.

Individual Grab Samples. An individual grab sample is an isolated sample collected from one specific sampling point at a given time and placed in its own container for individual analysis. It provides information about the sample media at the exact time of collection and for a specific sampling point. Volatile organics (which may be lost by other sampling methods) can be collected in grab samples.

Simple Composite Samples. A simple composite sample is a combination sample comprised of subsamples collected either from various locations within a population or from the same location at various times. The subsamples are combined to form as homogenous a mixture as possible. Simple composite samples provide an estimate of the mean value of the parameter of interest, but cannot provide information about the high and low concentrations within the subsamples. They can also be used to screen an area for the contaminant of interest, but will not provide information on the spatial or time distribution of contaminants.

Sequential Composite Samples. A sequential composite sample is a sample formed from combining a series of simple composite samples. It is very useful for looking at the overall averages of a waste stream which varies significantly with time (e.g., an outfall from a plant which conducts batch dumping).

Hand-Proportioned Composite Samples. Hand-proportioned samples are subsamples manually composited in proportion to the effluent flow. The subsamples may be individual samples or proportional sequential composite samples.

Automatically-Proportioned Composite Samples. Composite samples are collected automatically by using equipment that can vary the size of the subsample in proportion to the total effluent flow.

Continuous Samples. Continuous sampling involves routing a small amount of the waste stream through a continuous monitor for direct measurement of contaminants. Continuous sampling may be used to monitor stack emissions/liquids for compliance/exposure levels.

3.1.2. Sampling Strategies

Sampling programs for site characterization activities will be designed to provide statistically valid data within a specified confidence level. Selection and implementation of the proper strategy will depend on the objectives of the sampling plan and the amount of information available on the

parameters of interest. The following sampling strategies will be considered in developing the SSMP sampling plans:

Simple Random Sampling. Simple random sampling uses the theory of random chance probabilities to choose representative sample locations. Random sampling is generally employed when little information is available on the contaminants or their spatial distribution within a population. This strategy is most effective when the population is large enough to lend statistical validity to the random selection process. Random sampling is implemented by overlaying the sample population (e.g., field, profile, group of drums) with a grid, and through the use of random number tables, selecting sampling points on the grid. Data taken in this manner show progressively less error with increasing numbers of samples collected.

Stratified Random Sampling. Stratified random sampling is a refinement of the simple random sampling approach to increase the accuracy of the data. It is generally employed when sufficient information is available to divide the population into relatively homogenous subpopulations (i.e., the subpopulations are individually more homogenous than the total population) based on the parameters of interest. The strategy is implemented through the collection of random samples of the subpopulation (e.g., vegetation samples that have been collected at randomly selected points according to the percentage of area each type of vegetation covers). The precision of the data will generally increase with an increase in the number of stratifications (subpopulations). However, the increase in numbers of analyses must be weighed against the actual gain in precision.

Systematic Sampling. Systematic sampling is also aimed at increasing the accuracy of the sampling data through the collection of samples at predetermined, regular-interval sampling points. This strategy is implemented by overlaying a grid over the population (e.g., site) and collecting samples at the grid intersections or at points equal distances away from each other. Systematic sampling introduces bias when there are periodic variations/trends in the population that may

become partially phased with the sampling points.

Stratified Systematic Sampling. Stratified systematic sampling involves the systematic collection of samples from subpopulations in proportion to the relative size of the subpopulation within the total population. It can only be employed when sufficient information is available to divide the population into relatively homogenous subpopulations (i.e., the subpopulations are individually more homogenous than the total population) based on the parameters of interest.

Judgment Sampling. Judgment sampling involves the selection of sampling sites based on the information base of the sample collector. Such samples are inherently biased; however, they may be used to document the presence (but not the absence) of particular contaminants. They may be very useful for situations in which the investigator knows where to look for a particular contaminant or is taking only a limited number of samples such as during initial screening/scoping (i.e., reconnaissance) activities. Depending on the knowledge of the investigator, this type of sample may provide more information than a sample taken at some statistically random point.

3.2 SAMPLING EQUIPMENT AND PROCEDURES

Sampling activities will be conducted at the sites using a variety of equipment and procedures. The equipment and procedures will be selected on a site-specific basis depending on the media and the nature of the contaminants to be sampled. This section provides a summary of some of the available equipment and methods for sampling materials that may be encountered during the site characterization activities. Each sampling plan will incorporate specific factors and the SSMP plans will include a detailed description of the procedures selected. Sampling equipment and procedures will be selected to obtain representative samples with minimal introduced interferences and to minimize personnel risk/environmental releases.

Numerous standardized methods are available for sampling contaminant sources and collecting environmental samples. The GMP will use EPA-approved and DOE-approved methods for sample collection whenever possible. If no EPA or DOE method is available, the samples will be collected using the best available methods from other sources [i.e., the American Society for Testing and Materials (ASTM), and the American National Standards Institute (ANSI)]. These alternate methods will be reviewed by EPA as part of the SSMP review cycle. The laboratory analyzing the samples should also be consulted before samples are collected to be sure that the collection methods, number, and quantity of samples are compatible with the analytical techniques to be employed. The Quality Assurance/Quality Control (QA/QC) Plan contains a description of the QA/QC procedures for sample collection.

3.2.1. Preparation of Sampling Equipment

Sampling equipment must be prepared for field use prior to the initiation of the sampling effort. Because contaminated samplers can cause cross-contamination of samples, proper cleaning of equipment before and between each application is imperative. If samples are expected to contain very low concentrations of contaminants, new unused (or disposable) sampling equipment may be necessary. Disposable samplers may also be needed for sampling media with very high concentrations of contaminants that will be too difficult or too expensive to remove.

The first step of sampler cleaning is to remove any materials or residues from the sampler. The method for removal of the residue will depend on the nature of the material present. Most residues can be removed by scrubbing in a warm detergent solution. However, petroleum products/oily residues should be removed with organic solvents (usually hexane or acetone) and wipes prior to cleansing with water. After all the residue has been removed, the sampler should be rinsed thoroughly in tap water, then in distilled water, and then completely dried. Steam cleaning may also be used for cleaning large pieces of sampling equipment as long as care is taken to ensure that all residues are completely removed. Contaminated water and solvents from the cleaning process should be collected and treated as hazardous waste.

Following cleaning, sampling equipment should be protected from contamination by wrapping/packaging and storing in a clean place until needed. The sampler cleaning process should be periodically checked (quality control) by rinsing the samplers and submitting the blanks for analyses.

3.2.2 Source Sampling

Sampling of contaminant sources involves the collection of samples from air emission sources, liquid effluent streams, liquid waste containers (e.g., bottles, drums, tanks, surface impoundments), and/or solid wastes (e.g., containers, piles, trenches, pits). In some cases, environmental contamination may also be considered a contaminant source because of the high concentrations of contaminants present (e.g., highly-contaminated leachate). Contaminant sources are generally characterized by fairly high concentrations of hazardous materials that may or may not be well contained. Because contaminant sources generally represent the highest concentration of hazardous materials, special precautions will be identified in the plan and implemented to minimize personnel exposure and to control releases of materials. Source sampling may be conducted using grab samples, composite samples, proportional samples, or continuous samples. When continuous sampling is used, it should be augmented by proportional composite samples and grab samples when specified levels are exceeded.

Collection of samples for the site characterization effort will be conducted in accordance with the sample plan design and sampling procedures identified in each SSMP. The following general guidelines will be incorporated into each SSMP:

- o The sampling approach will be well outlined prior to initiation of the sampling effort.
- o Sample containers will be cleaned and marked with the designated sample number using a wax pencil or temporary label.

- o A system for decontaminating the outside of the sample containers will be established. Following decontamination of the sample containers, permanent sample tags will be affixed and the samples logged on the chain-of-custody record (Section 5).
- o Preservation techniques will be employed in the field as appropriate (Section 4).
- o Transportation will be arranged in advance to avoid long delays in getting the samples to the laboratory for analyses (Section 6).

Sampling of contaminant sources can be used to quantify and confirm the nature of the source and assess the mobility of the contaminants. Some of the more commonly practiced methods for sampling sources are summarized in the following paragraphs and tables. Selection of an appropriate sampling method will depend on the waste containment and the physical state of the waste.

3.2.2.2 Liquid Effluent Stream Sampling Methods

Liquid effluent streams may be sampled to determine source terms and evaluate compliance. Sampling points must be selected to obtain a representative characterization of both the quantitative flow and the quality of the effluent stream.

The type of samples collected will depend on the site-specific characteristics of the discharge. The following guidance is provided for consideration in the development of each SSMP:

- o Grab and/or simple composite samples are seldom representative of liquid waste streams unless discharge is only from a continuous uniform process, or unless many samples are collected at frequent intervals over a wide time period. Grab/simple composite samples do not reflect either average concentrations or maximum values. However, grab samples can be useful in sampling liquid effluent

streams for volatile organics (which may evaporate during the collection of other types of samples).

- o Proportional composite and/or continuous samples will generally provide the most representative sample data (except for volatile organics). Continuous monitoring methods can be used to ensure that contaminant concentrations do not exceed specified levels.

3.2.2.4 Solid Waste Sampling Methods

Solid wastes may consist of various chemicals, miscellaneous waste materials (e.g., contaminated building debris, metals), or contaminated soil. The wastes may be contained in drums, buried in trenches/pits, or dumped in piles. The equipment/method selected for sample collection will depend on the nature of the material to be sampled and the containment of the material. Specific equipment/methods will be identified in each SSMP. A summary of some of the sampling equipment/methods is provided in Table 1.

3.2.3 Air Pathways Sampling

Contaminants released from hazardous waste sites through vapor release or resuspension of particulates can be transported to other areas through the air pathway. If potential sources such as open containers, heavily contaminated soils, or gas vents are identified during the initial site inspection, air monitoring programs may be included in the SSMP.

The principal goal of an air sampling program will be to quantify source terms and evaluate migration potential through the air pathway. Sites for air monitoring stations will be selected based on the source emissions, climatological considerations (primarily wind speed and direction), and the local topography. Background stations will be installed if necessary to adequately assess the situation and interpret the data. Specific monitoring requirements and sampling procedures will be identified in each SSMP. The following general guidelines will be considered in SSMP development:

TABLE 1. SAMPLERS FOR LIQUID AND SOLID WASTES

| Container | Sampler | Depth Capability | Advantages | Disadvantages |
|---------------------------|---|------------------|---|---|
| Drums/bottles (liquid) | glass tubing (drum thief) rigid plastic tubing | 4 ft | liquids and sludges ^a caustic liquids | cannot be used for caustic liquids may not be sufficiently rigid cannot collect multiphase samples |
| Tanks | glass vial attached to a wooden dowell teflon/glass tubing with vacuum pump stainless steel well bailer coliwassa bacon bomb Kemmerer sampler weighted bottle open drain valves | 16 to 20 ft | liquids and sludges good depth good for multiphase sampling good for samples from discrete levels good for samples from discrete levels | contamination from upper levels release contaminants if can't close, sample only layer of drain |
| Surface Impoundments | teflon beaker on telescoping aluminum pole bacon bomb (see above) Kemmerer sampler (see above) scoop | | | |
| Drums (solid) | spoon on wooden dowell chisel and hammer | | | |

TABLE 1. SAMPLERS FOR LIQUID AND SOLID WASTES (CONTINUED)

| Container | Sampler | Depth Capability | Advantages | Disadvantages |
|-------------|-----------------------------------|------------------|--|---------------|
| Waste Piles | scoops/trowels sampling triers | 1 ft | good in moist, sticky powder, or granules | |
| | grain sampler | 40 in | good in powdered or granular material | |

^a Larger bore tubing can be used for viscous liquids and sludges.

- o Air sampling devices should be located to minimize interference from obstructions and ground dust.
- o Air sampling devices should be equipped with real time flow recorders to accurately reflect the volume of air sampled. Flow rates will depend on the sampling device and contaminants. Automatic timers can be used as appropriate.
- o An anemometer and wind direction recorder should be located in the vicinity to collect wind data.
- o Barometric pressure, relative humidity, and ambient temperature readings will be recorded in conjunction with the air sampling data.
- o Impingers/absorbents/filters will be selected for the specific contaminants of interest according to EPA methods or other approved methods as appropriate.
- o Samples for volatile organics will be sealed, packed in dry ice, and sent for analysis as soon as possible.

3.2.4 Surface Water Pathways Sampling

Surface water sampling may be conducted as part of the site characterization activities to determine migration potential from the surface water pathway. The surface water sampling program will include collection of both water samples and sediment samples. The type, location, and frequency of samples will depend on the site-specific conditions. Specific equipment/methods will be identified in each SSMP. EPA-approved methods and guidance will be used as appropriate.

3.2.4.1 Surface Waters

To obtain representative surface water samples, the hydraulics of the water course must be determined prior to sampling. Representative sampling

points will be selected to reflect both the quality and the quantity of contamination. Because surface water quality normally varies considerably over time, grab, composite, and/or sequential composite samples will be collected and/or continuous monitoring will be conducted, as appropriate, to indicate contaminant loadings and migration potential.

In large ponds and lakes, nonuniform vertical mixing of chemical constituents often occurs because of wind and temperature changes, the shape of the lake basin, biological activity, and other factors. Therefore, water samples will be collected from different depths as appropriate.

Equipment/methods for sampling surface waters depends on the physical conditions of the surface water body and the chemical contaminants of interest. A brief summary of some of the EPA-approved water sampling equipment is provided in Table 2. Streamflow measurements will also be recorded as part of the sampling program as appropriate.

3.2.4.2 Sediments

Sediment samples can provide additional information on the transport of contaminants that may partition onto soil particles or settle out in deposits on the bottom of the watercourse. While sediments are generally saturated, sampling procedures are generally similar to those used for soil sampling (Section 3.2.6). Equipment includes scoops or trowels, sampling triers, soil augers, waste pile samplers, dredges, and split spoon samplers.

When sediment sampling is conducted simultaneously with surface water sampling, the water sample should be obtained first (and upstream of sampling personnel) to minimize the amount of suspended solids in the water sample. Sediment sampling equipment and techniques must be designed to minimize the risk of dilution or loss of material as the sample is moved through the water column.

TABLE 2. SUMMARY OF WATER SAMPLING EQUIPMENT

| | Construction | Closure Mechanism | Size Range | Depth Range Meters (feet) | Possibility of Contamination | Advantages | Disadvantages |
|--|---|--|-------------------------------------|---------------------------|---|--|---|
| Kammerer water sample bottle | Nickel plated brass | Internal rod or wire, messenger activated | 0.4 and 1.2L (0.1 - 0.3 gal) | 1 (3) to 90 (300) | Metals from bottle and from closure mechanism | Ease of use; good depth range | Separate sampler needed to sample for metals |
| | Acrylic plastic, urethane end seals. | Internal rod or wire, messenger activated | 1.2 and 2.2 L (0.3 and 0.6 gal) | 1 (3) to 90 (300) | Phthalate esters and possibly other organics. Metals possible from bottle closure mechanism. | Ease of use; good depth range | Separate sampler needed to sample for phthalate esters. Possible metals contamination from closure mechanism. |
| Van Dorn bottle | Acrylic plastic, PVC, other materials | Internal elastic tubing. Messenger activated | 2 to 30L (0.5 to 7.9 gal) | Surface to 90 (300) | Phthalate esters and other organics | Ease of use; good depth range | High probability of contamination. |
| Hansen bottle | Brass tubing, Teflon-lined Neoprene gaskets | Rotary valves close when bottle turns end-over-end to close valves. Messenger activated. | 1.25L (0.35 gal) and 1.5L (0.4 gal) | Surface to deep ocean | Minimal if Teflon-lined | Can be used in series for deep water | Reversing operation prevents sampling close to bottom |
| Fjarlie water bottle | Brass tubing, Teflon coated | Spring-loaded metal cover plates with rubber discs to seal ends. Messenger activated. | 1.3L (0.35 gal) | Surface to deep ocean | Possible organics or metal contamination from rubber seals | Flow-through design. Can sample near bottom. | Possible contamination |
| Niskin sampling bottle - Teflon coated internal closure | Rigid PVC with optional Teflon coating | Internal latex tubing. Messenger activated. | 1.7 to 30L (0.4 to 7.8 gal) | 1.8 (6) to deep ocean | Trace metals and organics from latex closure mechanism. Organics from PVC if not Teflon coated. | Multiple bottles can be triggered remotely by use of appropriate accessory | Not convenient for very shallow water. Some contamination possibilities. |
| Flow-through Niskin type bottle Teflon-coated-external closure | Rigid PVC with optional Teflon coating | Close-open-close valves. No internal mechanism. | 1.7 to 60L (0.4 to 15.6 gal) | 1.8 (6) to deep ocean | Minimal if Teflon coated. Otherwise good chance of organics contamination from PVC. | Can penetrate surface slicks with minimal chance of contamination. | Not convenient for shallow water. |

