Review Draft

INACTIVE WASTE SITE STUDY REPORT

September 3, 1987

Submitted to:

Westinghouse Hanford Company
Richland, Washington 99352

Prepared by:

Science Applications International Corporation
Richland, Washington and
McLean, Virginia

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FOREWORD

This report is an account of work performed under Consultant Agreement MDD-SCA-432162 between June 19, 1987, and September 1, 1987. This work utilized information provided to SAIC by Westinghouse Hanford Company and Rockwell Hanford Operations. The documents used in this work are listed in Section 5 of this report.

It is the purpose of this report to provide an estimate of the cost of characterizing and remediating 81 potential CERCLA sites and more than 500 potential RCRA 3004(u) sites. The development of characterization plans and the selection of remedial actions to be implemented was outside the scope of this study and will require more detailed information on each site than is available in the documents reviewed for this study. This more detailed information will be obtained as a part of the Remedial Investigation/Feasibility studies performed for these sites.

EXECUTIVE SUMMARY

This report is an account of work performed between June 19, 1987, and September 1, 1987, under Consultant Agreement MDD-SCA-432162. The purpose of this work was to develop a strategy for the characterization and remediation of potential CERCLA and RCRA 3004(u) inactive sites in sufficient detail to enable the development of costs and schedules.

Each of the 81 individual CERCLA sites and each type of RCRA 3004(u) site (covering approximately 500 sites) were evaluated to identify the types of data that might be required for characterization, remedial investigation, or remediation. The data needs were identified for each site or type of site, and a strategy for characterizing the sites was prepared. This strategy was then used to develop a summary of the potential costs and possible schedule for characterizing and remediating each site. Each of the 81 CERCLA sites was addressed individually during this study. Contractual restraints precluded analysis of the approximately 500 RCRA 3004(u) sites on an individual basis. As a result, the 3004(u) sites were analyzed and placed into 15 categories of waste management unit types. A generic Hanford unit (size, construction, waste managed, etc.) was then developed as a representative unit to be used during the remainder of the study. This process and its applications are discussed in greater detail in Section 3.2 and Appendix C of this report.

On an individual site basis, the costs of characterization range from a low of $3.2 million to a high of $7.7 million for CERCLA sites. Similarly, the costs for the sampling and analysis required for RCRA 3004(u) sites ranges from a low of $23,000 for a generalized Hanford underground tank to a high of $8.6 million for a generalized Hanford ditch. In many cases, the costs for characterizing adjacent sites can be materially reduced by treating these sites as a group rather than treating each site individually. For example, characterizing the 20 trenches in the 200 East BC Crib Area (200 East Group Z) on an individual basis is estimated to cost approximately $111,340,000, based on the generalized Hanford units developed for this study. In contrast, characterizing these units as a group is estimated to cost approximately $19,625,000--an 82 percent cost reduction. Cost savings result from economies of scale and the elimination of double counting of sampling requirements and associated costs. Some grouping arrangements may

not result in cost reductions, but they were made to facilitate a more efficient characterization and remediation schedule. Cost reductions of up to 80% have been identified by grouping of these sites. A more detailed discussion of the grouping of sites can be found in Section 4.0 of this report.

Although the remedial technology for each site cannot be determined at this time, some estimate can be made of the probable range of costs for each CERCLA site and each type of RCRA 3004(u) site. For the CERCLA sites evaluated in this study, the least cost alternative is nearly always the capping of the site with some type of subsurface barrier. The most expensive alternative is nearly always some type of removal action such as excavation and disposal. More detailed evaluation of each site as a part of Remedial Investigation/Feasibility Study will be required to select the remediation technologies to be used, to refine the cost estimates, and to provide the information required by EPA and State of Washington Regulations for use in the final selection of a remedial technology.

The schedule for the CERCLA sites indicates that it will take approximately ten years to complete site characterization based on a budget of $50 million per year. RCRA sites could take an additional 15 years. Remediation of the sites could take more than fifty years if all sites are remediated (assuming a budget limit of $100 million per year for remediation).

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remedial responses under CERCLA. Selection of a response is based on factors such as health and environmental protection, technology, cost, institutional considerations, and site-specific factors. The NCP provides limited guidance regarding the standards to be applied to CERCLA cleanups, but directs that remedial actions must be protective of human health and the environment and attain legally applicable or relevant and appropriate Federal and State regulations (ARAR's).

The Superfund Amendments and Reauthorization Act of 1986 (SARA) incorporated several of these factors into the statute and added a new mandate with regard to standards for cleanup remedies. Remedial actions at CERCLA sites must be:

- Protective of human health and the environment (including meeting Federal and State ARARs);
- Cost effective in achieving goals; and
- Utilize permanent remedies and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

The strong preference for "permanent" remedies is a significant new direction for the CERCLA program and will receive major emphasis at RCRA cleanups as well.

Application of RCRA requirements to CERCLA actions has recently been clarified by a working draft guidance that EPA has released for review and, as previously mentioned, by Section 121 of SARA which addresses ARAR's. The draft guidance is not to be cited or quoted, but it is very similar to the requirements in the SARA. SARA requirements indicate that all Superfund remedial actions are to attain ARAR's (except for permits for onsite actions), unless the Administrator waives the ARAR's. SARA lists six reasons for waiving applicable or relevant and appropriate requirements. These are:

- The remedial action is an interim measure where the final remedy will attain the ARAR upon completion

- Compliance will result in greater risk to human health and the environment than other options

- Compliance is technically impracticable

- An alternative remedial action will attain the equivalent of the ARAR

- For state requirements,the state has not consistently applied the state requirement in similar circumstances

- For Section 104 remedial actions, compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of Fund money for response at other facilities (Fund-balancing).

The result of SARA Section 121 will be increased application of RCRA procedures and standards to CERCLA actions, especially for discreet disposal units that clearly meet the traditional sense of a solid waste management unit. Waivers will require additional efforts by the responsible parties to construct supporting arguments that the Administrator will need to incorporate with the consent decrees or records of decision.

Conflicts Identified for the CERCLA Sites. The DOE ORDER 5480.14, Comprehensive Environmental Response, Compensation and Liability Program, describes the decision process used by DOE in determining whether or not a site requires further action beyond phase 1. Sites posing no threat of release are eliminated from further consideration. Sites qualifying for the NPL are recommended for further action to quantify migration potential. Sites not qualifying for the NPL, but exceeding other applicable DOE remedial action criteria or guidance or posing potential regulatory concern under other environmental acts, are proposed for further action.

As a result of SARA, DOE facilities will be required to carry out the same activities as previously required of private facilities. The new law also requires that the Remedial Investigation/Feasibility Study (RI/FS) be a mandatory requirement for sites on the NPL. This will require the revision of DOE Order 5480.14 to require the initiation of the RI/FS process within 12 months of the site being listed on the NPL.

Certain guidelines are specified by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (40 CFR 300) for preliminary assessment of sites potentially containing hazardous substances that might adversely affect human health or welfare. The Superfund Amendments and Reauthorization Act of 1986 (SARA) modifies CERCLA but these changes will not apply to any response action or remedial action for which a plan is under development by the DOE at the Hanford Site. The Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford, June 1986, Volumes 1 and 2, meets the requirements of 40 CFR 300 for the preliminary assessment. The preliminary site investigation has compiled available literature, interviews of knowledegable sources, monitoring data, records and photographs of all sites currently in question into a comprehensive report. Volume 1 also describes the methods and data used as input to EPA's Hazard Ranking System (HRS) and the resulting scores. Some questions were raised as to the validity of some of the HRS scores. Particularly the handling of radioactive materials and the scores resulting from hazardous substances that may have been released in small quantities. An additional ranking was performed which was called mHRS. This reevaluation of sites resulted in the changing of some of the final HRS scores. The approach has been documented in Volume 1. With the notification of the Administrator of the EPA, the Hanford Site has fulfilled all requirements for the preliminary assessment as required by 40 CFR 300.

The RCRA corrective action authority is a redundant authority that EPA could use at DOE facilities. The RCRA authorities are broader than the CERCLA authorities because the standard that must be met in order to invoke the authority is as low as (for Section 3008(h)) the mere existence of a release,whether or not any person or any part of the environment is

threatened by the release. EPA is not required by Sections 3004(u), 3004(v), or 3008(h) to show an "imminent and substantial endangerment", as required under CERCLA.

Sections 3004(u) and (v) and 3008(h) of RCRA were added by the Hazardous and Solid Waste Amendments of 1984 (HSWA). These "corrective action" provisions of RCRA authorize the EPA to require corrective action to be undertaken to address releases of hazardous constituents at sites located at either interim status facilities or facilities that will require a RCRA permit. Consequently, for any federal facility that will require a RCRA permit for one or more treatment, storage, or disposal units, releases from even pre-RCRA solid waste management units (SWMU's) at that facility can be addressed by EPA under RCRA authorities.

The corrective action programs already in place under CERCLA and RCRA Part 264 Subpart F are the foundation for the 3004 (u) program. Sections 104 and 106 of the Comprehensive Environmental Response Compensation and Liability Act authorize EPA to take response actions, including removal or remedial measures, when a release or threat of release of a hazardous substance is discovered which may effect health or welfare. Generally, these authorities are used in situations where contamination has occurred at abandoned sites. Where contamination is related to activities at hazardous waste management facilities that are operating or have operated at any time since November 1980, both RCRA and CERCLA potentially apply. EPA has chosen, as a matter of policy, to initiate action under RCRA rather than CERCLA at most facilities.

The RCRA program will utilize, where feasible, remedial approaches that provide for treatment of wastes and control of the source as opposed to limited solutions such as capping, where the contaminating material is allowed to remain in place.

The Hazardous Solid Waste Act (HSWA) corrective action regulations, when they become available, will represent the most important set of RCRA standards (ARARs) for CERCLA remedial actions. As such, a <u>primary</u> goal in development of the RCRA regulations will be to establish, to the maximum

extent possible, a consistent approach between the RCRA and CERCLA programs to remediating environmental problems.

Existing RCRA regulations for ground water corrective action (40 CFR Part 264, Subpart F) prescribe a specific approach for detection, characterization, and cleanup of contaminated ground water from permitted land disposal units that received waste after July 26, 1982. Subpart F requires that ground water be removed or treated in-place within a reasonable period of time when a pre-determined performance standard has been exceeded at a point of compliance (unit boundary). The performance standard may be defined as background, a generic drinking water standard applicable to all facilities (maximum concentration limits or MCLs) or a health-based standard calculated on the basis of actual facility conditions (alternate concentration limits or ACLs).

RCRA standards for closure of operating hazardous waste management units are also related to establishing cleanup remedy standards for 3004(u) corrective action. Many corrective actions are likely to involve measures designed to control sources of contamination. RCRA closure regulations specify how wastes in units may be removed or decontaminated or otherwise subjected to post-closure care requirements. Although the concept of RCRA "closure" of operating units is in some ways different from cleanup of old, abandoned waste management units or contaminated areas, the approach to regulating corrective action should be consistent with the principles of RCRA closure.

Conflicts Identified for RCRA 3004(u) Sites. EPA has not resolved how it will apply the CERCLA and RCRA corrective action authorities. Many situations, at least over the short-term, can be addressed by orders under either authority, thus leaving EPA with a choice of tools. But, over the long-term, for active sites that will eventually require a permit, the Administrator of EPA is required by Section 3004(u) of RCRA to put conditions in the permit that require corrective actions to address releases from SWMU's. Thus, even if all SWMU's that score above 28.5 on the HRS (or the required score on the new replacement for the HRS which SARA requires) are addressed by DOE under CERCLA, DOE could later be required under RCRA to

address releases from any sites that did not qualify for the NPL. Therefore, it is unclear for the present whether CERCLA or RCRA will apply at uncontrolled DOE waste sites.

Relationship Between DOE Orders, EPA and Washington Department of Ecology Regulations. The Operative CERCLA DOE Order is No. 5480.14. As noted in the previous section, the SARA requires that the Federal facilities respond to the same requirements as private facilities. Furthermore, the Environmental Protection Agency has just amended 40 CFR 300 to add several new Federal Facility Sites. In the explanation of the rule, EPA has indicated they may choose not to use CERCLA to respond to certain releases because other authorities can be used to achieve these cleanups (52 FR 27625, July 22, 1987). In most cases, Federal Facility cleanups can be conducted under the corrective action provisions of RCRA.

Therefore, Federal RCRA regulations may be used for CERCLA sites. EPA can delegate the authority for RCRA to the states; and in the case of Washington State, the State program has been accepted by EPA. In this situation, EPA retains oversight for the implementation of the regulations. Recent guidance from EPA indicates that the agency is moving in the direction of making corrective action guidance under CERCLA and the corrective action under RCRA equivalent.

The Washington State Regulations for Dangerous Waste (173-303 WAC) will apply to all dangerous waste interim status waste management units, dangerous waste permitted waste management units, and units seeking a closure/post-closure permit as a dangerous waste management unit. The corrective action provisions under this regulation include groundwater monitoring corrective action (interim and final status land disposal units) and closure requirements (clean up contamination to background or close as a "RCRA" landfill). These regulations are equivalent to 40 CFR 264.100, 264.112, 264.117, 265.93, 265.112, 265.117, and 265.118.

Corrective action of solid waste management units can be mandated by EPA under RCRA 3004(u). Any facility seeking a dangerous waste permit (final status or closure/post-closure) will be subject to the corrective

action provisions of the 1984 RCRA amendments. EPA currently has sole authority for the 3004(u) corrective action program. No states have been delegated this authority. Under the EPA 3004(u) corrective action program, special conditions will be included in the permit specifying remediation or verification sampling to be performed and a schedule for meeting these requirements.

1.1.2 General Description of the Hanford Reservation and Inactive Waste Disposal Sites

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.

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:

- shutdown of the last of eight once-through cooled production reactors (adjacent to the Columbia River) in 1971

- 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)

- segregation of transuranic solid waste, stored for later shipment off site,beginning in 1970 by DOE Order

- termination of routine liquid discharges containing transuranics to the soil column in 1973

- 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).

General Description of Inactive Waste Disposal Sites

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 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 Operational Areas are located near the center of the Hanford Reservation on the Central Plateau approximately 7 miles from the Columbia River. The 300 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 consists of the rest of the Hanford Reservation that is not located in the other operational areas. Figures 1-1 through 1-10 shows the general locations of the operational areas within the Hanford Reservation.

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).

1.1.3 Overview of the Inactive Waste Sites 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; the associated uncertainty of the estimates is unknown.)

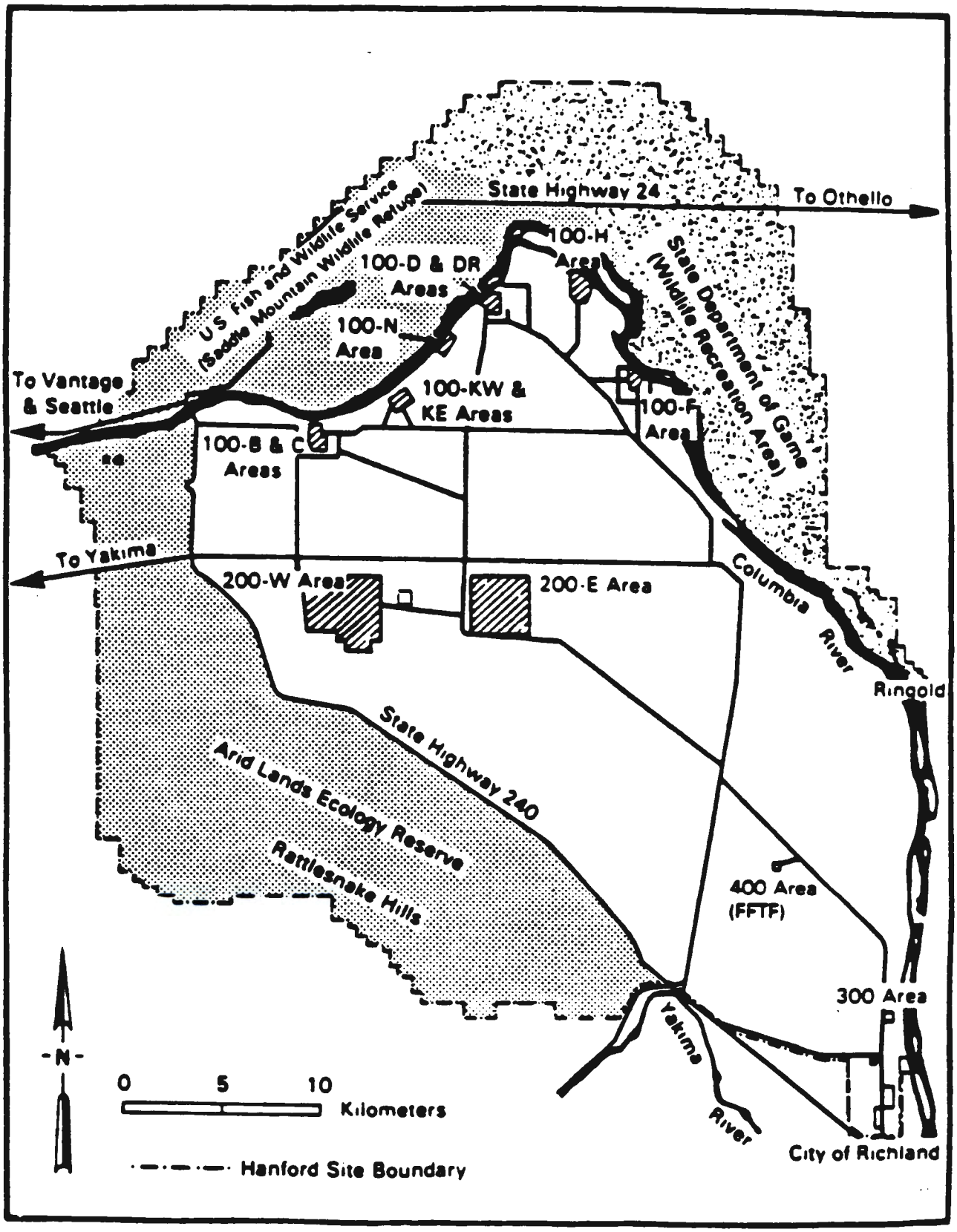
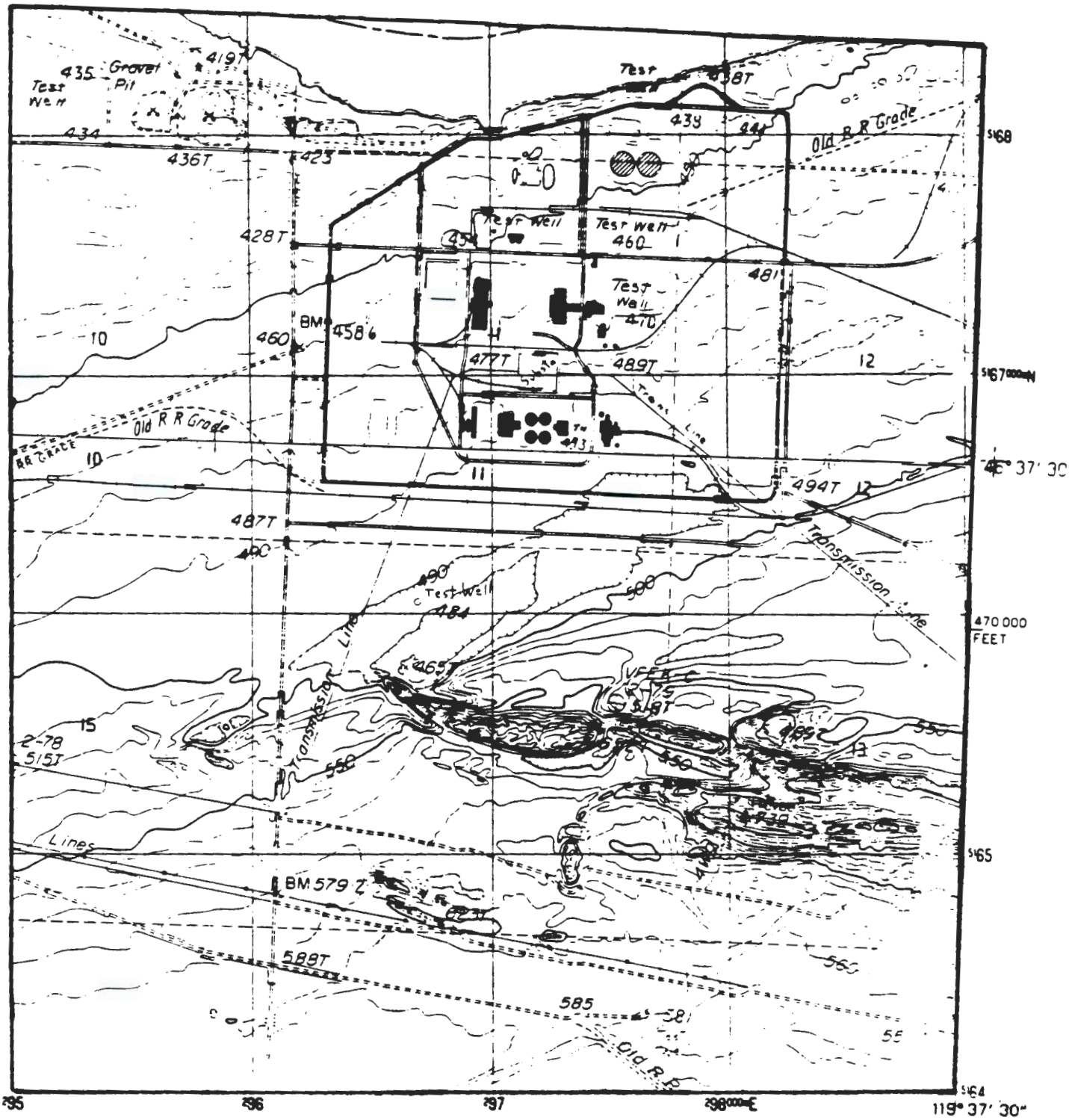


FIGURE 1-1. FEATURES OF THE HANFORD SITE.

SOURCE: U.S. DOE 1986a.



SCALE 1:24 000

ROAD LEGEND

Improved Road

Unimproved Road

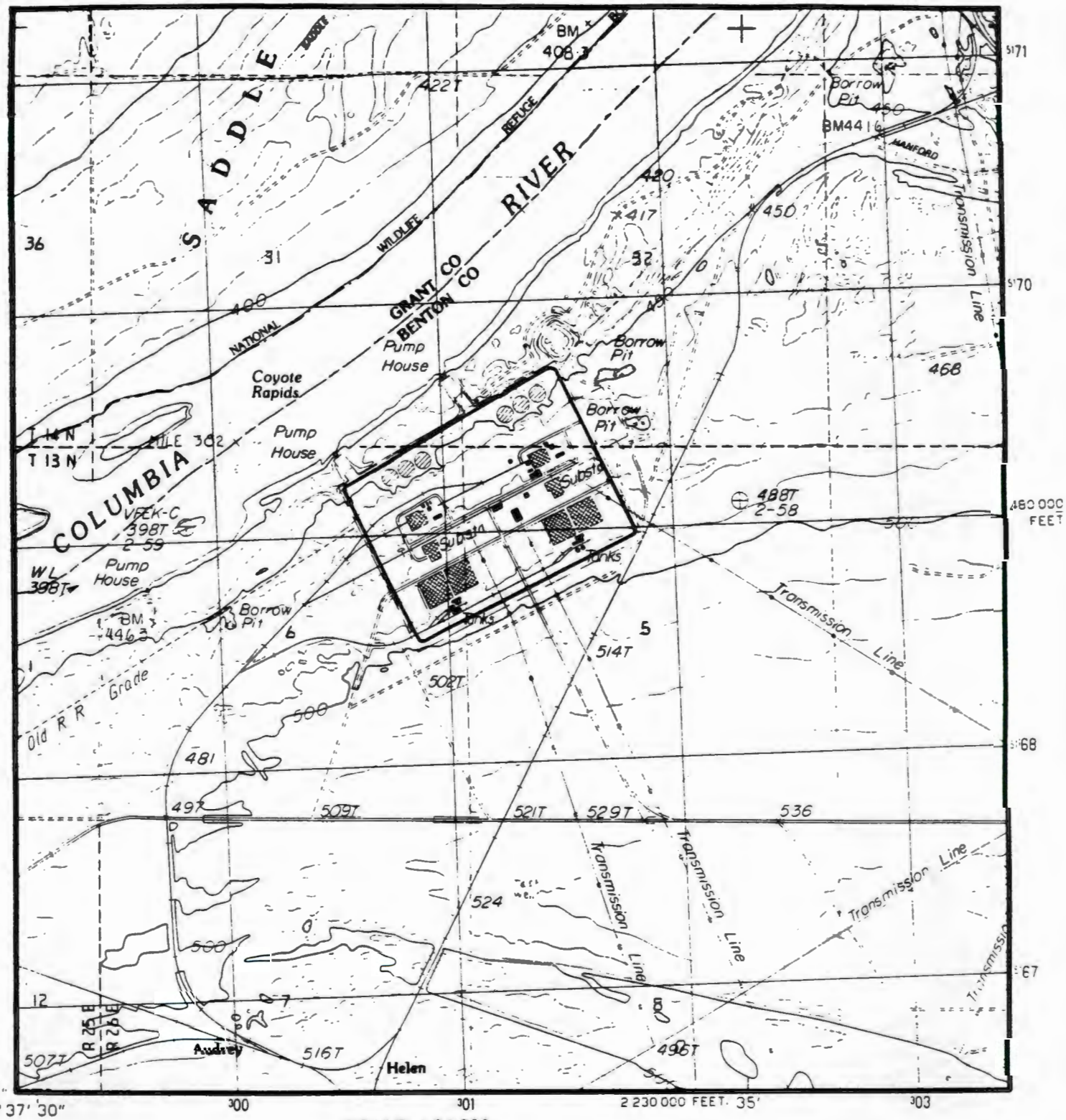
Trail

Interstate Route U.S. Route State Route

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

CONTOUR INTERVAL 10 FEET

FIGURE 1-2. 100 B/C AREA



SCALE 1:24 000

1 .5 0 1 MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000 FEET

ROAD LEGEND

Improved Road

Unimproved Road

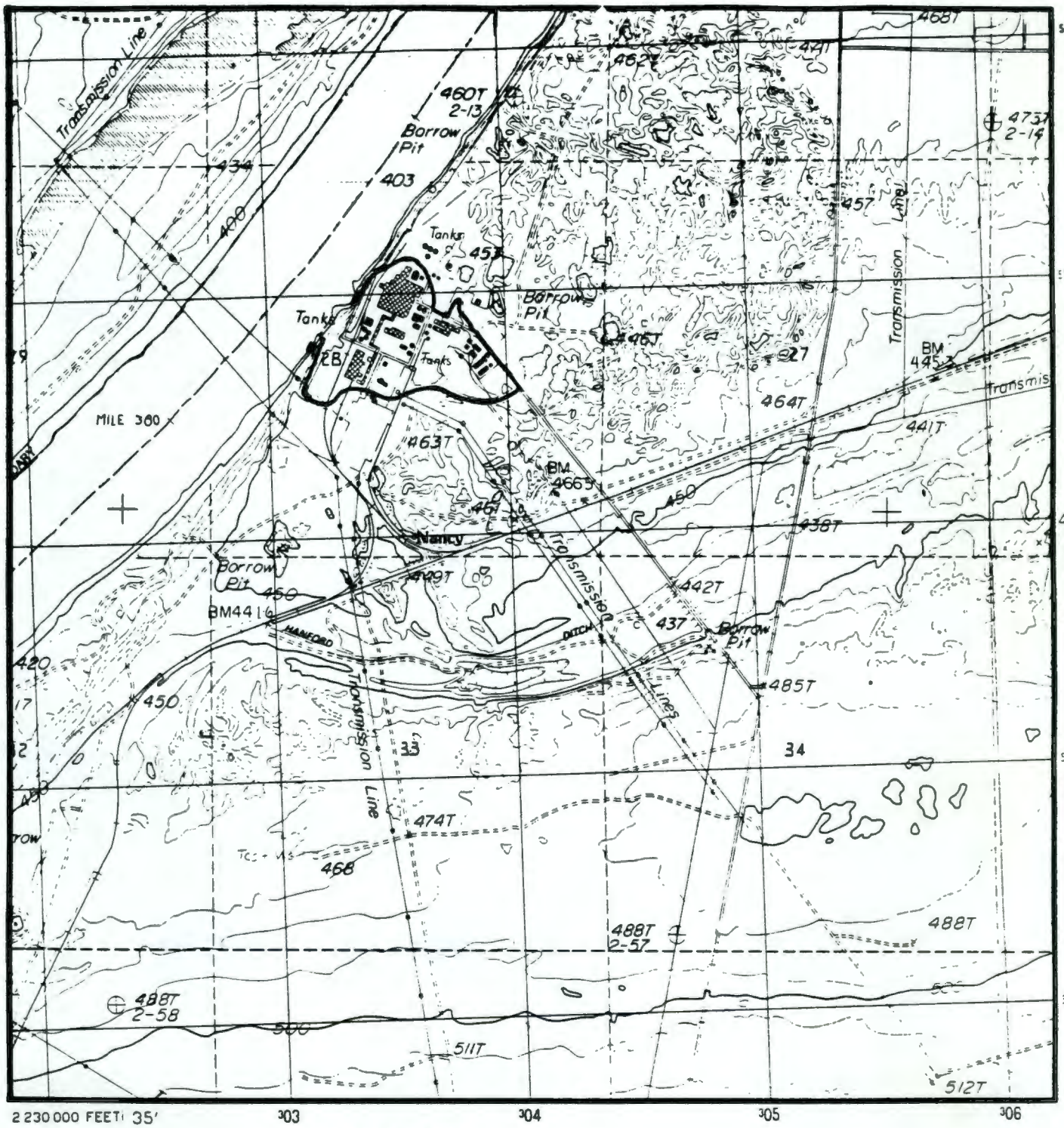
Trail

Interstate Route **U.S. Route** **State Route**

CONTOUR INTERVAL 10 FEET

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

FIGURE 1-3. 100 KE/KW AREA



SCALE 1:24 000

1 .5 0 1 MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000 FEET

ROAD LEGEND

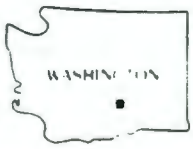
Improved Road ..... ═══

Unimproved Road ..... ========

Trail ..... - - - - - - - -

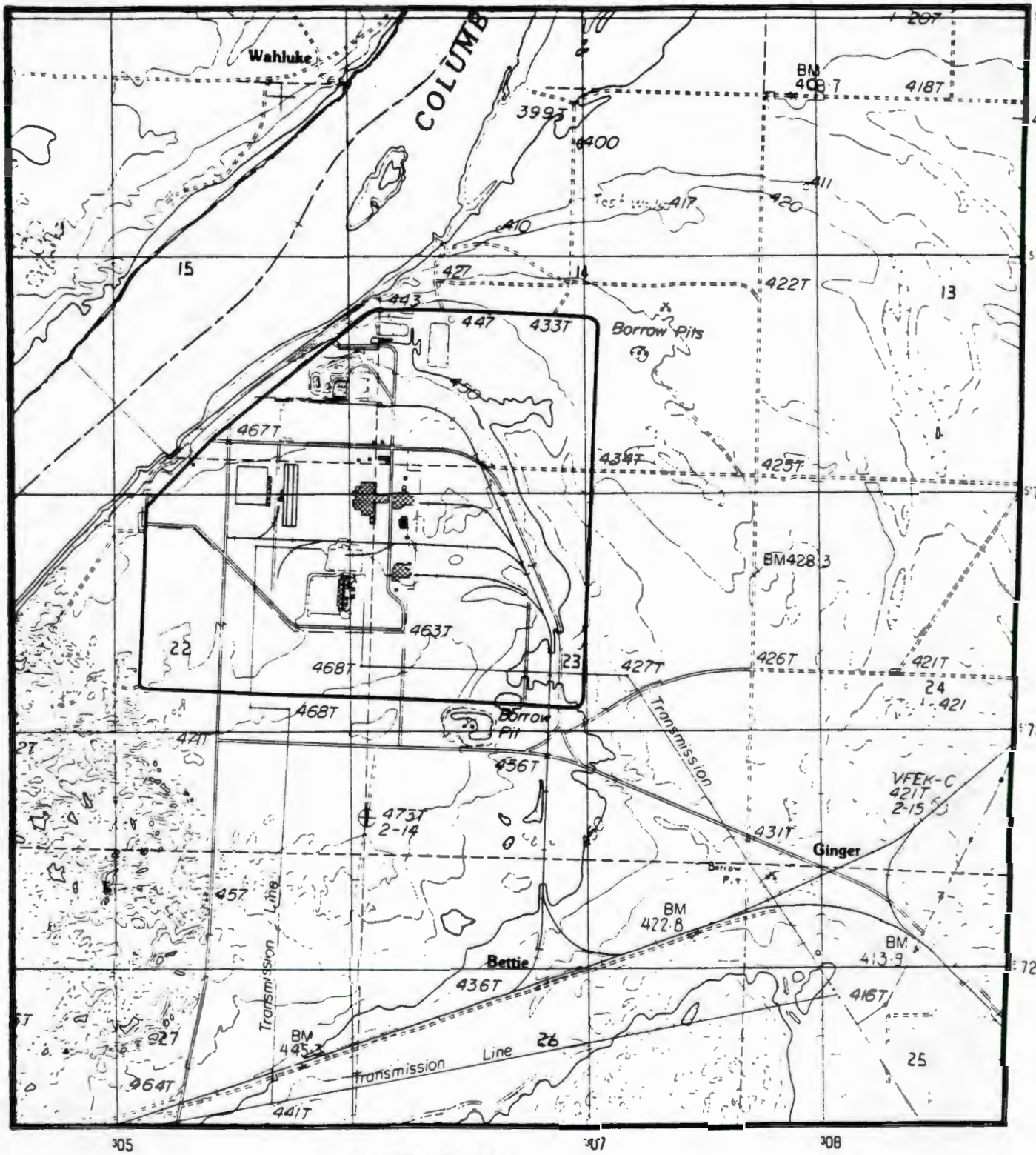
Interstate Route **U.S. Route** **State Route**

CONTOUR INTERVAL 10 FEET



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

FIGURE 1-4. 100 N AREA



SCALE 1:24 000

1 .5 0 1 MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000 FEET

ROAD LEGEND

Improved Road

Unimproved Road

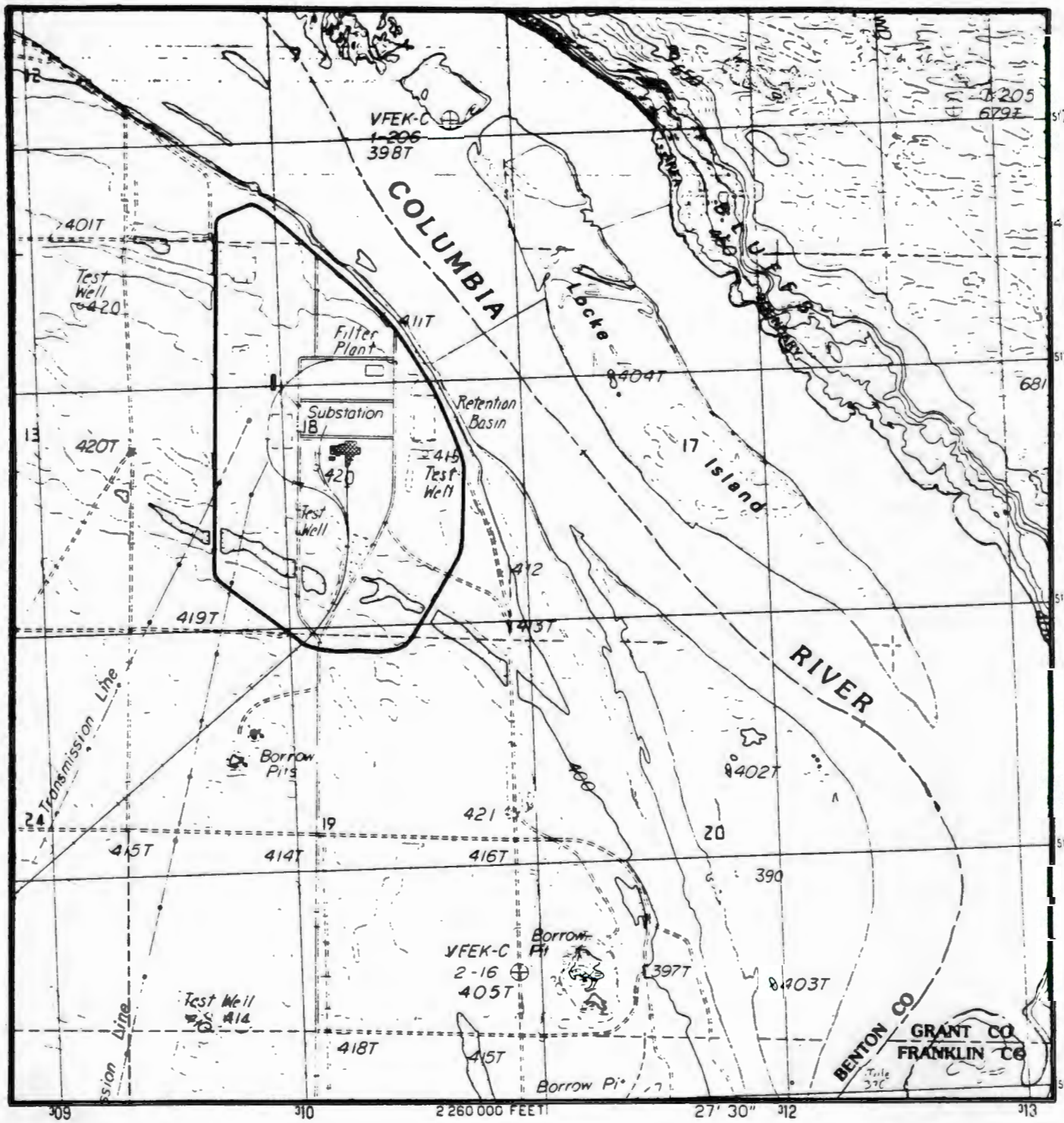
Trail

Interstate Route U.S. Route State Route

CONTOUR INTERVAL 10 FEET

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

FIGURE 1-5. 100 D/DR AREA



SCALE 1:24 000

1 .5 0 1 MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000 FEET

ROAD LEGEND

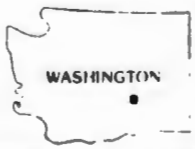
Improved Road

Unimproved Road

Trail

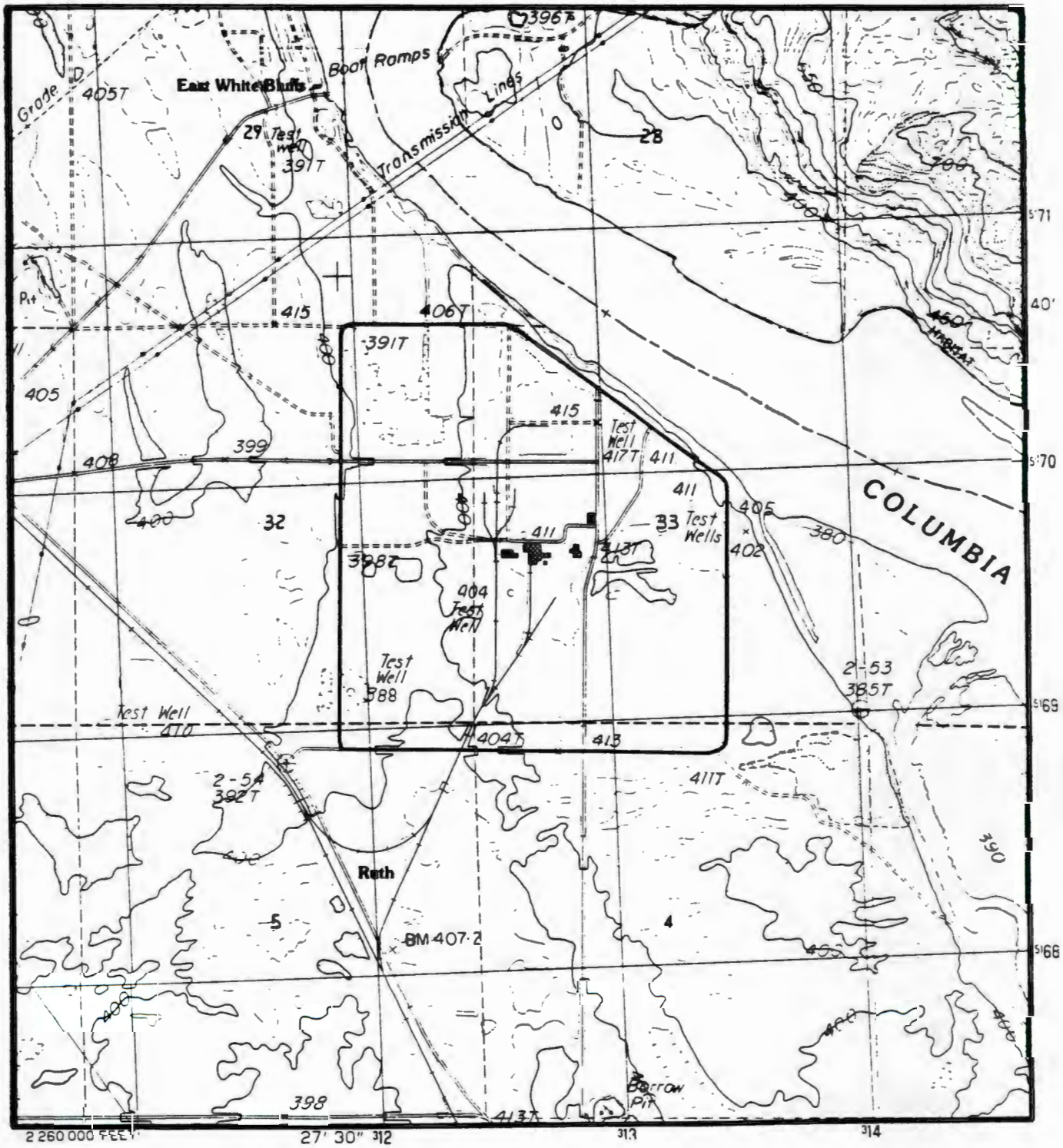
Interstate Route **U.S. Route** **State Route**

CONTOUR INTERVAL 10 FEET



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

FIGURE 1-6. 100 H AREA



SCALE 1:24 000

1 .5 0 1 MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000 FEET

ROAD LEGEND

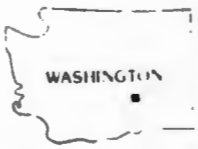
Improved Road

Unimproved Road

Trail

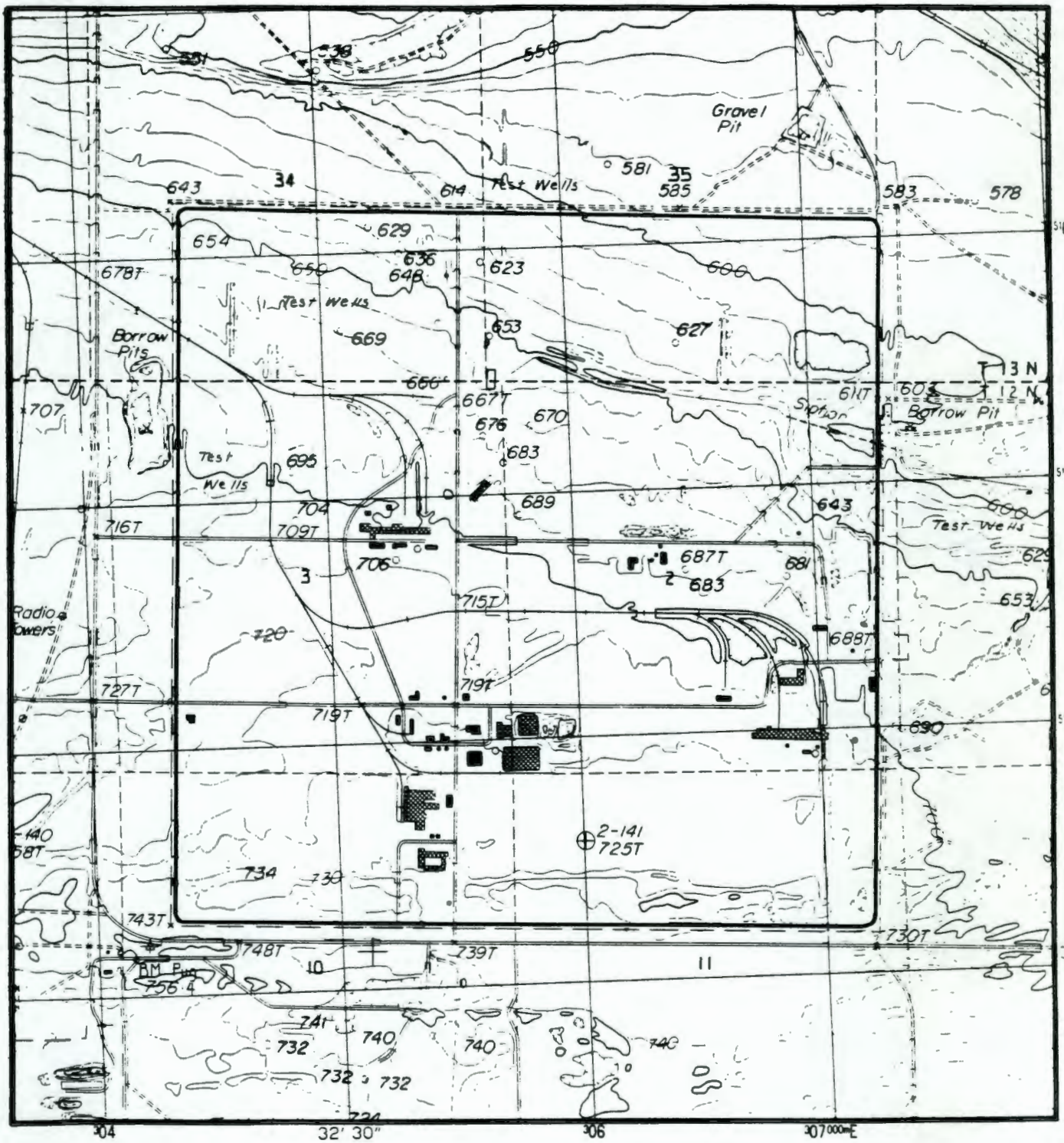
Interstate Route **U.S. Route** **State Route**

CONTOUR INTERVAL 10 FEET



SOURCE: USGS, 198
Locke Island, WA
46119-F4-TF-024

FIGURE 1-7. 100 F AREA



SCALE 1:24 000

1 .5 0 1 MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000 FEET

ROAD LEGEND

Improved Road

Unimproved Road

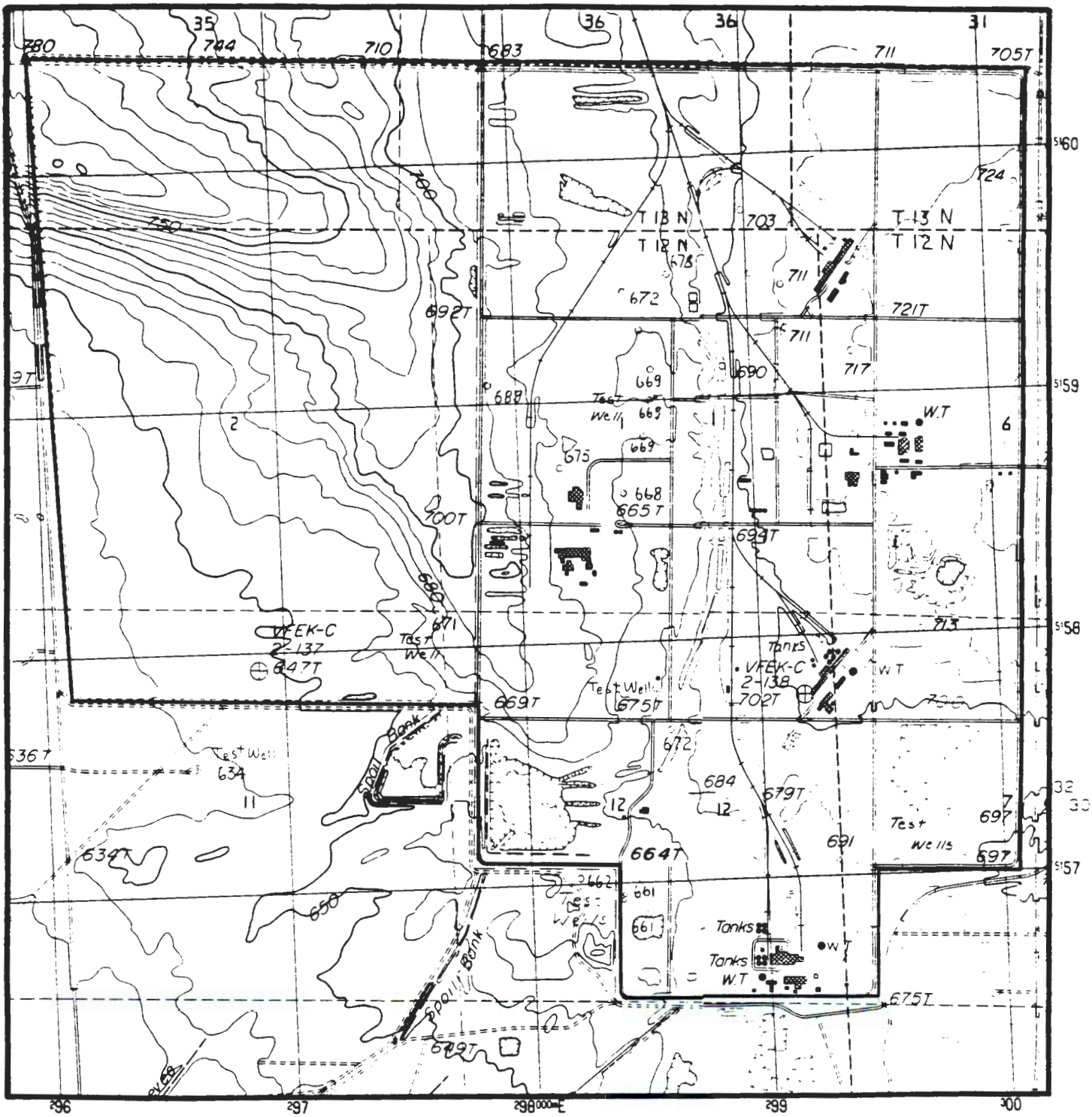
Trail

Interstate Route U.S. Route State Route

CONTOUR INTERVAL 10 FEET

SOURCE: USGS, 1986
Gable Butte, WA
46119-E5-TF-024

FIGURE 1-8. 200 EAST AREA



SCALE 1:24 000

1 .5 0 1 MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000 FEET

ROAD LEGEND

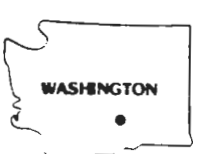
Improved Road

Unimproved Road

Trail

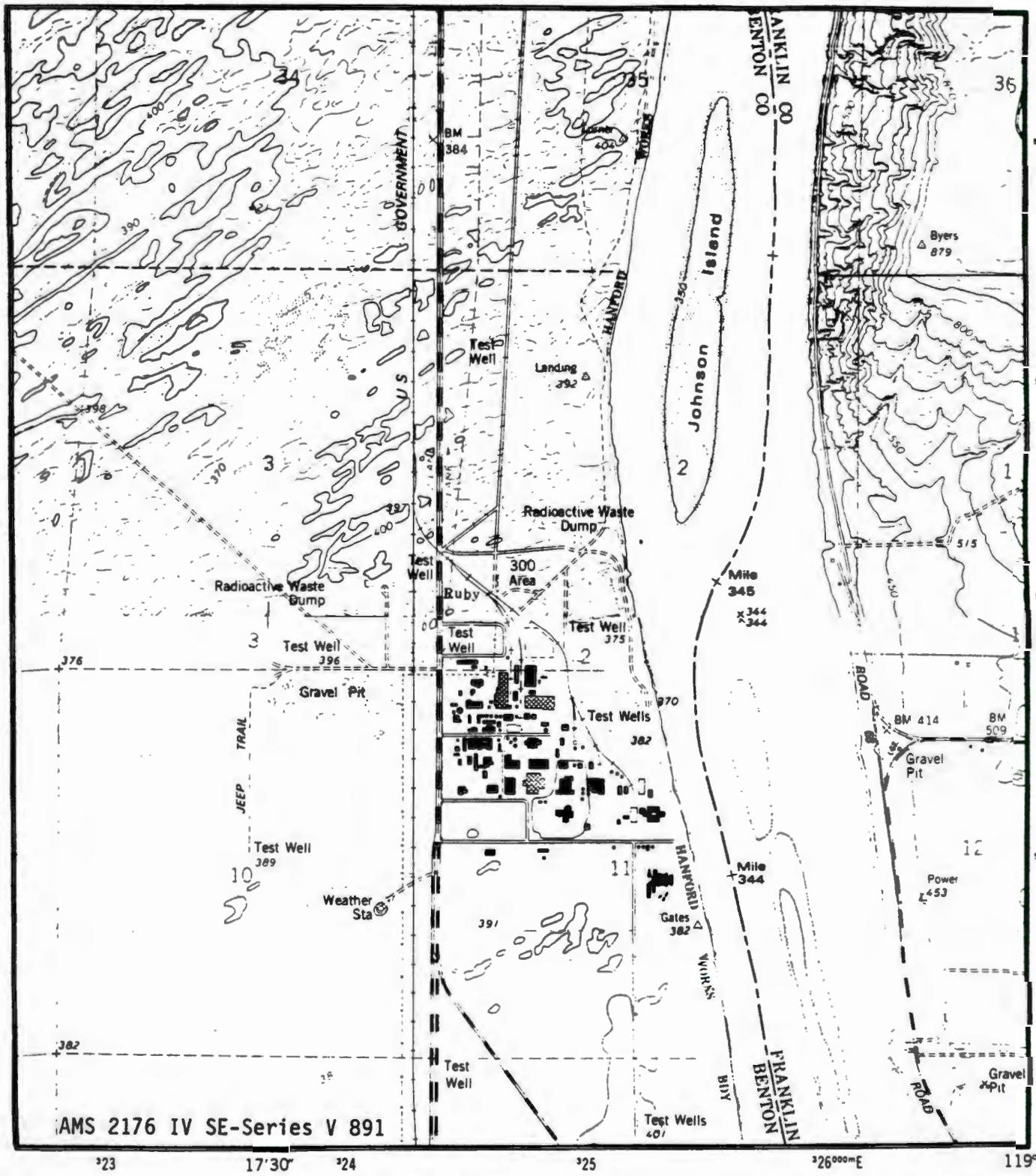
Interstate Route **U.S. Route** **State Route**

CONTOUR INTERVAL 10 FEET



SOURCE: USGS, 1986
Riverland, WA
46119-E6-TF-024 and
Gable Butte, WA
46119-E5-TF-024

FIGURE 1-9. 200 WEST AREA



ROAD CLASSIFICATION

Primary highway hard surface

Light-duty road, hard or improved surface

Secondary highway, hard surface

Unimproved road

Interstate Route

U. S Route

State Route

1-22

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

FIGURE 1-10. 300 AREA

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:

Contaminant	Quantity (metric tons)	Quantity (tons)
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:

Radionuclide	Quantity (curies)
^{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 intimate knowledge of the processes used. The uncertainty associated with these estimates is unknown but may be significant.

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. 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.

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, diodine-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. Each of the areas within the Hanford Reservation is described below:

The nine 100 Areas (B, C, D, DR, KE, KW, F, H, N) border the Columbia River in the northern most part of the Hanford Site. Each of the nine areas has one production reactor. Eight of these reactors have been shut down; only the N Reactor, used for both plutonium and electricity production, is still operating. Because some of the areas are contiguous (B/C, D/DR, KE/KW), the Hanford Site map shows only six 100 Areas (Figure 1-11).

The 100 Areas are generally flat with no major surface features. The Hanford Formation lies near the surface of the 100 Areas, covered by a thin layer of wind-deposited silt and fine sand. The water table is found in these sediments at a depth of about 20 meters (66ft), except in the F and H Areas where the depth to the water table is about 35 meters (115 ft) and 40 meters (131 ft), respectively. The depth to the Ringold Formation is about

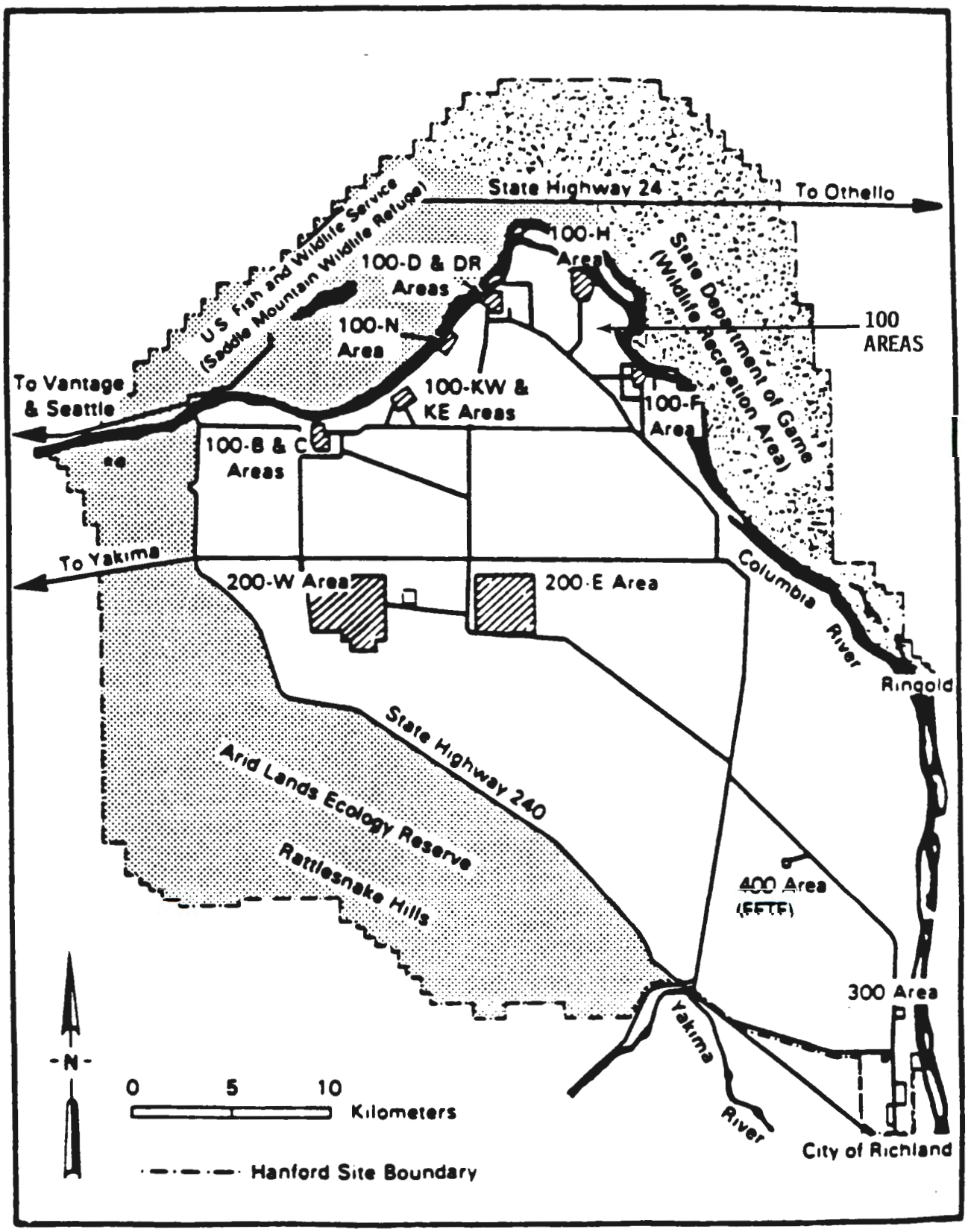


FIGURE 1-11. LOCATIONS OF THE 100 AREA SITES

SOURCE: U.S. DOE 1986a.

25 meters (82 ft); the top of the basalt bedrock is approximately 240 meters (790 ft) below the surface.