TABLE 2. SUMMARY OF WATER SAMPLING EQUIPMENT (CONTINUED)

| Construction | Closure Mechanism | Size Range | Depth Range Meters (feet) | Possibility of Contamination | Advantages | Disadvantages |
|--|---|--|---|--|--|---|
| Glass-lined contamination-free modification of the Niskin bottle. | Stainless steel disc ruptures at preset depth. Stainless steel check valve prevents contamination after bottle is filled. | 5 to 90L (1.3 to 23.5 gal) 15L (3.9 gal) standard size. | Moderate depth to 4000 meters (13,200 feet) | Minimal | Lack of contamination, especially organics | Very expensive. Very heavy and cumbersome. |
| Body-anodized aluminum alloy. Pyrex glass liner sample chamber. Flow restrictor, check valve, rupture disc of stainless steel. | Spring closure. Pulled open by auxiliary line at depth. | 3.7L (1 gal) | Surface to 9 (30) | Minimal | Can penetrate surface slicks. Easily constructed. | Limited to relatively shallow waters. |
| Glass bottle supported by metal frame-Teflon cap. | External lever on pole. | 125ml to 1L (3.75 to 30 oz) | Surface to approximately 1.8 (6) | Minimal | Can penetrate surface slicks. Interchangeable bottles. | Limited to shallow waters. |
| Grab sampler-glass bottle on pole. | N/A | 473 ml (14 oz) | 0 to 5.8 (19) | Minimal organics with bronze body. Minimal metals with painted body. | Depth integrating. Can be operated from bridges or boats. Hand-line operation. | Depth limitation. Intake tube may become plugged by trash. Primarily designed for sampling flowing water. |
| Depth-integrating Samplers Sampling. | N/A | 946 ml (28 oz) | 0 to 5.8 (19) | Minimal organics with bronze body. Minimal metals with painted body. | Depth integrating. Can be operated from bridges or boats. | Depth limitation. Intake tube may become plugged by trash. Primarily designed for sampling flowing water. |

TABLE 2. SUMMARY OF WATER SAMPLING EQUIPMENT (CONTINUED)

| Construction | Closure Mechanism | Size Range | Depth Range Meters (feet) | Possibility of Contamination | Advantages | Disadvantages |
|--|--|-----------------------------|---|--|---|---|
| Aluminum (available with epoxy-painted body, nylon nozzles, and silicone rubber gaskets for trace metal sampling.) | N/A | 473 or 946 ml (14 to 28 oz) | 0 to 22 (73) with 473 ml container; 0 to 15.5 (51) with 946 ml container. | Minimal organics with aluminum body. Minimal metals with painted body. | Point-integrating. Can sample continuously over a range in depth. | Depth limitation. Valving systems requires a DC power supply. |
| Aluminum side plates with polyethylene bags. | Messenger activated; knife cuts open sealed fill tube. | 1.5 L (0.4 gal) | Unlimited | Phthalate esters and other organics from bag. | Can penetrate surface slicks; may be useful for metals. | Potential for organics contamination. |

Source: EPA

3.2.5 Groundwater Pathways Sampling

Groundwater monitoring will be conducted as part of the site characterization effort to identify subsurface pathways of contaminant migration and to define the areal and vertical extent of subsurface contamination. This information will be used in assessing the risks to humans and the environment through the groundwater pathway. Computer modeling of groundwater movement and contaminant migration may be conducted as part of the risk assessments. If models are to be used in the evaluation, sufficient data should be collected during the site characterization effort to provide input to the models.

3.2.5.1 Saturated Zone

The groundwater monitoring must consider both the hydraulics (movement, rates, and directions of groundwater and contaminant flow) and the quality of the groundwater. This information can be obtained through data collection from appropriately located monitor wells and piezometers. Because of the relatively high cost of wells and piezometers, their utility can be optimized by using indirect geohydrological data to select sampling locations. Indirect data can be obtained from existing hydro-geologic maps and reports, aerial image interpretation, soil-gas analysis, geophysical surveys, and other techniques. Typically, groundwater studies are conducted in several stages to take advantage of new information derived from indirect and direct sources.

The equipment/methods for groundwater sampling may be found in the following references: Johnson 1986; Freeze and Cherry 1979; Kruseman and DeRidder 1976; Van der Leeden 1983; Walton 1970; Everett 1980; Sanders et al. 1983; and Sisk 1981. EPA-approved methods will be used whenever possible. Drilling methods and well casing and screening materials for monitoring wells are summarized in Tables 3 and 4.

Methods of drilling, well completion, and well development will vary depending on site conditions. General precautions that should be followed at all sites include:

TABLE 3. DRILLING METHODS FOR MONITORING WELLS

| Type | Advantages | Disadvantages |
|-------------------|---|--|
| Hollow stem auger | <p>Split spoon and continuous core give excellent samples from precise depths</p> <p>No drilling fluid is used, minimizing contamination problems</p> <p>Formation waters can be sampled during drilling by using a screened lead auger or advancing a well point ahead of the augers</p> <p>Hole caving can be overcome by implacing screen and casing before augers are removed</p> | <p>Cannot be used in all consolidated materials</p> <p>Limited to depths of 100-200 ft; formation samples may not be completely accurate, depending upon how they are taken</p> |
| Mud rotary | <p>Can be used both in unconsolidated and consolidated formations</p> <p>Core samples can be collected for certain types of analysis</p> <p>Cores excellent for lithological correlation</p> <p>Capable of drilling to any depth</p> <p>Casing not required during drilling</p> <p>Flexibility in well construction</p> | <p>Drilling fluid is required:</p> <ul style="list-style-type: none"> - contaminants are circulated with the fluid - the fluid mixes with the formation water and invades the formation and is sometimes very difficult to remove - Bentonite fluids may absorb metals and may interfere with some other parameters - organic fluids may interfere with bacterial analyses and/or organic-related parameters <p>No information on location of the water table and only limited information on water-producing zones, is directly available during drilling</p> |

TABLE 3. DRILLING METHODS FOR MONITORING WELLS (Continued)

| Type | Advantages | Disadvantages |
|------------|--|---|
| Air rotary | <p>No drilling fluid is used, minimizing contamination problems</p> <p>Cores can be analyzed for certain types of constituents</p> <p>Can be used in both unconsolidated and consolidated formations</p> <p>Capable of drilling to any depth</p> | <p>Casing is required to keep the hole open when drilling in soft, caving formation below the water table</p> <p>When more than one water-bearing zone is encountered and hydrostatic pressures are different, flow between zones occurs between the time drilling is completed and the time the hole can be properly cased and grouted off</p> |
| | <p>Formation sampling ranges from excellent in hard, dry formations to nothing when circulation is lost in formations with cavities</p> | <p>Cuttings are difficult to control creating dust problems. Health hazards in contaminated areas</p> |
| | <p>Formation water is blown out of the hole along with cuttings making it possible to determine when the first water-bearing zone is encountered</p> | |
| | <p>Collection and field analysis of water blown from the hole can provide enough information regarding changes in water quality for parameters such as chlorides for which only large concentration changes are significant</p> | |
| Cable tool | <p>Only small amounts of drilling fluid (generally water with no additives) are required</p> | <p>Potential contamination by drilling fluid</p> <p>Relatively large diameters are required (minimum 4-in. casing)</p> |

TABLE 3. DRILLING METHODS FOR MONITORING WELLS (Continued)

| Type | Advantages | Disadvantages |
|------|--|--|
| | Can be used in both unconsolidated and consolidated formations; well suited for caving, large gravel type formations with large cavities above the water table | Steel drive pipe must be used Caving of holes requires the casing to be run with the drilling |
| | Formation samples can be excellent with a skilled driller | Usually a screen must be set before a water sample can be taken |
| | When water is encountered, changes in potentiometric levels are observable | Open hole gives poor samples for analysis |
| | Relative permeabilities and rough water quality data from different zones penetrated can be obtained by skilled operators | |
| | Good seal between casing and formation if flush jointed casing is used | |

TABLE 4. WELL CASING AND SCREEN MATERIALS

| Type | Advantages | Disadvantages |
|--|--|---|
| PVC (Polyvinyl chloride) | Excellent chemical resistance to weak alkalis, alcohols, aliphatic hydrocarbons, and oils Good chemical resistance to strong mineral acids, concentrated oxidizing acids, and strong alkalis | May absorb some constituents from groundwater May react with and leach some constituents into groundwater if not sampled correctly |
| Polypropylene | Excellent chemical resistance to mineral acids Good to excellent chemical resistance to alkalis, alcohols, ketones, and esters Good chemical resistance to oils | May react with and leach some constituents into groundwater |
| Teflon (Teflon is a registered trademark of DuPont, Inc.) | Fair chemical resistance to concentrated oxidizing acids, aliphatic hydrocarbons, and aromatic hydrocarbons Outstanding resistance to chemical attack; insoluble in all organics except a few exotic fluorinated solvents | Very expensive |
| Mild steel | Strong, rigid; temperature sensitivity not a problem | May react with and leach some constituents into groundwater Not as chemically resistant as stainless steel |

TABLE 4. WELL CASING AND SCREEN MATERIALS

| Type | Advantages | Disadvantages |
|-----------------|---|---|
| Stainless steel | Excellent resistance to corrosion and oxidation | Need good equipment to make connections Heavier than plastics May corrode and leach some chromium in very acidic waters May act as a catalyst in some organic reactions Hard to handle and make connections |

- o Prevent hydraulic connections between different stratigraphic units while drilling
- o Seal completely the screened interval from overlying layers
- o Manage water pumped or blown from the well during development properly, and
- o Clean all equipment to prevent downhole cross-contamination.

Sampling method selection criteria and sampling devices for monitoring wells are summarized in Tables 5 and 6. Samples should be carefully drawn and preserved to maintain the integrity of the samples and prevent cross contamination between strata. Methods that allow excessive exposure to the atmosphere, to other gases, or to other strata should not be used if they might influence the measurement of specific constituents. For example, exposure of the sample to the atmosphere, to other gases, or to other strata may result in changes in the concentration of dissolved gases in the sample. These changes can alter the pH of the sample, which in turn can alter the dissolution of specific constituents, particularly metals, and influence water quality measurements. Similarly, changes in the redox potential and, consequently, in the chemical species present may result. Exposure of the sample to the atmosphere or to reduced pressures can also result in the degassing and loss of volatile organics from the sample.

Collection of immersible fluid samples requires special procedures because evacuation immediately prior to sampling is not appropriate. A sample of the floating immersible may be taken by using a bailer that fills from the bottom. Care should be taken to lower the bailer just through the floating layer but not significantly down into the underlying groundwater. Samples of the groundwater at the bottom of the screen and at some intermediate location, such as the midpoint of the screen, may also be obtained with a bailer. Sampling of a dense immersible can be accomplished by using a grab sampler. Pumps with intakes located in immersible fluid may also be used. If a pump is used, it must be operated at a sufficiently low rate to ensure that no mixing occurs.

TABLE 5. GROUNDWATER SAMPLING--METHOD SELECTION CRITERIA

| Analyte Parameters | Positive Displacement Bladder Pumps | Thief, in situ or Dual Check Valve Bailers | Mechanical Positive Displacement Pumps | Gas Drive Devices | Suction Mechanisms |
|-------------------------------|--|--|--|-------------------|--|
| Volatile organic compounds | Superior performance for most applications | May be adequate if well-purging is assured | May be adequate if design and operation are controlled | Not recommended | Not recommended |
| Dissolved gases | Superior performance for most applications | May be adequate if well-purging is assured | May be adequate if design and operation are controlled | Not recommended | Not recommended |
| Well-purging parameters | | | | | |
| Trace inorganic metal species | Superior performance for most applications | May be adequate if well-purging is assured | Adequate | May be adequate | May be adequate if materials are appropriate |
| Reduced species | | | | | |
| Major cations and anions | Superior performance for most applications | May be adequate if well-purging is assured | Adequate | Adequate | Adequate |

Adapted from: EPA-600/2-85-104.

TABLE 6. SAMPLING DEVICES FOR MONITORING WELLS

| Device | Appropriate Maximum Sampling Depth | Materials (Sampling Device Only) | Potential for Chemical Alteration | Ease of Operating, Cleaning and Maintenance |
|---------------------------------|--------------------------------------|---|-----------------------------------|---|
| Bailers | Unlimited | Any | Slight-moderate | Easy |
| Syringe samplers | Unlimited | Stainless 316. Teflon or polyethylene/glass | Minimum-slight | Easy |
| Suction-lift (vacuum) pumps | 8-10 ft | Highly variable | High-moderate | Easy |
| Gas-drive samplers | 300 ft | Teflon, PVC, polyethylene | Moderate-high | Easy |
| Bladder pumps | 400 ft | Stainless 316. Teflon/Viton PVC, silicone | Minimum-slight | Easy |
| Gear-driven submersible pumps | 200 ft | Stainless 304 Teflon, Viton | Minimum-slight | Easy |
| Helical rotor submersible pumps | 125 ft | Stainless 304 EPDM Teflon | Slight-moderate | Moderately difficult |
| Gas-driven piston pumps | 500 ft | Stainless 304 Teflon Delrin | Slight-moderate | Easy to moderately difficult |
| Air lift sampler | Limited by bursting strength of pipe | Variable | High-moderate | Easy to difficult |

TABLE 6. SAMPLING DEVICES FOR MONITORING WELLS (Continued)

| Device | Appropriate Maximum Sampling Depth | Materials (Sampling Device Only) | Potential for Chemical Alteration | Ease of Operating, Cleaning and Maintenance |
|----------------------|--|--|---|--|
| Jet pump | 150 ft | Variable | Slight-high | Moderately difficult |
| Rod or pitcher pumps | 400 ft | Plastic steel | High-moderate | Difficult |

Source: DOE 1986.

3.2.5.2 Unsaturated Zone

Groundwater risk assessments need to include characterization and assessment of the unsaturated (vadose) zone. The unsaturated zone is described as the layers of soil or parent material between the surficial layer and the saturated (groundwater) zone. The movement of moisture in this zone is usually relatively slow; however, under some conditions, a rapid downward flux of moisture may occur. The unsaturated zone will be monitored, as appropriate, to define the spatial distribution of contamination and to detect any significant movement of contaminants downward towards both soil cores and soil-pore liquids. The number, location, and depth of soil core and soil-pore liquid samples collected will be determined on a site-specific basis to allow an accurate indication of both water and soil quality. The study of the unsaturated zone is usually more difficult to implement than studies of groundwater. Techniques for monitoring the vadose zone are not as well developed as techniques for monitoring groundwater; however some guidelines for vadose zone monitoring may be found in the following references Wilson 1979; Wilson 1981; Wilson 1982; and Wilson 1983. Vadose zone sampling techniques are briefly summarized in Table 7.

3.2.6 Land Migration Pathways

The site characterization activities will include sampling of land migration pathways. The land pathways sampling program will be primarily directed at collecting soil samples. The type, location, and frequency of samples collected will depend on the site-specific conditions. Specific equipment/methods will be identified in each SSMP Sampling Plan. EPA-approved methods and guidance will be used as appropriate.

Soil sampling is conducted to determine the general soil characteristics and the type, degree, and extent of soil contamination resulting from various operational activities and disposal practices. Selection of the most appropriate sampling techniques and equipment to be used for soils will be dependent on the soil type and condition, the sample depth, and the amount of material required for analysis. The major

TABLE 7. VADOSE AONE MONITORING TECHNIQUES

| Methods | Applications |
|--------------------------------------|---|
| Soil core samples | |
| 1) triers | very shallow core samplers |
| 2) oakfield | shallow core samples |
| 3) bucket augers | good quantity cores to approximately 60 m |
| 4) power driven continuous corers | |
| 5) power driven split spoon | very good quality cores to approximately 60 m |
| Soil-pore liquid samples | |
| 1) pressure vacuum lysimeters | generally good for field application ceramic cup may affect water quality not recommended for volatiles |
| 2) trench lysimeters | samples only free water in excess of saturation |
| 3) vacuum extractors | required excavation of large trench gives quantitative estimate of moisture delicate instrument, trained operator poor in clay soils |

Source: Extracted from EPA SW-846.

differentiating factor in the selection of techniques and equipment is the depth of the sample. Surface samples are generally easy to obtain using hand equipment. Subsurface samples are obtained by drilling or by excavating test pits. Soil sample collection methods are summarized in Table 8. In order to minimize the chances that samples will be cross contaminated, all sampling equipment must be carefully cleaned before each use (Section 3.2.1).

Subsurface sampling is conducted to obtain soil from known depths in order to evaluate site characteristics, detect the presence of any contaminants, and to evaluate the potential for pollutant migration. Drill rigs or backhoes are generally necessary to collect subsurface soil samples. Subsurface samples may be obtained continuously, at predetermined depths, or at every change in lithology. Continuous sampling provides the most accurate record of subsurface conditions for interpretive purposes but is not always necessary, depending on the objectives of sampling. Test pits may be used to expose shallow soil units in order to obtain detailed soil descriptions and multiple samples from specific soil horizons.