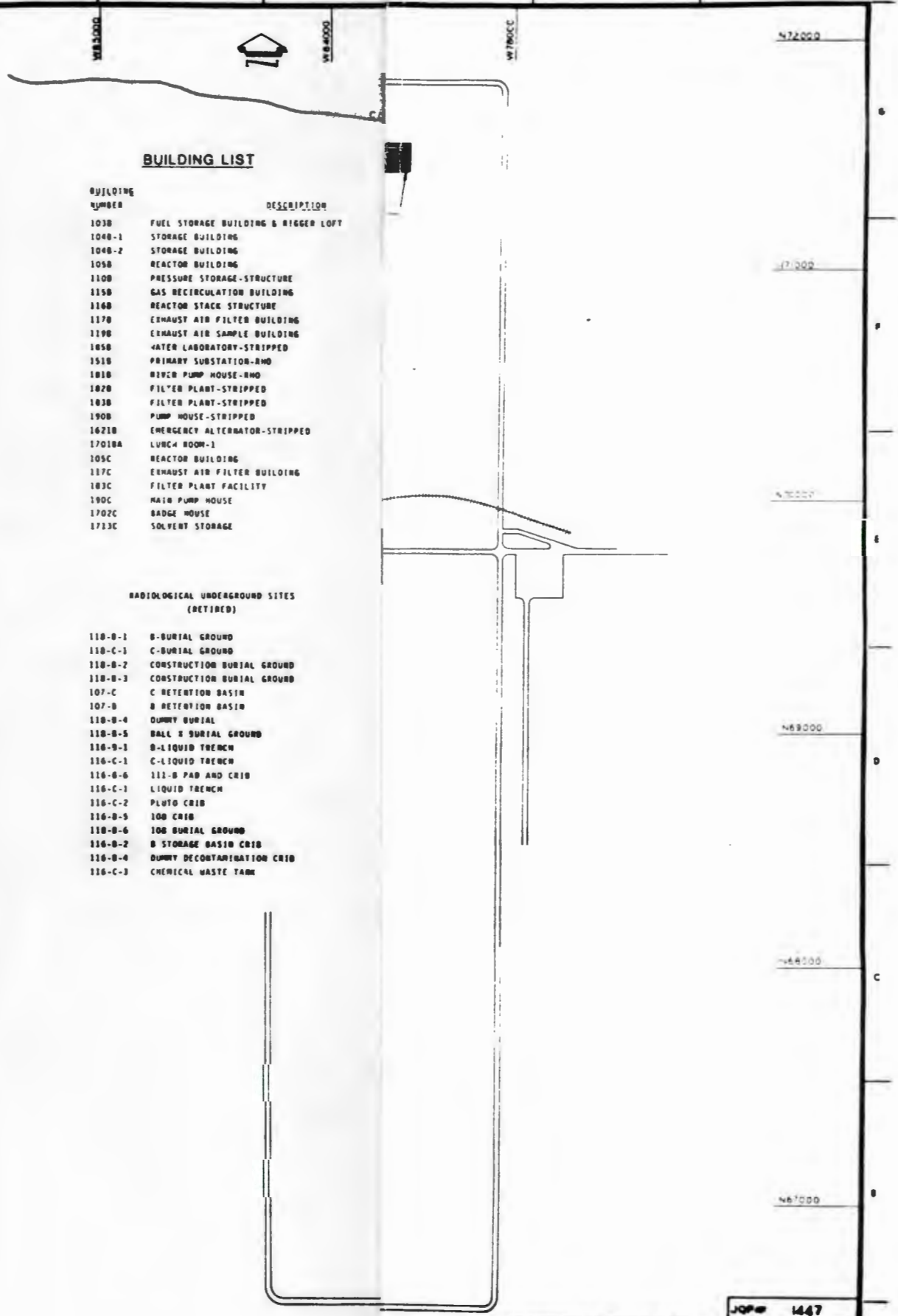
Because the water table occurs within the highly permeable sandy gravels of the Hanford Formation, it fluctuates as the river level rises and falls. The ground water generally flows from the 100 Areas and toward the river. When active, each of the 100 Areas included support facilities such as powerhouses. Except for 100-N, these powerhouses produced process steam from coal-fired boilers; 100-N has oil-fired boilers. Adjacent to each area's powerhouse were large storage areas that received railroad carloads of coal and disposal areas for flyash/clinker disposal. Most areas also included water-treatment plants, water-storage tanks, subsurface sewage-disposal systems, raw-water intake structures, and process sewers.

B and C Areas. The B and C reactors are located adjacent to each other on a 2.6-square-kilometer (650-acre) site (9the 100 B/C Area) and are the farthest upstream of the 100 Areas. The B Reactor was operated from 1944 to 1968, and the C Reactor was operated from 1952 to 1969. Virtually all the facilities in the area are inactive, with the exception of the B/C export water system, which continues to provide the raw water supply to the 200 Area and some 100 Areas. An electrical substation in the area taps power for the pumps providing the 200-Area water.

Four CERCLA sites are located on the 100 B/C Area. These sites are 116-B-1, 116-C-1, 116-B-4, and 116-C-2. 116-B-1 and 116-C-1 are trenches. 116-B-4 is a French Drain and 116-C-2 is a crib. All facilities are no longer in use and are considered inactive. See Figure 1-12 for location of the 100 B/C area building, facilities, railroads, etc.

The 650 acres of 100 B/C area are situated farthest upstream of the 100 facilities along the Columbia River.

D and DR Areas. The 100-D/DR Areas, covering about 3.9 square kilometers (970 acres), are located 11 kilometers (7 mi) downriver of the 100-B/C Area. The D Reactor was operated from 1944 to 1967 and the DR Reactor from 1950 to 1965. These areas are extensively used, and their utilities and services



BUILDING LIST

BUILDING NUMBER	DESCRIPTION
103B	FUEL STORAGE BUILDING & RIGGER LOFT
104B-1	STORAGE BUILDING
104B-2	STORAGE BUILDING
105B	REACTOR BUILDING
110B	PRESSURE STORAGE-STRUCTURE
115B	GAS RECIRCULATION BUILDING
116B	REACTOR STACK STRUCTURE
117B	EXHAUST AIR FILTER BUILDING
119B	EXHAUST AIR SAMPLE BUILDING
165B	WATER LABORATORY-STRIPPED
151B	PRIMARY SUBSTATION-RHO
181B	RIVER PUMP HOUSE-RHO
182B	FILTER PLANT-STRIPPED
183B	FILTER PLANT-STRIPPED
190B	PUMP HOUSE-STRIPPED
1621B	EMERGENCY ALTERNATOR-STRIPPED
1701BA	LUNCH ROOM-1
105C	REACTOR BUILDING
117C	EXHAUST AIR FILTER BUILDING
183C	FILTER PLANT FACILITY
190C	MAIN PUMP HOUSE
1702C	BADGE HOUSE
1713C	SOLVENT STORAGE

RADIOLOGICAL UNDERGROUND SITES
(RETIRED)

118-B-1	B-BURIAL GROUND
118-C-1	C-BURIAL GROUND
118-B-2	CONSTRUCTION BURIAL GROUND
118-B-3	CONSTRUCTION BURIAL GROUND
107-C	C RETENTION BASIN
107-B	B RETENTION BASIN
118-B-4	DUMMY BURIAL
118-B-5	BALL X BURIAL GROUND
116-B-1	B-LIQUID TRENCH
116-C-1	C-LIQUID TRENCH
116-B-6	111-B PAD AND CRIB
116-C-1	LIQUID TRENCH
116-C-2	PLUTO CRIB
116-B-5	108 CRIB
118-B-6	108 BURIAL GROUND
116-B-2	B STORAGE BASIN CRIB
116-B-4	DUMMY DECONTAMINATION CRIB
116-C-3	CHEMICAL WASTE TANK

JOB# 1447

U. S. Department Of Energy
Richland Operations Office

PACIFIC NORTHWEST LABORATORY
OPERATED BY BATTELLE MEMORIAL INSTITUTE

100-B & 100-C AREA WASTE SITES

100 AREA | 0401

H-3-57210 | 2 | 10

are still in operation. The electrical substation serves as a backup supply for the 100-N Area. The water system is a backup system for the 100-B water system, which supplies water to the 200 Areas. The UNC Nuclear Industries engineering laboratory here is operated in support of the N Reactor.

CERCLA sites within the 100 D/DR area include: 116-DR-1 (trench), 116-DR-2 (trench), 116-D-1B (trench), 116-DR-6 (trench), and 116-DR-7 (crib) (see Figure 1-13 for site location).

F Area. The 100-F Area is located about 10.4 kilometers (6.4 mi) downriver of the 100-D/DR Reactors and is the 100 Area closest to Richland. This area covers about 2.2 square kilometers (540 acres). The F Reactor was operated from 1945 to 1965. At one time, the Pacific Northwest Laboratory (PNL) operated a biology laboratory in this area to study the effects of inhaled and ingested radioactive and toxic materials on animals. Except for the reactor and reactor support facilities, the site has been decommissioned.

The 100-F area has six CERCLA sites located on it. These six sites include 116-F-1, 116-F-2, 116-F-3, 116-F-6, 116-F-9, and 116-F-10 trenches. See Figure 1-14 for the location of 100-F area buildings, and facilities.

H Area. The 100-H Area is located about 5.2 kilometers (3.2 mi) downriver of the 100-D/DR Areas and covers about 1.3 square kilometers (320 acres). Very little activity continues in this area. Several major buildings, including the powerhouse, stacks, and some of the water treatment buildings have been removed. The H Reactor was operated between 1945 and 1965.

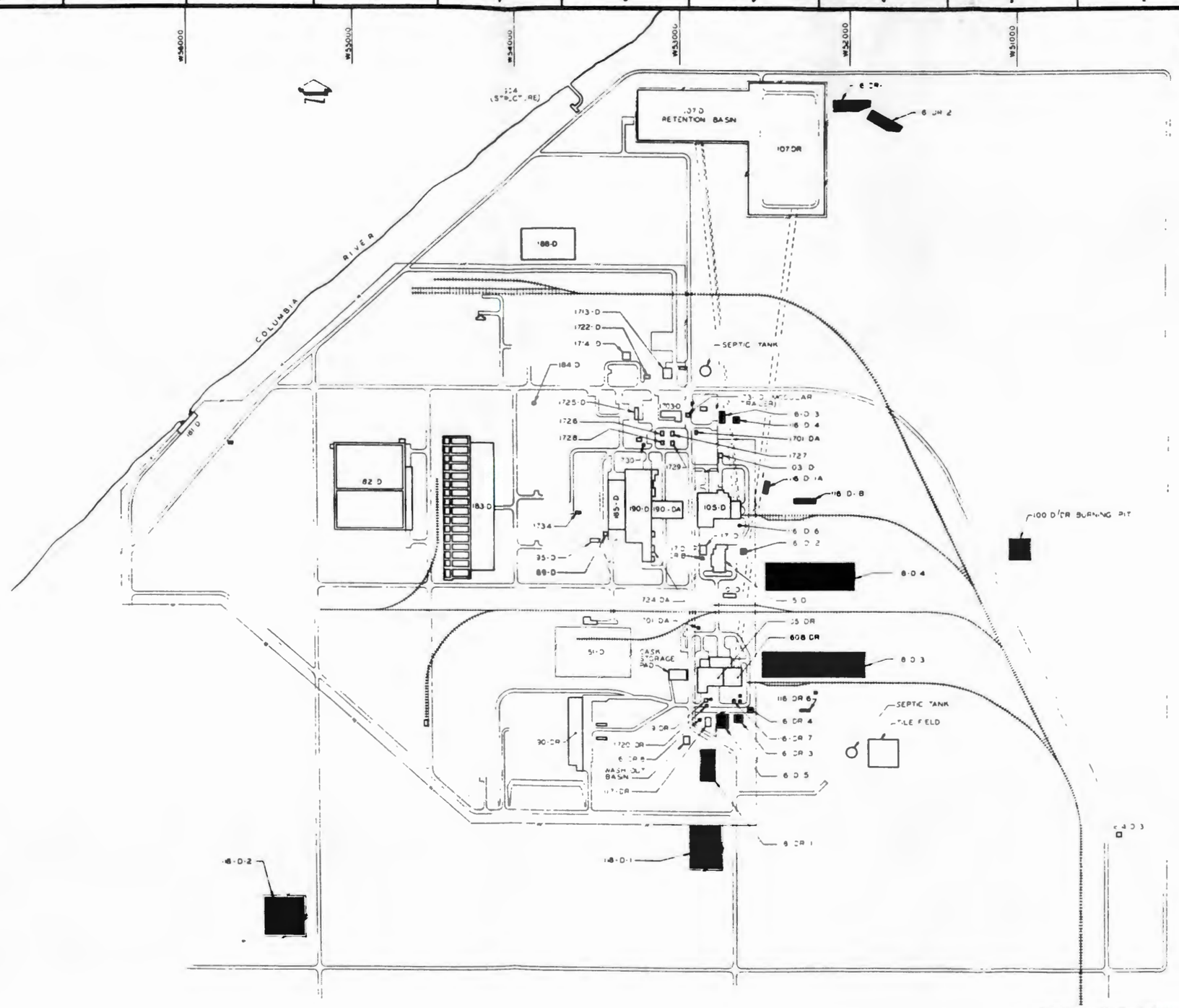
Located on the 100-H area are three CERCLA sites. These sites are 116-H-1, 116-H-2, and 116-H-3. 116-H-1 and 116-H-2 are trenches and 116-H-3 is a French Drain. See Figure 1-15 for location of 100-H area facilities.

K Area. The 100-KE/KW Areas, covering about 0.6 square kilometers (150 acres), are almost 4 kilometers (2.5 mi) downriver of the 100-B/C complex and contain two shutdown reactors. These reactors were operated between 1955 and 1971.

BUILDING LIST

BUILDING NUMBER	DESCRIPTION
103-D	FUEL ELEMENT STORAGE BUILDING
105-D	REACTOR BUILDING
110-D	HELIUM STORAGE
115-D	GAS RECIRCULATION BUILDING
117-D	REACTOR EXHAUST AIR FILTER BUILDING
151-D	PRIMARY SUBSTATION
151-D	RIVER PUMP HOUSE (SERVES D & DR)-RHO
152-D	RESERVOIR & PUMP HOUSE-RHO
153-D	FILTER PLANT OPERATIONS-RHO
154-D	HIGH TANK-RHO
185-D	THERMAL HYDRAULICS BUILDING
188-D	ASH DISPOSAL BASIN-RHO
189-D	MECHANICAL DEVELOPMENT LAB
189-D	STORAGE
195-D	VERTICAL SAFETY ROD TEST TOWER
1608-D	WASTE WATER PUMP HOUSE
1701-DA	OFFICE BUILDING
1703-D	TECHNICAL OFFICE BUILDING
1713-D	INST & ELEC DEVELOPMENT LAB
1714-D	SOLVENT STORAGE
1722-D	EQUIPMENT DEVELOPMENT LAB
1725-D	TRAILER 1726-1727-1728-1729 & 1731 MODULAR
105-D	REACTOR BUILDING
116-DR	REACTOR STACK
117-DR	REACTOR EXHAUST AIR FILTER BUILDING
119-DR	REACTOR EXHAUST INSTRUMENT BUILDING
190-DR	STORAGE
195-D	VERTICAL SAFETY ROD TEST TOWER
1608-DR	WASTE WATER PUMP HOUSE
1792-DR	BRIDGE HOUSE
1720-DR	1001 M TANK ENCLOSURE-WHCO
	CASK STORAGE PAD
1724-D	UNDERWATER TEST FACILITY
1724-DA	UNDERWATER TEST FACILITY EXPANSION

	RADIOLOGICAL UNDERGROUND SITES (RETIRED)
118-D-1	ORIGINAL BURIAL GROUND NO. 1
118-D-2	ORIGINAL BURIAL GROUND NO. 2
118-D-3	ORIGINAL BURIAL GROUND NO. 3
118-D-4	LAST JUNCTION BURIAL GROUND
118-D-5	SMALL BURIAL GROUND
118-DR-1	135-HR GAS LOOP BURIAL GROUND
107-D	
107-DR	
116-DR 1 & 2	1301-D WASTE DISPOSAL TRENCHES
116-D A & B	SEPAGE BASIN TRENCH
116-D-1 & 4	120-D REES
116-D-2	105-D PLUTO CRIB
116-DR-3	105-DR STORAGE BASIN TRENCH
116-DR-4	105-DR PLUTO CRIB
116-D-5	1904-D OUTFALL
116-DR-5	1904-DR OUTFALL



NACTIVE WASTE SITES (PRE-NOVEMBER, 1980)

JOB# 1447

U. S. Department Of Energy
Richland Operations Office
PACIFIC NORTHWEST LABORATORY
OPERATED BY BATTELLE MEMORIAL INSTITUTE

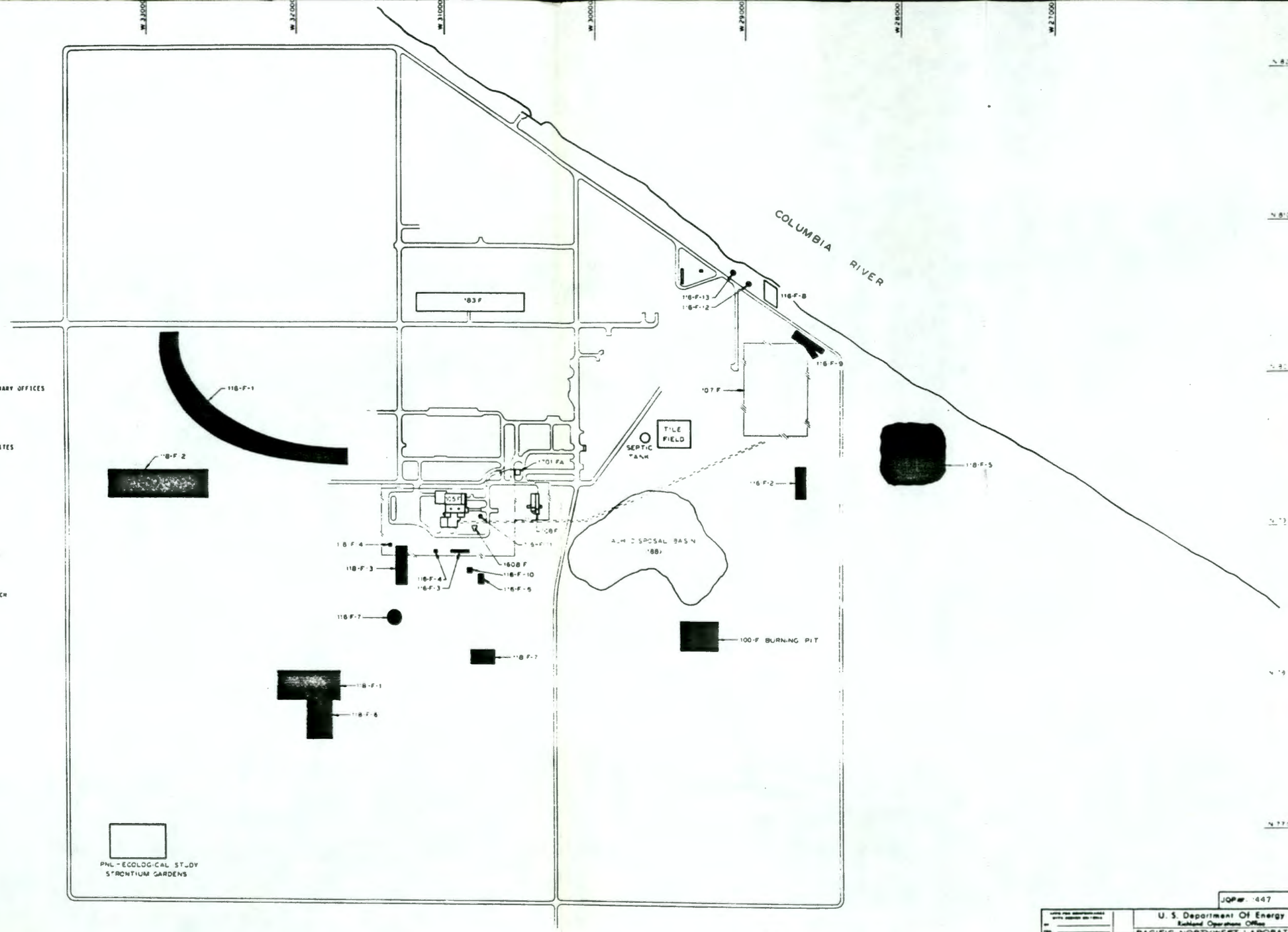
100-D & 100-DR AREA WASTE SITES

100 AREA | 0401

H-3-57210 | 3 | 10

HOT RIDGE

NONE



BUILDING LIST

BUILDING NUMBER	DESCRIPTION
105 F	REACTOR BUILDING
108 F	BIOLOGY LABORATORY - TEMPORARY OFFICES
183-F	CLEAR WELLS
1608 F	WASTE WATER PUMP HOUSE
1701 FA	FIRE WATCHGUARD

RADIOLOGICAL UNDERGROUND SITES (RETIRED)

118-F-1	NO. 1 BURIAL GROUND
118-F-2	NO. 2 BURIAL GROUND
118-F-3	NO. 3 BURIAL GROUND
118-F-4	115-F PIT
118-F-5	SAWDUST PIT
118-F-6	999 BURIAL GROUND
116-F-1	LEWIS CANAL
116-F-2	107-F TRENCH
116-F-3	105-F STORAGE BASIN TRENCH
116-F-4	105-F PLUTO CRIB
161-F-5	BALL WASHER
116-F-8	1904 OUTFALL
116-F-9	ANIMAL WASTE LEACHING TRENCH
116-F-10	SPACER DRAIN
116-F-11	3" DIAMETER DRAIN
116-F-12	3" DIAMETER DRAIN
116-F-13	3" DIAMETER DRAIN
137-F	RETENTION BASIN

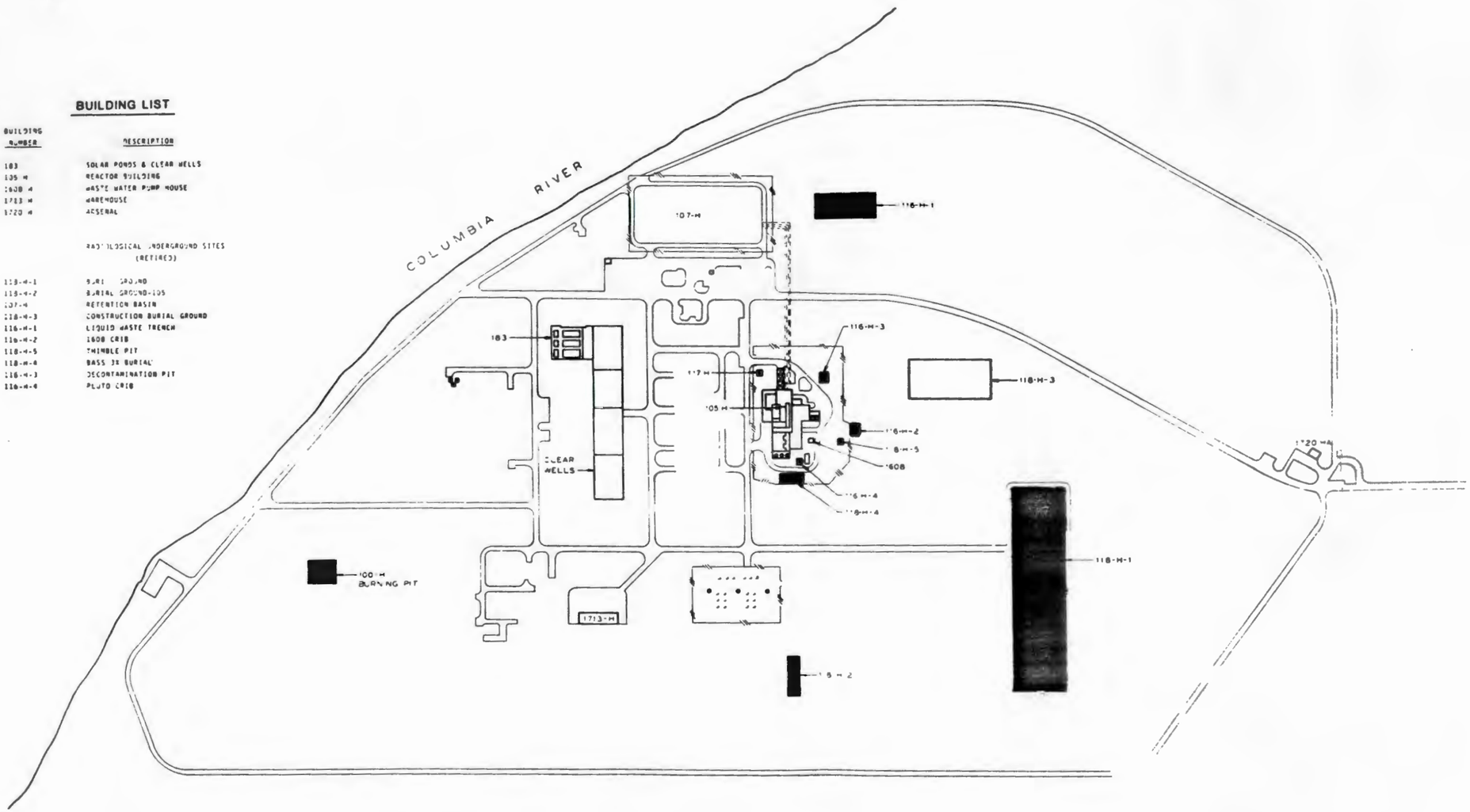
INACTIVE WASTE SITES (PRE-NOVEMBER, 980)

JOB# 1447

U. S. Department Of Energy
Richland Operations Office
PACIFIC NORTHWEST LABORATORY
OPERATED BY BATTELLE MEMORIAL INSTITUTE

100-F AREA
WASTE SITES

SCALE NONE
NOT REQD
NONE
100 F AREA
H-3-57210 | 4 | 10



BUILDING LIST

BUILDING NUMBER	DESCRIPTION
183	SOLAR PONDS & CLEAR WELLS
105-H	REACTOR BUILDING
1608-H	WASTE WATER PUMP HOUSE
1713-H	WAREHOUSE
1720-H	ARSENAL
	RADIOLOGICAL UNDERGROUND SITES (RETIRED)
118-H-1	BURIAL GROUND
118-H-2	BURIAL GROUND-105
107-H	RETENTION BASIN
118-H-3	CONSTRUCTION BURIAL GROUND
116-H-1	LIQUID WASTE TRENCH
116-H-2	1608 CRIB
118-H-5	THIMBLE PIT
118-H-4	BASS JR BURIAL
116-H-3	DECONTAMINATION PIT
116-H-4	PLUTO CRIB

INACTIVE WASTE SITES (PRE-NOVEMBER, 1980)

JOP# 1447

U. S. Department Of Energy
Richland Operations Office
PACIFIC NORTHWEST LABORATORY
OPERATED BY BATTELLE MEMORIAL INSTITUTE

100-H AREA WASTE SITES

NONE

100 H AREA

0401

H-3-57210

5 | 10

Considerable use is made of the shutdown 100-KE/KW Areas. For example, spent fuel from the N Reactor is stored there. All services and utilities except the power house are in operation. The Decommissioning Services Section of UNC Nuclear Industries also operates from offices and laboratories in this area. UNC Nuclear Industries operates a research and development laboratory in this area; the Fuel Operations Section of UNC has personnel stationed at the K Area to operate the KE and KW fuel-storage basins. See Figure 1-16 for 100-KE/KW site locations.

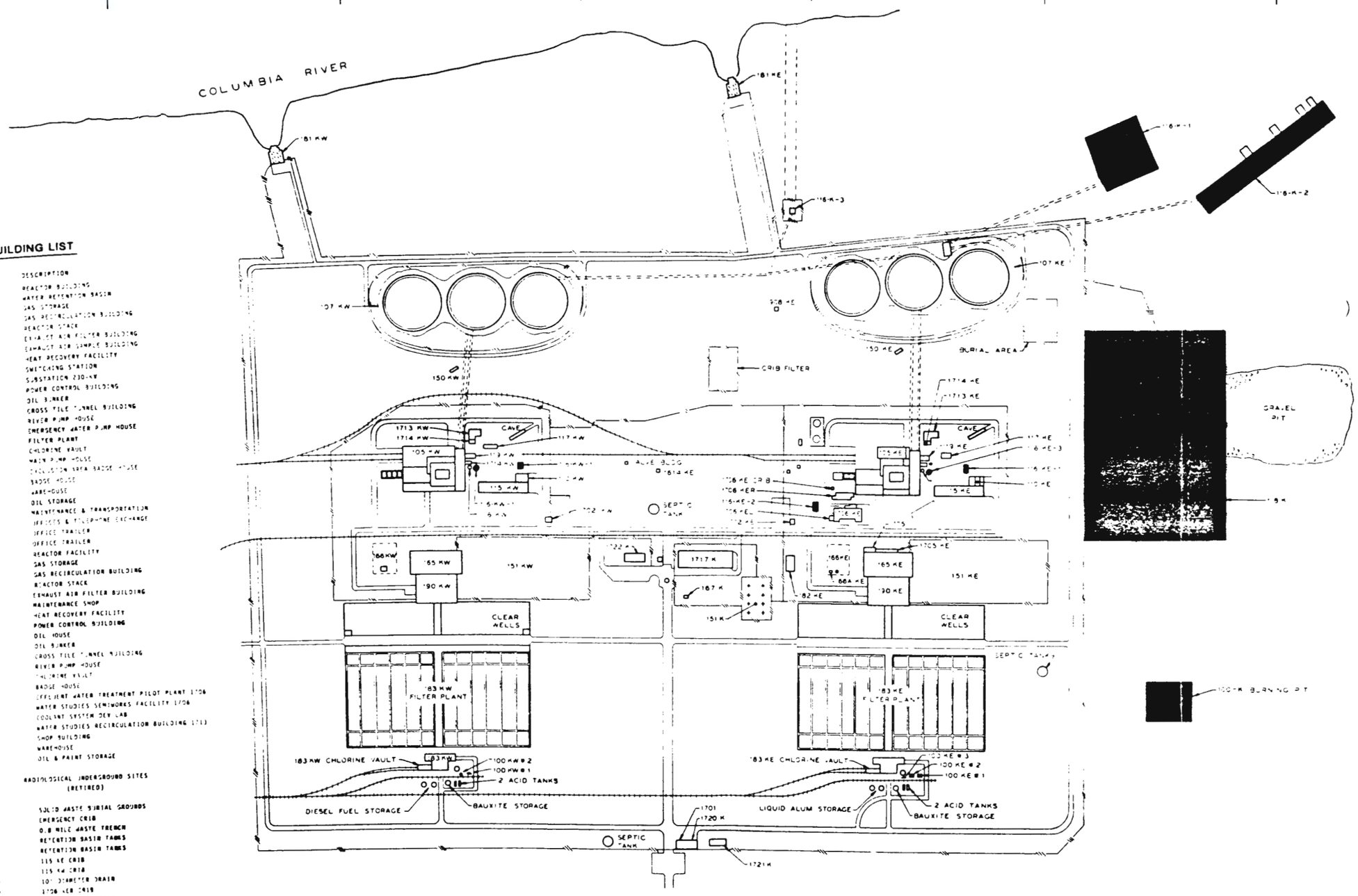
In the approximate middle of the Hanford Site, on a plateau about 11 kilometers (7 mi) from the Columbia River, are the two 200 Areas (200-East and 200-West), dedicated to chemical separations and waste management. Irradiated fuel, waste-processing,and waste-storage activities are located in these two areas because they are the most isolated from the Site boundaries and are the farthest from both surface and ground water. The water table in this area is 46 to 911 meters (150 to 300 ft) below the surface.