In addition to field sampling logs, descriptive logs of visual soil characteristics should be maintained for all soil sampling operations. The log should contain a description of the soil horizons, including soil color (visual inspection or Munsell Color Notation), texture (USDA or a unified soil classification system including grain size), density (standard penetration tests) or consistency, measurements made with organic vapor detectors, and relative moisture content.

3.2.7 Biotic Sampling and Evaluations

The collection of biotic samples (flora and fauna) will be conducted as part of the site characterizations to provide information relative to contaminant migration for risk assessments. The type of samples collected will depend on the site-specific conditions and will be detailed in each SSMP. However, in general, important food chain species (including domestic species as appropriate) and biological indicator species will be targeted for evaluation.

TABLE 8. SOIL SAMPLING METHODS

| Sampler | Depth Capability | Application | Materials |
|---|------------------|--|--|
| ring samplers/ soil punch | 20 cm | nonclay surface soils (reproducible area) | stainless steel, chrome- plated steel |
| trowels | 30 cm | surface soils (nonreproducible area) | stainless steel |
| shovels | 90cm | loose subsurface sediments (nonreproducible area) | steel |
| hand augers | 2 m | disrupted cores (cross contamination problems) | stainless steel, brass |
| bucket augers | 3 m | stony, dense, sandy, or saturated materials | stainless steel, brass |
| power driven corer/auger | variable | cores from greater depths than hand auger | stainless steel |
| power driven auger with split spoon | variable | good samples at distinct depths | stainless steel |
| trenching | variable | broad subsurface application (expensive) | steel |

In addition, biotic communities may be evaluated (but not necessarily sampled) to provide information on community disturbances and assess environmental effects. These evaluations may include surveys for invader species (indicating past disturbance or contamination), surveys to detect community composition changes, characterization of endangered/threatened species habitat (to minimize impact from a site), and/or quantification of biomass production relative to total regional availability.

3.2.8 Geophysical Investigations

Geophysical techniques may be used in the site characterization effort to locate and provide additional information on hazardous waste sites and contamination plumes. Geophysics will be primarily used to collect reconnaissance data and provide input for selection of sampling sites and groundwater monitoring locations. Geophysical surveys may be used to:

- o Detect unknown waste deposits, pipes, and cables;
- o Determine lateral boundaries of plots and trenches;
- o Determine the thickness of overburden material;
- o Discriminate between metallic and non-metallic materials;
- o Map chemical contaminant migration plumes;
- o Locate sinkholes; and
- o Determine the depth to groundwater and bedrock.

A general summary of geophysical methods is provided in Table 9. The application of geophysical surveys will be identified in each SSMP. Geophysical methods can provide useful reconnaissance information through indication of soil disturbances, buried objects, and changes in conductivity/resistivity. However, geophysical investigations cannot specifically identify the nature of the objects or locate buried objects/contaminant plumes with a high degree of resolution. Geophysical data collected under Section 3.2.8 will not be used to provide definitive answers.

TABLE 9. GEOPHYSICAL METHODS

| Techniques | Applications | Depth |
|-------------------------|---|-------------|
| Metal Detector | Large metal objects | shallow |
| Magnetometer | Iron and steel objects | 10 ft |
| Ground Penetrating | Anomalies in the soil column trenches, pits, voids | 5 to 100 ft |
| Aerial Imaging | | |
| .thermal | Vapor releases | NA |
| .photography | Surface anomalies Vegetation changes | NA |
| Acoustic Reflection | Buried objects Metallic/nonmetallic in tight/moist soils (poor resolution) | |
| Electrical Resistivity | Buried objects Metallic/nonmetallic in tight/moist soils | 25 ft |
| Electrical Conductivity | Buried objects (poor resolution) | 25 ft |
| Seismic Techniques | Site geology Groundwater contamination in unconsolidated sand | |
| Bore Hole Geophysics | Stratigraphy and lithology evaluations Water quality determinations | variable |

3.2.9. Radiological Surveys

Radiological surveys may be necessary to locate radionuclide contamination and to characterize the types of radionuclides present. Radiological contamination can be measured directly through monitoring for gross alpha and beta or x-ray/gamma, or it may be determined by sampling soils, sediments, surface waters, groundwater, suspended particulates, and/or biota.

Some analytical measurements for soil and water sampling are discussed in Section 7. When soil samples are collected and analyzed for alpha contamination, the soils must be dry to prevent shielding by soil water.

3.2.9.1 Surface X-Ray/Gamma Measurements

External x-ray/gamma measurements may be used to estimate the near surface extent and levels of x-ray/gamma contamination present at a waste site and to estimate the potential health effects from external exposure. Standard x-ray/gamma survey instruments are commercially available and include high purity germanium detectors, sodium-iodide crystal scintillation counters, and portable survey counters. Because the instruments differ in their sensitivity for gross measurements, a microR meter should be used for most environmental measurements. If very high radiation levels are expected, a miliR meter will be adequate. Calibration of the instrument at regular intervals using a source of known strength is important. (Because the x-ray/gamma spectrum is dependent upon the source used, some errors in the absolute readings will result if the radionuclides being surveyed give a somewhat different spectrum from the source.)

Surficial (depth less than 20 cm) x-ray/gamma contamination can be detected by walking the area (on a grid superimposed over the site) holding the survey meter at a constant height above the ground. The relative differences between readings on the site and background measurements (made under similar conditions including similar soils) can be used to identify areas of potential contamination.

3.2.9.2 Surface Alpha and Beta Measurements

External alpha and beta measurements may be used to estimate the near surface extent and levels of alpha and beta contamination present at a waste site, and to estimate the potential health effects from external exposure. Standard portable alpha and beta survey instruments are commercially available. Because of the very short range of alpha particles, alpha detection instruments must be in close contact with the sample. Calibration of the instruments at regular intervals using a source of known strength is important. Measurements are only useful for high intensity fields that approach personnel safety. Areas that cannot be adequately surveyed by laboratory analysis of collected samples.

3.2.9.3 Borehole Measurements

Down hole radionuclide measurements may be required to characterize the radionuclide concentrations as a function of depth. Standard gamma logging instruments are available for making borehole measurements, including a thallium-enriched analyzer. Borehole instrumentation must be calibrated to the sample medium to provide meaningful results.

4. SAMPLE CONTAINERS, PRESERVATION, AND HOLDING

To minimize changes in the chemical quality of a sample during shipping and storage prior to analysis, the investigator should use proper containers and adequate procedures for sample preservation and shipment. In some cases, the investigator may also need to split the sample into several different samples, specifying different sample containers and preservation methods for each sample based on the analyses of interest.

Methods of preservation are relatively limited and are intended generally to (1) retard biological action, (2) retard the reaction of chemical compounds and complexes, (3) reduce volatility of constituents, and (4) reduce absorption effects. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and freezing.

4.1. SAMPLE CONTAINERS

The most important factors to consider when choosing containers for hazardous material samples are compatibility, resistance to breakage, volume, and compliance with Department of Transportation (DOT) shipping regulations.

The sample container requirements for soil/sediment and aqueous samples are summarized in Tables 10 and 11, and for wastes are summarized in Table 12.

Sample container materials will be selected to reduce interference with the chemical parameters of interest. Glass and polyethylene containers are the most commonly used. Polyethylene containers and caps are preferred for metals. Glass containers with Teflon-lined caps must be used for organics. Teflon-faced septa are used for volatile organics. The selection of containers, closures, and linings must be coordinated with the analytical laboratory, which may require specific containers for certain analyses.

Selection of container size will depend on the quantity of sample needed for analysis and the nature of the material. The container should be large enough to contain a sufficient sample for analysis, split analysis, hand/or archiving. However, using excessively large containers will increase storage problems and shipping costs. In addition, containers for samples that may contain volatile compounds should be selected to minimize the amount of empty space in the container.

Depending on the analyses to be performed and the nature of the samples being collected, the sample containers must be treated according to specific procedures. Some general guidelines are provided below. More specific cleaning instructions will be given in the SSMPs as necessary.

- o General Bottle Cleaning:

- o Procedure; rinse bottles with tap water, soak bottles in phosphate-free detergent solution for approximately 30

TABLE 10. SAMPLE REQUIREMENTS--SOIL/SEDIMENT SAMPLES

| Analytical Parameter | Sample Size | Container | Preservatives | Holding Time | Comments |
|---------------------------------------|--------------------------------|--|--------------------------|---|--|
| Halogenated volatile organics | Enough to fill (2) 40 ml vials | Glass vial with Teflon-faced silicon septa and screw cap | 4°C, hermetically sealed | Must analyze within 14 days | Sample container should contain no headspace |
| Nonhalogenated volatile organics | Enough to fill (2) 40 ml vials | Glass vial with Teflon-faced silicon septa and screw cap | 4°C, hermetically sealed | Must analyze within 14 days | Sample container should contain no headspace |
| Aromatic volatile organics | Enough to fill (2) 40 ml vials | Glass vial with Teflon-faced silicon septa and screw cap | 4°C, hermetically sealed | Must analyze within 14 days | Sample container should contain no headspace |
| Acrolein, acrylonitrile, acetonitrile | Enough to fill (2) 40 ml vials | Glass vial with Teflon-faced silicon septa and screw cap | 4°C, hermetically sealed | Must analyze within 14 days | Sample container should contain no headspace |
| Phenols | Minimum 100 g | Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing | 4°C | Must extract within 7 days, and analyze within 30 days | |
| Phthalate esters | Minimum 100 g | Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing | 4°C | Must extract within 7 days, preferably within 2, and analyze within 30 days | |
| Organochlorine pesticides and PCBs | Minimum 100 g | Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing | 4°C | Must extract within 7 days, preferably within 2, and analyze within 30 days | |

TABLE 10. SAMPLE REQUIREMENTS--SOIL/SEDIMENT SAMPLES (Continued)

| Analytical Parameter | Sample Size | Container | Preservatives | Holding Time | Comments |
|-----------------------------------|-------------------------|--|------------------------|---|------------------------------|
| Nitroaromatics and cycloketones | Minimum 100 g | Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing | 4°C | within 30 days Must extract within 7 days, preferably within 2, and analyze within 30 days | |
| Polynuclear aromatic hydrocarbons | Minimum 100 g | Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing | 4°C | Must extract within 7 days, preferably within 2, and analyze within 30 days | |
| Chlorinated hydrocarbons | Minimum 100 g | Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing | 4°C | Must extract within 7 days, preferably within 2, and analyze within 30 days | Minimize headspace of sample |
| Organophosphorous pesticides | Minimum 100 g | Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing | 4°C | Must extract with 7 days, preferably within 2, and analyze within 30 days | |
| Chlorinated herbicides | Minimum 500 g | Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing | 4°C | Must extract within 7 days, and analyze within 30 days | |
| Volatile organics (GC/MS) | To fill (2) 40 ml vials | Glass vial with Teflon-faced silicon septa and screw cap | 4°C/protect from light | Extract and analyze within 14 days | Minimize headspace of sample |
| Semivolatiles (GC/MS) | To fill (2) 40 ml vials | Glass vial with Teflon-faced silicon septa and screw cap | 4°C | Extract within 14 days and analyze within 40 days | |

TABLE 10. SAMPLE REQUIREMENTS--SOIL/SEDIMENT SAMPLES (Continued)

| Analytical Parameter | Sample Size | Container | Preservatives | Holding Time | Comments |
|----------------------|---------------|--|---------------|--|--|
| Metals | Minimum 100 g | HDPE or glass, prewashed with detergent, acid, and Type II | 4°C | Analyze ASAP | Special containers necessary if volatile As, Se compounds present. Ag samples stored in brown bottles in the dark. |
| Cyanide | 100 g | HDPE or glass | 4°C | Analyze ASAP, 24 hours max. | |
| Chromium VI | 100 g | HDPE or glass | 4°C | Analyze ASAP, 48 hours max. | |
| EP Toxicity | Minimum 600 g | Borosilicate glass | 4°C | Metals-ASAP Pesticides - extract within 7 days and analyze within 30 days | |

Sample preservation should be performed immediately upon collection. For composite samples each aliquot should be preserved at the time of collection. When impossible to preserve each aliquot, then samples may be preserved by maintaining at 4 C until compositing and sample splitting is completed.

Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis to be still considered valid.

This information taken from EPA publication SW-846, 2nd Edition, "Test Methods for Evaluating Solid Waste" (July 1982)

TABLE 11. SAMPLE REQUIREMENTS--AQUEOUS SAMPLES

| Parameter Name | Container ¹ | Preservation ^{2,3} | Maximum Holding Time ⁴ |
|--|------------------------|--|-----------------------------------|
| <u>Inorganic Tests</u> | | | |
| Acidity | P, G | Cool, 4° C | 14 days |
| Alkalinity | P, G | do | Do |
| Ammonia | P, G | Cool, 4°C, H ₂ SO ₄ to pH<2 | 28 days |
| Biochemical oxygen demand | P, G | Cool, 4°C | 48 hours |
| Bromide | P, G | None required | 28 days |
| Biochemical oxygen demand, carbonaceous | P, G | Cool, 4°C | 48 hours |
| Chemical oxygen demand | P, G | Cool, 4°C, H ₂ SO ₄ to pH<2 | 28 days |
| Chloride | P, G | None required | Do |
| Chlorine, total residual | P, G | Dp | Analyze immediately |
| Color | P, G | Cool, 4°C | 48 hours |
| Cyanide, total and amendable to chlorination | P, G | Cool, 4°C, NaOH to pH>12, 0.6g asorbic acid ⁵ | 14 days ⁶ |
| Fluoride | P | None required | 28 days |
| Hardness | P, G | HNO ₃ or H ₂ SO ₄ to pH<2 | 6 months |
| Hydrogen ion (pH) | P, G | None required | Analyze immediately |
| Kjeldahl and organic nitrogen | P, G | Cool, 4°C, H ₂ SO ₄ to pH<2 | 28 days |
| Nitrate | P, G | Cool, 4°C | 48 hours |
| Nitrate-nitrite | P, G | Cool, 4°C, H ₂ SO ₄ to pH<2 | 28 days |
| Nitrite | P, G | Cool, 4°C | 48 hours |
| Oil and grease | G | Cool, 4°C, H ₂ SO ₄ to pH<2 | 28 days |
| Organic carbon | P, G | Cool, 4°C, HCl or H ₂ SO ₄ to pH<2 | Do |
| Orthophosphate | P, G | Filter immediately, Cool, 4°C | 48 hours |
| Oxygen, Dissolved Probe | G Bottle and top | None required | Analyze immediately |
| Winkler | do | Fix on site and store in dark | 8 hours |
| Phenols | G only | Cool, 4°C, H ₂ SO ₄ to pH<2 | 28 days |
| Phosphorus (elemental) | G | Cool, 4°C | 48 hours |
| Phosphorus total | P, G | Cool, 4°C, H ₂ SO ₄ to pH<2 | 28 days |
| Residue, total | P, G | Cool, 4°C | 7 days |
| Residue, filterable | P, G | Cool, 4°C | 48 hours |
| Residue, nonfilterable (TSS) | P, G | Cool, 4°C | 7 days |
| Residue, settleable | P, G | Cool, 4°C | 48 hours |

TABLE 11. SAMPLE REQUIREMENTS--AQUEOUS SAMPLES (Continued)

| Parameter Name | Container ¹ | Preservation ^{2,3} | Maximum Holding Time ⁴ |
|--|------------------------|--|---|
| Residue, volatile | P, G | Cool, 4°C | 7 days |
| Silica | P | Cool, 4°C | 28 days |
| Specific conductance | P, G | Do | Do |
| Sulfate | P, G | Cool, 4°C | Do |
| Sulfide | P, G | Cool, 4°C, add zinc acetate plus sodium hydroxide to pH>9 | 7 days |
| Sulfite | P, G | None required | Analyze immediately |
| Surfactants | P, G | Cool, 4°C | 48 hours |
| Temperature | P, G | None required | Analyze immediately |
| Turbidity | P, G | Cool, 4°C | 48 hours |
| <u>Metals</u> ⁷ | | | |
| Chromium VI | P, G | Cool, 4°C | 24 hours |
| Mercury | P, G | HNO ₃ to pH<2 | 28 days |
| Metals, except chromium VI and mercury | P | HNO ₃ to pH<2 | 6 months |
| <u>Organic Tests</u> ⁸ | | | |
| Purgeable Halocarbons | G, Teflon-lined septum | Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁵ | 14 days |
| Purgeable aromatic hydrocarbons | G, Teflon-lined septum | Cool, 4°C, 0.0008% Na ₂ S ₂ O ₃ ⁵ , HCl to pH 2 ⁹ | Do |
| Acrolein and acrylonitrile | G, Teflon-lined septum | Cool, 4°C, 0.0008% Na ₂ S ₂ O ₃ ⁵ , Adjust pH to 4-5 ¹⁰ | Do |
| Phenols ¹¹ | G, Teflon-lined cap | Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁵ | 7 days until extraction, 40 days after extraction |

TABLE 11. SAMPLE REQUIREMENTS--AQUEOUS SAMPLES (Continued)

| Parameter Name | Container ¹ | Preservation ^{2,3} | Maximum Holding Time ⁴ |
|---|------------------------|--|---|
| Benzidines ^{11,12} | G, Teflon-lined cap | Cool, 4°C | 7 days until extraction ¹³ |
| Phthalate esters ¹¹ | G, Teflon-lined cap | Cool, 4°C | 7 days until extraction, 40 days after extraction |
| Nitrosamines ^{11,14} | G, Teflon-lined cap | Cool, 4°C 0.008% Na ₂ S ₂ O ₃ ⁵ , store in dark, | Do |
| PCBs ¹¹ | G, Teflon-lined cap | Cool, 4°C | Do |
| Nitroaromatics and isophorone ¹¹ | G, Teflon-lined cap | Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁵ , store in dark | Do |
| Polynuclear aromatic hydrocarbons ¹¹ | G, Teflon-lined cap | Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁵ | Do |
| Nalcoethers ¹¹ | G, Teflon-lined cap | Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁵ | Do |
| Chlorinated hydrocarbons ¹¹ | G, Teflon-lined cap | Cool, 4°C | Do |

TABLE 11. SAMPLE REQUIREMENTS--AQUEOUS SAMPLES (Continued)

| Parameter Name | Container ¹ | Preservation ^{2,3} | Maximum Holding Time ⁴ |
|--|------------------------|--|-----------------------------------|
| ICDD ¹¹ | 6, Teflon-lined cap | Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁵ | Do |
| <u>Pesticides</u> Pesticides ¹¹ | 6, Teflon-lined cap | Cool 4°C, pH 5-9 ¹⁵ | Do |
| <u>Radiological</u> Alpha, beta, and radium | P, G | HNO ₃ to pH<2 | 6 months |

¹Polyethylene (P) or glass (G).

²Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

³When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table 4.2, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulation do not apply to the following materials: hydrochloric acid (HCl) in water solutions at concentration of 0.04% by weight or less (pH about 1.96 or greater); nitric acid (HNO₃) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); sulfuric acid (H₂SO₄) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

⁴Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show that this is necessary to maintain sample stability.

TABLE 11. SAMPLE REQUIREMENTS--AQUEOUS SAMPLES (Continued)

- 5 Should only be used in the presence of residual chlorine.
- 6 Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed only by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.
- 7 Samples should be filtered immediately on-site before adding preservative for dissolved metals.
- 8 Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.
- 9 Sample receiving no pH adjustment must be analyzed within seven days of sampling.
- 10 The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.
- 11 When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for maximum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12 and 13 (re: the analysis of benzidine).
- 12 If 1,2-dipherrylyhydrazine is likely to be present, adjust the pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.
- 13 Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.
- 14 For the analysis of diphenylnitrosamine, add 0.008% $\text{Na}_2\text{S}_2\text{O}_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.
- 15 The pH adjustment may be performed upon receipt at the Laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $\text{Na}_2\text{S}_2\text{O}_3$.

This information is taken from 40 CFR 136.

TABLE 12. SAMPLES CONTAINERS FOR WASTE

| Waste Type | Recommended Container | Recommended Closure | Analysis |
|---|---|---|--|
| Photosensitive wastes | Amber HDPE or amber glass bottles 1,000 or 2,000 mL | LPE caps for HDPE bottles; Bakelite caps with Teflon liners for glass bottles | Waste characterization per 40 CFR-Part 261 |
| Pesticides, hydrocarbons, chlorinated hydrocarbons, petroleum distillates | Wide mouth borosilicate glass bottles 1,000 or 2,000 mL | Bakelite caps with Teflon liner | Waste characterization per 40 CFR-Part 261 |
| Oil wastes | Wide mouth borosilicate glass bottles 1,000 or 2,000 mL | Bakelite capes with Teflon liner | Waste characterization per 40 CFR-Part 261 |
| Strong alkali or hydrofluoric acid | HDPE bottles, wide mouth 1,000 mL | LPE caps | Waste characterization per 40 CFR-Part 261 |
| Aqueous wastes-- characterization of organics | Borosilicate glass bottles 1,000 or 2,000 mL | Caps with Teflon liner | Waste characterization per 40 CFR-Part 261 |
| solids (sludge, soil, granular) | 8 oz wide mouth glass bottle | Bakelite caps with Teflon liners | Waste characterization per 40 CFR-Part 261 |

minutes, scrub bottles with a brush, rinse bottles several times with tap water to remove the detergent, rinse bottles thoroughly several times with distilled water, rinse bottles with methanol, oven dry for one hour at 300°F.

o Bottle Cleaning for Metals Determination:

- o Procedure; follow general bottle cleaning procedure, add 1:1 nitric acid to bottles, cap, and shake briefly, allow bottles to stand for approximately 30 minutes, shaking them intermittently, pour acid from bottles and rinse them with tap water, repeat steps 2, 3, and 4 with 1:1 hydrochloric acid, rinse bottles thoroughly several times with deionized distilled water.

o Bottle Cleaning for Oil and Grease Determinations:

- o Procedure: follow general bottle cleaning procedure, rinse bottles (excluding caps) with acid solution, pour acid from bottles and rinse them with tap water, rinse bottles thoroughly several times with distilled water, rinse bottles with Freon-113. (Do not mix Freon with nitric acid.)

o Bottle Cleaning for Extractable Organics:

- o Procedure; follow general bottle cleaning procedure, rinse bottles several time with distilled water, rinse bottles and caps two times with pesticide quality hexane.

Note 1: Chromic acid may be used to remove organic deposits from glassware; however, the glassware must be thoroughly rinsed with water afterward, and the last traces of chromium are nearly impossible to remove. The chromium residues may interfere with chromium analysis. Chromic acid should not be used with plastic bottles

Note 2: If it can be documented through an active analytical quality control program using spiked samples and reagent and sample blanks that certain steps in the cleaning procedure are not required for routine samples, those steps may be eliminated from the procedure.

4.2 PRESERVATION TECHNIQUES AND HOLDING TIMES

In general, chemical analyses of samples should be conducted as soon as possible after sample collection. However, because samples are normally transported from the field to a sometimes distant analytical laboratory, some preservation is necessary to maintain the integrity of the samples. Samples will be preserved and stored in accordance with EPA-approved methods and holding times. Sample preservation measures are summarized in Tables 10 through 12. More specific information will be provided in the SSMPs. The guidance provided in the analytical methods documentation should also be consulted.

Sample preservation should be initiated in the field at the time the samples are collected. The preservation may include the addition of chemical reagents, refrigeration (or icing) to less than 4°C, and/or the storage of sample containers in the dark. In some instances, the optimal method for sample preservation can not be used because of shipping restrictions (Department of Transportation (DOT) regulations) or other special circumstances. When this occurs, the best alternative preservation method should be used. Samples containing high concentrations of hazardous materials should not be chemically preserved or packed in ice.

5. SAMPLE CONTROL AND DOCUMENTATION

All information pertinent to field sampling activities must be recorded as part of the CERCLA Site Characterization documentation archive. The purpose of sample control and documentation is to ensure that samples are documented and documents for a specific project are accounted for when the project is completed. Accountable documents include items such as logbooks, data records, correspondence, sample tags, graphs, chain-of-custody reports, analytical records, and photographs. Each document should bear a serial

number and should be listed, with the number, in a project document inventory assembled at the completion of the project. The documentation coordinator assigned to an installation or specific site will number all logbooks, sample tags, graphs, chain-of-custody records, photographs, and other records.

Project logbooks (bound books with consecutively numbered pages) will be assigned to project personnel to keep records for each site characterization. The logbook will be the responsibility of the assigned individual, and transfers of the book will be entered and signed as part of the record. In addition, a field logbook (also a bound book with consecutively numbered pages) will be kept to record all field activities. Entries in the logbook must include at least the following:

- o Date and time of entry;
- o Purpose of sampling;
- o Name and address of field contact (federal, state, local representative);
- o Producer of waste and address (if known);
- o Type of process producing waste (if known);
- o Type of waste (sludge, waste water, etc.);
- o Description of sample;
- o Waste components and concentrations (if known);
- o Identification number and size of sample taken
- o Description of sampling point;
- o Date and time of collection of sample;
- o Collector's sample identification number(s) and/or name;
- o References such as maps or photographs of the sampling site;
- o Field observations; and
- o Any field measurements made, such as pH.

Because sampling situations vary widely, notes should be as descriptive and inclusive as possible. Someone reading the entries should be able to reconstruct the sampling situation from the recorded information. Language must be objective, factual, and free of personal feelings or any other inappropriate terminology. All entries in the field logbook must be dated

and signed. In addition, no erasures or scratchouts are permitted, and corrections must be logged in as separate entries. All project logbooks are to be turned over to the coordinator at the completion of each work period and sent to a central file at the completion of the field activity.

5.1. CHAIN-OF-CUSTODY PROCEDURES

Figure 1 is an example of a chain-of-custody/record. Chain-of-custody procedures will be employed for all samples collected during CERCLA site characterization activities. Chain-of-custody procedures provide a written record of the persons responsible for handling samples.

A sample is in someone's "custody" if:

- o It is in one's actual possess, or
- o It is in one's view, after being in one's physical possession, or
- o It is in one's physical possession and then locked up so that no one can tamper with it, or
- o It is kept in a secured area, restricted to authorized personnel only.

5.2. SAMPLE LABELS

Each sample must be sealed immediately after it is collected and labeled using waterproof ink. The label tag must include at least the name of the collector, date and time of collection, plant of collection, and the sample number. Label tags may be filled out prior to collection to minimize handling of the sampling containers. Figures 2 and 3 are examples of common sample label or tag formats.

Labels must be firmly affixed to the sample containers. Tags attached by string are acceptable when gummed labels are not available or applicable. The container must be dry enough for a gummed label to remain securely attached.

Occasionally, sample containers are marked in the field using a etching tool rather than immediately applying a sample label or tag. This avoids

FIGURE 2. SAMPLE LABEL

OFFICIAL SAMPLE LABEL

Collector _____ Collector's Sample No. _____

Place of Collection _____

Date of Sample _____ Time Sampled _____

Field Information _____

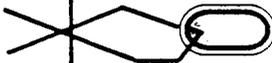
Example of Official Sample Label

Source: *Sampling for Hazardous Materials* (U.S. Environmental Protection Agency, Cincinnati, Ohio, November 1984).

FIGURE 3. SAMPLE TAGS

| | | | | | |
|---|---|-------------|--------------|-------------|-------|
|  | Proj. Code | Station No. | Sequence No. | Mo./Day/Yr. | Time |
| | Station Location | | | Camp | Grade |
| | ENVIRONMENTAL PROTECTION AGENCY OFFICE OF ENFORCEMENT NATIONAL ENFORCEMENT INVESTIGATIONS CENTER BUILDING 33, BOX 25777, DENVER FEDERAL CENTER DENVER, COLORADO 80225 | | | | |
| | Sampler: (Signature) | | | | |

Obverse

| |
|--|
|  |
| <p style="text-align: center;">Sample Types/Preservatives</p> <ol style="list-style-type: none"> 1. General Inorganics/Ice 2. Metals, MNO 3. Nutrients, MISO, & Ice 4. Oil & Grease, MISO, & Ice 5. Phenolics, H₂PO₄ & CuSO₄ & Ice 6. Cyanide, NaOH & Ice 7. Organic Characterization/Ice 8. Volatile Organics/Ice 9. General Organics/Ice 10. Tracer/None 11. Solids - Inorganics/Ice or Freeze 12. Solids- Organics/Ice or Freeze 13. Biol - Inorganics/Ice or Freeze 14. Biol - Organics Ice or Freeze 15. Source Filter, None 16. Probe Wash, None 17. Impinger Catch, None 18. Ambient Filter/ None 19. Solid Adsorbant/Ice or Freeze 20. Ambient Impinger/ Amb. or Ice 21. Benthos, Ethanol or Formal 22. Cacteriology, Ice 23. Plankton, Formal; MgCl₂; Lugol's 24. Chlorophyll/Ice or Freeze 25. Pathogenic Bacteria/Ice |
| <p>Remarks:</p> |

Reverse

Source: *Sampling for Hazardous Materials* (U.S. Environmental Protection Agency, Cincinnati, Ohio, November 1984).

possible label contamination probes and subsequent decontamination difficulties. In this case, the data intended for the sample label are written into a sampling logbook and transcribed onto the label after the sample containers have been decontaminated.

The document coordinator records in the logbook the assignment of serial sample tags to field personnel. Sample tags must never be discarded. Lost, voided, or damaged tags are immediately noted in the logbook of the person to whom they are assigned.

5.3. IDENTIFICATION OF SAMPLES

The number of persons involved in collecting and handling samples should be kept at a minimum. Guidelines established in the SSMP Sampling Plan for sample collection, preservation, and handling must be used. Field records must be completed at the time the sample is collected and must be signed or initialed, including the date and time, by the sample collector(s). Field records must contain the following information:

- o Unique sampling or log number;
- o Date and time;
- o Source of sample (including name, location, and sample type);
- o Preservative used (if any);
- o Analysis required;
- o Name of collector(s);
- o Pertinent field data (pH, dissolved oxygen, chlorine residue, etc.);
and
- o Serial numbers on seals and transportation cases.

One member of the sampling team will be appointed field custodian. If the documentation coordinator is present in the field, he/she may also be designated the field custodian. Samples will be turned over to the field custodian by team members who collected the samples. The field custodian documents each transaction and the sample remains in the custodian's custody until it is shipped to the laboratory.

Each sample is identified by affixing a gummed label or standardized tag on the container(s). This label or tag should contain the sample identification number, date and time, of collection, source, preservative used, analysis required, and the collector(s) initials. If a label or tag is not available, the same information should be recorded on the sample container legibly and with waterproof ink.

The sample container should then be placed in a transportation case, along with the chain-of-custody record, pertinent field records, and analysis request form as needed. The transportation case should be sealed or locked. A locked or sealed chest eliminates the need for close control of individual samples. However, on those occasions when the use of chest is inconvenient, the collector should seal the cap of the individual sample container in a way such that any tampering would be easy to detect.

When samples are composited over a time period, unsealed samples can be transferred from one crew to the next. The transferring crew lists the samples and a member of the receiving crew signs the list. The receiving crew transfers the samples to another crew or delivers them to a laboratory person, who signs for the samples.

5.4. TRANSFER OF CUSTODY AND SHIPMENT

When transferring the samples, the person who accepts them must sign and record the date and time on the chain-of-custody record. Custody transfers made to a sample custodian in the field should account of each sample, although samples may be transferred as a group. Every person who takes custody must fill in the appropriate section of the chain-of-custody record. to minimize custody records, the number of custodians in the chain of possession should be minimized.

The field custodian is responsible for properly packaging and dispatching samples to the appropriate laboratory. This responsibility includes filling out, dating, and signing the appropriate portion of the chain-of-custody record.

All packages sent to the laboratory should be accompanied by the chain of custody record and other pertinent forms. A copy of these forms should be retained by the originating office (either carbon or photocopy). Mailed packages can be registered with return receipt requested. For packages sent by common carrier, receipts should be retained as part of the permanent chain-of-custody documentation. Samples to be shipped must be packed so as not to break, and the package sealed or locked so that any tampering can be readily detected.

5.5. PHOTOGRAPHS

Photographs are the most accurate record of the field conditions at a specified time. Information about photographs should be recorded in the field logbook and on the back of the photographs. This should include:

- o Date and time;
- o Signature of photographer;
- o Name and identification number of site;
- o General direction faced and description of the subject;
- o Location on the site; and
- o Sequential number of the photographs and the roll number.

If possible, photographs should be taken with a camera lens system with a perspective similar to that offered by the naked eye.

6. HANDLING, TRANSPORT, AND STORAGE OF SAMPLES

Sample collected during CERCLA site characterization will be transported from the field to the analytical laboratory. The transportation of samples must be accomplished not only in a manner designed to protect the integrity of the sample, but also to prevent any detrimental effects from potentially hazardous samples. Regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous wastes are promulgated by the U.S. Department of Transportation (DOT) and described in the Code of Federal Regulations (49 CFR 171 through 177, in particular, 172.402h, Packages Containing Samples). Although these

regulations were not written for the shipment of samples collected at hazardous waste sites, the EPA has recommended packaging, markings, labeling, and shipping samples in accordance with DOT procedures. The following guidelines for potentially hazardous CERCLA samples are based on the same approach.

Samples collected at a site should be classified either as environmental (low contaminant concentrations) or hazardous (high contaminant concentrations). A distinction between the two types of samples, environmental and hazardous, must be made to (1) determine the appropriate procedures for the transportation of the samples, and (2) protect the health and safety of the laboratory personnel receiving the samples. Special precautions, procedures, and containment will be used when hazardous samples are received. If there is any doubt as to the classification of a sample, it will be considered a hazardous sample and shipped accordingly.

6.1. ENVIRONMENTAL SAMPLES

Environmental samples are not considered hazardous materials. They will be packaged and shipped according to the following procedures.