The 200-Area plateau is a glacial, fluvial gravel bar. A thin surface layer of wind-blown silts and sands covers the well-sorted, coarse sands that comprise the Hanford Formation sediments.

The 200 Areas contain nonradioactive support facilities,including transportation maintenance buildings, service stations,and coal-fired powerhouses (with baghouses for airstream cleanup) for process steam production, steam transmission lines, raw-water treatment plants, water-storage tanks, electrical maintenance facilities,and subsurface sewage disposal systems. In short, the 200 Areas are almost cities to themselves in that they have most of the utilities necessary to be self supporting.

Located on the 200 East Area are 26 inactive CERCLA sites, which can be grouped into fourteen units for characterization* (see Table 1-1). The units are groupings of sites that have the following:

*Further discussion of the characterization will be discussed in Section 2.4.



BUILDING LIST

BUILDING NUMBER	DESCRIPTION
135 KW	REACTOR BUILDING
107 KW	WATER RETENTION BASIN
107 KW	GAS STORAGE
107 KW	GAS RECIRCULATION BUILDING
116 KW	REACTOR STACK
117 KW	EXHAUST AIR FILTER BUILDING
119 KW	EXHAUST AIR SAMPLE BUILDING
150 KW	HEAT RECOVERY FACILITY
151 K	SWITCHING STATION
151 KW	SUBSTATION 230-KW
165 KW	POWER CONTROL BUILDING
166 KW	OIL BUNKER
167 K	CROSS TILE TUNNEL BUILDING
181 KW	RIVER PUMP HOUSE
182 K	EMERGENCY WATER PUMP HOUSE
183 KW	FILTER PLANT
183 KW	CHLORINE VAULT
190 KW	MAIN PUMP HOUSE
1701 K	EXCLUSION AREA BADGE HOUSE
1702 KW	BADGE HOUSE
1703 KW	WAREHOUSE
1704 KW	OIL STORAGE
1717 K	MAINTENANCE & TRANSPORTATION
1717 K	OFFICES & TELEPHONE EXCHANGE
1719 K	OFFICE TRAILER
1721 K	OFFICE TRAILER
1722 K	OFFICE TRAILER
1725 KE	REACTOR FACILITY
110 KE	GAS STORAGE
115 KE	GAS RECIRCULATION BUILDING
116 KE	REACTOR STACK
117 KE	EXHAUST AIR FILTER BUILDING
119 KE	MAINTENANCE SHOP
150 KE	HEAT RECOVERY FACILITY
165 KE	POWER CONTROL BUILDING
166-A KE	OIL HOUSE
166 KE	OIL BUNKER
167 KE	CROSS TILE TUNNEL BUILDING
181 KE	RIVER PUMP HOUSE
[illegible]	CHLORINE VAULT
1702 KE	BADGE HOUSE
1705 KE	EFFLUENT WATER TREATMENT PILOT PLANT 1706
KE	WATER STUDIES SEMIWORKS FACILITY 1706
[illegible]	COOLANT SYSTEM DEV LAB
1706 KER	WATER STUDIES RECIRCULATION BUILDING 1711
KE	SHOP BUILDING
1713 KER	WAREHOUSE
1714 KE	OIL & PAINT STORAGE

RADIOLOGICAL UNDERGROUND SITES (RETIRED)

119 K	SOLID WASTE BURIAL GROUNDS
116 K-1	EMERGENCY CRIB
116 K-2	0.8 MILE WASTE TRENCH
107 KE	RETENTION BASIN TANKS
107 KW	RETENTION BASIN TANKS
116 KE-1	115 KE CRIB
116 KW-1	115 KW CRIB
116 KW-2	10" DIAMETER DRAIN
116 KE-2	1706 KER CRIB
116 KE-3	10" DIAMETER DRAIN
116 K-3	1908 OUTFALL
133 KE*2	3" DIAMETER DRAIN
133 KW*2	3" DIAMETER DRAIN

NACT KE WASTE SITES (PRE NOVEMBER, 1980)

JOB #: 1447

U. S. Department Of Energy
Richland Operations Office
PACIFIC NORTHWEST LABORATORY
OPERATED BY BATTELLE MEMORIAL INSTITUTE

100-K AREA
WASTE SITES

SCALE: NONE
NOT REQD
NONE
100 K AREA
C401
H-3-57210
6 | 10

TABLE 1-1. LIST OF CERCLA SITES IN THE 200 EAST AREA

SUBAREA NO.	INACTIVE SITES	DISPOSAL METHOD	WASTE TYPE	USE DATES FROM	USE DATES TO
I	216-B-43	Crib	T/SW	11/54	11/54
	216-B-44	Crib	T/SW	12/54	3/55
	216-B-45	Crib	T/SW	4/55	6/55
	216-B-46	Crib	T/SW	9/55	12/55
	216-B-48	Crib	T/SW	11/55	7/57
	216-B-49	Crib	T/SW	11/55	12/55
	216-B-50	Crib	T/SW	1/65	1/79
II	216-B-7A & B	Crib	T/SW	9/46	5/66
III	216-B-2-2	Ditch	SC & CW	11/63	5/70
IV	216-B-5	Reverse Well	T/SW	4/45	10/47
V	216-B-10-A	Crib	PW	12/49	1/52
	216-B-6	Reverse Well	PW	4/45	12/49
VI	216-C-1	Crib	PC	1/53	6/57
	216-C-10	Crib	PC	11/64	10/69
VII	216-B-16	Crib	T/SW	4/56	8/56
VIII	216-A-40	Trench	SC & CW	1/68	5/79
IX	216-A-24	Crib	T/SW	5/58	1/66
X	216-A-9	Crib	PW	3/56	8/69
XI	216-A-7	Crib	MLW	11/55	11/66
XII	216-A-28	French Drain	MLW	12/58	11/67
XIII	216-A-4	Crib	MLW	12/55	12/58
	216-A-5	Crib	PC	11/55	11/61
	216-A-21	Crib	PC	11/57	6/65
	216-A-27	Crib	MLW	6/65	7/70
	216-A-36A	Crib	MLW	9/65	3/66
XIV	216-A-6	Crib	MLW	11/55	1/70

Notes:

(From potentially least hazardous to potentially most hazardous)

SC & CW - Steam Condensate and Cooling Water
PC - Process Condensate
MLW - Miscellaneous Liquid Waste
PW - Process Waste
T/SW - Tank and Scavenged Waste

- similar or identical waste types
- close proximity to each other
- similar sources of wastes.

The 200 East Area is located in a controlled area of approximately 8.4 sq. km (3.2 sq. mi.). It is about 6.2 miles from the Columbia River and 11 miles from the nearest Hanford Reservation boundary. It is located on a plateau approximately 1.8 miles southwest of Gable Mountains.

The historical operations in the 200 East Area included chemical separation and waste management. Irradiated fuel, waste processing, and waste storage activities are located in this area, due to its far distance from both surface and ground waters. The plants in the 200 East Area were first constructed in 1943 and are presently active. See Figure 1-17 for site locations in the 200 East area.

The 200 West Area has a total of 27 CERCLA sites divided into 15 units. The sites/units are listed in Table 1-2. These sites are no longer operating and are therefore considered "inactive."

The 200 West Area is located in the middle of the Hanford Site, on a plateau about 11 kilometers (7mi.) from the Columbia River.

The 200 West Area was dedicated to chemical separations and waste management. Irradiated fuel, waste-processing, and waste-storage activities are located in this area because of the isolation from the site boundaries and because it is the farthest from both surface and ground-water.

The 200 West Area is a controlled area of approximately 8.2 square kiometers (3.2 sq. mi.); it is about 8 kilometers (5 mi.) from the Columbia River and 11 kilometers (6.8 mi.) from the nearest site boundary. In the early 1980's, it was expanded to the west to add land for future burial grounds. There are no naturally occurring surface water bodies within the wpp West Area; however, process cooling water and aqueous waste are discharged to surface impoundments, creating several artificial ponds within

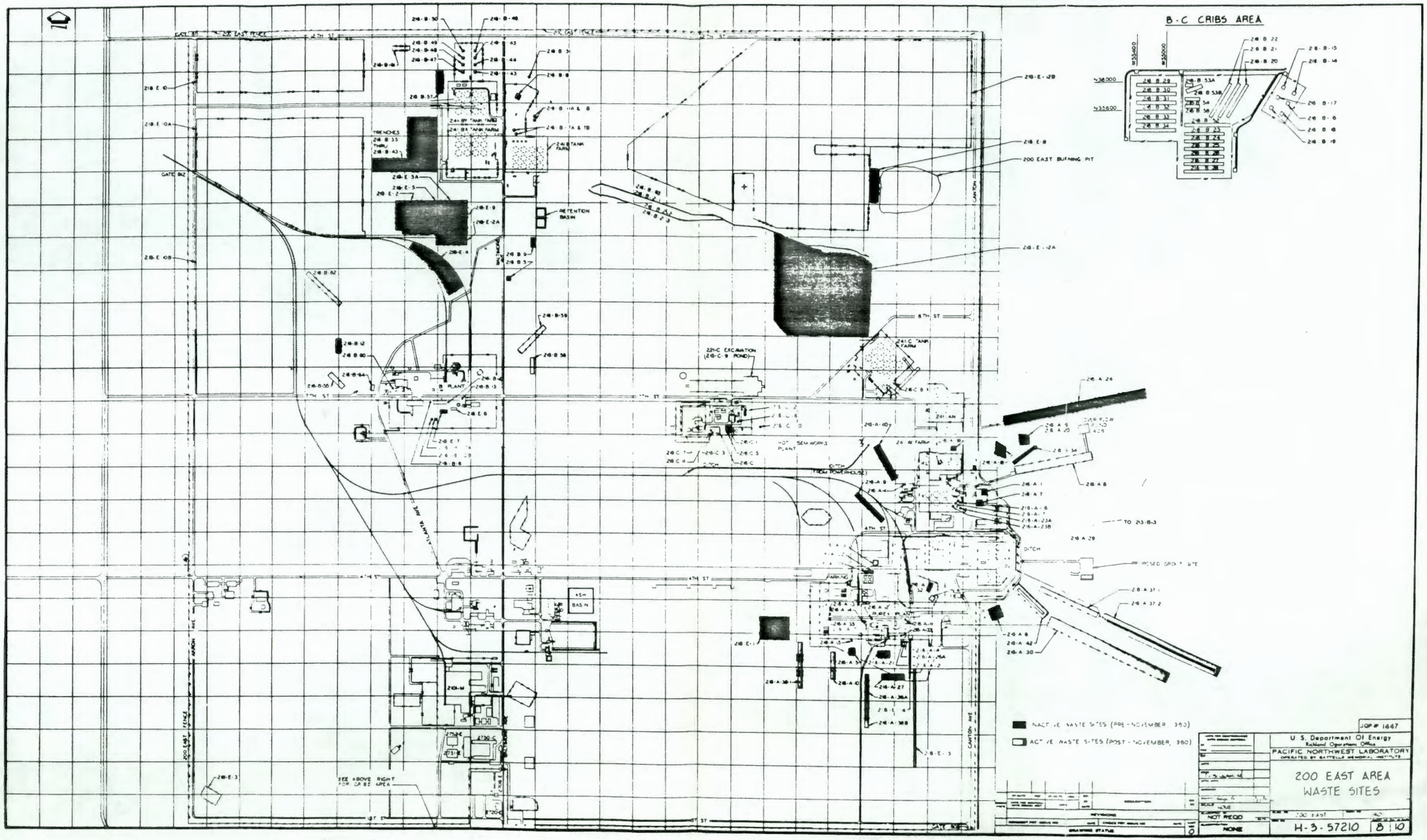
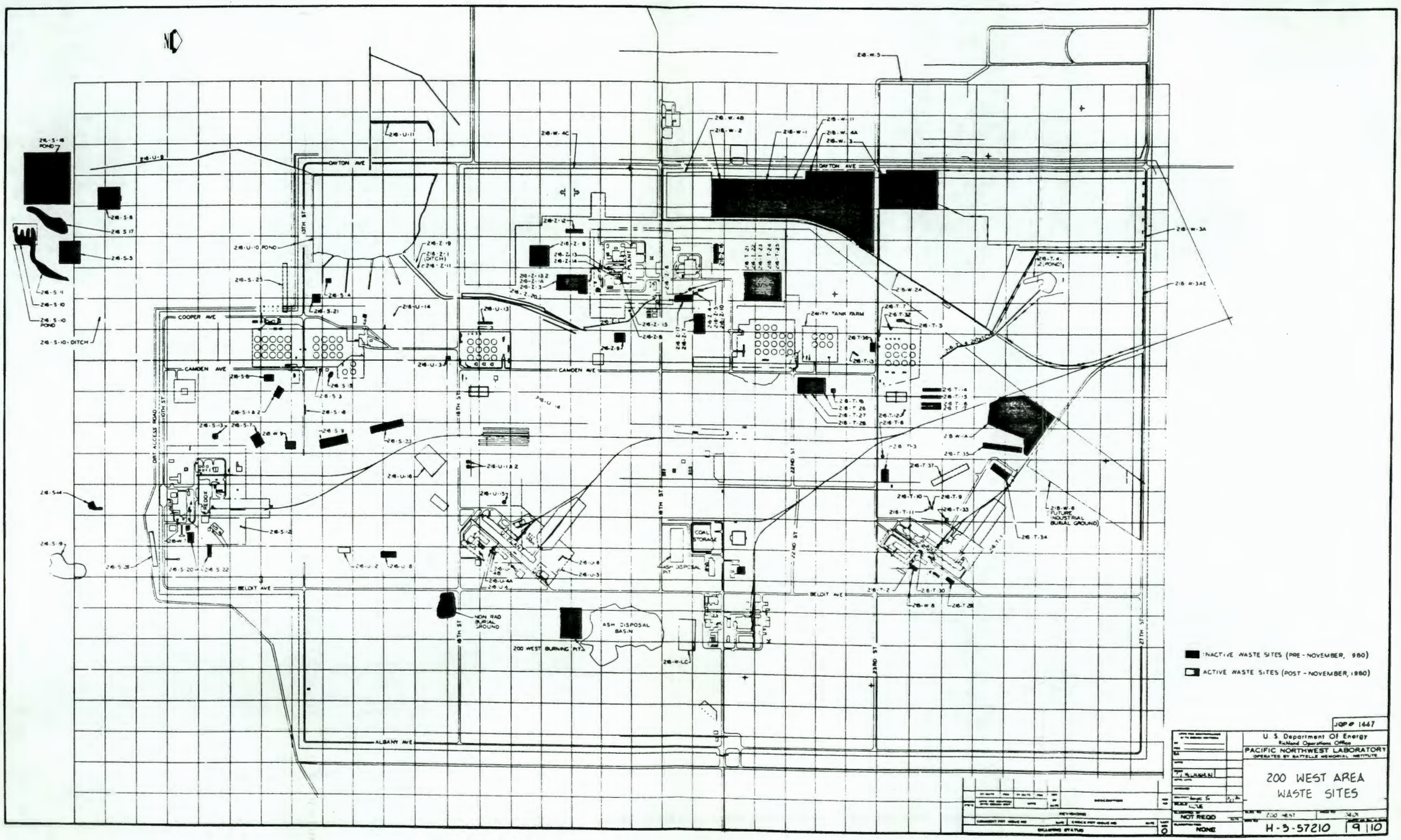

B-C CRIBS AREA
200 EAST BURNING PIT
RETENTION BASIN
TANK FARM
TRENCHES
ALABAMA AVE
4TH ST
7TH ST
8TH ST
CANTON AVE
ASH BASIN
PROPOSED SPOIL SITE
TO 213-B-3
NACTIVE WASTE SITES (PRE-NOVEMBER 1980)
ACTIVE WASTE SITES (POST-NOVEMBER 1980)
U. S. Department Of Energy
Richland Operations Office
PACIFIC NORTHWEST LABORATORY
200 EAST AREA
WASTE SITES
H-3-57210
8 10

TABLE 1-2. LIST OF CERCLA SITES IN THE 200 WEST AREA

Units No.	Inactive Sites	Disposal Method	Waste Type	Use Dates From	To
I	216-S-5	Crib	SC & CW	3/54	3/57
	216-S-6	Crib	SC & CW	11/54	7/72
	216-S-17	Pond	SC & CW	10/51	4/54
	216-S-16P	Pond	SC & CW	1/57	2/75
	216-S-16D	Ditch	SC & CW	1/57	2/75
II	216-S-1&2	Crib	PC	1/52	1/56
	216-S-7	Crib	PC	1/56	7/65
	216-S-3	French Drain	SC & CW	9/53	8/56
	216-S-9	Crib	PC	7/65	1/69
III	216-S-20	Crib	PW	1/52	5/73
IV	216-S-4	French Drain	SC & CW	8/53	8/56
	216-S-21	Crib	PC	4/54	2/69
V	216-U-11	Ditch	PW	4/44	1957
VI	216-U-3	French Drain	T/SW	5/54	8/55
VII	216-Z-1&2	Crib	PW	6/49	4/69
VIII	216-U-1&2	Crib	MLW	3/52	5/67
IX	216-U-4	Reverse Well	PW	3/47	7/55
	216-U-4A	French Drain	PW	7/55	7/70
	216-U-4B	French Drain	PW	1/60	7/70
X	216-Z-7	Crib	PW	2/47	2/67
	216-Z-10	Reverse Well	PW	2/45	6/45
XI	216-T-19	Crib and Tile Field	PC	9/51	7/80
XII	216-T-7	Crib and Tile Field	T/SW	7/78	11/55
XIII	216-T-28	Crib	PW	2/60	12/66
XIV	216-T-3	Reverse Well	MLW	6/45	8/46
XV	216-T-2	Reverse Well	PW	1/45	5/50
	216-T-8	Crib	PW	5/50	9/51

NOTES: (from potentially least hazardous to potentially most hazardous)

SC & CW = Steam Condensate and Cooling Water
PC = Process Condensate
MLW = Miscellaneous Liquid Waste
PW = Process Waste
T/SW = Tank and Scavenged Waste


DAYTON AVE
COOPER AVE
CAMDEN AVE
BELDIT AVE
ALBANY AVE
13TH ST
18TH ST
19TH ST
20TH ST
22ND ST
23RD ST
27TH ST
DIRT ACCESS ROAD
216-S-16 POND
216-U-10 POND
216-S-10 POND
216-S-10-DITCH
216-Z-1 (DITCH)
216-Z-11
216-Z-9
216-Z-18
216-Z-19
216-Z-20
216-Z-1A
216-Z-1B
216-Z-2
216-Z-3
216-Z-4
216-Z-5
216-Z-6
216-Z-7
216-Z-8
216-Z-9
216-Z-10
216-Z-12
216-Z-13
216-Z-14
216-Z-15
Z-PLANT
216-W-5
216-W-4B
216-W-2
216-W-1
216-W-11
216-W-4A
216-W-3
216-W-4C
216-W-3A
216-W-3AE
216-W-2A
216-W-A
216-W-6 FUTURE INDUSTRIAL (BURIAL GROUND)
216-W-LC
216-U-11
216-U-9
216-U-14
216-U-13
216-U-3
216-U-16
216-U-18A
216-U-18B
216-U-15
216-U-8
216-U-5
216-U-4A
216-U-4
216-U-2
216-U-6
216-S-18
216-S-17
216-S-5
216-S-11
216-S-10
216-S-25
216-S-4
216-S-21
216-S-6
216-S-1A
216-S-1B
216-S-3
216-S-16
216-S-13
216-S-7
216-S-9
216-S-23
216-S-12
216-S-44
216-S-19
216-S-38
216-S-20
216-S-22
216-T-4 (POND)
216-T-7
216-T-32
216-T-5
216-T-36
216-T-13
216-T-4
216-T-3
216-T-6
216-T-12
216-T-18
216-T-26
216-T-27
216-T-28
216-T-35
216-T-37
216-T-10
216-T-9
216-T-33
216-T-11
216-T-34
216-T-2
216-T-30
216-T-29
216-W-8
TY TANK FARM
COAL STORAGE
ASH DISPOSAL PIT
ASH DISPOSAL BASIN
NON RAD BURIAL GROUND
200 WEST BURNING PITS
INACTIVE WASTE SITES (PRE-NOVEMBER, 1980)
ACTIVE WASTE SITES (POST-NOVEMBER, 1980)
JOB # 1447
U. S. Department Of Energy
Richland Operations Office
PACIFIC NORTHWEST LABORATORY
OPERATED BY BATTELLE MEMORIAL INSTITUTE
200 WEST AREA
WASTE SITES
NOT REQD
NONE
H-3-57210
9 | 10

or adjacent to the area. See Figure 1-18 for site locations in the 200 West area.

The 300 Area is located about 1.6 kilometers (1 mi) north of the Richland city limits, on the bank of the Columbia River. Roughly rectangular in shape, the area covers about 1.5 square kilometers (370 acres); waste-management facilities have been added just to the north of the 300 Area.

Occupying a relatively flat area on the west bank of the Columbia River, the area has an elevation that is about 15 meters (50 ft) above the average elevation of the adjacent river. The Hanford Site land surface surrounding the 300 Area is devoid of prominent surface features and slopes gently upward to the northwest.

The surface sediments in the 300 Area are largely wind-transported sands and silts. These sediments, which were deposited in dunes up to about 3 meters(9.8 ft) in depth, have been largely stabilized by vegetation. Below this layer lie 20 to 25 meters (66 to 82 ft) of coarse-grained glaciofluvial deposits known as the Pasco Gravels; the permeability of these deposits is very high.

The high porosity and permeability of the sands and gravels that underlie the the area allow any precipitation to infiltrate rapidly. Flooding of any portion of the 300 Area by rainwater is therefore highly improbable. There are no natural streams or watercourses other than the Columbia River within or adjacent to the 300 Area.

The residence nearest the 300 Area is approximately 1.5 kilometers (0.9 mi) east across the Columbia River. A number of irrigated farms are located just across the river from the 300 Area. The northern part of Richland, lying within about 4 kilometers (2.5 mi) of the 300 Area, is an industrial park. The nearest residences in Richland are about 4.6 kilometers (2.9 mi) from the 300-Area boundary. The nearest city water intake is the Richland pumping station, 6 kilometers (3.7 mi) downstream from the 300 Area.

The sites within the 300 area include: 316-1 (Pond), 316-2 (Pond), 316-3 (Trench), 316-4 (Crib). See Figure 1-19 for the location of site 316-1 in the 300 area. Because of the location of the sites, they could not be grouped for characterization or remediation.

The 400 Area is a controlled area of about 0.5 square kilometer (130 acres) located in the southeast part of the Hanford Site; it is approximately 7.2 kilometers (4.5 mi) from the Columbia River and 6.2 kilometers (3.9 mi) from the nearest Site boundary.

The area is located at an elevation of about 170 meters (558 ft) above MSL. The land around the site slopes gently away to the south and east toward the Columbia and Yakima rivers. The site is devoid of prominent topographic features.

The glaciofluvial deposits upon which the 400 Area is located extend from the surface to a depth of about 45 meters (148 ft). The surface sediments are coarse sands merging into the coarse Pasco gravels. The water table beneath the 400 Area is in the upper part of the Ringold Formation, at a depth of about 50 meters (164 ft).

The ground water moves from west to east toward the Columbia River. A small amount of ground water is withdrawn from the unconfined aquifer for sanitary use and air conditioning, but the effect on ground-water level is not significant.

The residence nearest to the 400 Area is approximately 8 kilometers (5 mi) to the southwest. The Richland city limits are about 11 kilometers (6.9 mi) to the southeast.

The 600 Area includes all of the Hanford Site not occupied by the 100, 200, 300, or 400 Areas. Land within the 600 Area is used for:

- The Arid Lands Ecology (ALE) Reserve, a 310-square-kilometer (120-sq-mi) tract set aside for ecological studies

- A 4-square-kilometer (990-acre) tract leased to the State of Washington, part of which is used for low-level waste disposal

- A 4.4-square-kilometer (1,100-acre) tract for WNP nuclear power plants

- A 2.6-square-kilometer (640-acre) tract transferred to the State of Washington as a potential site for the disposal of nonradioactive hazardous wastes

- About 130 square kilometers (50 sq mi) under permit to U.S. Fish and Wildlife Service

- A 225-square-kilometer (87-sq-mi) tract under permit to Washington State Department of Game for recreational game management

- Support facilities for the controlled-access areas

- The Near-Surface Test Facility in Gable Mountain, which is part of the Basalt Waste Isolation Project (BWIP) to assess the feasibility of storing high-level radioactive waste in basalt formations

- A 46.7-square-kilometer (18-sq-mi) tract for the reference repository location for the Basalt Waste Isolation Project (BWIP). This site includes all of the 200-West Area (U.S. DOE 1982, 1984). The site of the principal borehole and exploratory shaft for the BWIP covers about 1 square kilometer (250 acres) and is located just west of the 200-West Area within the reference repository location. See Figure 1-20 for the 600 area map.

Although they are not of significance for this study, other Hanford areas are in the downtown Richland area, where federal and contractor employees work in the Federal Building and several others (700 Area), the area south of the 300 Area primarily used for research and development (3000 Area), and the area between the 700 and 3000 Areas that is the main

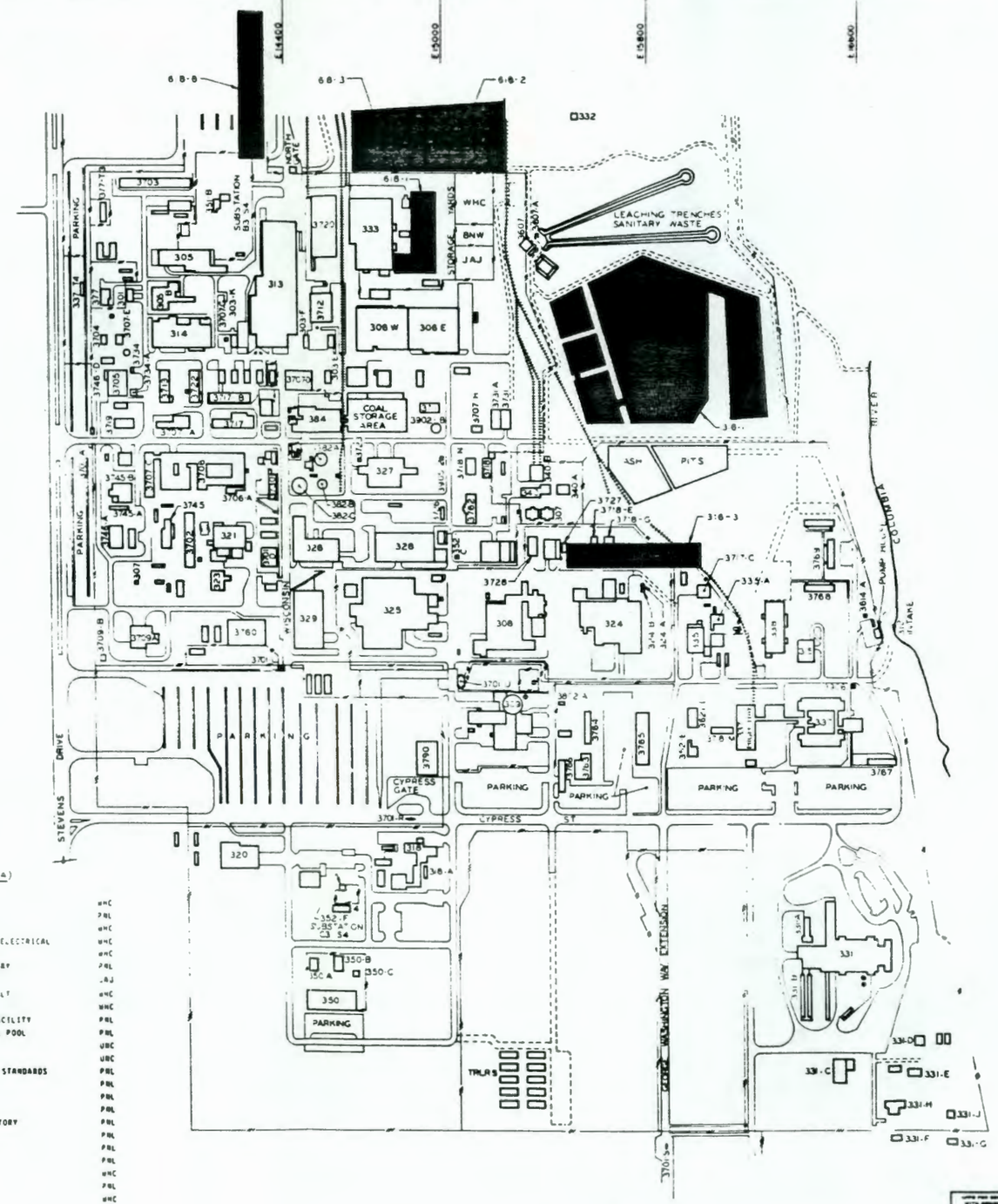
BUILDING LIST

BUILDING NUMBER	BUILDING NAME	LANDLORD
301	STORAGE	WHC
303-A	URANIUM STORAGE	WHC
303-B	URANIUM STORAGE	WHC
303-C	URANIUM STORAGE	JAJ
303-E	URANIUM STORAGE	JAJ
303-F	CHEMICAL PUMP HOUSE	JAJ
303-G	URANIUM STORAGE	JAJ
303-J	STORAGE	PNL
303-K	STORAGE	WHC
303-M	URANIUM OXIDE FACILITY	WHC
304	CONSTRUCTION FACILITY	JAJ
305	HOT CELL VERIFICATION FACILITY (HCVF)	WHC
305A	CONSTRUCTION OFFICE	JAJ
305B	ENGINEERING DEVELOPMENT LAB ANNEX	JAJ
306 (EAST)	FABRICATION AND TESTING LAB	WHC
306(WEST)	METAL FABRICATION DEVELOPMENT BUILDING	PNL
308	FUELS DEVELOPMENT LABORATORY	WHC
309	CONTROL AND DATA SYSTEMS	WHC
311	STEEL HOUSE	WHC
313	FUELS MANUFACTURING LABORATORY	WHC
314	ENGINEERING DEPARTMENT	PNL
315	FILTERED WATER PLANT	WHC
318	HTLT REACTOR AND MONITORING SERVICES	PNL
320	LOW LEVEL RADIOCHEMISTRY BLDG	PNL
321	HYDROMECHANICAL FACILITY	WHC
323	METALS CREEP LABORATORY	WHC
324A & C	CHEMICAL ENGINEERING LABORATORY	WHC
325	RADIOCHEMISTRY LABORATORY	WHC
326	MATERIALS TECHNOLOGY LABORATORY	WHC
327	POST IRRADIATION TESTING LABORATORY	WHC
328	ENGINEERING SERVICES AND SAFETY	WHC
329	BIOPHYSICS LABORATORY	PNL
331	LIFE SCIENCE LABORATORY	PNL
332	HAZARDOUS WASTE TREATMENT HOLDING FACILITY	PNL
333	N FUELS MANUFACTURING	
333-1 TRL	OFFICES	
334	SAMPLING SHED	
334-A	SPENT ACID STORAGE	JAJ
335	AEROSOL TEST FACILITY	PNL
335A	FAST REACTOR THERMAL ENGINEERING FACILITY	WHC
336	SODIUM TESTING FACILITY	WHC
337	HIGH TEMPERATURE SODIUM FACILITY AND OFFICES	WHC
338	SAF COLD TEST FACILITY	WHC
340A	RETENTION AND NEUTRALIZATION FACILITY	WHC
340B & C	RR WASTE LOADOUT FACILITY	WHC
350	PLANT OPERATIONS AND MAINTENANCE FACILITY	PNL
350A	PAINT SHOP	PNL
350B	WAREHOUSE	PNL
350C	STORAGE	PNL
352A-A	INFRA RED LAB	WHC
352E	GENERATOR SUBSTATION	WHC
377	STEAM GENERATOR EXAMINATION FACILITY	WHC
182	PUMP HOUSE	WHC
182A	NORTH GROUND WATER TANK 100,000 GAL	WHC
182B	SOUTH GROUND WATER TANK 100,000 GAL	WHC
182C	WEST GROUND WATER TANK 400,000 GAL	WHC
384	POWER HOUSE	WHC
3506-A	MATERIALS PROPERTIES LAB	WHC
3536-B	SERVICE SHOP	WHC
3607	SEPTIC TANKS	WHC
3621B & C	EMERGENCY GENERATOR AND CONTROL	WHC
3621D	EMERGENCY GENERATOR STATION #3	WHC
3701A	APPLE STREET GUARD STATION	WHC
3701D	PATROL HEADQUARTERS	WHC
3701L	WISCONSIN STREET GUARD STATION	WHC
3701M	NORTH GUARD STATION	JAJ
3701N	CYPRESS STREET GUARD STATION	WHC
3701O	STEVENS ARCHIVISTS WAY GUARD STATION	WHC
3701J	PROTECTED AREA GUARD STATION	WHC
3702	OFFICES	WHC
3703	OFFICES	WHC
3704	STORAGE (JAJ)	JAJ
3705	PNL PHOTOGRAPHY	PNL
3706	INFORMATION SERVICES	WHC
3707A	FUELS TRAINING	JAJ
3707B	CUSTODIAL SERVICES	WHC
3707C	AUTOMATED TECHNOLOGY	WHC
3707D	INFORMATION SERVICES	WHC
3707E	STORAGE(JAJ)	WHC
3707F	PERSONNEL SURVEY	WHC
3707	CHANGE ROOM	WHC
3708	RADIATION MEASUREMENTS	PNL
3709	HEDL PAINT SHOP	WHC
3709A	FIRE STATION	RHO
3710-A	OIL STORAGE	WHC
3711	MAINTENANCE STORAGE	WHC
3712	FUELS WAREHOUSE	JAJ
3713	PAINT AND CARPENTER SHOP	WHC
3715	STORAGE	WHC
3716	STORAGE	JAJ
3717	SHEET METAL AND ENGINEERING OFFICES	JAJ
3718B	STANDARDS LABORATORY	WHC
3718C	ARCHIVE VAULT	WHC
3718	OPERATIONS SUPPORT SERVICES MECHANICAL	WHC
3718A	LABORATORY EQUIPMENT CENTRAL POOL	PNL
3718B	LABORATORY EQUIPMENT CENTRAL POOL	PNL
3718C	STORAGE (308)	WHC
3718E	STORAGE (324)	WHC

(CONT'D AT ZONE 10-C)

(CONT'D FROM ZONE 2-A)

3718F	SODIUM STORAGE	WHC
3718G	STORAGE BUILDING	PNL
3718H	SODIUM STORAGE FACILITY	WHC
3718M	OPERATIONS SUPPORT SERVICES ELECTRICAL	WHC
3719	COMPUTER FACILITY	WHC
3720	CENTRAL SERVICE AND LABORATORY	PNL
3722	CONSTRUCTION SHOP	JAJ
3727	ARCHIVE FISSILE SPECIMEN VAULT	WHC
3728	TEST ARTICLE STORAGE	WHC
3730	GAMMA NEUTRON IRRADIATION FACILITY	PNL
3731	LABORATORY EQUIPMENT CENTRAL POOL	PNL
3730	STORAGE	WHC
3734-A	PAINT STORAGE	WHC
3745	RADIOLOGICAL CALIBRATIONS & STANDARDS	PNL
3745A	ELECTRON ACCELERATOR	PNL
3745B	POSITIVE ION ACCELERATOR	PNL
3746	RADIOLOGICAL PHYSICS BLDG	PNL
3746A	RADIOLOGICAL PHYSICS LABORATORY	PNL
3746D	TECHNICAL SERVICE ANNEX	PNL
3760	TECHNICAL INFORMATION BLDG	PNL
3762	OFFICES	PNL
3763	OFFICES	WHC
3764	OFFICES	PNL
3765	OFFICES	WHC
3766	OFFICES	WHC
3767	OFFICES	WHC
3768	OFFICES	WHC
3769	OFFICES	WHC
3770	OFFICES	WHC
3790	SECURITY OPERATIONS	WHC



ACTIVE WASTE SITES (PRE-NOVEMBER 198-)

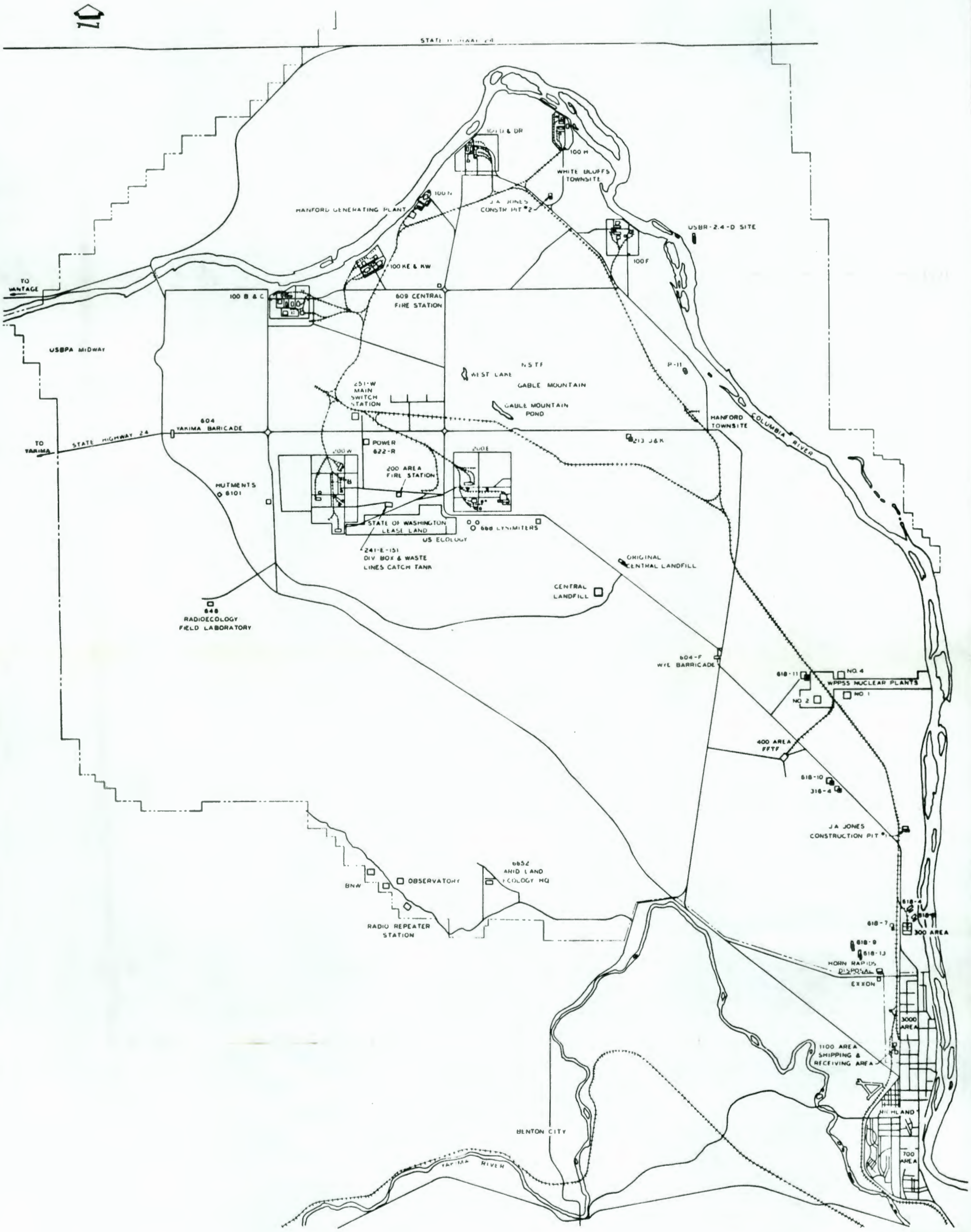
JOB# 1447

U. S. Department Of Energy
Richland Operations Office
PACIFIC NORTHWEST LABORATORY
OPERATED BY BATTELLE MEMORIAL INSTITUTE

300 AREA WASTE SITES

300 AREA

H-3-57210 10 10



JQP#. 1447

U. S. Department Of Energy
Richland Operations Office
PACIFIC NORTHWEST LABORATORY
OPERATED BY BATTELLE MEMORIAL INSTITUTE

600 AREA WASTE SITES

NONE

NOT REQD

NONE

600 AREA

0401

H-3-57210 | 1 | 10

REFERENCE DRAWINGS

NEXT USED ON

REVISIONS

DRAWING STATUS

shipping, receiving, warehousing, transportation, maintenance, utilities, and service station area (1100 Area). These areas include small oil-fired boilers for space heating.

1.2 SUMMARY

Each of the individual CERCLA sites and each type of RCRA 3004(u) site was evaluated to identify the types of data that might be required for characterization (remedial investigation) or remediation. The data needs were identified for each site or type of site, and a plan for characterizing the site was prepared. This plan was then used to develop a summary of the potential cost and possible schedule for characterizing and remediating each site.

Table 1-2 presents a summary of the costs anticipated for characterizing each of the 81 CERCLA sites. On an individual site basis, the costs range from a low $3.2 million to a high of $7.7 million.* Similarly, the costs for the sampling and analysis required of RCRA 3004(u) sites ranges from a low of $23,000 for a generalized Hanford underground tank to a high of $8.6 million for a generalized Hanford ditch.** In many cases, the costs for characterizing adjacent sites can be materially reduced by treating these sites as a group rather than treating each site individually. Costs reductions of up to 85% have been identified by grouping of these sites. A more detailed discussion of the grouping of sites can be found in Section 4.0 of this report.

Although the remedial technology for each site can not be determined at this time, some estimate can be made of the probable range of costs for each CERCLA site and each type of RCRA 3004(u) site. Table 1-3 presents the range of costs for CERCLA sites evaluated in this study. As may be seen, the lest cost alternative is nearly always the capping of the site with some type of surface barrier. The most expensive alternative is nearly always some type

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* See Table 2-23

** See Tables 3-35 and 3-36

TABLE 1-2. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY AREA*

Sources	Pathway				
	Surface Geophysics/ Soil Gas	Groundwater[1]	Vadose Zone	Surface Water/ Sediments	Source Total Cost**
Area 100	$1,459,600	$55,813,550	$22,018,050	$1,372,800	$81,544,000
Area 200	E $ 866,800 W $2,372,900 $3,239,700	$41,622,400 $50,282,400 $91,904,800	$59,819,100 $61,855,000 $121,674,100	$810,400 $654,000 $1,464,400	$219,443,000
Area 300	$471,600	$3,174,800	$2,195,100	$187,200	$6,148,700
					$307,135,700

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square are specified in Table 2-14.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

[1]Assumes each site is evaluated separately. See Table 2-23 for detailed evaluation by site or group of sites.

TABLE 1-3. COST OF REMEDIAL TECHNOLOGIES IN MILLIONS OF DOLLARS FOR SEVERAL TYPES OF DISPOSAL UNITS

Type of Disposal Unit		REMEDIAL TECHNOLOGY								
		Cap/Cover	Grout-in-Place	In-situ Vitrification	Excavation with Disposal	Excavation with Incineration and Disposal	Soil Flushing	Soil Flushing after Excavation	Soil Flushing after Vitrification	No Action
Cribs	(min)	2.3	13	28	79	150	28	23	22	6.1
	(Aug)	2.4	47	63	120	210	58	44	36	6.1
	(max)	2.7	150	140	220	420	180	60	63	6.1
Ditch	(min)	6.7	230	---	1,200	---	280	220	---	6.1
	(Aug)	7.9	230	---	1,200	---	280	220	---	6.1
	(max)	9.2	230	---	1,200	---	280	220	---	6.1
Drywell	(min)	2.3	---	---	79	---	---	---	---	6.1
	(Aug)	2.3	---	---	79	---	---	---	---	6.1
	(max)	2.3	---	---	79	---	---	---	---	6.1
French	(min)	2.2	10	29	62	190	30	22	23	6.1
	(Aug)	2.2	20	45	69	190	30	22	23	6.1
	(max)	2.2	32	61	100	190	30	22	23	6.1
Pond	(min)	6.0	42	250	1,300	---	33	300	---	6.1
	(Aug)	7.6	200	300	1,400	---	270	330	---	6.1
	(max)	12.0	510	350	1,500	---	540	360	---	6.1
Reverse Well	(min)	2.2	19	---	---	---	22	---	---	6.1
	(Aug)	2.2	19	---	---	---	23	---	---	6.1
	(max)	2.2	19	---	---	---	24	---	---	6.1
Trench	(min)	2.3	15	68	92	---	8	---	---	6.1
	(Aug)	3.3	29	86	330	---	21	---	---	6.1
	(max)	7.4	93	130	1,200	---	74	---	---	6.1

of removal such as excavation and disposal. More detailed evaluation of each site as a part of the Remedial Investigation/Feasibility Study will be required to refine the cost estimates and provide the information required by EPA and State of Washington Regulations for use in selection of a remedial technology.

The schedule for the characterization of the sites indicates that the CERCLA sites will take approximately ten years to complete characterization. RCRA sites could take an additional 15 years. Remediation of the sites could take more than fifty years if all sites are remediated (assuming a budget cap of $100 million per year).

2.0 SUMMARY OF CERCLA SITES

The Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford, July 1986, Volumes 1 and 2, was the primary source of information used for the summary descriptions of the CERCLA sites. This information is presented in Tables 2-1 through 2-6. Table 2-3 combines sources of information from Volume 1 (as referenced on the table itself), that described the 81 CERCLA sites and indicates the subarea each site is located in, the method of disposal (unit type) and the waste disposed of at each site. From Table 2-3, Tables 2-1 and 2-2 were derived. Table 2-1 breaks the 81 sites into the number of sites located in each area and subarea. Table 2-2 gives the number of each unit type used in a subarea. Tables 2-4, 2-5 and 2-6 are sorts of Table 2-3. Table 2-3 has the sites listed with the site numbers in ascending order. Table 2-4 orders the sites by area. Tables 2-5 and 2-6 are ordered by unit type and waste disposed respectively.

Table 2-1 indicates that 65% of the CERCLA sites are located in the 200 area, 29% in the 100 area and 4% in the 300 area. Table 2-2 lists dry wells as a unit type while Volume 1 describes dry wells as monitoring measures of liquid releases in the vadose zone. Reverse wells are described in Volume 1 as being used at earlier sites but eventually discontinued when it was found that they released liquid wastes too close to the water table. It appears that reverse wells were used at sites that were in operation before the 1950's and that dry wells replaced reverse wells at later sites.

2.1 DETERMINING THE NEED FOR REMEDIATION

As will be noted in the sections which follow, the criteria presented are derived from a review of the federal and state regulations and DOE Orders which apply to the sites. These are known as the applicable relevant and appropriate regulations (ARARs).

TABLE 2-1. BREAKDOWN OF CERCLA SITES AT ROCKWELL HANFORD OPERATIONS BY AREA AND SUBAREA.

Area	Subarea	No. of CERCLA Sites
100	100-KE/KW	7
	100-B/C	4
	100-D/DR	5
	100-F	6
	100-H	3
	Total	25
200	200 East	26
	200 West	27
	Total	53
300	Total	3

TABLE 2-2. BREAKDOWN OF THE UNIT TYPE USED AT CERCLA SITES AT THE ROCKWELL HANFORD OPERATIONS BY AREA AND SUBAREA.

100-KE/KW Subarea
- 2 Dry Wells
- 2 Cribs
- 2 French Drains

100-B/C Subarea
- 1 French Drain
- 1 Crib
- 2 Trenches

100-D/DR Subarea
- 1 Crib
- 4 Trenches

100-F Subarea
- 5 Trenches
- 1 French Drain

100-H Subarea
- 1 French Drain
- 2 Trenches

200 East Subarea
- 1 French Drain
- 21 Cribs
- 2 Reverse Wells
- 1 Trench
- 1 Ditch

200 West Subarea
- 2 Ditches
- 5 French Drains
- 12 Cribs
- 4 Reverse Wells
- 2 Crib and Tile Fields
- 2 Ponds

300 Area
- 1 Trench
- 2 Ponds

TABLE 2-3. HANFORD INACTIVE WASTE SITES SORTED BY SITE ID.

81 Priority Sites Recommended for Characterization.

Site No. (1)	Area (12)	Unit Type (12)	Waste Disposed
100 KE*1	100-KE/KW	Dry Well (11&12)	Misc. (2)
100 KE*2	100-KE/KW	French Drain (12)	Misc. (2)
100 KW*1	100-KE/KW	Dry Well (11&12)	Misc. (2)
100 KW*2	100-KE/KW	French Drain (12)	Misc. (2)
116-B-1	100-B/C	Trench	Reactor coolant (a) (2)
116-B-4	100-B/C	French Drain	Decontamination Waste (2)
116-C-1	100-B/C	Trench	RC (a) (2)
116-C-2	100-B/C	Crib	Ruptured Fuel Effluent (2)
116-DR-1	100-D/DR	Trench	RC (2)
116-DR-2	100-D/DR	Trench	RC (2)
116-DR-6	100-D/DR	Trench	RC (2)
116-DR-7	100-D/DR	Crib	Misc. (2)
116-D-1B	100-D/DR	Trench	DW (2)
116-F-1	100-F	Trench	DW (2)
116-F-10	100-F	French Drain	RC (2)
116-F-2	100-F	Trench	RFE (2)
116-F-3	100-F	Trench	RFE (2)
116-F-6	100-F	Trench	RC (2)
116-F-9	100-F	Trench	Misc (2)
116-H-1	100-H	Trench	RFE (2)
116-H-2	100-H	Trench	RC (2)
116-H-3	100-H	French Drain	DW (2)
116-KE-2	100-KE/KW	Crib	Misc. (2)
116-K-1	100-KE/KW	Crib	RC (2)
116-K-2	100-KE/KW	Trench	Misc. Liquid Waste (3)
216-A-21	200 East	Crib (11&12)	PW (3)
216-A-24	200 East	Crib (12)	Tank/Scavenged Waste (3)
216-A-27	200 East	Crib (11&12)	MLW (3)
216-A-28	200 East	French Drain	MLW (3)
216-A-36A	200 East	Crib	MLW (3)
216-A-4	200 East	Crib (11&12)	MLW (3)
216-A-40	200 East	Trench	Steam Condensate, Cooling Water (3)
216-A-5	200 East	Crib (12)	Process Condensate (3)
216-A-6	200 East	Crib (12)	MLW (3)
216-A-7	200 East	Crib (12)	MLW (3)
216-A-9	200 East	Crib (12)	Process Waste (3)
216-B-10A	200 East	Crib	PW (4)
216-B-16	200 East	Crib (12)	T/SW (4)
216-B-2-2	200 East	Ditch	Steam Condensate, Cooling Water (4)
216-B-43	200 East	Crib	T/SW (4)
216-B-44	200 East	Crib (12)	T/SW (4)
216-B-45	200 East	Crib (12)	T/SW (4)
216-B-46	200 East	Crib (12)	T/SW (4)

TABLE 2-3. HANFORD INACTIVE WASTE SITES SORTED BY SITE ID.
(Continued)

81 Priority Sites Recommended for Characterization.

Site No. (1)	Area (12)	Unit Type (12)	Waste Disposed
216-B-48	200 East	Crib (12)	T/SW (4)
216-B-49	200 East	Crib (12)	T/SW (4)
216-B-5	200 East	Reverse Well	T/SW (4)
216-B-50	200 East	Crib (12)	T/SW (4)
216-B-6	200 East	Reverse Well	PW (4)
216-B-7 A&B	200 East	Crib	T/SW (4)
216-C-1	200 East	Crib	PC (5)
216-C-10	200 East	Crib	PC (5)
216-S-16D	200 West	Ditch	Steam Condensate, Cooling Water (6)
216-S-16P	200 West	Pond	Steam Condensate, Cooling Water (6)
216-S-17	200 West	Pond	Steam Condensate, Cooling Water (6)
216-S-1&2	200 West	Crib	PC (6)
216-S-20	200 West	Crib	PW (6)
216-S-21	200 West	Crib	PC (6)
216-S-3	200 West	French Drain	Steam Condensate, Cooling Water (6)
216-S-4	200 West	French Drain	Steam Condensate, Cooling Water (6)
216-S-5	200 West	Crib	Steam Condensate, Cooling Water (6)
216-S-6	200 West	Crib	Steam Condensate, Cooling Water (6)
216-S-7	200 West	Crib	PC (6)
216-S-9	200 West	Crib	PC (6)
216-T-19	200 West	Crib & Tile Field	PC (7)
216-T-2	200 West	Reverse Well	PW (7)
216-T-28	200 West	Crib	PW (7)
216-T-3	200 West	Reverse Well	MLW (7)
216-T-7	200 West	Crib & Tile Field	T/SW (7)
216-T-8	200 West	Crib	PW (7)
216-U-11	200 West	Ditch	PW (8)
216-U-1&2	200 West	Crib	MLW (8)
216-U-3	200 West	French Drain	T/SW (8)
216-U-4	200 West	Reverse Well (11&12)	PW (8)
216-U-4A	200 West	French Drain (11&12)	PW (8)
216-U-4B	200 West	French Drain (11&12)	PW (8)
216-Z-10	200 West	Reverse Well	PW (9)
216-Z-1&2	200 West	Crib	PW (9)
216-Z-7	200 West	Crib	PW (9)
316-1	300 Area	Pond (11&12)	PW and Lab Wastes (10)
316-2	300 Area	Pond (11&12)	PW and Lab Wastes (10)
316-3	300 Area	Trench	PW and Lab Wastes (10)

References used in columns are given at the top of the column headings. The reference used in Unit Type is given at the column heading unless additional or different sources are listed in parenthesis for for a given site. References used for Waste Disposed are given in parenthesis for a site.

TABLE 2-4. HANFORD INACTIVE WASTE SITES SORTED BY AREA.

81 Priority Sites Recommended for Characterization.

Area (12)	Site No. (1)	Unit Type (12)	Waste Disposed
100-B/C	116-B-4	French Drain	Decontamination Waste (2)
100-B/C	116-B-1	Trench	Reactor coolant (a) (2)
100-B/C	116-C-2	Crib	Ruptured Fuel Effluent (2)
100-B/C	116-C-1	Trench	RC (a) (2)
100-D/DR	116-DR-2	Trench	RC (2)
100-D/DR	116-DR-7	Crib	Misc. (2)
100-D/DR	116-DR-6	Trench	RC (2)
100-D/DR	116-D-1B	Trench	DW (2)
100-D/DR	116-DR-1	Trench	RC (2)
100-F	116-F-1	Trench	DW (2)
100-F	116-F-9	Trench	Misc (2)
100-F	116-F-2	Trench	RFE (2)
100-F	116-F-3	Trench	RFE (2)
100-F	116-F-6	Trench	RC (2)
100-F	116-F-10	French Drain	RC (2)
100-H	116-H-1	Trench	RFE (2)
100-H	116-H-3	French Drain	DW (2)
100-H	116-H-2	Trench	RC (2)
100-KE/KW	100 KW*2	French Drain (12)	Misc. (2)
100-KE/KW	116-KE-2	Crib	Misc. (2)
100-KE/KW	116-K-1	Crib	RC (2)
100-KE/KW	100 KE*1	Dry Well (11&12)	Misc. (2)
100-KE/KW	100 KW*1	Dry Well (11&12)	Misc. (2)
100-KE/KW	100 KE*2	French Drain (12)	Misc. (2)
100-KE/KW	116-K-2	Trench	Misc. Liquid Waste (3)
200 East	216-B-44	Crib (12)	T/SW (4)
200 East	216-B-43	Crib	T/SW (4)
200 East	216-A-24	Crib (12)	Tank/Scavenged Waste (3)
200 East	216-A-21	Crib (11&12)	PW (3)
200 East	216-A-28	French Drain	MLW (3)
200 East	216-B-45	Crib (12)	T/SW (4)
200 East	216-A-4	Crib (11&12)	MLW (3)
200 East	216-B-46	Crib (12)	T/SW (4)
200 East	216-A-5	Crib (12)	Process Condensate (3)
200 East	216-B-48	Crib (12)	T/SW (4)
200 East	216-A-7	Crib (12)	MLW (3)
200 East	216-B-49	Crib (12)	T/SW (4)
200 East	216-B-10A	Crib	PW (4)
200 East	216-B-5	Reverse Well	T/SW (4)
200 East	216-B-2-2	Ditch	Steam Condensate, Cooling Water (4)
200 East	216-B-50	Crib (12)	T/SW (4)
200 East	216-A-36A	Crib	MLW (3)
200 East	216-B-6	Reverse Well	PW (4)
200 East	216-A-6	Crib (12)	MLW (3)
200 East	216-B-7 A&B	Crib	T/SW (4)
200 East	216-B-16	Crib (12)	T/SW (4)

TABLE 2-4. HANFORD INACTIVE WASTE SITES SORTED BY AREA.
(Continued)

81 Priority Sites Recommended for Characterization.

Area (12)	Site No. (1)	Unit Type (12)	Waste Disposed
200 East	216-C-1	Crib	PC (5)
200 East	216-A-40	Trench	Steam Condensate, Cooling Water (3)
200 East	216-A-27	Crib (11&12)	MLW (3)
200 East	216-A-9	Crib (12)	Process Waste (3)
200 East	216-C-10	Crib	PC (5)
200 West	216-S-17	Pond	Steam Condensate, Cooling Water (6)
200 West	216-T-3	Reverse Well	MLW (7)
200 West	216-T-7	Crib & Tile Field	T/SW (7)
200 West	216-S-16D	Ditch	Steam Condensate, Cooling Water (6)
200 West	216-T-8	Crib	PW (7)
200 West	216-S-20	Crib	PW (6)
200 West	216-U-11	Ditch	PW (8)
200 West	216-S-3	French Drain	Steam Condensate, Cooling Water (6)
200 West	216-U-1&2	Crib	MLW (8)
200 West	216-S-5	Crib	Steam Condensate, Cooling Water (6)
200 West	216-U-3	French Drain	T/SW (8)
200 West	216-S-7	Crib	PC (6)
200 West	216-U-4	Reverse Well (11&12)	PW (8)
200 West	216-T-19	Crib & Tile Field	PC (7)
200 West	216-U-4A	French Drain (11&12)	PW (8)
200 West	216-T-28	Crib	PW (7)
200 West	216-U-4B	French Drain (11&12)	PW (8)
200 West	216-S-1&2	Crib	PC (6)
200 West	216-Z-10	Reverse Well	PW (9)
200 West	216-S-4	French Drain	Steam Condensate, Cooling Water (6)
200 West	216-Z-1&2	Crib	PW (9)
200 West	216-S-9	Crib	PC (6)
200 West	216-Z-7	Crib	PW (9)
200 West	216-S-16P	Pond	Steam Condensate, Cooling Water (6)
200 West	216-S-6	Crib	Steam Condensate, Cooling Water (6)
200 West	216-T-2	Reverse Well	PW (7)
200 West	216-S-21	Crib	PC (6)
300 Area	316-1	Pond (11&12)	PW and Lab Wastes (10)
300 Area	316-2	Pond (11&12)	PW and Lab Wastes (10)
300 Area	316-3	Trench	PW and Lab Wastes (10)

References used in columns are given at the top of the column headings. The reference used in Unit Type is given at the column heading unless additional or different sources are listed in parenthesis for for a given site. References used for Waste Disposed are given in parenthesis for a site.