- o Packaging/Packing. Sample containers that are properly identified, have a sealed lid, and are contained in sealed polyethylene bags can be packed in fiberboard containers or metal picnic cooler-type containers. Sufficient noncombustible, absorbent cushioning material should be used to minimize the possibility that the sample containers might break. To further reduce the possibility of leakage, the sample container, the sample bottles, and absorbent material can be placed in a larger sealed bag.
- o Marking and Labeling. Sample containers must have a completed sample identification tag. The outside container should be marked "Environmental Sample." No DOT marking and labeling is required.

- o Shipping Papers. No DOT shipping papers are required.
- o Transportation. There are no DOT restrictions on the mode of transportation.

6.2. HAZARDOUS SAMPLES

Samples expected to contain hazardous materials must be considered hazardous substances and transported according to DOT requirement 49 CFR 172.101. If the material in the sample is known or can be identified, then it should be packaged, marked, labeled, and shipped according to the specific instructions for that material (if listed). For potentially hazardous samples with unknown contents, the selection of the appropriate transportation category is based upon the DOT Hazardous Material Classification, a prioritized system of transportation categories. This system is presented in Table 13.

The selection of the correct category for an unknown sample is through a process of elimination using the DOT classification system. Unless known or demonstrated otherwise (through the use of radiation survey instruments), the sample is considered radioactive and appropriate shipping regulations for radioactive material will be followed. If radioactive material is eliminated, the sample is considered to contain Poison "A" materials, the next material on the list. Poison "A" is defined by DOT as extremely dangerous poisonous gases or liquids of such a nature that a very small amount of gas, or vapor of the liquid, mixed with air, is dangerous to life. The class "A" poisons listed in 49 CFR 172.101 and their physical state at normal temperatures are presented in Table 14.

If the classification of radioactive, Poison "A" flammable and nonflammable gas, which require more stringent shipping procedures, can be eliminated, then the sample may be classified as flammable liquid (or solid) and shipped accordingly. Other categories of lower priority than flammable liquids/solids are generally not considered for unknown samples, because eliminating substances as flammable liquids requires flashpoint testing, which is impractical and possibly dangerous if conducted at a site.

TABLE 13. DOT CLASSIFICATION FOR HAZARDOUS MATERIALS

1. Radioactive Material
 2. Poison "A"
 3. Flammable Gas
 4. NonFlammable Gas
 5. Flammable Liquid
 6. Oxidizer
 7. Flammable Solid
 8. Corrosive Material (liquid)
 9. Poison B
 10. Corrosive Material (liquid)
 11. Irritating Materials
 12. Combustible Liquid (in containers having capacity exceeding 110 gallons)
 13. ORM-B
 14. ORM-A
 15. Combustible Liquid (in containers having capacity of 100 gallons or less)
 16. ORM-E
-

TABLE 14. CLASS "A" POISONS AND THEIR PHYSICAL STATE
AT ROOM TEMPERATURE

| <u>Compound</u> | <u>Physical State</u> |
|---|---|
| arsine | gas |
| bromoacetone | liquid |
| chloropicrin & methyl chloride mixture | gas |
| chloropicrin & nonflammable, non- liquified compressed gas mixture | gas |
| cyanogen chloride | gas at temperature greater than 13.1°C |
| cyanogen gas | gas |
| gas identification set | --- |
| gelatin dynamite (H.E. Germaine) | --- |
| grenade (with poison "A" gas charge) | --- |
| hexaethyl tetraphosphate & compressed gas mixture | gas |
| hydrocyanic acid (prussic solution) | liquid |
| hydrocyanic acid, liquefied | gas |
| insecticide liquefied gas, containing poison "A" or poison "B" materials | gas |
| methyldichloroarsine | liquid |
| nitric acid | gas |
| nitrogen peroxide | gas |
| nitrogen tetroxide | gas |
| nitrogen dioxide, liquid | gas |
| parathion & compressed gas mixture | gas |
| phosgene (diphosgene) | liquid |

Additionally, unless the sample can be demonstrated to consist of material listed as being of a lower priority than flammable liquid, the samples must be considered a flammable liquid (or solid) and shipped as such.

Materials are classified by the DOT as radioactive materials if the specific activity is greater than 0.002 microcuries/gram. Most samples collected under the CERCLA Site Characterization Program CEARP will have specific activities less than this level; however, some samples could exceed these levels and would need to be transported as radioactive materials. Samples classified as radioactive will be packaged and shipped according to the DOT regulations for limited quantity radioactive materials as summarized below.

- o Packaging, Marking, Labeling, and Shipping Papers. Limited quantities of radioactive materials (materials whose activity per package does not exceed the limit specified in 49 CFR 173.423) are excepted from the specification packaging, shipping paper and certification, marking, and labeling requirements if they meet the following requirements: (1) the materials are packaged in strong, tight, packages that will not leak any of the radioactive materials during conditions normally incident to transportation; (2) the radiation level at any point on the external surface of the package does not exceed 0.5 mrem/hr; (3) the nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in 49 CFR 173.443(a); (4) the outside of the inner packaging or if there is no inner packaging, the outside of the packaging itself bears the marking RADIOACTIVE; (5) the package does not contain more than 15 grams of uranium-235; (6) the package is certified as being acceptable for transportation by having a notice enclosed in or on the package/packing list which bears the name of the consignor or consignee and the statement "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for excepted radioactive materials, limited quantity, n.o.s. UN2910" or "This package conforms to the conditions and limitations

specified in manufactured from natural or depleted uranium or natural thorium, UN2909" (49 CFR 173.421).

- o Transportation. Limited quantity radioactive materials may be transported by common carrier excluding aircraft.

Samples classified as Poison "A" will be packaged and shipped according to the following procedures.

- o Packaging. Collect samples in a polyethylene or glass container with an outer diameter narrower than the valve hole on a DOT Spec. #3A1800 or #3AA1800 metal cylinder. Fill the sample container, allowing sufficient ullage (approximately 10% by volume) so it will not be liquid-full at 130°F. Seal the sample container. Attach a properly completed identification tag to the sample container. With a string or flexible wire attached to the neck of the sample container, lower the container into a metal cylinder that has been partially filled with noncombustible, absorbent, loose packaging material (vermiculite or diatomaceous earth). Allow sufficient absorbing material between the bottom and sides of the container and the metal cylinder to prevent breakage or absorb leakage. After the cylinder is filled with cushioning material, drop the ends of the string or wire into the cylinder valve hole. Only one sample may be placed in a metal cylinder. Replace the valve, torque to 250 ft/lb (for a 1 inch opening) and replace the valve protector on the metal cylinder using Teflon tape. One or more cylinders may be placed in a DOT approved outside container.
- o Marking and Labeling. Use abbreviations only where specified. Place the following information either hand printed or in label form on the side of the cylinder or on a tag wired to the cylinder valve protector: "Poisonous Liquid, n.o.s." or "Poisonous Gas, n.o.s. NA9035," and laboratory name and address, and place the following DOT label on the cylinder: "Poisonous Gas" (even if the sample is liquid). If the metal cylinders are placed in an

outside container, both the container and cylinders inside must have the same markings and labels as above. In addition, "Laboratory Sample" and "Inside Packages Comply with Prescribed Specifications" should be marked on the top and/or front side of the outside container. "THIS SIDE UP" marking must be placed on the topside of the container, and upward pointing arrows on all four sides.

- o Shipping Papers. Complete the bill of lading provided by the shipper and sign the certification statement with the following information in the order listed. (If the carrier does not provide a certification statement, use a standard industry form.) One form may be used for more than one exterior container. Use abbreviations only as specified. "Poisonous Liquid, n.o.s. NA9035, "Limited Quantity" or "Ltd. Qty.," net weight or net volume. The net weight or net volume must be placed just before or just after the "Poisonous Liquid, n.o.s." marking. A chain-of-custody record form should also be included in the container or with the cylinder.
- o Transportation. Poison "A" categorized packages may not be transported by common carrier aircraft, cargo only aircraft, or charter aircraft. Samples may be shipped only by ground transport or government owned aircraft.
- o The shipping container should be accompanied to the transport carrier and, if required, the outside container opened for freight inspection. Using the DOT "poisonous" classification does not convey the certain knowledge that a sample is in fact poisonous, or how poisonous, but is intended to describe the class of packaging in order to comply with regulations.

Samples classified as flammable liquids or flammable solids will be packaged and shipped according to the following procedures.

- o Packaging. Place samples in glass containers with nonmetallic, Teflon-lined screw caps. Allow sufficient ullage (approximately 10% by volume) so that the container is not full of liquid at 130°F. If an air space in the innermost container cannot be tolerated in order to maintain the integrity of the sample, place it within a second container to provide the required ullage. Attach a properly completed sample identification tag to the sample container. Seal the sample container closure and place it in 2-mil thick (or thicker) polyethylene bag, one sample per bag. The sample identification tag should be positioned so that it can be read through the bag. Place each sealed bag inside a separate metal can that is the appropriate size to contain noncombustible, absorbent, cushioning matter (e.g., vermiculite or diatomaceous earth) to prevent breakage or absorb leakage. Pressure close the can and use clips, tape, or other positive means to hold the lid securely, tightly, and effectively. Place one or more metal cans (or single 1-gallon bottles), surrounded by noncombustible, absorbing packaging material for stability during transport, into a strong outside container, such as in a cooler or inside an approved fiberboard box.

- o Marking and Labeling. Use abbreviations only where specified. Place the following information on the metal can (or 1 gallon bottle), either hand printed or in label form: laboratory name and address, "Flammable Liquid n.o.s UN1993" or "Flammable Solid n.o.s. UN1325". Not otherwise specified (n.o.s) is not used if the flammable liquid or solid is identified. In these cases, the name of the specific material is used and listed before the category, for example, "Toluene-Flammable Liquid." Place the following DOT labels on the outside of the can (or bottle): "Flammable Liquid" or "Flammable Solid". The "Dangerous When Wet" label must be used with the "Flammable Solid" label if the material meets the definition of a water reactive material. The "Cargo Aircraft Only" label must be used if the net quantity of the sample in each package is greater than 1 quart (for "Flammable Liquid," n.o.s) or 25 lbs (for "Flammable Solid" n.o.s) (49 CFR

172.402, 172.101). If the cans are placed in an exterior container, both that container and the inside can (or bottle) must have the same markings and labels as above. The words "This End Up" or "This Side Up" must be clearly printed on the top of the outer package. Upward pointing arrows should be placed on the sides of the package. The words, "Laboratory Samples," should also be printed on the top of the package.

- o Shipping Papers. Use abbreviations only where specified below. Complete the bill of lading provided by the carrier and sign the certification statement with the following information in the order listed. (If the carrier does not provide it, use a standard industry form.) One form may be used for more than one exterior container. "Flammable Liquid n.o.s UN1993" or "Flammable Solid n.o.s. UN1325"; Limited Quantity (or Ltd. Qty); net weight or net volume (abbreviations of weight or volume are acceptable). Further descriptions such as "Laboratory Samples" or "Cargo Aircraft Only" (if applicable) are allowed if they do not contradict the required information. The net weight or net volume must be placed just before or just after the "Flammable Liquid n.o.s." or "Flammable Solid, n.o.s." description. A chain-of-custody record must be included in the exterior container.
- o Transportation. Unknown hazardous substances classified as flammable liquids may be transported by rented or common carrier truck or bus, by railroad, or by cargo-only aircraft. Samples transported only by government-owned vehicles on government roads do not require a DOT bill of lading with a certification.
- o Other Considerations. Identifying samples as "flammable" does not necessarily mean that a sample is in fact flammable but is intended to prescribe the class of packaging in order to follow DOT regulations. Shipping containers should be accompanied to the transport carrier and, if required, the outside container(s) opened for inspection. For overnight shipments, weight

restrictions should be determined. Federal Express, for instance, is 70 lbs or less.

7. SAMPLE PREPARATION AND ANALYSES

Sample analyses of interest in site characterization activities can include various combinations of the following parameters and matrices.

| <u>Parameters</u> | <u>Matrices</u> |
|-------------------|-----------------|
| Inorganics | Air |
| Organics | Water |
| Radionuclides | Soil |
| Explosives | Sediment |
| | Biologicals |

The EPA has approved analytical procedures for preparation of some inorganics, organics, and radionuclides in water, soil, and sediment. These are summarized in Tables 15 through 19. There are no EPA-approved analytical procedures for air and biological matrices (except for air monitoring methods for primary and hazardous air pollutants). Each SSMP Sampling Plan will specifically enumerate the analytical procedures to be used for samples from that site. These will be EPA-approved procedures when available and alternative procedures when not. The procedures to be used at the site will be reviewed by EPA as part of the SSMP.

8. SAMPLE ARCHIVING AND DISPOSAL

The need to archive samples will be made on a site-specific basis. Appropriate procedures will be specified in the SSMP. Following analysis of CERCLA Site Characterization samples, nonhazardous materials will be disposed of with laboratory waste. Hazardous and radioactive materials, as determined through analysis, will be appropriately contained or disposed of.

TABLE 15. INORGANICS

| Parameter | Liquids ¹ | | Solids ² | |
|-----------|---------------------------|--------------------------|---------------------|----------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| Arsenic | 1) ^a 3030/3040 | 1)7060 | 1)3050 | 1)7060 |
| | 1)7061 | 1)7061 | 1)7061 | 1)7061 |
| | 2) ^b 303E | 2)303E | | |
| | 2)304 | 2)304 | | |
| | 3) ^c 206.5 | 3)206.5 | | |
| | 3)206.3 | 3)206.3 | | |
| | 3)206.2 | 3)206.2 | | |
| | 3)206.4 | 3)206.4 | | |
| | | 4) ^d 2972.84B | | |
| | | 5) ^e 3062.84 | | |
| Barium | 1)3010 | 1)7080 | 1)3050 | 1)7080 |
| | 1)3030/3040 | | 1)3030/3040 | |
| | 1)3020 | 1)7081 | 1)3050 | 1)7081 |
| | 1)303/3040 | | 1)3030/3040 | |
| | 2)303C | 2)303C | | |
| | 2)304 | 2)304 | | |
| | 3)208.1 | 3)208.1 | | |
| | 3)208.2 | 3)208.2 | | |
| | 4)3654-84(A) | | | |
| Beryllium | 1)3010/3020 | 1)7090 | 1)3050 | 1)7090 |
| | | 1)7091 | | 1)7091 |
| | 2)303C | 2)303C | | |
| | 2)304 | 2)304 | | |
| | 3)210.1 | 3)210.1 | | |
| | 3)210.2 | 3)210.1 | | |
| | 4)3654-84(A) | | | |
| Cadmium | 1)3010 | 1)7130 | 1)3050 | 1)7130 |
| | 1)3030/3040 | | 1)303/3040 | |
| | 1)3020 | 1)7131 | 1)3050 | 1)7131 |
| | 1)3030/3040 | | 1)3030/3040 | |
| | 2)303A/303B | 2)303A/303B | | |
| | 2)304 | 2)304 | | |
| | 2)310B | 2)310B | | |
| | 3)213.1 | 3)213.1 | | |
| | 3)213.2 | 3)213.2 | | |
| | | 4)D3557-84 (A or B) | | |
| | | 5)1-3135-84 | | |
| | | 5)1-3136-84 | | |

TABLE 15. INORGANICS (Continued)

| Parameter | Liquids ¹ | | Solids ² | |
|-----------|-----------------------------|------------------------|-----------------------|-------------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| Chromium | 1)3010 | 1)7190 | 3050 | 1)7190/7191 |
| | 1)3030/3040 | | 1)3030/3040 | |
| | 1)3020 | 1)7191 | 1)3050 | 1)7191 |
| | 1)3030/3040 | | 1)3030/3040 | |
| | 2)303A | 2)303A | | |
| | 2)303B | 2)303B | | |
| | 2)304 | 2)304 | | |
| | 2)312B | 2)312B | | |
| | 3)218.1 | 2)218.1 | | |
| | 3)218.3 | 3)218.3 | | |
| | 3)218.2 | 3)218.2 | | |
| | | 4)1687-84D | | |
| | | 4)1687-84A | | |
| | | 5)1-3236-84 | | |
| | Chromium VI (Hexavalent) | 1)7195 | 1)7195 (7190/7191) | 1)7195 |
| 1)7196 | | 1)7196 | 1)7196 | 1)7196 |
| 1)7197 | | 1)7197 | 1)7197 | 1)7197 |
| 2)303B | | 2)303B | | |
| 3)218.4 | | 3)218.4 | | |
| | | 5)1-1230-84 | | |
| Lead | 1)3010 | 1)7420 | 1)3050 | 1)7420 |
| | 1)3030/3040 | | 1)3030/3040 | |
| | 1)3020 | 1)7421 | 1)3050 | 1)7421 |
| | 1)3030/3040 | | 1)3030/3040 | |
| | 2)303 A or B | 2)303 A or B | | |
| | 2)304 | 2)304 | | |
| | 2)316 | 2)316 | | |
| | 3)239.1 | 3)239.1 | | |
| | 3)239.2 | 3)239.2 | | |
| | | 4)D3559-85 (A or B) | | |
| | | 4)D3559-85C | | |
| | | 5)1-3399-84 | | |