TABLE 2-5. HANFORD INACTIVE WASTE SITES SORTED BY UNIT TYPE.

81 Priority Sites Recommended for Characterization.

Unit Type (12)	Site No. (1)	Area (12)	Waste Disposed
Crib	116-C-2	100-B/C	Ruptured Fuel Effluent (2)
Crib	116-DR-7	100-D/DR	Misc. (2)
Crib	116-KE-2	100-KE/KW	Misc. (2)
Crib	116-K-1	100-KE/KW	RC (2)
Crib	216-B-43	200 East	T/SW (4)
Crib	216-C-1	200 East	PC (5)
Crib	216-B-7 A&B	200 East	T/SW (4)
Crib	216-C-10	200 East	PC (5)
Crib	216-B-10A	200 East	PW (4)
Crib	216-A-36A	200 East	MLW (3)
Crib	216-Z-1&2	200 West	PW (9)
Crib	216-S-9	200 West	PC (6)
Crib	216-S-7	200 West	PC (6)
Crib	216-S-21	200 West	PC (6)
Crib	216-S-6	200 West	Steam Condensate, Cooling Water (6)
Crib	216-T-8	200 West	PW (7)
Crib	216-U-1&2	200 West	MLW (8)
Crib	216-S-1&2	200 West	PC (6)
Crib	216-S-5	200 West	Steam Condensate, Cooling Water (6)
Crib	216-Z-7	200 West	PW (9)
Crib	216-S-20	200 West	PW (6)
Crib	216-T-28	200 West	PW (7)
Crib & Tile Field	216-T-7	200 West	T/SW (7)
Crib & Tile Field	216-T-19	200 West	PC (7)
Crib (11&12)	216-A-27	200 East	MLW (3)
Crib (11&12)	216-A-4	200 East	MLW (3)
Crib (11&12)	216-A-21	200 East	PW (3)
Crib (12)	216-A-5	200 East	Process Condensate (3)
Crib (12)	216-B-45	200 East	T/SW (4)
Crib (12)	216-A-24	200 East	Tank/Scavenged Waste (3)
Crib (12)	216-B-46	200 East	T/SW (4)
Crib (12)	216-B-50	200 East	T/SW (4)
Crib (12)	216-B-48	200 East	T/SW (4)
Crib (12)	216-A-7	200 East	MLW (3)
Crib (12)	216-A-6	200 East	MLW (3)
Crib (12)	216-B-49	200 East	T/SW (4)
Crib (12)	216-A-9	200 East	Process Waste (3)
Crib (12)	216-B-44	200 East	T/SW (4)
Crib (12)	216-B-16	200 East	T/SW (4)
Ditch	216-B-2-2	200 East	Steam Condensate, Cooling Water (4)
Ditch	216-S-16D	200 West	Steam Condensate, Cooling Water (6)
Ditch	216-U-11	200 West	PW (8)
Dry Well (11&12)	100 KW*1	100-KE/KW	Misc. (2)
Dry Well (11&12)	100 KE*1	100-KE/KW	Misc. (2)
French Drain	116-B-4	100-B/C	Decontamination Waste (2)
French Drain	116-F-10	100-F	RC (2)

TABLE 2-5. HANFORD INACTIVE WASTE SITES SORTED BY UNIT TYPE.
(Continued)

81 Priority Sites Recommended for Characterization.

Unit Type (12)	Site No. (1)	Area (12)	Waste Disposed
French Drain	116-H-3	100-H	DW (2)
French Drain	216-A-28	200 East	MLW (3)
French Drain	216-S-4	200 West	Steam Condensate, Cooling Water (6)
French Drain	216-U-3	200 West	T/SW (8)
French Drain	216-S-3	200 West	Steam Condensate, Cooling Water (6)
French Drain (11&12)	216-U-4B	200 West	PW (8)
French Drain (11&12)	216-U-4A	200 West	PW (8)
French Drain (12)	100 KW*2	100-KE/KW	Misc. (2)
French Drain (12)	100 KE*2	100-KE/KW	Misc. (2)
Pond	216-S-17	200 West	Steam Condensate, Cooling Water (6)
Pond	216-S-16P	200 West	Steam Condensate, Cooling Water (6)
Pond (11&12)	316-2	300 Area	PW and Lab Wastes (10)
Pond (11&12)	316-1	300 Area	PW and Lab Wastes (10)
Reverse Well	216-B-6	200 East	PW (4)
Reverse Well	216-B-5	200 East	T/SW (4)
Reverse Well	216-T-2	200 West	PW (7)
Reverse Well	216-Z-10	200 West	PW (9)
Reverse Well	216-T-3	200 West	MLW (7)
Reverse Well (11&12)	216-U-4	200 West	PW (8)
Trench	116-B-1	100-B/C	Reactor coolant (a) (2)
Trench	116-C-1	100-B/C	RC (a) (2)
Trench	116-DR-6	100-D/DR	RC (2)
Trench	116-DR-2	100-D/DR	RC (2)
Trench	116-DR-1	100-D/DR	RC (2)
Trench	116-D-1B	100-D/DR	DW (2)
Trench	116-F-1	100-F	DW (2)
Trench	116-F-2	100-F	RFE (2)
Trench	116-F-3	100-F	RFE (2)
Trench	116-F-6	100-F	RC (2)
Trench	116-F-9	100-F	Misc (2)
Trench	116-H-1	100-H	RFE (2)
Trench	116-H-2	100-H	RC (2)
Trench	116-K-2	100-KE/KW	Misc. Liquid Waste (3)
Trench	216-A-40	200 East	Steam Condensate, Cooling Water (3)
Trench	316-3	300 Area	PW and Lab Wastes (10)

References used in columns are given at the top of the column headings. The reference used in Unit Type is given at the column heading unless additional or different sources are listed in parenthesis for for a given site. References used for Waste Disposed are given in parenthesis for a site.

TABLE 2-6. HANFORD INACTIVE WASTE SITES SORTED BY WASTE DISPOSED.

81 Priority Sites Recommended for Characterization.

Waste Disposed	Site No. (1)	Area (12)	Unit Type (12)
Decontamination Waste (2)	116-B-4	100-B/C	French Drain
DW (2)	116-H-3	100-H	French Drain
DW (2)	116-F-1	100-F	Trench
DW (2)	116-D-1B	100-D/DR	Trench
Misc (2)	116-F-9	100-F	Trench
Misc. Liquid Waste (3)	116-K-2	100-KE/KW	Trench
Misc. (2)	100 KE*1	100-KE/KW	Dry Well (11&12)
Misc. (2)	116-KE-2	100-KE/KW	Crib
Misc. (2)	100 KW*1	100-KE/KW	Dry Well (11&12)
Misc. (2)	100 KE*2	100-KE/KW	French Drain (12)
Misc. (2)	100 KW*2	100-KE/KW	French Drain (12)
Misc. (2)	116-DR-7	100-D/DR	Crib
MLW (3)	216-A-27	200 East	Crib (11&12)
MLW (3)	216-A-28	200 East	French Drain
MLW (3)	216-A-4	200 East	Crib (11&12)
MLW (3)	216-A-36A	200 East	Crib
MLW (3)	216-A-7	200 East	Crib (12)
MLW (3)	216-A-6	200 East	Crib (12)
MLW (7)	216-T-3	200 West	Reverse Well
MLW (8)	216-U-1&2	200 West	Crib
PC (5)	216-C-10	200 East	Crib
PC (5)	216-C-1	200 East	Crib
PC (6)	216-S-1&2	200 West	Crib
PC (6)	216-S-7	200 West	Crib
PC (6)	216-S-9	200 West	Crib
PC (6)	216-S-21	200 West	Crib
PC (7)	216-T-19	200 West	Crib & Tile Field
Process Condensate (3)	216-A-5	200 East	Crib (12)
Process Waste (3)	216-A-9	200 East	Crib (12)
PW and Lab Wastes (10)	316-1	300 Area	Pond (11&12)
PW and Lab Wastes (10)	316-3	300 Area	Trench
PW and Lab Wastes (10)	316-2	300 Area	Pond (11&12)
PW (3)	216-A-21	200 East	Crib (11&12)
PW (4)	216-B-10A	200 East	Crib
PW (4)	216-B-6	200 East	Reverse Well
PW (6)	216-S-20	200 West	Crib
PW (7)	216-T-8	200 West	Crib
PW (7)	216-T-2	200 West	Reverse Well
PW (7)	216-T-28	200 West	Crib
PW (8)	216-U-4A	200 West	French Drain (11&12)
PW (8)	216-U-4B	200 West	French Drain (11&12)
PW (8)	216-U-11	200 West	Ditch
PW (8)	216-U-4	200 West	Reverse Well (11&12)
PW (9)	216-Z-7	200 West	Crib
PW (9)	216-Z-10	200 West	Reverse Well
PW (9)	216-Z-1&2	200 West	Crib

TABLE 2-6. HANFORD INACTIVE WASTE SITES SORTED BY WASTE DISPOSED.
(Continued)

81 Priority Sites Recommended for Characterization.

Waste Disposed	Site No. (1)	Area (12)	Unit Type (12)
RC (2)	116-K-1	100-KE/KW	Crib
RC (2)	116-H-2	100-H	Trench
RC (2)	116-DR-2	100-D/DR	Trench
RC (2)	116-DR-6	100-D/DR	Trench
RC (2)	116-F-6	100-F	Trench
RC (2)	116-F-10	100-F	French Drain
RC (2)	116-DR-1	100-D/DR	Trench
RC (a) (2)	116-C-1	100-B/C	Trench
Reactor coolant (a) (2)	116-B-1	100-B/C	Trench
RFE (2)	116-F-2	100-F	Trench
RFE (2)	116-H-1	100-H	Trench
RFE (2)	116-F-3	100-F	Trench
Ruptured Fuel Effluent (2)	116-C-2	100-B/C	Crib
Steam Condensate, Cooling Water (3)	216-A-40	200 East	Trench
Steam Condensate, Cooling Water (4)	216-B-2-2	200 East	Ditch
Steam Condensate, Cooling Water (6)	216-S-16D	200 West	Ditch
Steam Condensate, Cooling Water (6)	216-S-6	200 West	Crib
Steam Condensate, Cooling Water (6)	216-S-16P	200 West	Pond
Steam Condensate, Cooling Water (6)	216-S-5	200 West	Crib
Steam Condensate, Cooling Water (6)	216-S-3	200 West	French Drain
Steam Condensate, Cooling Water (6)	216-S-17	200 West	Pond
Steam Condensate, Cooling Water (6)	216-S-4	200 West	French Drain
Tank/Scavenged Waste (3)	216-A-24	200 East	Crib (12)
T/SW (4)	216-B-48	200 East	Crib (12)
T/SW (4)	216-B-45	200 East	Crib (12)
T/SW (4)	216-B-49	200 East	Crib (12)
T/SW (4)	216-B-5	200 East	Reverse Well
T/SW (4)	216-B-50	200 East	Crib (12)
T/SW (4)	216-B-16	200 East	Crib (12)
T/SW (4)	216-B-44	200 East	Crib (12)
T/SW (4)	216-B-46	200 East	Crib (12)
T/SW (4)	216-B-7 A&B	200 East	Crib
T/SW (4)	216-B-43	200 East	Crib
T/SW (7)	216-T-7	200 West	Crib & Tile Field
T/SW (8)	216-U-3	200 West	French Drain

References used in columns one and two are given at the column headings. The reference used in column three, Unit Type, is given at the column heading unless additional, or different, sources are listed in parenthesis for for a given site. References used for column four, Waste Disposed, are given in parenthesis for a site.

The criteria of importance in establishing whether a site is a potential CERCLA site or a RCRA 3004(u) site are presented in Table 2-7. In addition, the table provides a checklist for the information that is important to determining if there is a need for remediation. The matrix is divided into two sets of criteria, one set appropriate to CERCLA sites and one appropriate to RCRA 3004(u) sites. If a site meets all the criteria under the CERCLA listing, remedial action is required under 40 CFR 300. This remedial action may involve the collection of additional data to characterize the site, and/or the selection of a remedial alternative. Sites meeting only some of the criteria may be potential 3004(u) sites.

In the CERCLA process, sites are screened to determine if they have potential for being included on the National Priority List (NPL). This screening, using the Hazard Ranking System (HRS), or the Modified Hazard Ranking System (mHRS) in the case of sites with contamination from radionuclides, evaluates sites according to criteria contained in the National Oil and Hazardous Substances Contingency plan (NCP). In this way, sites are scored on their relative potential for releases that pose a hazard to health or the environment. Sites which score higher than 28.5 are candidates for the National Priority List (NPL).

The scoring is initially conducted during the Preliminary Assessment (PA) (DOE Phase I). Data collected in the PA are evaluated and the HRS (or mHRS) system is applied. The resulting score is a preliminary determination of the relative hazard/threat posed by the site. A score less than 28.5 is generally considered to pose no threat under the CERCLA program.

The HRS/mHRS considers a number of criteria in developing the relative score. These criteria include:

1. Principal injury, radiation, and exposure hazards

   - Injestion of contaminated groundwater or surface water
   - Direct contact with wastes
   - Fire and explosion

TABLE 2.7. CRITERIA APPLICABLE TO DETERMINING NEED FOR REMEDIATION - A FORM FOR SITE EVALUATION

Site	Release of Hazardous Material	Site not Used Since 11/19/80	HRS or mHRS score >28.5	Unit Used to Manage Solid Waste	Unit Contains Hazardous Constituents	Likely to have a Future Release	Likely to have had a Past Release

Note: a. A site requires Remedial Action under CERCLA if the site has an affirmative determination under 1, 2 and 3. If only affirmative under 1 and 2 it may still be a potential CERCLA site, but not one requiring remediation under 40 CFR 300.

b. A site which is not a CERCLA site with an affirmative determination for 4 and 5; and an affirmative finding for 1, 6, or 7 will require some type of remediation under corrective action regulation being currently developed by U.S. EPA.

- Migration to contaminate drinking water or other human use resources, or to result in direct contact
- Waste characteristics, toxicity, and persistence
- Radioactive materials.

2. Physical security and safeguard requirements

- Accessibility to hazardous substances
- Containment of wastes and contamination
- Proximity to populations and resources

3. Site location

- Environmental setting (depth to aquifer of concern, unsaturated zone permeability, slope, surrounding terrain, distance to surface water)
- Land use and resource use
- Proximity to populations, sensitive environments, and resources

4. Risk and Natural forces

- Migration along surface water, groundwater, and air routes to expose populations or impact natural resources
- Chemical toxicity and radioactive materials.

The only criteria addressing artificial forces are containment and fire and explosion. The HRS/mHRS does not address regulations, codes, standards, and guides. However, these issues as well as many of the criteria addressed above are considered further under the selection of remediation. The CERCLA/SARA identify many of these criteria as the bases for assessment of remedial alternatives during the selection process.

The data used in the HRS process usually varies in quality from site to site and may require that some assumptions be made regarding site conditions, waste constituents, migration pathways, and potential receptors in order to develop a site score. When data quality is poor, the resulting

score may be an artifact of the assumptions rather than a reasonable representation of the contamination situation. Under such circumstances, additional information (including limited sampling) may be conducted as part of the CERCLA site inspection (DOE Phase IIa) in order to confirm important assumptions. Site scores may then be reevaluated based on the new data. As a result, site scores may change and additional sites may be removed from consideration. Again, the need for remediation is determined by a site score greater than 28.5.

With the passage of the Superfund Amendments and Reauthorization Act of 1986 (SARA), all facilities, including federal facilities, are required to undertake a Remedial Investigation/Feasibility Study (RI/FS) for sites which qualify for the NPL (Scores greater than 28.5).

2.2 APPROACH TO DEVELOPING SITE CHARACTERIZATION METHODOLOGY

Requirements for characterizing the CERCLA sites derive from CERCLA and SARA regulations, particularly "applicable or relevant and appropriate regulations" (ARARs, see report) and the need for collecting site-specific information for ensuring that implemented remedial actions are capable of achieving and maintaining ARARs. Such information includes identification and quantification of contaminants (i.e., the source), identification and characterization of probable pathways of transport, and identification and characterization of probable receptors. This information is used to define the site and the problems caused by the site and to predict the effects of potential remedial action alternatives. Site-specific information is generally obtained through the use of multiple investigation techniques. The approach to developing the site characterization methodology integrates regulatory requirements, contaminant transport pathways of concern, and potentially applicable site characterization methods to establish a framework for planning the investigation of each of the CERCLA sites. The steps involved in developing the approach are summarized in the following subsections.

The methodology for characterizing the CERCLA sites is designed to provide necessary and sufficient data to allow definition of the sites and

their problems; and to support the evaluation, selection, and implementation of appropriate remedial actions for meeting regulatory requirements and providing protection of public health and the environment. The methodology, which will guide and focus the development of site characterization plans consists of the following steps:

- Step 1 - Identify requirements for site characterization. "Requirements", as used herein, refers to the regulatory requirements of EPA and the State of Washington and directives issued by DOE. Regulations and directives have been evaluated in this Task for their applicability to the Hanford CERCLA sites; the specific requirements in each regulation will be identified in the preparation of site characterization plans.

- Step 2 - Identify pathways for each site. "Pathways" refers to the route(s) that contaminants could follow in transport from the source (the site) to receptors (human populations and/or plant and animal species). Pathways can consist of one or more environmental media. Potential pathways have been identified in this task for each site on using available information on the nature and environmental settings of the sites.

- Step 3 - Determine methods for characterizing sites. "Methods" refers to those activities that could be conducted to provide definition of the sites, the site problem, and the site setting. Site characterization methods are generally considered to consist of on-site investigation of the site using existing data and through the collection and evaluation of new data for sites for which relatively little data are available. Potentially applicable site investigation techniques have been identified in this task for the potential transport pathways.

During the site characterization activity information must be obtained on the following topics:

- Waste source -- physical and chemical aspects of the waste materials (solubility, persistence, quantity, toxicity) and the media in which they are contained.

- Geology -- structures influencing groundwater movement, geologic properties of aquifers and confining units (porosity, permeability, geochemistry).

- Groundwater -- direction and rate of flow, seasonal/temporal variations, aquifer properties, recharge/discharge areas.

- Surface Water -- drainage patterns, runoff, seasonal variations, sediment pathways.

- Pedology -- characteristics of surface soils and soils in the vadose zone, porosity, soil chemistry.

- Air -- climatic data, wind speed and direction.

- Public health -- demography, public use of groundwater surface water, and exposed animals/plants, contaminant toxicity.

- Plant and animal species -- bioaccumulation of contaminants, populations of plant/animal species.

2.2.1 Identification of Remedial Action Requirements

The site characterization process has three primary purposes. First, site characterization should define the nature and extent of contamination (waste type, concentration, and distribution). Second, it should allow data quality objectives (DQOs) to be refined. Finally, it should assess the need for treatability studies. This process is required for collection of data to determine the need for, and extent of, remedial action.

Since the information gathered in the remedial investigation is then used to proceed to the feasibility study, the process of selecting

appropriate remedial action activities requires that the concentration and distribution of contaminants be determined. In order to accomplish this goal, it is necessary to identify the requirements as stated in Federal and State regulations and guidance. Table 2-8 identifies the specific regulations containing the requirements applicable to site characterization. In the matrix, the specific sections of each source which provides the requirement are noted. These sources contain very specific requirements which will be identified as part of the development of the site characterization plan.

2.2.2 Identification of Site-Specific Contaminant Transport Pathways of Concern

In order to identify appropriate investigation techniques for the CERCLA sites, the likely pathways of contaminant transport to be investigated must first be identified. Available information on waste disposal methods, the types of wastes disposed, and the environmental settings of the locations of the sites were evaluated and possible pathways of transport were identified for each site. The pathways, which include media that are both direct and intermediate pathways to receptors, that were considered include:

- Groundwater
- Surface soils
- Vadose zone
- Air
- Surface water
- Sediments
- Waste source
- Plant uptake
- Animal uptake

2.3 SITE CHARACTERIZATION METHODOLOGY

The primary purpose of site characterization is to define the sites, site problems, and settings to support the development, screening, evaluation and selection of remedial action alternatives in the feasibility

TABLE 2-8. THE REMEDIAL ACTION REQUIREMENTS TO SUPPORT THE SITE CHARACTERIZATION METHODOLOGY FOR CERCLA SITES

	Sources for Remedial Action Requirements				
	Federal			State	
Remedial Action Activities	Regulations	SARA (PL99-962)	Policy/Guidance/ Orders	Regulations	Policy/Guidance
Remedial Investigation	40 CFR 300.67	Title 1 Sec.120	DOE 5480.14 EPA Directive 9355.0-19		
Site Characterization			DOE 5480.14		--
Pathways Characterization				WAC 173-304-490	--
Receptors Characterization					
Problem Definition					
Feasibility Study	40 CFR 300.68		DOE 5480.14		
Cleanup Criteria	40 CFR 116.4 117.3 141.11 141.12 141.15 141.16 141.50 141.61 143.3	Title 1 Sec.120	EPA Directive 9355.0-19	WAC 173-201 173-303 173-304 -9901	--
Evaluation factors	10 CFR 61.41-61.44	Title 1 Sec.121			--
Cost-effectiveness		Title 1 Sec.121			--
Selection/documentation	40 CFR 300.70 300.69				--
Implementation					
Permitting		Title 1 Sec.121		WAC 173-216 173-303	-- --
Compliance with other laws	10 CFR 61.41 61.43 61.44			173-304	--

study and the implementation of the selected remedial action. Site information should be sufficient to determine the necessity, extent, and feasibility of remedial actions, evaluate costs of potential remedial action alternatives, allow for the prioritization of sites based on threat to human health and the environment, and perform any required risk assessments.

The site characterization methodology consists of evaluation of existing data and collection and evaluation of additional data. Additional data may need to be collected and evaluated in more than one round in order to provide data on the sites and site problems sufficient to allow the evaluation, selection, and implementation of remedial actions.

2.3.1 Evaluation of Existing Data

The first step in site characterization is to locate, compile, and evaluate data available for each site. Investigators will, to the extent allowed by the available data, compile a site description, history, and chronology of significant events that will aid in planning subsequent detailed characterization efforts. Existing data will be evaluated to determine the following:

- Locations, quantities, concentrations, and characteristics of hazardous waste disposed at each site. The investigators will evaluate results of previous sampling, results of chemical and physical testing, and records of disposal practices and operating procedures to characterize the properties of the hazardous waste disposed at each site.

- Pathways and extent of contaminant migration. The investigators will evaluate existing monitoring data (water, soil, sediment, air, biota) and regional and site-specific information pertaining to site geology, pedology, hydrogeology, meteorology, and biology to identify the pathways and extent of contaminant migration at the site.

- Human and environmental receptors. The investigators will evaluate demographic and land use information, surface water/groundwater use adjacent and downstream/downgradient of the site, regional and site

ecology, and the results of biological testing to identify the human populations and environmental species potentially impacted by the site.

- The impact of the site on human and environmental receptors. The investigators will evaluate the site with respect to waste characteristics and probable transport pathways to determine the site's impact on humans and the environment.

- Factors that must be considered in future field investigations (e.g., site-specific health and safety requirements, limitations in conducting field activities, extreme weather, or difficult terrain).

This information to characterize CERCLA sites can be grouped 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 extent and completeness of the available data to characterize the site is discussed below:

2.3.1.1 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.

- 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.

- United States Energy Research and Development Administration. Final Environmental Statement - Waste Management Operations Hanford - Reservation, Richland, Washington. ERDA-1538 UC70. December 1975.

- 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.

- 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.

2.3.1.2 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:

- 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.

- 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.

- 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.

2.3.1.3 Environmental Concentrations

Table 2-9 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:

TABLE 2-9. **ADEQUACY OF PATHWAY CHARACTERISTICS DATA**

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

TABLE 2-9. **ADEQUACY OF PATHWAY CHARACTERISTICS DATA (Continued)**

GENERAL PATHWAY CHARACTERISTICS	DATA ADEQUACY			PURPOSE OR RATIONALE
	100 Area	200 Area	300 Area	
Vadose Zone		**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	1	1	1	
Contaminants	2	2	1	Determine path of migration and contaminant type.
Air		**Air**		
Meterological 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		**Surface Water**		
River				Determine the degree of contaminant transport and quantity of contaminants
Hydraulics/Geometry	1	-	1	
Chemistry	1	-	1	
Ground Water - Surface Water Relationships				Evaluate for contaminant pathway cycling
Location/Quantities	1	1	1	
Chemistry	1	1	1	Determine water/sediment partitioning and capacity for water to assimilate contaminant
Drainage				
Location/Quantities	2	2	2	Determine if chemical flow or overload flow will remove contaminants offsite or on.
Sediments		**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

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.

2.3.1.4 Potential Impacts on Receptors

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

- 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.

- U.S. Department of Energy (U.S. DOE), Richland Operations Office. Hanford Environmental Management Program Plan. Richland, Washington. November 1986.

- United States Energy Research and Development Administration. Final Environmental Statement - Waste Management Operations Hanford - Reservation, Richland, Washington. ERDA-1538 UC70. December 1975.

- 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.

- 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.

2.3.2 Collection and Evaluation of Additional Data

If existing information is not sufficient to meet the data needs of the feasibility study, additional information must be obtained. The collection and evaluation of additional data will serve two purposes. First, additional data will verify the information gathered from existing sources (e.g., pathways, receptors, contaminants of concern). Second, additional investigations will provide an opportunity to collect data that will support the development and screening of remedial action alternatives.

2.3.2.1 Identification of Potentially Applicable Site Characterization Methods.

Site investigation methods appropriate to the environmental setting of the CERCLA sites and the identified potential pathways of concern were identified for consideration in the development of site-specific characterization plans. The methods, each of which was determined to be potentially applicable to the sites, include:

- Soil borings and sampling and analysis/testing of the soil column.

- Test pit excavation, direct observation of subsurface conditions, and sampling and analysis/testing of excavated material.

- Groundwater monitoring well installation,sampling and analysis of groundwater, monitoring groundwater levels.

- Piezometer installation and monitoring groundwater levels.

- Probe driving and sampling and analysis of soil gases in the vadose zone.

- Sampling and analysis/testing of biota (terrestial and aquatic plants and animals).

- Sampling and analysis of air for emission of gases and/or volatile compounds.

- Grab sampling and analysis of wastes, surface soils, surface water, and/or sediments.

- Remote sensing (i.e., geophysical surveys) of subsurface conditions, such as geologic anomalies and strata, contaminant distribution, and locations of underground structures:

  - ground-penetrating radar
  - electromagnetic induction
  - earth resistivity
  - borehole resistivity
  - borehole conductivity.

- Aquifer tests for hydrogeologic properties such as transmissivity, storativity, and drawdown.

- Modeling of groundwater flow to interpolate/extrapolate within/beyond areas of available data and to predict the effects of imposed subsurface conditions.

- Aerial photography for identifying surface anomalies and historic surface changes (by comparison) and for supporting mapping of surface conditions.

- Infrared imagery for identifying areas of vegetative stress and/or contamination.

These site characterization methods are the tools that are commonly used for defining the CERCLA sites and corresponding environmental problems. The applicability of these methods to characterizing and determining the presence and transport of contaminants in the each of the pathways of concern is shown in Table 2-10.

Each medium in the column heading of Table 2-10 is a potential migration pathway for both radioactive and hazardous chemical contaminants. The amount and nature of the contaminants present in these media need to be characterized in order to be able to assess the extent of existing contamination and the potential for future transport through that pathway. Chemical and radioactive analyses performed on samples obtained by the methods flagged by asterisks in the table, along with physical (i.e., hydrologic and structural) information obtained by using the other methods, provide the data necessary to perform this evaluation.

2.3.2.2 Compliance of Site Characterization Methods with Environmental Regulations

The sampling methods required for characterization are selected to satisfy the requirements of the regulations identified in Table 2-8. These regulations sometimes specify the methods to be employed, and otherwise allow the use of generally accepted and appropriate techniques. Table 2-11 presents a comparison of the identified site characterization methods with the applicable regulations.

TABLE 2-10. POTENTIALLY APPLICABLE SITE CHARACTERIZATION METHODS

Characterization Methods	Potential Environmental Pathways								
	Groundwater	Surface Soil	Vadose Zone	Air	Surface Water	Sediments	Waste Source	Plant Uptake	Animal Uptake
Borings*		X	X				X		
Test Pits*		X	X				X		
Well Installation/Sampling*	X	X	X				X		
Piezometer Installation*	X								
Hand Auger Samples*		X							
Soil Gas*	X	X	X						
Biological Samples*								X	X
Air Monitoring*				X					
Grab Sample Collection*		X			X	X	X		
Geophysical Surveys									
Ground Penetrating Radar	X		X				X		
Electromagnetic Induction	X		X				X		
Earth Resistivity	X		X				X		
Borehole Methods									
Resistivity	X		X				X		
Conductivity	X		X				X		
Aquifer Tests	X								
Models	X	X	X	X	X	X	X	X	X
Aerial Photography		X			X			X	X
Infrared Imagery					X			X	

* Samples obtained using these methods can be analyzed for a suite of organic chemical, inorganic chemical and radioactive contaminants.

TABLE 2-11. COMPLIANCE OF SITE CHARACTERIZATION METHODS WITH ENVIRONMENTAL REGULATIONS

Characterization Methods	Environmental Regulations			
	Federal Regulations	Federal Guidance	State Regulations	Local
Drilling/sampling/ analysis	40 CFR 264.90 40 CFR 147.2400	RCRA Groundwater Monitoring Technical Enforcement Guidance Document		---
Well installation/ sampling analysis	40 CFR 141.23 40 CFR 141.24 40 CFR 141.25		WAC173-304-490 173-160	---
Hand auger sampling/ analysis				---
Soil gas sampling/ analysis				---
Geophysical surveys				---

2.4 PLAN FOR CONDUCTING THE SITE CHARACTERIZATION

The plan presented here 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 for purposes of developing estimates of the cost and time required to conduct the Remedial Investigation required of the CERCLA RI/FS process. 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:

- Confirmation of releases of contaminants and evaluation of potential for future releases

- Delineation of the horizontal and vertical extent of contaminant plumes and effects of the media characteristics on contaminant migration

- Determination of existing surface and groundwater quality and characterization of chemical nature of contaminant plume

- Determination of the direction and rate of contaminant movement.

A 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 waste disposal at the sites impacting 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 2-12 through 2-15 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 2-12, 2-13, and 2-14 discuss the unconfined aquifer's sampling efforts and Table 2-15 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 2-9. 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 2-12 through 2-14 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 2-16 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 2-12, 2-13, and 2-14.

TABLE 2-12 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 / Source	100 B/C Area							
	Groundwater	Surface Soils	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal Uptake
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 2-12 Summary of Sampling Needs for the 100 Area Sources

Pathway / Source	100 B/C Area							
	Groundwater	Surface Soils	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal Uptake
116-C-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 20 borings sampled every 5 feet to water level. 376 samples ... Soil Gas Survey for Volatile Organic Compounds 50 ft. grids		Stage V Ephemeral overflows 4 random samples	Stage V Seepage 4 random samples	-	

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

TABLE 2-12 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 / Source	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 2-12 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 / Source	100 D/DR Area							
	Groundwater	Surface Soil	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal Uptake
116-DR-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. 166 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-DR-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 borings sampled every 5 feet to water level. 166 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-DR-1B	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 7 borings sampled every 5 feet to water level. 116 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids		Stage V Ephemeral overflows 4 random samples	Stage V Seepage 4 random samples		

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	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	Stage V Seepage 4 random samples		

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

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

Pathway / Sources	100 F Area: Groundwater	Surface Soil	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal Uptake
116-F-1	Stage II & III Installation of 5 cluster (3 depths) monitoring wells Stage V Water Quality 23 Samples		Stage II & III Installation 2 cluster (3 depths) lysimeters ... Soil Borings 40 borings sampled every 5 feet to water level. 400 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-F-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 13 borings sampled every 5 feet to water level. 130 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-F-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 10 borings sampled every 5 feet to water level. 100 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 2-22 Summary of Sampling Needs for the 100 Area Sources

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

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

Pathway / Source	Groundwater	Surface Soil	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal Uptake
	100 KE/KW Area							
I (2 sources) 100-KW*1 100-KW*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	-	
II (2 sources) 100-KE*1 100-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 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-K-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 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		

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

TABLE 2-12 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 / Source	100 KE/KW Area: 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 2-13 **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.

Pathway / Source	200 E Area: 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 V Water Quality 20 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 10 borings sampled every 5 feet to water level. 676 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 (1 source) 216-B-7A&B	Stage II & III Installation of 5 monitoring wells Stage V Water Quality 8 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 541 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-B-2-2	Stage II & III Installation of 5 monitoring wells Stage V Water Quality 8 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 8 borings sampled every 5 feet to water level. 541 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 2-13 **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.

Pathway / Source	200 E Area: Groundwater	Surface Soils	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal Uptake
IV (1 source) 216-B-5	Stage II & III Installation of 6 monitoring wells Stage V Water Quality 9 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 6 borings sampled every 5 feet to water level. 406 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids		Stage V Ephemeral overflows 6 random samples	Stage V Seepage 6 random samples		
V (2 sources) 216-B-10-A 216-B-6	Stage II & III Installation of 7 monitoring wells Stage V Water Quality 11 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 10 borings sampled every 5 feet to water level. 676 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids		Stage V Ephemeral overflows 6 random samples	Stage V Seepage 6 random samples		
VI (2 sources) 216-C-1 216-C-10	Stage II & III Installation of 5 monitoring wells Stage V Water Quality 8 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 12 borings sampled every 5 feet to water level. 811 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 E Area								
Pathway / Source	Groundwater	Surface Soils	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal Uptake
VII (1 source) 216-B-16	Stage II & III Installation of 5 monitoring wells Stage V Water Quality 8 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter ... Soil Borings 8 borings sampled every 5 feet to water level. 541 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-A-40	Stage II & III Installation of 5 monitoring wells Stage V Water Quality 8 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter ... Soil Borings 8 borings sampled every 5 feet to water level. 541 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 (1 source) 216-A-24	Stage II & III Installation of 5 monitoring wells Stage V Water Quality 8 Samples		Stage II & III Installation 2 cluster (3 depths) lysimeters ... Soil Borings 12 borings sampled every 5 feet to water level. 811 samples ... Soil Gas Survey for Volatile Organic Compounds 50 ft. grids		Stage V Ephemeral overflows 6 random samples	Stage V Seepage 6 random samples		

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

TABLE 2-13

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.

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

Pathway / Source	Groundwater	Surface Soils	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal Uptake
	200 E Area							
XIII (5 sources) 216-A-4 216-A-21 216-A-27 216-A-5 216-A-36A	Stage II & III Installation of 10 monitoring wells Stage V Water Quality 15 Samples		Stage II & III Installation 2 cluster (3 depths) lysimeters ... Soil Borings 32 borings sampled every 5 feet to water level. 2163 samples ... Soil Gas Survey for Volatile Organic Compounds 50 ft. grids		Stage V Ephemeral overflows 6 random samples	Stage V Seepage 6 random samples		
XIV (1 source) 216-A-6	Stage II & III Installation of 5 monitoring wells Stage V Water Quality 8 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter ... Soil Borings 8 borings sampled every 5 feet to water level. 541 samples ... Soil Gas Survey for Volatile Organic Compounds 50 ft. grids		Stage V Ephemeral overflows 6 random samples	Stage V Seepage 6 random samples		
XV (1 source) 216-A-28	Stage II & III Installation of 5 monitoring wells Stage V Water Quality 8 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter ... Soil Borings 8 borings sampled every 5 feet to water level. 541 samples ... Soil Gas Survey for Volatile Organic Compounds 50 ft. grids		Stage V Ephemeral overflows 6 random samples	Stage V Seepage 6 random samples		

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

TABLE 2-13 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.

Pathway / Source	200 W Area: 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		

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

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

TABLE 2-13

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.

Pathway / Source	200 W Area: Groundwater	Surface Soils	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal 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		

TABLE 2-13 Summary of Sampling Needs for the 200 Area Sources

Pathway / Source	200 W Area: 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 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	-	
XI (1 source) 216-T-19	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		
XII (1 source) 216-T-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. 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		

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

TABLE 2-13 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.

Pathway / Source	200 W Area: Groundwater	Surface Soils	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal Uptake
XIII (1 source) 216-T-28	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		
XIV (1 source) 216-T-3	Stage II & III Installation of 6 cluster (3 depths) monitoring wells Stage V Water Quality 27 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		
XV (2 sources) 216-T-2 216-T-8	Stage II & III Installation of 6 cluster (3 depths) monitoring wells Stage V Water Quality 27 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		

TABLE 2-14 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.

Pathway / Source	300 Area							
	Groundwater	Surface Soils	Vadose Zone	Air	Sediments	Surface Water	Plant Uptake	Animal Uptake
316-1	Stage II & III Installation of 8 cluster (2 depths) monitoring wells Stage V Water Quality 24 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 12 borings sampled every 5 feet to water level. 103 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids		Stage V Ephemeral overflows 4 random samples	Stage V Seepage 4 random samples		
316-2	Stage II & III Installation of 8 cluster (2 depths) monitoring wells Stage V Water Quality 24 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 14 borings sampled every 5 feet to water level. 120 samples --- Soil Gas Survey for Volatile Organic Compounds 50 ft. grids		Stage V Ephemeral overflows 4 random samples	Stage V Seepage 4 random samples		
316-3	Stage II & III Installation of 6 cluster (2 depths) monitoring wells Stage V Water Quality 18 Samples		Stage II & III Installation 1 cluster (3 depths) lysimeter --- Soil Borings 12 borings sampled every 5 feet to water level. 103 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 2-15 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 2-16 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

Table 2-15 is a Stage IV summary table for well monitoring of the confined aquifer for the three CERCLA areas of the Hanford Reservation.

2.5 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-85/002and 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 2-17 and 2-18. 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 techniquies and methods. Table 2-19 identifies accepted methods for analysis of the samples.

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

2.6 ENGINEERING ALTERNATIVES FOR REMEDIATING CERCLA SITES

The purpose of this section is to evaluate the available remedial action technologies that have been applied to the cleanup of radioactive and hazardous wastes and to select a number of technologies that are most applicable to the problems associated with the 81 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites at Hanford. This selection will enable a comparison of the technical feasibility and unit

TABLE 2-17. SELECTED APPLICABLE OR RELEVANT AND APPROPRIATE AMBIENT REQUIREMENTS

Chemical	Safe Drinking Water Act MCLs b/ (mg/l)	Safe Drinking Water Act MCLGs c/ (mg/l)	Clean Air Act NAAQS (ug/m3)
Arsenic	0.05		
Barium	1.0		
Benxene		0	
Cadmium	0.01		
Carbon monoxide			40,000 (1-hour) d/ 10,000 (8-hour) d/
Carbon tetrachloride		0	
Chlorophenoxys			
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) d/
Lead	0.05		1.5 (90-day) e/
Mercury	0.002		
Methoxychlor	0.1		
Nitrate (as N)	10.0		
Nitrogen dioxide			100 (1-year) f/
Ozone			235 (1-hour) d/
Particulate Matter			260 (24-hour) d/ 75 (1-year) g/
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	h/		
Selenium	0.01		
Silver	0.05		
Sulfur oxides			365 (24-hour) d/ 80 (1-year) f/
Toxaphene	0.005		
1,1,1-Trichloroethane		0.2	

TABLE 2-17. SELECTED APPLICABLE OR RELEVANT AND APPROPRIATE AMBIENT REQUIREMENTS (Continued)

Chemical	Safe Drinking Water Act MCLs b/ (mg/l)	Safe Drinking Water Act MCLGs c/ (mg/l)	Clean Air Act NAAQS (ug/m3)
Trichloroethylene		0	
Trihalomethanes (total) i/	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-dichlorethylene, 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 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, bromodichlormethane, dibromochloromethane, and bromoform.

TABLE 2-18. 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) a/	
	Aquatic Organisms and Drinking Water	Adjusted for Drinking Water Only b/
Acenapthene	20 ug/l (Organoleptic) c/	20 ug/l (Organoleptic)
Acrolein	320 ug/l	540 ug/l
Acrylonitrile*	0 (58 ng/l)	0 (63 ng/l)
Aldrin*	0 (0.074 ng/l)	0 (1.2 ng/l)
Antimony*	146 ug/l	146 ug/l
Arsenic*	0 (2.2 ng/l)	(25 ng/l)
Asbestos	0 (30,000 fibers/l)	(30,000 fibers/l)
Benzene*	0 (0.66 ug/l)	0 (0.67 ug/l)
Benzidine*	0 (0.12 ng/l)	0 (0.15 ng/l)
Beryllium*	0 (3.7 ng/l)	0 (3.9 ng/l)
Cadmium*	10 ug/l	10 ug/l
Carbon tetrachloride*	0 (0.4 ug/l)	0 (0.42 ug/l)
Chlordane*	0 (0.46 ng/l)	0 (22 ng/l)
Chlorinated benzenes		
Hexachlorobenzene*	0 (0.72 ng/l)	0 (21 ng/l)
1,2,4,5-Tetrachlorobenzene*	38 ug/l	180 ug/l
Pentachlorobenzene*	74 ug/l	570 ug/l
Trichlorobenzene*	Insufficient data	Insufficient data
Monochlorobenzene*	488 ug/l	488 ug/l
Chlorinated ethanes		
1,2-Dichloroethane*	0 (0.94 ug/l)	0 (0.94 ug/l)
1,1,1-Trichloroethane*	18.4 mg/l	19 mg/l
1,1,2-Trichloroethane*	0 (0.6 ug/l)	0 (0.6 ug/l)
1,1,2,2-Tetrachloroethane*	0 (0.17 ug/l)	0 (0.17 ug/l)
Hexachloroethane*	0 (1.9 ug/l)	0 (2.4 ug/l)

TABLE 2-18. 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) a/	
	Aquatic Organisms and Drinking Water	Adjusted for Drinking Water Only b/
Monochloroethane*	Insufficient data	Insufficient data
1,1-Dichlorethane*	Insufficient data	Insufficient data
1,1,1,2-Tetrachlorethane	Insufficient data	Insufficient data
Pentachloroethane	Insufficient data	Insufficient data
Chlorinated naphthalenes	Insufficient data	Insufficient data
Chlorinated phenols		
3-Monochlorophenol	0.1 ug/l (Organoleptic)	0.1 ug/l (Organoleptic)
4-Monochlorophenol	0.1 ug/l (Organoleptic)	0.1 ug/l (Organoleptic)
2,3-Dichlorophenol	0.04 ug/l (Organoleptic)	0.04 ug/l (Organoleptic)
2,5-Dichlorophenol	0.5 ug/l (Organoleptic)	0.5 ug/l (Organoleptic)
2,6-Dichlorophenol	0.2 ug/l (Organoleptic)	0.2 ug/l (Organoleptic)
3,4-Dichlorophenol	0.3 ug/l (Organoleptic)	0.3 ug/l (Organoleptic)
2,3,4,6-Tetyrachlorophenol*	1.0 ug/l (Organoleptic)	1.0 ug/l (Organoleptic)
2,4,5-Trichlorophenol*	2600 ug/l	2600 ug/l
2,4,6-Trichlorophenol*	0 (1.2 ug/l)	0 (1.8 ug/l)
2-Methyl-4-chlorophenol	1800 ug/l (Organoleptic)	1800 ug/l (Organoleptic)
3-Methyl-4-chlorophenol	3000 ug/l (Organoleptic)	3000 ug/l (Organoleptic)
3-Methyl-6-chlorophenol	20 ug/l (Organoleptic)	20 ug/l (Organoleptic)
Chloroalkyl ethers		
bis-(Chloromethyl) ether*	0 (0.0038 ng/l)	0 (0.0039 ng/l)
bis-(2-Chloroethyl) ether*	0 (30 ng/l)	0 (30 ng/l)
bis-(2-Chloroisopropy) ether	34.7 ug/l	34.7 ug/l
Chloroform*	0 (0.19 ug/l)	0 (0.19 ug/l)
2-Chlorophenol	0.1 ug/l (Organoleptic)	0.1 ug/l (Organoleptic)

TABLE 2-18. 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) a/	
	Aquatic Organisms and Drinking Water	Adjusted for Drinking Water Only b/
Chromium Cr+6*	50 ug/l	50 ug/l
Cr+3*	170 mg/l	179 mg/l
Copper*	1 mg/l (Organoleptic)	
Cyanide*	200 ug/l	200 ug/l
DDT*	0 (0.024 ng/l)	0 (> 1.2 ng/l)
Dichlorobenzenes* (all isomers)	400 ug/l	470 ug/l
Dichlorobenzidines	0 (10.3 ng/l)	0 (20.7 ng/l)
Dichloroethylenes		
1,1-Dichloroethylene*	0 (33 ng/l)	0 (33 ng/l)
1,2-Dichloroethylene	Insufficient data	Insufficient data
Dichloromethane*	See Halomethanes	See Halomethanes
2,4-Dichlorophenol*	3.09 mg/l	3.09 mg/l
Dichloropropanes/Dichloropropenes		
Dichloropropanes	Insufficient data	Insufficient data
Dichloropropenes	87 ug/l	87 ug/l
Dieldrin*	0 (0.071 ng/l)	0 (1.1 ng/l)
2,4-Dimenthylphenol	400 ug/l (Organoleptic)	400 ug/l (Organoleptic)
2,4-Dinitrotoluene*	0 (0.11 ug/l)	0 (0.11 ug/l)
1,2-Diphenylhydrazine*	0 (42 ng/l)	0 (46 ng/l)
Endosulfan*	74 ug/l	138 ug/l
Endrin	1 ug/l	1 ug/l
Ethylbenzene*	1.4 mg/l	2.4 mg/l
Fluoranthene	42 ug/l	188 ug/l
Haloethers	Insufficient data	Insufficient data
Halomethanes	0 (0.19 ug/l)	0 (0.19 ug/l)

TABLE 2-18 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) a/	
	Aquatic Organisms and Drinking Water	Adjusted for Drinking Water Only b/
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 2-18. 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) a/	
	Aquatic Organisms and Drinking Water	Adjusted for Drinking Water Only b/
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)
Polynyuclear 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 (0.000013 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} concentratons 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 dish, and human body weight was assumed to be 70 kilograms. Values for bioconcentraton factor, carcinogenic potency, and acceptable daily intake were those used for water quality criteria development.

c/ Criteria designiated 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 2-19. 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

costs of these technologies to evaluate their applicability to the sites at Hanford. The objective is to identify at least two remedial action alternatives (one a removal alternative, and one an in-place alternative) for each site that, based on the data available, have a high probability for application to the site problem.

2.6.1 Methodology of the Remedial Action Selection Process

The actual selection of a remedial action will be made as a part of The Remedial Investigation/Feasibility Study (RI/FS) performed for the site. In this effort, it is necessary to identify reasonable alternatives to allow the estimation of the cost and schedule for remediation of each site.

Selection of appropriate remedial actions for the 81 sites is dependent upon the following information:

- Physical site conditions
- Volume and types of wastes disposed
- Fate and transport mechanisms for the wastes
- Previous applications (and scale) of the remedial technology
- Technical feasibility of the technology for the waste type and site conditions in terms of effectiveness, reliability, and state of development
- Applicable environmental regulations
- Cost

The basic sequence for selecting the most applicable remedial technologies is illustrated in Figure 2-21. The first two tasks, done simultaneously, are the definition of the area, volume, form, and matrix of contaminated materials at each site and the identification of a list of potential remedial technologies.

2.6.1.1 Site Conditions and Waste Disposed

Definition of the problem at each site included summarizing the following information:

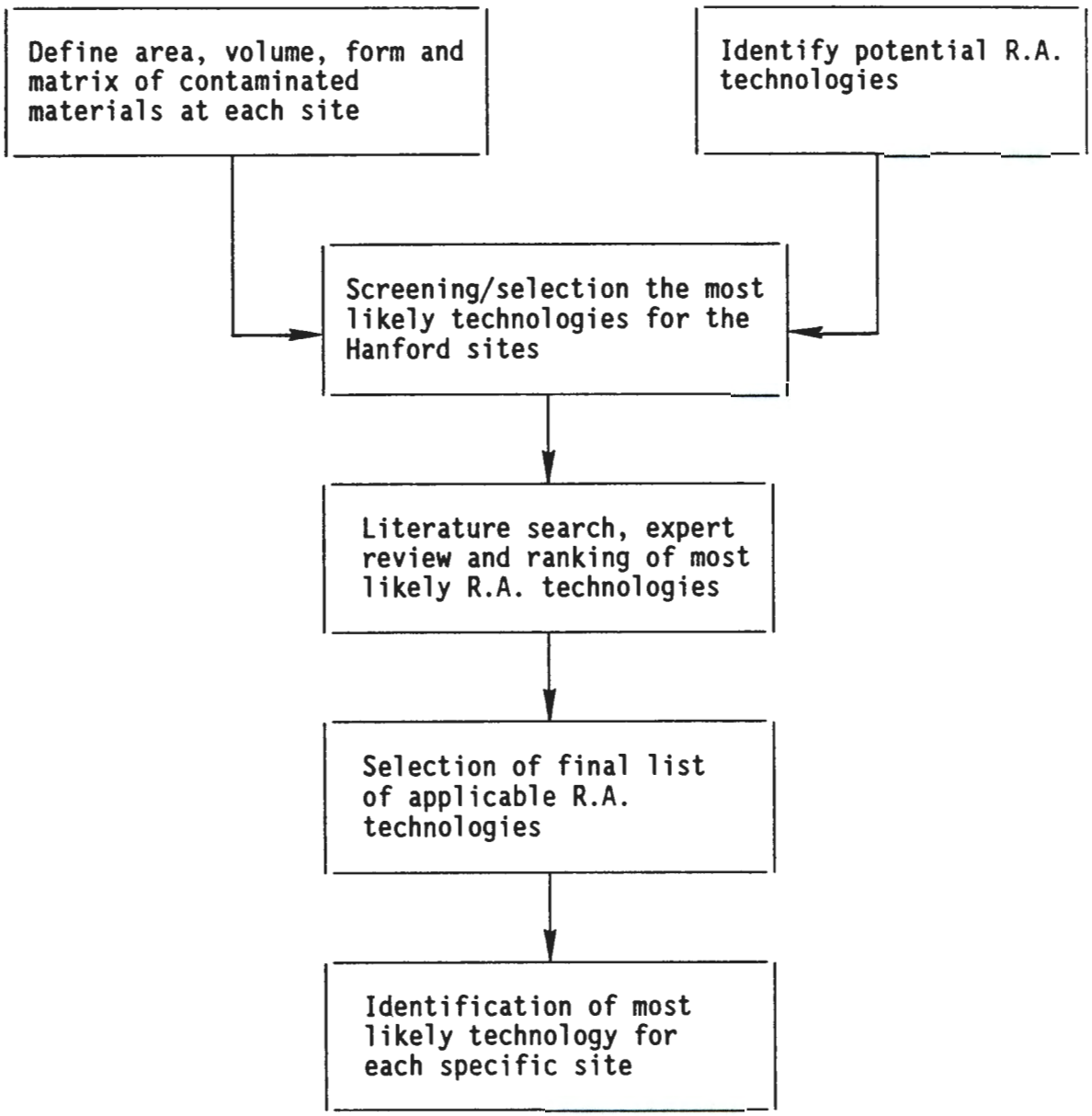

FIGURE 2-21

REMEDIATION TECHNOLOGY SELECTION SEQUENCE

- Type of disposal unit
- Proximal location
- Radionuclides disposed and their solubility
- Other wastes disposed, including salts
- Depth of wastes
- Depth to groundwater
- Volume of liquid wastes disposed
- Calculated field capacity for the soil column

This information is presented in Columns 1-15 of Table 2-20.

2.6.1.2 Pathways and Fate of Pollutants

Since selection of remedial technologies is primarily dependent on knowing how much contaminated material there is, and where it is, calculations or assumptions on the following pathways or fates were made for each site.

- Soil attenuation - This is used to determine the probable fate of heavy metals and nonsoluble radionuclides. It is assumed that unless very high rates of water were applied to the site or acid solutions were disposed of at the site, most of these elements would adsorb to soil particles within a 20-foot depth below the point of application.

- Downward migration - It has been assumed that the more soluble radionuclides such as tritium or cesium and salts such as nitrates or sulfates would have migrated through the soil column to groundwater in the time period since the sites were closed. It should be noted, however, that some active sites releasing these elements to the soil column may be near CERCLA sites.

- Radionuclide uptake - An analysis was made of the potential for plant root uptake at each site. Maximum root penetration was assumed to be 40 feet.

KEY TO TABLE 2-20

POTENTIAL REMEDIAL ACTION ALTERNATIVES - CERCLA SITES

Column No.	Title	Explanation
1	Site number	Site ID number from Phase II report
2	Type	Type of disposal unit
3	Proximal location	0 - site is within 500' of another site 1 - continuous sites
4	HRS score	Not m HRS score
5	Total curies disposed	
6	Total of H, C, Ru, Eu	Total disposed curies of H-3, C-14, Ru-106, Eu-154, Eu-155
7	Total of Cs, Sr	Total disposed curies of cesium and strontium
8	Total of all else	Total disposed curies of all other radionuclides
9	Other waste disposed	See index at bottom of table
10	Depth to waste	Depth to point of application
11	Depth to groundwater	
12	Volume disposed	
13-15	Field capacity	These 3 columns are an estimate of the potential for the liquids disposed at each site to be either still in the soil column (0) or have probably entered the groundwater (X). Three different field capacities (FC = 0.05, 0.1 and 0.25) were used to cover the expected porosity ranges in the Hanford soils.

KEY TO TABLE 2-20 (Continued)

POTENTIAL REMEDIAL ACTION ALTERNATIVES - CERCLA SITES

Column No.	Title	Explanation
16	Soil attenuation	X - highly likely that significant amounts of radionuclides are adsorbed in soil column at less than 20′ depth O - highly likely that other metals (Hg, Cr, etc.) are stored in shallow depth of soil column
17	Downward migration	X - soluble radionuclides in excess of 1.0 curie applied to site O - less than 1.0 curie of soluble radionuclides applied to site
18	Radionuclide uptake	X - more than 1.0 curie of radionuclides stored in top 20′ of soil O - potentially either less than 1.0 curie in top 20′ of soil or more than 1.0 curie in the soil but at depths between 20′ and 40′ deep
19	Groundwater release	X - groundwater contamination highly likely because FC/WV is less than 1.0 O - potential groundwater contamination due to readily soluble contaminants, high volumes (more than 10 million liters) of disposed liquids or FC/WV less than 10
20	Surface erosion	O - waste is less than 10′ below the surface thus potentially subject to erosion
21-26	Potentially feasible remedial action	X - feasible for that site

TABLE 2-20. POTENTIAL REMEDIAL ACTION ALTERNATIVES (Continued)

Hanford Inactive Waste Site Study.

	Site No.	FATE OF CONTAMINANTS: Soil Attenuation	Downward Migration	Vegetation Uptake of Radionuclides	Ground-Water Release	Surface Erosion	Depth to Waste Feet	Depth to GW Feet	Volume Disposed (Liters)	Field Capacity (FC=0.05)	Field Capacity (FC=0.1)	Field Capacity (FC=0.25)
1	116-B-1	o	x	o	x		20	41	6,000,000	x	x	x
2	116-B-4	x		o	o		20	71	300,000	o		
3	116-C-1	x	x	o	x		25	41	100,000,000	x	x	x
4	116-C-2	o	x		o		20	94	3,500,000	x	o	
5	116-D-1B	o	o	o	x		15	83	8,000,000	x	x	x
6	116-DR-1	x	x	o	x		20	56	40,000,000	x	x	x
7	116-DR-2	x	x	o	x		20	56	40,000,000	x	x	x
8	116-DR-6	o			x		10	83	7,000,000	x	x	x
9	116-DR-7	o					10	73	4,000			
10	116-F-1	o	x	x	x		10	13	1,000,000,000	x	x	x
11	116-F-2	o	x	x	x		15	35	60,000,000	x	x	x
12	116-F-3	o			x	o	8	37	4,000,000	x	x	x
13	116-F-6	o	x	x			10	36	100,000			
14	116-F-9	o	x	o	x		10	50	300,000,000	x	x	x
15	116-F-10	o	o	o	x		10	38	400,000	x	x	x
16	116-N-1	x	x	x	x		15	42	90,000,000	x	x	x
17	116-N-2	o	o	o	x	o	6	42	600,000,000	x	x	x
18	116-N-3	o	o	o	x		15	42	400,000	x	x	x
19	100 KE*1	x				o	4	68	0			
20	100 KE*2	x				o	3	68	0			
21	100 KW*1	x				o	4	72	0			
22	100 KW*2	x				o	3	72	0			
23	116-K-1	x	x	o	x		30	50	40,000,000	x	x	x
24	116-K-2	x	x	o	x		20	34	300,000,000,000	x	x	x
25	116-KE-2	x	x	o	x		32	68	3,000,000	x	x	x

TABLE 2-20. POTENTIAL REMEDIAL ACTION ALTERNATIVES (Continued)

Hanford Inactive Waste Site Study.

	Site No.	Type	Proximal Location (<500')	HRS Score	Total Curies Disposed (1)	Total of H,C,Ru,Eu	Total of Cs,Sr	Total of All Else	Other Wastes Disposed (2)	Cap/Cover w/ PC Monitoring	Grout-in-Place w/ PC Monitoring	In-Situ Vitrification	Solution Mining & GW Recovery/ Treatment	Excavation & Disposal	No Action
1	116-B-1	Trench	o	42.32	1.95	1.45	0.38	0.13	1	x			x		
2	116-B-4	Fr. Drain		44.55	4.33	0.00	0.00	4.33	1,2		x	x		x	
3	116-C-1	Trench	o	42.32	329.58	213.96	7.46	108.17	1		x	x	x	x	
4	116-C-2	Crib		42.32	1.33	0.33	0.98	0.01	1,2	x				x	x
5	116-D-1B	Trench		42.32	1.48	0.73	0.68	0.08	1,3	x				x	
6	116-DR-1	Trench		42.32	21.57	6.92	13.51	1.14	1		x		x		
7	116-DR-2	Trench		42.32	21.57	6.92	13.51	1.14	1		x		x		
8	116-DR-6	Trench	o	42.32	0.00	0.00	0.00	0.00	1	x				x	x
9	116-DR-7	Crib	o	28.96	0.00	0.00	0.00	0.00	4	x				x	x
10	116-F-1	Trench		44.55	2.17	0.96	0.96	0.25	1,2	x	x		x		
11	116-F-2	Trench		42.32	9.77	8.12	0.83	0.82	1			x	x		
12	116-F-3	Trench	o	42.32	0.00	0.00	0.00	0.00	1	x					x
13	116-F-6	Trench	o	28.96	3.94	2.87	0.72	0.35	3		x	x		x	
14	116-F-9	Trench		42.32	2.84	0.59	2.05	0.19	5		x		x		
15	116-F-10	Fr. Drain	o	42.32	0.07	0.05	0.01	0.01	1,2	x				x	x
16	116-N-1	Trench		42.32	20.12	14.42	4.56	1.14	1		x	x	x		
17	116-N-2	Trench	o	42.32	1.04	0.28	0.75	0.02	1	x			x		x
18	116-N-3	Fr. Drain	o	42.32	0.05	0.01	0.03	0.01	1,2	x				x	x
19	100 KE*1	Drywell	-	42.32	0.00	0.00	0.00	0.00	6	x				x	
20	100 KE*2	Fr. Drain	-	42.32	0.00	0.00	0.00	0.00	6	x				x	
21	100 KW*1	Drywell	-	40.09	0.00	0.00	0.00	0.00	6	x				x	
22	100 KW*2	Fr. Drain	-	40.09	0.00	0.00	0.00	0.00	6	x				x	
23	116-K-1	Crib	o	42.32	30.56	8.79	18.79	2.98	1			x	x		
24	116-K-2	Trench	o	51.23	1320.59	961.34	158.75	200.50	1,2,3,7		x		x	x	
25	116-KE-2	Crib		35.64	14.65	0.74	2.79	11.12	3	x	x	x		x	

TABLE 2-20. POTENTIAL REMEDIAL ACITON ALTERNATIVES (Continued)

Hanford Inactive Waste Site Study.