TABLE 15. INORGANICS (Continued)

| Parameter | Liquids ¹ | | Solids ² | |
|------------|---|--|--|------------------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| Mercury | 1)7470 2)303F 3)245.1 3)245.2 | 1)7470 2)303F 3)245.1 3)245.2 | 1)7471 | 1)7471 |
| Molybdenum | 2)303C 2)304 3)246.1 3)246.2 | 2)303C 2)304 3)246.1 3)246.2 5)1-3490-84 | | |
| Nickel | 1)3010 1)3030/3040 1)3020 1)3030/3040 2)303 A or B 2)304 2)321B 3)249.1 3)249.2 | 1)7520 1)7521 2)303 A or B 2)304 2)321B 3)249.1 3)249.2 4)D1886-84 (C or D) 5)1-3499-84 | 1)3050 1)3030/3040 1)3050 1)3030/3040 | 1)7520 1)7521 |
| Selenium | 1)7740 1)7741 2)304 2)303E 3)270.2 3)270.3 | 1)7740 1)3030/3040 1)7741 2)304 2)303E 3)270.2 3)270.3 4)D3859-84A 5)1-3667-84 | 1)7750 1)7741 | 1)7740 1)7741 |
| Silver | 1)7760 1)7761 2)303 A or B 2)304 3)272.1 3)272.2 | 1)7760 1)7761 2)303 A or B 2)304 3)272.1 3)272.2 5)1-3720-84 | 1)3050 1)3030/3040 1)3050 1)3030/3040 | 1)7760 1)7761 |
| Titanium | 2)303C 2)304 3)283.1 3)283.2 | 2)303C 2)304 3)283.1 3)283.2 | | |

TABLE 15. INORGANICS (Continued)

| Parameter | Liquids ¹ | | Solids ² | |
|-----------|----------------------|-----------------------|---------------------|----------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| Zinc | 1)3010 | 1)7950 | 1)3050 | 1)7950 |
| | 1)3030/3040 | | 1)3030/3040 | |
| | 1)3020 | 1)7951 | 1)3050 | 1)7951 |
| | 1)3030/3040 | | 1)3030/3040 | |
| | 2)303 A or B | 2)303 A or B | | |
| | 2)304 | 2)304 | | |
| | 2)328C | 2)328C | | |
| | 3)289.1 | 3)289.1 | | |
| | 3)289.2 | 3)289.2 | | |
| | | 4)D1691-84 (C orD) | | |
| | | 5)1-3900-84 | | |

Table Identification Notes

1. Liquid matrix includes groundwater, surface water, waste water, and liquid waste.
2. Solid matrix includes soil, sediment, sludge, and solid waste.
 - a. Test Methods for Evaluating Solid Waste (EPA SW-846).
 - b. Standard Methods for the Examination of Water and Wastewater (16th Edition, publisher, place 1985).
 - c. Methods for Chemical Analysis of Water and Wastes (EPA 600/4-79-020).
 - d. Annual Book of Standards, Section II Water (American Society for Testing and Materials).
 - e. Methods for Determination of Inorganic Substances in Water and Fluvial Sediments (U.S. Department of Interior, U.S. Geological Survey - Open File Report 84-495 1986).

*Note: References b, c, d, and e are from the Federal Register, Vol. 51, No. 125, Part IV, Environmental Protection Agency - "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act"; Technical Amendments and Notice of Availability of Information - 40 CFR Part 136.

TABLE 16. ORGANICS

| Parameters | Liquids ¹ | | Solids ² | |
|---------------------------|---|--|--|------------------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| Organochlorine Pesticides | | | | |
| Chlordane | 1) ^a 3510/3520 2) ^b 509A | 1)8080 2)509A 3) ^c 608/625 4) ^d D3068 | 1)3540/3550 1)3510/3530/ 3540/3550 | 1)8080 1)8250 |
| Dieldrin | 1)3510/3520 2)509A | 1)8080 2)509A 3)608/625 | 1)3540/3550 1)3510/3530/ 3540/3550 | 1)8080 1)8250 |
| Endrin | 1)3510/3520 2)509A | 1)8080 2)509A 3)608/625 4)D3086 | 1)3540/3550 1)3510/3530/ 3540/3550 | 1)8080 1)8250 |
| 4,4-DDT | 1)3510/3520 2)509A | 1)8080 2)509A 3)608/625 4)D3086 | 1)3540/3550 1)3510/3530/ 3540/3550 | 1)8080 1)8250 |
| Heptachlor | 1)3510/3520 2)509A | 1)8080 2)509A 3)608/625 4)D3086 | 1)3540/3550 1)3510/3530/ 3540/3550 | 1)8080 1)8250 |
| Lindane | | 2)509A | | |
| Toxaphene | 1)3510/3520 2)509A | 1)8080 2)509A 3)608/625 4)D3086 | 1)3540/3550 1)3510/3530/ 3540/3550 | 1)8080 1)8250 |
| PCBs | 1)3510/3520 | 1)8080 3)608/625 | 1)3540/3550 1)3510/3530/ 3540/3550 | 1)8080 1)8250 |

TABLE 16. ORGANICS (Continued)

| Parameters | Liquids ¹ | | Solids ² | |
|----------------------------------|---|---|--|--------------------------------------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| Chlorinated Herbicides | | | | |
| 2,4-D | 1)8150 2)509B | 1)8150 2)509B | 1)8150 | 1)8150 |
| 2,4,5-T | 1)8150 2)509B | 1)8150 2)509B | 1)8150 | 1)8150 |
| Non-Pesticide Organic Chemicals | | | | |
| Acrylonitrile | 1)5020/5030 | 1)8030 3)603 | 1)5020/5030 | 1)8030 |
| Benzene | 1)5020/5030 1)5030 | 1)8020 1)8240 3)602/624 | 1)5020/5030 1)5020/5030 | 1)8020 1)8240 |
| Bromomethane (methyl bromide) | 1)5030 | 1)8010 3)601/624 | 1)5020/5030 | 1)8010 |
| Carbon tetrachloride | 1)5030 1)5030 | 1)8010 1)8240 3)601/624 | 1)5020/5030 1)5020/5030 | 1)8010 1)8240 |
| Chlorobenzene | 1)5030 1)5020/5030 1)5030 | 1)8010 1)8020 1)8240 3)601/602/624 | 1)5020/5030 1)5020/5030 1)5020/5030 | 1)8010 1)8020 1)8240 |
| Chloroform | 1)5030 1)5030 | 1)8010 1)8240 3)601/624 | 1)5020/5030 1)5020/5030 | 1)8010 1)8240 |
| 1,2-dichlorobenzene | 1)5030 1)5020/5030 1)5030 1)3530 | 1)8010 1)8020 1)8240 1)8250 3)601/602/612 | 1)5020/5030 1)5020/5030 1)5020/5030 1)3510/3530/ 3540/3550 | 1)8010 1)8020 1)8240 1)8250 |
| 1,3-dichlorobenzene | 1)5030 1)5020/5030 1)5030 1)3530 | 1)8010 1)8020 1)8240 1)8250 3)601/602/612 | 1)5020/5030 1)5020/5030 1)5020/5030 1)3510/3530/ 3540/3550 | 1)8010 1)8020 1)8240 1)8250 |

TABLE 16. ORGANICS (Continued)

| Parameters | Liquids ¹ | | Solids ² | |
|-------------------------|----------------------|---------------|---------------------------|----------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| 1-4-dichlorobenzene | 1)5030 | 1)8010 | 1)5020/5030 | 1)8010 |
| | 1)5020/5030 | 1)8020 | 1)5020/5030 | 1)8020 |
| | 1)5030 | 1)8240 | 1)5020/5030 | 1)8240 |
| | 1)3530 | 1)8250 | 1)3510/3530/ 3540/3550 | 1)8250 |
| | | 3)601/602/612 | | |
| Dichlorodifluoromethane | 1)5030 | 1)8010 | 1)5020/5030 | 1)8010 |
| | 1)5030 | 1)8240 | 1)5020/5030 | 1)8240 |
| | | 3)601 | | |
| Hexachlorobenzene | 1)3510/3520 | 1)8120 | 1)1)3540/3550 | 1)8120 |
| | 1)3530 | 1)8250 | 1)3510/3530/ 3540/3550 | 1)8250 |
| | | 3)612-625 | | |
| Hexachlorobutadine | 1)3530 | 1)8250 | 1)3510/3530/ 3540/3550 | 1)8250 |
| | | 3)612/625 | | |
| Methylene chloride | 1)5030 | 1)8240 | 1)5020/5030 | 1)8240 |
| | | 3)601/624 | | |
| Methylethylketone | 1)5030 | 1)8015 | 1)5020/5030 | 1)8015 |
| Naphthalene | 1)3510/3520 | 1)8100 | 1)3540/3500 | 1)8100 |
| | 1)3530 | 1)8250 | 1)3510/3530/ 3540/3550 | 1)8250 |
| | 1)8310 | 1)8310 | 1)8310 | 1)8310 |
| | 3)610/625 | | | |
| Nitrobenzene | 1)3510/3520 | 1)8090 | 1)3540/3550 | 1)8090 |
| | 1)3530 | 1)8250 | 1)3510/3530/ 3540/3550 | 1)8250 |
| | | 3)609/625 | | |
| Perchloroethylene | 1)5030 | 1)8010 | 1)5020/5030 | 1)8010 |
| Toluene | 1)5030 | 1)8020 | 1)5020/5030 | 1)8020 |
| | 1)5030 | 1)8240 | 1)5020/5030 | 1)8240 |
| | | 3)602/624 | | |
| Phenol | 1)3510/3520 | 1)8040 | 1)3540/3550 | 1)8040 |
| | 1)3530 | 1)8250 | 1)3510/3530/ 3540/3550 | 1)8250 |
| | | 3)604/625 | | |

TABLE 16. ORGANICS (Continued)

| Parameters | Liquids ¹ | | Solids ² | |
|------------------------|-----------------------|-------------------------------|--|------------------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| 1,2,4-trichlorobenzene | 1)3510/3520 1)3530 | 1)8120 1)8250 3)612/625 | 1)3540/3550 1)3510/3530/ 3540/3550 | 1)8120 1)8250 |
| 1,1,1-trichloroethane | 1)5030 1)5030 | 1)8010 1)8240 3)601/624 | 1)5020/5030 1)5020/5030 | 1)8010 1)8240 |
| 1,1,2-trichloroethane | 1)5030 1)5030 | 1)8010 1)8240 3)601/624 | 1)5020/5030 1)5020/5030 | 1)8010 1)8240 |
| Trichloroethylene | 1)5030 | 1)8010 3)601/624 | 1)5020/5030 | 1)8010 |
| Trichlorofluoromethane | 1)5030 1)5030 | 1)8010 1)8240 3)601/624 | 1)5020/5030 1)5020/5030 | 1)8010 1)8240 |
| 2,4,6-trichlorophenol | 1)3510/3520 | 1)8040 3)604/625 | 1)3540/3550 | |
| Vinyl chloride | 1)5030 1)5030 | 1)8010 1)8240 3)601/624 | 1)5020/5030 1)5020/5030 | 1)8010 1)8240 |
| Xylenes | 1)5030 | 1)8020 | 1)5020/5030 | 1)8020 |

1. Liquid matrix includes groundwater, surface water, waste water, and liquid waste.
2. Solid matrix includes soil, sediment, sludge, and solid waste.
 - a. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (EPA SW-846, Revised edition 1984).
 - b. Standard Methods for the Examination of Water and Wastewater (16th Edition, American Public Health Association, Washington, D.C., 1985).
 - c. "EPA Approved Test Procedures for Pesticides and Non-Pesticides Organic Compounds," Federal Register 49. No. 209/Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; 40 CFR Part 136 (October 1984).
 - d. Annual Book of Standards, Part 31 Water, American Society for Testing and Materials, 1980.

TABLE 17. MISCELLANEOUS ANALYSIS

| Parameter | Liquids ¹ | | Solids ² | |
|------------------------|--|--|---------------------|----------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| Boron | 2) ^b 404A | 2)404A 3) ^c 212.3 4) ^d D1246-82C 5) ^e 1-1125-84 | | |
| Cyanide (total) | 1) ^a 9010 2)412B 2)412C 2)412D 3)335.2 3)335.2 | 1)9010 2)412B 2)412C 2)412D 3)335.2 3)335.3 4)D2036-82A 5)1-3300-84 | 1)9010 | 9)9010 |
| Cyanide (amendable) | 1)9010 2)412F 3)335.1 | 1)9010 2)412F 3)335.1 4)D2036-82B | 1)9010 | 1)9010 |
| Fluoride | 2)413A 2)413B 2)413C | 2)413A 2)413B 2)413C 2)413E 3)340.2 3)340.1 3)340.3 4)D1179-80(A) 4)D1179-80(B) 5)1-4327-84 | | |
| Iodide | 3)345.1 2)414 2)414A 2)414B | 3)345.1 2)414 2)414A 2)414B | | |
| Nitrate (as N) | 3)352.1 | 3)352.1 4)D992-71 | | |
| Nitrate (as N) | 2)418C | 2)418C 2)418F 3)353.3 3)353.2 3)353.1 4)D3867-85(B) 4)D3867-85 (A) 5)1-4545-84 | | |

TABLE 17. MISCELLANEOUS ANALYSIS (Continued)

| Parameter | Liquids ¹ | | Solids ² | |
|------------------------------|----------------------|---|---------------------|----------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| Oil and Grease | | 2)503A 3)413.1 | | |
| Total Organic Carbon (TOC) | | 2)505 3)415.1 4)D2579-85 (A or B) | | |
| Total Organic Halides (TOX) | 1)9020 | 1)9020 | | |
| Total Dissolved Solids (TDS) | | 2)209B 3)160.1 | | |
| Trace Elements | 1)3020 | 1)3020 | 1)3020 | 1)3020 |

Table Identification Notes

1. Liquid matrix includes groundwater, surface water, waste water, and liquid waste.
2. Solid matrix includes soil, sediment, sludge, and solid waste.
 - a. Test Methods for Evaluating Solid Waste (EPA SW-846).
 - b. Standard Methods for the Examination of Water and Wastewater (16th Edition, publisher, place 1985).
 - c. Methods for Chemical Analysis of Water and Wastes (EPA 600/4-79-020).
 - d. Annual Book of Standards, Section II Water (American Society for Testing and Materials).
 - e. Methods for Determination of Inorganic Substances in Water and Fluvial Sediments (U.S. Department of Interior, U.S. Geological Survey - Open File Report 84-495 1986).

*Note: References b, c, d, and e are from the Federal Register, Vol. 51, No. 125, Part IV, Environmental Protection Agency - "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act", Technical Amendments and Notice of Availability of Information - 40 CFR Part 136.

TABLE 18. RCRA CHARACTERISTIC ANALYSES

| Parameter | Liquids ¹ | | Solids ² | |
|--|----------------------|------------------|---------------------|-----------------------------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| Ignitability | | | | 1010 1010 Sec. 2.1.1 |
| Corrosivity | | 1)9040 1)9041 | | 1110 Sec. 2.1.2 |
| Reactivity | | | | As defined in Sec. 2.1.3 |
| EP Toxicity (Extraction Procedure) | 1310 | 1310 | 1310 | 1310 See 2.1.4 |
| Arsenic | 7060, 7061 | | | 7060, 7061 |
| Barium | 7080, 7081 | | | 7080, 7081 |
| Cadmium | 7130, 7131 | | | 7130, 7131 |
| Total Chromium | 7190, 7191 | | | 7190, 7191 |
| Hexavalent Chromium | 7195, 7196 7197 | | | 7195, 7196 7197 |
| Lead | 7420, 7421 | | | 7420, 7421 |
| Selenium | 7740, 7741 | | | 7740, 7741 |
| Silver | 7760, 7761 | | | 7760, 7761 |
| Endrin (1,2,3,4,10, 10-Hexachloro-1,7-epoxy-1,4,4a,5,6,7,8,8a octahydro-1,4-endo, endo-5,8-dimethanonaphthalene) | 8080 | | | 8080 |
| Lindane (1,2,3,4,5,6-Hexachlorocyclohexane, gamma isomer) | 8080 | | | 8080 |
| Methoxychlor (1,1,1-trichloro-2,2-bis(p-methoxyphenyl)ethane) | 8080 | | | 8080 |

TABLE 18. RCRA CHARACTERISTIC ANALYSES (Continued)

| Parameter | Liquids ¹ | | Solids ² | |
|---|----------------------|----------|---------------------|----------|
| | Sample Prep | Analysis | Sample Prep | Analysis |
| Toxaphene (C ₁₀ H ₁₀ Cl ₈ , Technical chlorinated camphene, 67-69% chlorine) | | 8150 | | 8150 |
| 2,4-D (2,4-Dichloropheno- xyacetic acid) | | 8150 | | 8150 |
| 2,4,4-TP (Silvex) (2,4,5- Trichlorophenoxypropionic acid) | | 8150 | | 8150 |

¹Liquid matrix includes groundwater, surface water, waste water, and liquid waste.

²Solid matrix includes soil, sediments, sludge, and solid waste.

TABLE 19. RADIONUCLIDE METHODS

| Parameter | Liquids ¹ | | Solids ² | | Biota ³ | |
|-------------|--|-----------------------------------|---------------------|----------|--------------------|----------|
| | Sample Prep | Analysis | Sample Prep | Analysis | Sample Prep | Analysis |
| Gross Alpha | 4) ^a 703 5) ^b 900.0 | 4)703 5)900.0 5)Appendix B | 4)703 | 4)703 | 4)703 | 4)703 |
| Gross Beta | 4)703 5)900.0 | 4)703 5)900.00 5)Appendix B | 4)703 | 4)703 | 4)703 | 4)703 |

Table Identification Notes

1. Liquid matrix includes groundwater, surface water, waste water, and liquid waste.
 2. Solid matrix includes soil, sediment, sludge, and solid waste.
 3. Biota matrix includes foodstuffs, vegetation, and fauna.
- a. Standard Methods for the Examination of Water and Wastewater (EPA SW-846, revised edition, U.S. Environmental Protection Agency, 1984).
 - b. Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA-600/4-60-32, update, U.S. Environmental Protection Agency, August 1980).

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APPENDIX B

GENERIC HEALTH AND SAFETY PLAN

THIS GENERIC HEALTH AND SAFETY PLAN WAS ADAPTED FROM DOE.
COMPREHENSIVE ENVIRONMENTAL ASSESSMENT AND RESPONSE PROGRAM
PHASE 2 GENERIC MONITORING PLAN. WORKING DRAFT, JULY 1986.
ALBERQUERQUE OPERATIONS OFFICE.

GENERIC HEALTH AND SAFETY PLAN

1.0 INTRODUCTION

The following Health and Safety Plan discusses the generic guidelines and procedures that will be employed during the CERCLA site characterization activities to protect the health and safety of personnel involved in the CERCLA field investigations. This plan establishes the generic safety policy, sets general safety standards, identifies personnel training requirements for CERCLA field investigations, and provides the framework for the more site specific safety requirements to be employed during the Remedial Investigation/Feasibility Study (RI/FS). The site specific RI/FS Health and Safety Plan will include as a minimum the following additional elements:

- o identification of physical, chemical, radiological and biological hazards including a listing of known and possible contaminants;
- o a preliminary evaluation of risk to personnel from physical, chemical, and biological hazards at the site;
- o the methodology for continued assessment of the hazards during site characterization activities;
- o identification of the personal protective equipment levels for personnel to be used at the site for various activities and in various areas;
- o a complete description of ambient and personal monitoring requirements for the site;
- o identification of other hazard control measures, as appropriate;
- o identification of a Site Safety and Health Coordinator (SSHC) for the site investigations;
- o establishment of the acquirements for other health and safety support

personnel (safety engineer, industrial hygienist, and health physicist) needed for field investigation activities; and

- o a specific emergency response plan including individuals and department responsibilities, emergency telephone numbers, emergency decontamination procedures, and location of emergency treatment facilities.

2.0 POLICY AND STANDARDS

The Department of Energy has the responsibility for the health, safety, and environmental protection programs at DOE-owned, contractor-operated facilities. It is the policy of DOE to assure that DOE operations are conducted in a manner that will (1) limit the risks to the health and safety of the public and employees, and (2) adequately protect property and the environment (DOE Order 5481.1A). This policy is implemented through the development of contractor health and safety programs and the systematic review of operations and facilities.

The environmental protection, safety and health protection requirements applicable to all DOE operations are set forth in DOE orders. In addition, the DOE and its contractors must also comply with other applicable federal, state, and local standards. This plan is based on the following DOE orders and federal regulations:

- o DOE Order 3790.1A, "Federal Employee Occupational Safety and Health Program for Federal Employees."
- o DOE Order 5000.3, "Unusual Occurrence Reporting System."
- o DOE Order 5480.1B, "Environmental Protection, Safety, and Health Protection Standards."
- o DOE Order 5480.1B, Chapter XII, "Prevention, Control, and Abatement of Environmental Pollution" (including Executive Order 12088 of October 13, 1978)
- o DOE Order 5480.2, "Hazardous and Radioactive Mixed Waste Management."

- o DOE Order 5480.3, Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes".
- o DOE Order 5480.4, Environmental Protection Safety and Health Protection Standards".
- o DOE Order 5480.10, "Contractor Industrial Hygiene Program".
- o DOE Order 5481.1A, "Safety Analysis and Review System".
- o DOE Order 5482.1A, "Environmental, Safety, and Health Protection Appraisal Program".
- o DOE Order 5483.1A, "Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities".
- o DOE Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements."
- o DOE Order 5500.2, "Emergency Planning Preparedness, and Response for Operation".
- o DOE Order 5500.3, "Reactor and Nonreactor Nuclear Facility Emergency Planning, Preparedness, and Response Program for DOE Operations.
- o DOE Order 5500.4, "Public Affairs Policy and Planning Requirements for Emergencies.
- o 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plans"
- o 49 CFR 172-174, "DOT Transportation of Hazardous Materials.

The DOE has also adopted, as a matter of policy, the health and safety standards of the American Conference of Government Industrial Hygienists (ACGIH), the American National Standards Institute (ANSI), and the Occupational Safety and Health Administration (OSHA). All personnel involved

in the CERCLA field investigations will comply with the prescribed standards and keep occupational and public exposures to hazardous materials as low as reasonably achievable.

3.0 HEALTH AND SAFETY RESPONSIBILITIES

This section will need to include a discussion of the responsible organizations involved in the CERCLA field investigations projects. Included in this section (once the contractor is identified) should be the identification of the responsible Project Office or installation project leader and the assignment of a Site Safety and Health Coordinator (SSHC) for each CERCLA site. The following outlines some of the responsibilities that the SSHC will have:

- o Monitoring hazards to determine the degree of hazard present;
- o Implementing the personnel protection requirements specified in the site specific RI/FS Health and Safety Plan, including ensuring that appropriate clothing and equipment are available, maintained, and used;
- o Monitoring the performance of all personnel to ensure that the required safety and decontamination procedures are followed;
- o Notifying emergency authorities as appropriate;
- o Ensuring that all CERCLA personnel have been trained for any nonroutine (e.g. emergency) site activities; and
- o Ensuring that all subcontractor personnel (if any) have been trained in proper site safety procedures, including the use of personal protective equipment.

4.0 RISK ASSESSMENT AND PERSONNEL PROTECTION REQUIREMENTS

4.1 IDENTIFICATION OF HAZARDS AND EVALUATION OF RISK

This section provides guidance for (1) identification of physical, chemical, radiological and biological hazards, and (2) evaluation of the health and safety risks. Personnel protection requirements, general policies, and mitigation measures will be determined and implemented based on the preliminary risk assessment. Continual feedback on hazards and risks will be provided throughout the entire field investigation process and used to update the personnel protection requirements as necessary.

The hazard assessment will be based on all available information, including disposal logs and records, engineering drawings, site reconnaissance, current monitoring data, employee interviews, and any other available information for the site. Hazards to be identified and evaluated are described in the following sections.

4.1.1 Physical Hazards

Physical hazards at the sites will be evaluated and appropriate precautions taken prior to site entry. Some of the potential physical hazards that may be encountered include: (1) flammable/explosive materials or fire; (2) noise; (3) heat; (4) cold; (5) mechanical equipment; (6) projectiles created by operational activities; (7) electrical lines; (8) unsafe structure; (9) tanks; (10) pits, trenches or steep banks/cliffs; and/or (11) surface impoundments. Physical hazards will be identified and controlled to the extent possible prior to commencement of the field investigation.

4.1.2 Chemical Hazards

Chemical hazards at the sites will be identified and evaluated prior to site entry so that appropriate protective equipment can be used to minimize exposures. Some of the potential chemical hazards that may be encountered at the sites include: inhalation, ingestion, or skin absorption of toxic materials; contact with corrosive materials; and/or unsafe environments created by reactive materials.

4.1.3 Radiological Hazards

Radiological hazards at the sites will be identified and evaluated prior to site entry so that appropriate precautions may be taken to minimize exposures.

4.1.4 Biological Hazards

Biological hazards at the sites will be identified and evaluated prior to site entry so that appropriate precautions may be taken to minimize contact. Some of the potential biological hazards that may be encountered at the sites include: snakes; spiders; scorpions; and worker exhaustion (i.e. fatigue and heat stress).

4.2 PERSONNEL PROTECTION REQUIREMENTS

4.2.1 Protection Levels and Protective Clothing

The U.S. Environmental Protection Agency (EPA) has established four levels of protection for personnel entering potentially hazardous sites. Table 1 contains a description of sample protective ensembles including identifying the level of protection, equipment, protection provided, when this level of equipment should be used and the limiting criteria.

In addition to the requirements summarized in Table 1, the following requirements should also be considered:

- o Radioactive Anti-Contamination Clothing -- Special clothing to prevent radioactive contamination in radiation areas is available at all Hanford installations. The type of clothing to be worn depends on the nature and degree of contamination in the area and the work to be performed. Clothing varies from smocks and coveralls to fully-encapsulating suits. Clothing requirements are specified on a site-specific basis.

Table 1. Sample Protective Ensembles^a

| LEVEL OF PROTECTION | EQUIPMENT | PROTECTION PROVIDED | SHOULD BE USED WHEN: | LIMITING CRITERIA |
|---------------------|--|--|--|--|
| A | <p>RECOMMENDED:</p> <ul style="list-style-type: none"> • Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA. • Fully-encapsulating, chemical-resistant suit. • Inner chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Two-way radio communications. <p>OPTIONAL:</p> <ul style="list-style-type: none"> • Cooling unit. • Coveralls. • Long cotton underwear. • Hard hat. • Disposable gloves and boot covers. | <p>The highest available level of respiratory, skin, and eye protection.</p> | <ul style="list-style-type: none"> • The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either: <ul style="list-style-type: none"> – measured (or potential for) high concentration of atmospheric vapors, gases, or particulates or – site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin. • Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible. • Operations must be conducted in confined, poorly ventilated areas until the absence of conditions requiring Level A protection is determined. | <ul style="list-style-type: none"> • Fully-encapsulating suit material must be compatible with the substances involved. |
| B | <p>RECOMMENDED:</p> <ul style="list-style-type: none"> • Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA. • Chemical-resistant clothing (coveralls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit). • Inner and outer chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Hard hat. • Two-way radio communications. <p>OPTIONAL:</p> <ul style="list-style-type: none"> • Coveralls. • Disposable boot covers. • Face shield. • Long cotton underwear. | <p>The same level of respiratory protection but less skin protection than Level A.</p> <p>It is the minimum level recommended for initial site entries until the hazards have been further identified.</p> | <ul style="list-style-type: none"> • The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection. This involves atmospheres: <ul style="list-style-type: none"> – with IDLH concentrations of specific substances that do not represent a severe skin hazard; or – that do not meet the criteria for use of air-purifying respirators. • Atmosphere contains less than 19.5 percent oxygen. • Presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin. | <ul style="list-style-type: none"> • Use only when the vapor or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through the intact skin. • Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases, or particulates or splashes of material that will affect exposed skin. |

^aBased on EPA protective ensembles.

Table 1. Sample Protective Ensembles^a (Continued)

| LEVEL OF PROTECTION | EQUIPMENT | PROTECTION PROVIDED | SHOULD BE USED WHEN: | LIMITING CRITERIA |
|---------------------|---|---|---|--|
| C | <p>RECOMMENDED:</p> <ul style="list-style-type: none"> • Full-facepiece, air-purifying, canister-equipped respirator. • Chemical-resistant clothing (overall and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit). • Inner and outer chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Hard hat. • Two-way radio communications. <p>OPTIONAL:</p> <ul style="list-style-type: none"> • Coveralls. • Disposable boot covers. • Face shield. • Escape mask. • Long cotton underwear. | <p>The same level of skin protection as Level B, but a lower level of respiratory protection.</p> | <ul style="list-style-type: none"> • The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin. • The types of air contaminants have been identified, concentrations measured, and a canister is available that can remove the contaminant. • All criteria for the use of air-purifying respirators are met. | <ul style="list-style-type: none"> • Atmospheric concentration of chemicals must not exceed IDLH levels. • The atmosphere must contain at least 19.5 percent oxygen. |
| D | <p>RECOMMENDED:</p> <ul style="list-style-type: none"> • Coveralls. • Safety boots/shoes. • Safety glasses or chemical splash goggles. • Hard hat. <p>OPTIONAL:</p> <ul style="list-style-type: none"> • Gloves. • Escape mask. • Face shield. | <p>No respiratory protection. Minimal skin protection.</p> | <ul style="list-style-type: none"> • The atmosphere contains no known hazard. • Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals. | <ul style="list-style-type: none"> • This level should not be worn in the Exclusion Zone. • The atmosphere must contain at least 19.5 percent oxygen. |

- o Hard Hats -- Hard hats may be required for some work operations and may be worn with any level of protective clothing.
- o Safety Shoes -- Steeled-toed safety shoes/boots may be required for many field activities. They may be worn with any level of protective clothing.
- o Hearing Protection -- Ear muffs or ear plugs may be required when operating in areas with high noise levels. Care should be taken to ensure that hearing protection devices do not interfere with the ability to hear and respond to emergency warning signals.

The site specific RI/FS will define zones of contamination and identify which levels of protection will be required for each zone. All personnel entering a zone will be required to wear the attire designated for that zone. In all cases in which a self-contained breathing apparatus is required, at least three persons will be suited out for entry (two for entry and one back-up/rescue).

4.2.2 Protective Equipment

A variety of safety equipment may be used to protect personnel from safety hazards and minimize exposures to hazardous chemical and radionuclides during the CERCLA field investigations. In areas with potentially hazardous environments, ambient, personal, and portable monitors, meters, and alarms will be used to monitor exposures and measure air concentrations of contaminants, explosive materials, and oxygen as appropriate. Instruments will be selected for maximum reliability, sensitivity, selectivity, and safety in the field. Although specific safety monitoring equipment needs will be identified in the site specific RI/FS Health and Safety Plan, the following is a generic listing of some of the safety equipment which might be used:

- o Portable Oxygen indicator-- A portable oxygen indicator is used to measure the ambient oxygen concentrations in confined spaces or areas with high concentrations of combustible gases. The most useful indicators are those that measure from 0 to 25 percent oxygen. Oxygen indicators should be corrected for the elevation of the site.

- o Combustible gas indicator-- A combustible gas indicator (CGI) is used to measure the concentrations of flammable vapors and gases. The indicator usually shows the concentrations in terms of the percent of the lower explosives limit (LEL) of the calibration gas. The LEL represents the lowest concentration (by volume) in air that can explode, ignite, or burn when there is an ignition source. The oxygen concentration may effect the the accuracy of the CGI. A meter may be combined with an oxygen indicator.
- o Photoionization and flame ionization detection meters-- Photoionization and flame ionization (organic vapor analyzer (OVA)) detection meters can be used to indicate the approximate air concentration of many organic vapors. The response of the instruments depends on what gases have been used in calibration. In general, the instruments are more sensitive to complex organic compounds than to simple ones.
- o Direct-reading colorimetric indicator tubes-- Colorimetric indicator tubes may be used to quickly measure the approximate concentration of a vapor or gas. The tubes are made of glass and packed with an indicator (reactive) chemical. Different tubes are needed for different gases. A specified amount of air is drawn through the tube to give an approximation of the concentration.
- o High- and low-volume air samplers-- Various types of high and low volume air samplers are available to measure ambient and personal breathing zones concentrations of particulates, vapors, and gases. Particulates can be separated into size categories by using different filter sizes or impactor type collectors.
- o Radiation survey meters-- A variety of radiation survey meters are available for measuring alpha particles, beta particles, gamma rays, and x-rays. Instruments include ion detection tubes, proportional counters, Geiger-Mueller (GM) counters, and scintillation counters.
- o Thermoluminescent dosimeters (TLDs)-- TLDs are used to measure absorbed ionizing radiation. They can be worn both for ambient monitoring and personnel dosimetry.

Other safety equipment will be available and used as needed. Safety devices such as safety harnesses/belts/lines and safety ladders/cherrypickers will be used as appropriate to provide safe access and protect workers from falls. Cooling vests and warming equipment can be used as appropriate to minimize stress from climatic conditions. Emergency equipment (fire extinguishers, first aid kits, blankets, showers, and eye wash stations) will also be available for immediate response and emergency treatment. Emergency equipment will be clearly marked and the locations detailed on the site specific RI/FS Health and Safety Plan maps.

Fire extinguishers are classified by the type of combustible material they are designed for:

- o Class A--Ordinary combustible materials (wood,paper, textiles);
- o Class B-- Flammable liquids (oils, grease, paints);
- o Class C-- Electrical Fires;
- o Class D-- Metals capable of rapid oxidation (magnesium, sodium, zinc, aluminum, uranium, zirconium).

Many fire extinguishers are multipurpose types (A, B, C, and D) so that they can be used on mixed fires or fires of unknown composition.

4.2.3 General Safety Practices and Mitigation Measures

Some hazards can be minimized through the implementation of specific procedures, use of special equipment, training of personnel, or availability of emergency response equipment in the event of an accident. The following general requirements must be observed during all CERCLA field investigations:

- o Eating, drinking, smoking, chewing gum or tobacco, and putting on make-up is prohibited in any area designated as contaminated. The hands and face must be washed upon leaving a contaminated area and before eating, drinking, smoking, chewing gum or tobacco, or putting on make-up.

- o Decontamination procedures should be planned before site entry, practiced as close to the contaminated areas as possible, and followed by personnel showering as soon as possible.
- o Facial hair that interferes with the mask-to-face seal on respirators is not allowed on personnel entering respiratory protection areas.
- o Contact with contaminants should be minimized as far as can be reasonably achieved. Unnecessary personnel should not enter contaminated areas, and personnel in contaminated areas should avoid unnecessary contact with contaminated surfaces.

In addition the following general policies will be incorporated into the specialized practices and mitigation measures identified and implemented in the site specific RI/FS Health and Safety Plan.

- o Flammable Materials and Fire -- A fire and explosion prevention and control program will be established at sites with flammable and reactive materials. Good housekeeping practices and proper storage of flammable and combustible materials shall be required. In the event of a fire, personnel shall evacuate the area and contact the fire department immediately. Fire extinguishes will be available for control of small fires by personnel with fire safety training.
- o Explosivity -- Continuous, ground, waist, and head level combustible gas (explosivity) readings shall be obtained in confined areas, or where explosive gases and/or vapors are suspected. If readings approach or exceed 10 percent of the lower explosive limit (LEL), extreme caution will be exercised in continuing the investigation. If readings approach or exceed 25 percent of the LEL, all personnel will be withdrawn from the site immediately. Before resuming any onsite activities, project personnel should consult with fire protection experts and/or the local fire department and then develop explosion prevention procedures for safely conducting site work.
- o Oxygen Deficiency -- Confined spaces will be monitored for oxygen deficiency. Oxygen deficiency readings should be taken at ground,

Radiation exposures will be monitored through the use of thermoluminescent dosimeters (TLDs), other personal radiation dosimeters, radiation survey meters, and air monitoring. Radiation exposures will always be kept as low as reasonably achievable.

Administrative limits will be used to ensure that employees do not receive occupational exposures that exceed the quarterly or annual limits specified in DOE Order 5480.1B, Chapter XI (which will be replaced by DOE Order 5480.11). If administrative limits or standards are exceeded, employees exposed to the elevated levels of radiation shall be placed on work restriction until the end of the period of concern. Employees under the age of eighteen shall neither be employed in, nor allowed to enter, controlled areas where they may receive radiation exposures above background levels.

- o Noise -- DOE Prescribed Standard AF 161-35 identified the Threshold Limit Value (TLV) for personnel exposure to noise. Hearing protection equipment and noise suppression devices will be mandatory for levels above the TLV and encouraged for levels approaching the TLV. Hearing protection shall not interfere with rapid, clear communication. Special equipment (i.e. sound powered muffs/radios) may be required.
- o Physical Hazards -- Activities such as excavations, trenching, and shoring, and use of signs, signals barricades, motor vehicles, and mechanized equipment will be conducted in accordance with accepted requirements.

4.3 SITE ACCESS CONTROL

4.3.1 Restricted Access Zones

Control zones will be established at contaminated sites to protect employees and the general public from unnecessary exposure to toxic materials and/or radiation, and to prevent the spread of contamination. The control (exclusion) zones will be designated based on the nature, magnitude, and extent of contamination, and the potential for contaminant migration.

Different exclusion zones with different protective requirement may be established for a single site. Decontamination may be required for personnel, equipment, and vehicles moving from one zone to another.

Surrounding the exclusion zones is the contamination reduction zone in which a corridor will be established for final decontamination activities. The size of the contamination reduction corridor will depend on the number stations required for decontamination activities.

Additional control zones may also be established for safety considerations other than contamination, including hard hat, eye protection, and ear protection zones.

In areas of high contamination or other unusual circumstances, exit from an exclusion zone will normally only be allowed through an access control station manned by personnel specifically trained to conduct contamination monitoring. All personnel and equipment leaving the restricted work site or having been in contact with potentially contaminated materials will be monitored and decontaminated if necessary.

Exclusion zones will be posted with the exclusion criteria, protection requirements, contact person, and other relevant information in accordance with applicable DOE orders and the site specific RI/FS Health and Safety Plan.

4.3.2 Decontamination

Personnel, equipment and vehicles that have been in contaminated areas may carry residual contamination. Although protective clothing, respirators, and good work practices can help reduce contamination, decontamination may also be necessary to prevent personnel exposure and migration of contaminants. Decontamination procedures will be developed as part of the site specific RI/FS Health and Safety Plan and implemented prior to initial site entry and used throughout site operations. Modifications to the decontamination procedures will be adopted as appropriate.

The following general guidelines will be used for development of specific decontamination procedures:

- o The level of decontamination required will depend on the nature and magnitude of contamination, and the type of protective clothing worn.
- o Decontamination stations will be set up to reduce contamination as personnel move toward the end of the contamination reduction corridor. The system will be set up to wash and rinse, at least once, all protective equipment worn. A sequential doffing of protective equipment will be conducted, starting with the most heavily contaminated items at the first station and progressing to the least contaminated items at the final stations. Stations will be far enough apart to minimize cross-contamination.
- o All personnel entering an exclusion zone where personnel decontamination is required must follow the specified decontamination procedures. Personnel that are not required to wear the maximum level of protective gear may bypass the decontamination stations for gear they are not wearing.
- o Emergency decontamination procedures will be established for personnel who must evacuate or be evacuated the site under emergency conditions or because of injury. If decontamination activities may aggravate or cause more serious health effects to an injured person or if prompt life saving first aid and/or medical treatment is required, decontamination procedures will be omitted and life-saving care initiated without delay. The outer garments will be removed whenever practical (or if necessary because the victim has been contaminated with a life-threatening material). However, if the outer contaminated garments can not be safely removed, the individual should be wrapped in plastic, rubber, or blankets to help prevent contamination of medical personnel and/or the interior of the ambulance. Contaminated garments can then be removed at the medical facility. Whenever possible, response personnel will accompany contaminated victims to the medical facility to advise on matters involving decontamination.
- o Personnel assisting in decontamination activities will be attired in clothing to protect them from contamination released during the

decontamination procedure. Protection levels for decontamination workers will be defined in the site specific RI/FS Health and Safety Plan.

- o Periodically, swipes will be taken for chemical and radioactive contamination and analyzed in the laboratory to assess the effectiveness of decontamination or estimate permeation through protective clothing and personnel exposure.
- o A personnel contamination log will be maintained to record contamination levels and decontamination measures taken.
- o All equipment and vehicles used in the exclusion zone will require the same level of decontamination. Reusable clothing and respirators will be sanitized in addition to being decontaminated.
- o Audits will be conducted to ensure compliance with decontamination procedures.

4.4 Worker Training

A health and safety training program will be established to provide training for all personnel involved in the CERCLA field investigations in accordance with DOE orders and OSHA requirements (29CFR 1910.120), whichever is the most stringent. The type of training will depend on job functions and potential work hazards. All field personnel will receive training in first aid and cardio-pulmonary resuscitation (CPR). In addition, training will be provided in the following areas as appropriate: (1) radiological safety (including recommendations on limiting exposures during pregnancy); (2) industrial hazard recognition; (3) use of protective equipment (including respirators and clothing for Levels A through D); (4) decontamination procedures; (5) emergency response; (6) fire safety; and (7) field survival. The requirements for training are specific and require a minimum of 40 hours formal classroom training, as well as a minimum of 3 days on-the-job.

Subcontractors may develop their own additional training programs to comply with their company policy.

4.5 EMPLOYEE MEDICAL PROGRAM

All personnel involved in field activities will participate in an employee medical program. A medical program has been established for each of the DOE contractor companies in accordance with the requirements of DOE Order 5480.8. Subcontractors will operate their own employee medical programs to ensure a level of employee protection equivalent to the DOE system and/or in compliance with any other regulations applicable to their operations.

4.6 RECORDS AND REPORTING REQUIREMENTS

4.6.1 Exposure and Medical Records

Employee exposure and medical records will be maintained in accordance with the requirements in DOE Order 5480.2B and 5484.1. Subcontractors will be responsible for maintaining exposure and medical records for their own employees.

4.6.2 Unusual Occurrence Reports

All unusual occurrences must be reported to the CERCLA Project Office in accordance with DOE Orders 5484.1 and 5000.3. An occurrence is defined as "any deviation from planned or expected behavior or course of events in connection with any DOE or DOE controlled operation if the deviation has environmental protection, safety, or health protection significance" (DOE Order 5484.1). Reportable unusual occurrences include:

- o Any substantial degradation of a barrier designed to contain radioactive or toxic material or any substantial release of radioactive or toxic material.
- o Loss of control of hazardous or radioactive material.
- o Accidents involving the transport of radioactive or toxic materials.
- o Any fire or explosion which affects the integrity of the site or project.

- o Any condition resulting from natural events or man-made activities that substantially affects or threatens performance, reliability, or safe operation (e.g. flooding, wind damage, soil stability problems, equipment malfunctions, personnel operation errors that create hazardous conditions).
- o Any incidence of breach of access control by unauthorized personnel.
- o Any acts of vandalism or major theft occurring at a site.
- o Any release of contamination outside the controlled area.
- o Any injury or contamination to personnel.

In addition to the DOE reporting system, any subcontractors involved in unusual occurrences will be responsible for any reporting requirements to OSHA under the Occupational Safety and Health Act or any other reporting requirements directly applicable to them (e.g. workers' compensation insurance requirements).

4.7 EMPLOYEE INFORMATION

DOE Form F-5480.2 "Occupational Safety and Health Protection (a Poster outlining contractor responsibilities to provide safety and health protection) and DOE Form F-5480.4 "Occupational Safety and Health Complaint Form " (a form to be used in reporting violations) will be posted in prominent locations at the workplace (but not necessarily at the field site).

4.7.1 Employee Right to Know

All persons who may potentially be exposed to hazardous materials in the work place must be fully informed of potential health hazards and safety precautions. Warning notices shall be posted as appropriate. Procedures for employee right to know will be developed in the site specific RI/FS Safety and Health Plan.

4.7.2 Health and Safety Complaints

Employees are encourage to report any conditions or practices that may be detrimental to their health/safety or that they believe are in violation of applicable health and safety standards. Any imminent danger that potentially threatens life or serious physical harm should be brought to the immediate attention of the appropriate supervisor. In the event of inadequate corrective action, the CERCLA Project Office should be immediately notified by telephone and an immediate inspection requested. Employees should evacuate the area until corrective action is taken.

5.0 EMERGENCY RESPONSE

Generic guidance is provided in this section for preparing the site specific RI/FS emergency response plans for each individual CERCLA site field investigation. These specific procedures will be reviewed and approved by the appropriate personnel and organization prior to initial site entry. All personnel entering a site exclusion zone will be required to read and be familiar with the emergency response procedures.

5.1 Emergency Contacts

This section in the site specific RI/FS Health and Safety Plan will provide emergency contact information. The section will be placed on a separate page that can be copied and posted in prominent locations at the work site. Table 2 contains an example of the minimum emergency contacts to be identified and radio/telephone call numbers provided.

5.2 Emergency Contingency Plans

Emergency contingency plans will be included in the site specific RI/FS Health and Safety Plan. The contingency plans will include specific procedures to be followed in the event of specific types of emergencies. A copy of these plans must be available at the work site at all times, and all personnel entering the exclusion zone must be familiar with the procedures. The plans will designate responsible individuals, identify criteria for evacuation, detail evacuation routes, establish procedures for emergency treatment of victims, and indicate how to get emergency assistance.

5.2.1 Fire/Explosion

The site specific RI/FS Health and Safety Plan will provide procedures for dealing with fire/explosion accidents. The following guidelines are provided as generic guidance:

- o The Site Health and Safety Coordinator (SSHC) (or his alternate) shall have the authority to coordinate all evacuations and emergency response activities until the proper authorities arrive and assume control.
- o All injured personnel and other personnel not trained in fire safety shall be evacuated.
- o The fire department shall be notified immediately.
- o Personnel trained in fire safety may fight small, nontoxic fires. All personnel shall evacuate an area with a large fire or a fire generating toxic fumes.
- o All personnel shall be evacuated and the fire department notified if combustible gas meters show combustible gas concentrations approaching the lower explosive limit.
- o In the event of an explosion, all personnel (including the injured) shall be evacuated and no one shall re-enter the area until it has been cleared by personnel trained in dealing with explosive materials.
- o The occurrence shall be reported as specified in Section 4.6 of this plan.

TABLE 2.0

EMERGENCY CONTACTS

SITE SAFETY AND HEALTH COORDINATOR

NAME:

CALL:

FIRE CALL:

AMBULANCE CALL:

POISON CONTROL CENTER CALL:

SECURITY CALL:

POLICE CALL:

YOU ARE LOCATED AT:

THE NEAREST TELEPHONE IS LOCATED AT:

THE NEAREST EMERGENCY MEDICAL SERVICES ARE LOCATED AT (attach a map):

5.2.2 Personnel Injury

The site specific RI/FS Health and Safety Plan will provide emergency procedures for dealing with accidents involving personnel injuries. The following guidelines will be incorporated as appropriate:

- o In the case of an injury or medical emergency, the SSHC (or his alternate) will have the authority to issue orders for emergency response and first aid assistance.
- o Emergency first aid care will be initiated at the site by trained personnel. Treatment of injuries involving life-threatening situations or chemical burns/skin absorption should be initiated at once. Victims of serious injuries should be transported to a medical facility as soon as possible.
- o Whenever possible, one individual should remain with the victim while other personnel place necessary emergency phone calls and provide other assistance.
- o Minor injuries may be treated onsite by trained personnel. However, all injuries should be checked by qualified medical personnel.
- o Heat stress may require first aid treatment. Heat stroke requires prompt treatment to prevent irreversible damage or death. Cooling measures should be initiated and protective clothing removed as soon as possible. Victims of heat stroke should be checked by qualified medical personnel. Less serious forms of heat stress (fatigue/exhaustion) should also be treated to prevent further complications.
- o Victims of serious bites (i.e. rattlesnakes, spiders or scorpions) and stings (allergic reactions) should be taken to the nearest medical facility for prompt treatment. Personnel with known allergic reactions should notify the SSHC and carry allergy treatment kits to the field with them.

- o Decontamination of injured personnel shall depend on the nature of the injury. Decontamination shall be conducted to prevent further exposure as long as it will not aggravate the situation. Life-threatening or serious injury situations shall always be considered first.
- o The occurrence shall be reported as specified in Section 4.6 of this plan.

5.2.3 Personnel Contamination

The site specific RI/FS Health and Safety Plan will provide emergency procedures for dealing with personnel contaminations accidents. The following guidelines are provided as generic guidance:

- o The SSHC shall have the authority to issue orders for emergency response and decontamination.
- o External contamination of the skin shall be immediately decontaminated in accordance with the procedures outlined in the decontamination plan (including flushing with water as appropriate). Victims of burns or skin absorption should be checked by qualified medical personnel.
- o Victims of internal contamination (i.e. through inhalation, ingestion or absorption) shall be immediately transported to the nearest medical facility for emergency treatment. If the route of contamination is by ingestion, a call should be made to the nearest poison control center and first aid treatment initiated as directed by the center.
- o Report the occurrence as specified in Section 4.6 of this plan.

5.2.4 Accidental Release to the Environment

Emergency response measures for accidental releases to the environment have been developed by each facility onsite. The procedures deal with both emergency response (i.e., spill control, site evacuation and monitoring) and reporting to DOE and the National Response Center as appropriate. The site

specific RI/FS Health and Safety Plan will identify specific emergency procedures for dealing with releases to the environment.

The SSHC shall immediately notify the CERCLA Project Health and Safety Officer. The notification shall include: the location and time of release, the type of release and estimated magnitude; and the immediate spill containment procedures implements. The occurrence shall also be reported as specified in Section 4.6 of this plan.

6.0 ENVIRONMENTAL MONITORING

An ambient environmental monitoring program will be conducted at the CERCLA sites as appropriate to evaluate ambient concentrations and estimate potential doses to personnel and the public. The site specific RI/FS Health and Safety Plan will designate sampling requirements, types and location of samples requires, and the types of analyses requires.

Wastewater collected from onsite activities and from decontamination procedures will be sampled and analyzed prior to release from the site. Prior to releasing the wastewater, radionuclide concentrations shall meet the release requirements of DOE Order 5480.xx and other contaminants shall be in conformance with the National Pollutant Discharge Elimination System (NPDES) permit regulations.