	Site No.	FATE OF CONTAMINANTS: Soil Attenuation	Downward Migration	Vegatation Uptake of Radionuclides	Ground-Water Release	Surface Errosion	Depth to Waste Feet	Depth to GW Feet	Volume Disposed (liters)	Field Capacity (FC=0.05)	Field Capacity (FC=0.1)	Field Capacity (FC=0.25)
73	216-T-2	o	o				75	256	6,000,000			
74	216-T-3	x	x		x		206	249	11,300,000	x	x	x
75	216-T-7	x	x	o	x		26	191	110,000,000	x	x	x
76	216-T-8	o	o				25	258	500,000			
77	216-T-19	x	x	o	x		23	189	455,000,000	x	x	x
78	216-T-28	x	x	x	x		15	195	42,300,000	x	x	x
79	316-1	x	x	x	x	o	9	34	10,000,000,000	x	x	x
80	316-2	x	x	x	x		10	34	10,000,000,000	x	x	x
81	316-3	x		o	x		20	43	1,000,000,000	x	x	x

TABLE 2-20. POTENTIAL REMEDIAL ACTION ALTERNATIVES (Continued)

Hanford Inactive Waste Site Study.

	Site No.	Type	Proximal Location (<500')	HRS Score	Total Curies Disposed (1)	Total of H,C,Ru,Eu	Total of Cs,Sr	Total of All Else	Other Wastes Disposed (2)	POTENTIALLY FEASIBLE REMEDIAL ACTIONS: Cap/Cover w/ PC Monitoring	Grout-in-Place w/ PC Monitoring	In-Situ Vitrification	Solution Mining & GW Recovery/ Treatment	Excavation & Disposal	No Action
73	216-T-2	Rec. Well		50.34	0.00	0.00	0.00	0.00	1,2,8	x					x
74	216-T-3	Rec. Well		60.40	286.20	0.00	43.60	242.60	2,3,8,9,11		x		x		
75	216-T-7	Crib		65.44	58.74	0.00	49.30	9.44	2,3,8,9,11		x	x	x		
76	216-T-8	Crib		47.82	1.21	0.00	0.85	0.36	1,2,8	x					x
77	216-T-19	Crib		45.19	0.00	0.00	326.00	5.53	3,8,9		x	x	x	x	
78	216-T-28	Crib		42.14	331.53	0.00	7.06	4.44	8		x	x		x	
79	316-1	Pond		79.28	0.00	0.00	0.00	0.00	8,12,13,14,15	x	x	x	x		
80	316-2	Pond		79.28	0.00	0.00	0.00	0.00	8,12,13,14,15	x	x	x	x		
81	316-3	Trench		79.28	0.00	0.00	0.00	0.00	12,15	x	x	x		x	

Sub set data file

Isotope (1)	Decay Mode	Other Wastes Disposed (2)		
H-3	Beta	1	Cr(2)O(7)	
C-14	Beta	2	NO(3)S	
Co-60	Gamma	3	SO(4)	
Ni-63	Beta	4	B(4)O(7)	
Sr-90	Beta	5	NH(3)	
Ru-106	Beta	6	Hg	
Cs-134	Beta,Gamma	7	Cu	
Cs-137	Gamma	8	NO(3)	
Eu-152	Beta	9	PO(4)	
Eu-154	Beta	10	CN	
Eu-155	Beta	11	F	
Pu-238	Alpha	12	Metals	(inc. Hg, Pb, Cr, Be, Ag, Ni, etc)
Pu-239	Alpha	13	TCE	Trichlorlethylene
Pu-240	Alpha	14	MIRK	Methyl Isobutyl Ketone
U-235	Alpha	15	U	Uranium
U-238	Alpha			

TABLE 2-20. POTENTIAL REMEDIAL ACTION ALTERNATIVES (Continued)

Hanford Inactive Waste Site Study.

	Site No.	FATE OF CONTAMINANTS: Soil Attenuation	Downward Migration	Vegetation Uptake of Radionuclides	Ground-Water Release	Surface Erosion	Depth to Waste Feet	Depth to GW Feet	Volume Disposed (liters)	Field Capacity (FC=0.05)	Field Capacity (FC=0.1)	Field Capacity (FC=0.25)
26	216-B-43	o	x	o			15	228	2,120,000			
27	216-B-44	x	x	x			15	222	5,600,000			
28	216-B-45	o	x	o			15	220	4,920,000			
29	216-B-46	x	x	x			15	219	6,700,000			
30	216-B-48	o	x	o			15	225	4,090,000			
31	216-B-49	x	x	x			15	223	6,700,000			
32	216-B-50	o	x	o	o		15	223	54,800,000	x	x	o
33	216-B-5	x	x		x		302	283	30,600,000	x	x	x
34	216-B-2-2	o	x	o	x	o	8	255	149,000,000,000	x	x	x
35	216-B-6	o	o		o		75	296	6,000,000			
36	216-B-7 A&B	x	x	x	o		14	241	43,600,000	x	x	o
37	216-B-10A	o	x				20	300	9,990,000			
38	216-B-16	o	x	o			12	338	5,600,000			
39	216-C-1	o	x	o	o		13	282	23,400,000	x	o	
40	216-C-10	o	x	o		o	7	286	897,000			
41	216-A-9	x	x	o	x		12	294	981,000,000	x	x	x
42	216-A-40		o				16	284	946,000			
43	216-A-4	x	x				25	305	6,210,000			
44	216-A-5	x	x	x	x		32	313	1,630,000,000	x	x	x
45	216-A-6	x	x	x	x		19	290	3,400,000,000	x	x	x
46	216-A-7	o	x				15	274	326,000			
47	216-A-21	x	x	o	o		19	310	77,800,000	x	x	o
48	216-A-24	o	x	x	x		15	242	820,000,000	x	x	x
49	216-A-27	x	x		o		14	308	23,100,000	o		
50	216-A-28	o					11	298	30,000			
51	216-A-36A	x	x				22	314	1,070,000			

TABLE 2-20. POTENTIAL REMEDIAL ACTION ALTERNATIVES (Continued)

Hanford Inactive Waste Site Study.

	Site No.	Type	Proximal Location (<500')	HRS Score	Total Curies Disposed (1)	Total of H,C,Ru,Eu	Total of Cs,Sr	Total of All Else	Other Wastes Disposed (2)	POTENTIALLY FEASIBLE REMEDIAL ACTIONS: Cap/Cover w/ PC Monitoring	Grout-in-Place w/ PC Monitoring	In-Situ Vitrification	Solution Mining & GW Recovery/ Treatment	Excavation & Disposal	No Action
26	216-B-43	Crib		48.67	942.06	170.00	772.00	0.06	2,3,9,10		x	x	x	x	
27	216-B-44	Crib		50.42	2097.17	450.00	1646.00	1.17	2,3,9,10		x	x	x	x	
28	216-B-45	Crib		52.20	2407.82	390.00	2017.00	0.82	2,3,9,10		x	x	x	x	
29	216-B-46	Crib		52.20	1326.50	536.00	788.90	1.60	2,3,9,10		x	x	x	x	
30	216-B-48	Crib		52.20	1145.38	327.00	818.00	0.38	2,3,9,10		x	x	x	x	
31	216-B-49	Crib		52.20	1975.28	536.00	1438.00	1.28	2,3,9,10		x	x	x	x	
32	216-B-50	Crib		43.70	149.57	90.00	59.52	0.05	3		x	x	x	x	
33	216-B-5	Rec. Well		61.54	369.40	0.00	59.70	309.70	3,8,9,11		x		x		
34	216-B-2-2	Ditch		30.67	235.49	0.00	235.49	0.00			x		x		
35	216-B-6	Rec. Well	o	50.34	0.00	0.00	0.00	0.00	1,3,8	x					x
36	216-B-7 A&B	Crib		65.44	2764.07	0.00	2451.80	312.27	3,8,9,11		x		x	x	
37	216-B-10A	Crib	o	47.82	3.22	0.00	2.51	0.72	1,3,8	x	x	x			
38	216-B-16	Crib		52.20	1104.94	450.00	654.00	0.94	3,8,9,10				x	x	
39	216-C-1	Crib	o	39.33	164.53	70.00	93.85	0.68	8		x	x	x		
40	216-C-10	Crib	o	33.29	37.92	0.00	37.89	0.02	8	x	x	x		x	
41	216-A-9	Crib	o	42.79	4017.21	4000.00	17.17	0.04	8		x		x		
42	216-A-40	Trench	o	32.72	0.00	0.00	0.00	0.00	8	x					x
43	216-A-4	Crib	o	47.82	22.68	0.00	12.37	10.31			x	x		x	
44	216-A-5	Crib	o	50.42	130066.92	130000.00	58.80	8.12		x	x		x		
45	216-A-6	Crib		42.14	166.21	0.00	163.40	2.81			x		x		
46	216-A-7	Crib		42.79	3.07	0.00	2.99	0.08		x				x	
47	216-A-21	Crib	o	57.89	105.25	0.00	93.84	11.41				x		x	
48	216-A-24	Crib		48.67	1712.51	1400.00	312.10	0.41			x		x		
49	216-A-27	Crib	o	59.63	69.52	0.00	62.20	7.32				x		x	
50	216-A-28	Fr. Drain		32.72	0.21	0.00	0.00	0.21		x				x	x
51	216-A-36A	Crib	o	32.62	2010.56	0.00	2004.00	6.56				x		x	

TABLE 2-20. POTENTIAL REMEDIAL ACTION ALTERNATIVES (Continued)

Hanford Inactive Waste Site Study.

	Site No.	FATE OF CONTAMINANTS: Soil Attenuation	Downward Migration	Vegetation Uptake of Radionuclides	Ground-Water Release	Surface Erosion	Depth to Waste Feet	Depth to GW Feet	Volume Disposed (liters)	Field Capacity (FC=0.05)	Field Capacity (FC=0.1)	Field Capacity (FC=0.25)
52	216-S-5	x	x	x	x		15	180	4,100,000,000	x	x	x
53	216-S-6	x	x	x	x		15	180	4,470,000,000	x	x	x
54	216-S-16D		o	o	o	o	3	180	400,000,000	x	x	o
55	216-S-16P	x	x	x	x	o	3	180	41,000,000,000	x	x	x
56	216-S-17	o	x	x	x		10	180	6,430,000,000	x	x	x
57	216-U-11	o	o	o		o	7	185	0			
58	216-S-1&2	x	x		x		35	197	160,000,000	x	x	x
59	216-S-3	o	x	o		o	6	190	4,200,000			
60	216-S-4		o				20	180	1,000,000			
61	216-S-7	x	x	o	x		22	202	390,000,000	x	x	x
62	216-S-9	x	x	o	o		30	205	50,300,000	x	x	o
63	216-S-20	x	x	o	x		30	208	135,000,000	x	x	x
64	216-S-21	o	x		x		21	180	87,100,000	x	x	x
65	216-U-1&2	o	o	o	o		24	209	15,900,000	x	o	
66	216-U-3		o	o			12	190	791,000			
67	216-U-4		o				75	227	300,000			
68	216-U-4A		o	o			10	227	545,000			
69	216-U-4B		o	o			10	230	33,000			
70	216-Z-1&2	x	o	o	x		21	191	38,900,000	x	x	x
71	216-Z-7	x	x	x	x	o	5	187	79,900,000	x	x	x
72	216-Z-10		o		o		150	193	1,000,000	x	x	o

TABLE 2-20. POTENTIAL REMEDIAL ACTION ALTERNATIVES (Continued)

Hanford Inactive Waste Site Study.

	Site No.	Type	Proximal Location (<500')	HRS Score	Total Curies Disposed (1)	Total of H,C,Ru,Eu	Total of Cs,Sr	Total of All Else	Other Wastes Disposed (2)	POTENTIALLY FEASIBLE REMEDIAL ACTIONS: Cap/Cover w/ PC Monitoring	Grout-in-Place w/ PC Monitoring	In-Situ Vitrification	Solution Mining & GW Recovery/ Treatment	Excavation & Disposal	No Action
52	216-S-5	Crib	o	30.75	130.48	0.16	88.20	42.12	8		x		x	x	
53	216-S-6	Crib	o	42.14	384.95	0.50	349.00	35.45	8		x		x	x	
54	216-S-16D	Ditch	o	42.14	0.00	0.00	0.00	0.00	8	x					x
55	216-S-16P	Pond	o	32.72	110.57	0.20	82.10	28.27	8	x			x	x	
56	216-S-17	Pond	o	38.07	31.62	0.06	31.30	0.26	8		x		x	x	
57	216-U-11	Ditch (2)		37.75	0.00	0.00	0.00	0.00	?	x				x	
58	216-S-1&2	Crib (2)		57.73	6657.93	4000.00	2570.00	87.93	8		x	x	x		
59	216-S-3	Fr Drain (2)		48.97	3024.41	3000.00	24.35	0.05	1,8		x	x	x	x	
60	216-S-4	Fr Drain	o	32.72	0.02	0.02	0.00	0.00	8	x					x
61	216-S-7	Crib (2)		59.63	2320.40	0.00	2287.00	33.39	8		x	x	x		
62	216-S-9	Crib		39.23	6428.89	6000.00	422.00	6.88	8		x	x	x		
63	216-S-20	Crib		43.70	98.76	0.00	86.30	12.46	8		x	x	x		
64	216-S-21	Crib	o	31.93	117.29	0.00	117.10	0.19	8		x	x	x		
65	216-U-1&2	Crib (2)		48.97	11.50	0.00	0.52	0.01	3,8,9	x					x
66	216-U-3	Fr Drain		33.89	0.53	0.00	0.00	0.00	8	x					x
67	216-U-4	Rec. Well		32.72	0.00	0.00	0.22	0.00	8		x				x
68	216-U-4A	Fr Drain		32.72	0.22	0.00	0.22	0.00	8,9	x	x				x
69	216-U-4B	Fr Drain		30.20	0.22	0.00	0.22	0.00	8	x	x				x
70	216-Z-1&2	Crib		37.75	4672.37	0.00	0.32	4672.04	8,11		x	x		x	
71	216-Z-7	Crib (2)		43.70	591.88	0.00	447.00	144.88	8		x	x		x	
72	216-Z-10	Rec. Well		32.72	3.62	0.00	0.00	3.62	8	x					x

- Groundwater release - If the field capacity (FC) of the soil column is exceeded by the volume of waste disposed, groundwater contamination has been assumed. In addition, if the FC/volume ratio was less than ten, or more than ten million liters of water were applied, or the contaminate types were highly migratory, a high potential for discharge to groundwater was assumed. Note that no evaporation losses were considered.

- Surface erosion - Those sites with contamination less than ten feet below the ground surface were identified as having a potential for waste dispersion by wind or water erosion.

The summary of the site data and pathways/fate of pollutants for each site is presented in Columns 16-20 of Table 2-20.

2.6.1.3 Selection of Technologies

As the first step, published Environmental Protection Agency (EPA) handbooks and conference proceedings that listed numerous potential remedial technologies for hazardous and radioactive wastes were reviewed (see Appendix B for a list of Potential Technologies). The remedial technologies were divided into three groups:

- Waste isolation
- Excavation/removal
- In-situ treatment

Waste isolation addresses those technologies that contain all the contaminated material onsite and involve minimum movement of either wastes or contaminated soils. Excavation/removal addresses those technologies that generally involve removing the contaminated material and transferring it to another location for treatment and disposal. In-situ treatment involves technologies that effectively treat the contaminated material in place. Very little waste or soil is excavated or removed from the site by these technologies, which either extract the hazardous constituents for

treatment/recovery or physically, chemically, or biologically detoxify the hazardous constituents.

These groups are listed in the general order of overall demonstrated effectiveness and environmental acceptability from the perspective of meeting applicable standards and providing a permanent solution.

2.6.1.4 Screening of Technologies

Specific remedial technologies were identified in each of the three groups discussed above. This technology list is presented in Table 2-21, which shows both primary technologies that are used to treat the contaminated materials and some of the major support technologies that are used to protect the environment during remedial action operations. The next step was to screen these technologies and determine those that would be most applicable to the 81 CERCLA sites at Hanford. This was done by reviewing the site conditions and pollutant pathways and fate and identifying those technologies that were most advantageous based on previous applications to comparable waste types or site conditions.

2.6.1.5 Selection of Final Remedial Technologies

Once the primary candidate technologies had been identified, a literature and case study review was conducted to determine the following:

- Operating range/conditions for each technology - effective depth, waste types, soil types, etc.
- State of development of technology - bench, pilot, full scale
- Similarity of wastes and site conditions to those expected at Hanford
- Acceptability - demonstrated ability to meet applicable regulations and standards

TABLE 2-21 GENERAL REMEDIATION TECHNOLOGY GROUPS

WASTE ISOLATION

Primary Technologies

- o cap/cover systems
- o slurry walls
- o grout-in-place
- o in-situ vitrification

Support Technologies

- o dust control
- o runoff diversion/collection/treatment
- o equipment decontamination

EXCAVATION/REMOVAL

Primary Technologies

- o excavation/disposal
- o groundwater pump/treat systems
- o solidification/fixation

Support Technologies

- o waste handling/transportation
- o dust control
- o runoff diversion/collection/treatment
- o equipment decontamination

IN SITU TREATMENT

Primary Technologies

- o solution mining
- o soil flushing
- o air/steam stripping
- o biodegradation systems
- o chemical fixation/complexation

Support Technologies

- o extraction/concentration facilities
- o equipment decontamination

- Complexity - simpler is better
- Throughput/capacity - length of time to treat expected waste volumes
- O & M requirements (including decontamination needs)

This information was then reviewed by the task members, closely compared to the site conditions, and resulted in the selection of 6 technologies for potential application at Hanford:

- Cap/cover
- Grout-in-place
- In-situ vitrification
- Excavation and disposal
- Soil flushing
- Groundwater recovery and treatment

Table 2-22 provides a comparison of the technical feasibility, costs, applicable environmental regulations, and state of development for the technologies evaluated. The process, operations, costs, applications and limitations of the six selected technologies are described in more detail in Appendix C.

In addition, a no-action alternative has been included, since many of the sites received such apparently low volumes of wastes and had either no radionuclide or heavy metal waste or very low (less than two curies) amounts of radioactive materials.

2.6.1.6 Selection of the Remedial Technologies by Site

Once the final seven alternatives (six technologies plus no action) were selected, an evaluation was made for each site, and at least two technologies per site were identified as applicable. One further crucial assumption was made: to combine soil flushing and groundwater treatment as

TABLE 2-22

Summary Matrix of Applications of Remedial Action Technologies

Remedial Action Technology	Technical Feasibility: Total Radio-Nuclides	Technical Feasibility: Soluble/ Non-Soluble Radionuclides	Technical Feasibility: Heavy Metals	Technical Feasibility: Organics	Technical Feasibility: Effective Depth (Feet)	Technical Feasibility: Other Limitations	Costs: Factor	Costs: Unit Cost
Cap/Cover	<10Ci	Non-Soluble	Yes	Yes	No Limit	Susceptible to Subsidence	100 Square Yards	$4,500
Grout-in-Place	No Limit	Non-Soluble	Yes	Yes	No Limit	Extensive Site Character Required Difficult to Verify Effectiveness	100 Cubic Yards	$6,000
Vitrification	No Limit	Non-Soluble Low Volatility	Yes	No	<50	Low Soil Moisture Required High Energy Demand	100 Cubic Yards	$38,900
Excavation/ Disposal	No Limit	Non-Soluble Low Volatility	Yes	Yes	<60	Worker H&S Concerns	100 Cubic Yards	$36,500 - $68,900
Groundwater Pump/ Treatment								
Soil Flushing	No Limit	Soluble	Yes	Poor	No Limit	Need Extensive Characteristics of Soil/Waste Matrix	100 Cubic Yards	$3,500
Water Treatment	No Limit	Soluble	Yes	Yes	No Limit	Required Extensive Aquifer Characterization	100 Cubic Yards	$1,200

TABLE 2-22

Summary Matrix of Applications of Remedial Action Technologies

Remedial Action Technology	Applicable Env. Requirements				Demonstrated Compliance with Environmental Regulations				State of Development		
	Air	Surface Water	Ground Water	RCRA	CERCLA Sites	RCRA Sites	LLRAD Sites	HLRAD Sites	Radionuclides	Heavy Metals	Organics
Source Controls CAP/Systems	Yes	Yes	No	No	Yes	Yes	Yes	Unknown	Full Scale	Full Scale	Full Scale
Grout-in-Place	No	Yes	Yes	No	No	Unknown	No	No	Pilot Scale	Pilot Scale	Unknown
Vitrification	Yes	Yes	No	Yes (Site Prep.)	Unknown	Yes	Yes	Unknown	Pilot Scale At Hanford	Pilot Scale	Unknown
Excavation/ Disposal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Full Scale	Full Scale	Full Scale
Groundwater Pump/ Treatment											
Soil Flushing	Yes	No	Yes	Yes (Recovered Solution)	Proposed	Yes	Yes	Proposed	Full Scale On Ore Bodies	Full Scale On Ore Bodies Pilot Scale On Wastes	Pilot Scale
Water Treatment	Yes	No	Yes	Yes (Recovered Solution)	Yes	Yes	Yes	Proposed	Full Scale	Full Scale	Full Scale (Stripping)

one technology since they both involved essentially the same equipment, configuration and operational concerns.

The alternatives were selected for each site based on the following definitions:

Cap/Cover: Potentially useful for sites where the total curie count is less than ten, with most wastes having low solubility. Depth of materials is not a relevant item in the decision process, but the volume of wastes applied to the site should be less than 10,000,000 liters so as to be reasonably assured of fairly shallow depths of contamination.

Grout-in-Place: In-situ grouting using bentonites and portland cement to both chemically stabilize the materials (mostly metals) and physically isolate the wastes from water migration. There are no limits on the depth of wastes.

In-Situ Vitrification: Physical isolation of the wastes, with a depth of effectiveness to approximately 50 feet (assumed for this analysis). The actual limitation is the volume rather than the depth.

Excavation and Disposal: Most useful with sites where wastes have low solubility, are near the surface, and have had a low volume of wastewater.

Soil Flushing/Groundwater Recovery and Treatment: Most useful with the soluble pollutants, but generally not effective on wastes where the nonsoluble fraction was greater than 25 percent.

The most likely application for each technology with respect to radionuclide contamination, depth of wastes, and volume of waste and chemical waste discharged is summarized as follows:

Technology	Limiting Site/Waste Conditions				
	Ci Total	Ci Nonsoluble	Chemical Wastes	Depth of Wastes	Volume of Wastes
Cap/Cover	≤10	≤ 1	N.S.	N.S.	< 10,000,000
Grout-in-Place	N.S.	N.S.	N.S.*	N.S.	<100,000,000
In-Situ Vitrification	N.S.	N.S.	N.S.	< 50'**	<100,000,000
Excavation and Disposal	N.S.	≥25% of Ci	N.S.	< 50'+	< 10,000,000
Soil Flushing/ Groundwater Recovery and Treatment	N.S.	≤25% of Ci	N.S.	N.S.	<100,000,000
No Action	< 2	< 1	N.S.	N.S.	N.S.

N.S. = Not significant in decision process (but considered).

* = Any application of grout-in-place must be custom tailored to the geohydrologic conditions and waste characteristics.

+ = Assumed for analysis purposes. Greater depth would require shoring of the work area.

** = This limit is only assumed for applicability of the technology to specific Hanford Sites. The limiting factor is actually the volume that can be vitrified.

Using these criteria, each technology was compared to each site and a decision made on the potential feasibility for application at that site. These decisions are summarized in Columns 21-25 of Table 2-20.

2.6.2 Summary of Selected Remedial Action by Site

An evaluation resulted in the selection of two or more remedial actions for each site. The selections were based on technical feasibility and the objective of establishing a reasonable cost range for each site. The remedial action alternatives presented for each site are presented in

columns 21-26 of Table 2-20. In total, 19 sites were identified where the no-action alternative might be applicable, 36 sites for possible application of cap/cover, 49 sites for possible grout-in-place applications, 35 sites where in-situ vitrification may be appropriate, 42 sites for possible application of soil flushing and groundwater recovery and treatment, and 42 sites where excavation and disposal are feasible.

In terms of the number of possible remedial action alternatives per site, the 81 sites are distributed as follows:

No. of Possible Remedial Actions	No. of Sites
2	34
3	32
4	15

2.6.3 Remedial Action Unit Costs

As discussed in Appendix C, a unit cost has been developed for each proposed remedial action. The costs are in either $/100 cubic yard or $/square yard. The costs include equipment, materials, operation and maintenance (e.g., labor and power) and health and safety. Other costs, such as site preparation (e.g., demolition, road building, etc.), have not been included because they are highly variable for each site. Instead, it is proposed that a contingency factor or allowance for unforeseen costs be included in the site-specific remedial action cost estimate.

Unit costs for the remedial action alternatives are as follows:

- Cap/cover - $4,500/100 square yards (See Appendix C.1)
- Grout-in-place - $6,000/100 cubic yards (See Appendix C.2)
- In-situ vitrification - $38,900/100 cubic yards (See Appendix C.3)

- Excavation and disposal with incineration - $68,900/100 cubic yards (See Appendix C.6)

  Excavation and disposal without incineration - $36,500/100 cubic yards (See Appendix C.6)

- Soil flushing - $3,500/100 cubic yards (See Appendix C.4)

- Groundwater recovery and treatment - $1,200/100 cubic yards (See Appendix C.5)

For excavation and disposal, the higher number includes waste treatment/preparation for disposal.

2.7 COST ESTIMATES FOR INACTIVE WASTE DISPOSAL CHARACTERIZATION AND REMEDIATION

This section provides an order of magnitude estimate of the costs associated with characterizing and implementing remedial actions at all of the identified inactive waste disposal sites on the Hanford Reservation. The objective is to provide specific cost estimates for the characterization and remediation of each of the CERCLA sites and for each type (crib, trench, pond, etc.) of RCRA site and to provide a summary cost estimate for each area of the Hanford Reservation.

2.7.1 Cost Elements

The potential CERCLA sites at Hanford are clustered in the 100, 200, and 300 areas. The costs for characterization and remediation of the CERCLA sites in each area are composed of four elements:

- Characterization Costs
- Feasibility Study, Engineering, and Construction Management Costs
- Remedial Action (Cleanup) Costs
- Post Remedial Action Costs, i.e., Monitoring Costs

For the characterization costs and remedial action costs, a range is presented. For characterization, the low range represents the cost of only having to do Stage II site characterization which would be applicable to those sites where the wastes are minimally dispersed in the vadose zone. The high range represents the potential need for full and widespread site characterization covering all pathways and receptors and assuming a wide dispersion of wastes in soils and groundwater.

The cost of the engineering and construction management is generally in the range of 10 to 20% of the actual construction cost for almost any type of engineering project. For instance, on the DOE CENTRA Project, which involves low-level radioactivity and heavy metals wastes, this element averages about 15% of the remedial return cost. Generally, the percentage is inversely proportional to the project size assuming the same degree of complexity. Thus, for the CERCLA site at Hanford we have assumed the following factor for this cost element based upon site size:

Size of Site	Costs Required for Engr/CM as a % of R.A.
Small (<1,000 sq ft)	20%
Medium (1,000-10,000 sq ft)	15%
Large (>10,000 sq ft)	10%

The Feasibility Study required by CERCLA is assumed to range from $100,000 for smaller, less complex sites to $2,000,000 for large, complex sites.

The third factor that impacts the site remediation cost is the range of cost of the remedial action itself.

The remedial action cost element range reflects the high and low cost estimates developed for the candidate alternatives for each site. At least two alternatives were considered for each site as documented in the previous section. The cost estimates for each of these or combinations of alterna-

tives have been developed in this task. The cost estimates for each alternative generated for each site is presented in Section 2.7.2 while only the high and low cost alternatives for each site are presented in this summary matrix.

The last cost element, post remedial action monitoring, is oriented toward groundwater monitoring for each site covering both radionuclides, heavy metals, and other organic and inorganic pollutants of concern.

The cost associated with analyzing samples for the above contaminants is $4000 per sample. [Based on estimates provided by Susan Watt of Rocky Mountain Laboratory and Kelvin Wright of SAIC Rockville.] Assuming a 25% increase for blanks, duplicates, etc.; four wells per site and semi-annual sampling results in an annual site monitoring cost of $40,000 regardless of the site size or remedial action taken. Costs associated with soil and vegetation sampling were not included since this activity is currently contracted to Pacific Northwest Laboratory.

2.7.2 Site Characterization Costs

As mentioned early in this report, the degree and associated cost of site characterization depends upon the areal extent of the contamination and the pathways impacted. Each stage of the site characterization involves additional sampling and/or installation of monitoring devices. Since this is an order of magnitude estimate, it was decided to develop a unit cost for each activity of each stage and then summarize the costs by stage for each site. The unit cost for each activity is as follows:

Activity	Cost
1. Installation Sampling and Analysis of Clustered Monitoring Wells	$427,700 to $2,456,500 per cluster
2. Installation, and Analysis of Lysimeters	$9,900 to $25,400 (area range)
3. Soil Borings - Sampled Every 5 Feet (Inc. Analysis)	$51,000 to $418,200 (area average)
4. Soil gas Survey - 50′ Grid	$34.50 @ 50′ Centre
5. Areal Overflow Sediment Sampling and Analysis (Per Sample)	$650 per sample

The unit cost estimates are based on the following additional assumptions:

- The majority of the labor force resides in the Hanford area
- All work is done under Level C or D H&S conditions
- The range of total footage per cluster = 142 ft to 977 ft
- The range of depth of soil borings is 43 ft to 340 ft

Using these unit costs, working tables were developed that took the quantities and number of activities by stage by site identified and calculated the associated costs. Costs for each stage for each site were then summarized and are presented in Table 2-23.

2.7.3 Site Remedial Action Costs

The remedial action costs were developed using the unit costs developed in Task 5 for each alternative in conjunction with the surface and waste volume to be remediated at each site. For all the constructed sites (cribs, trenches, ditches, etc.) except the reverse wells, it was necessary to

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE - AREA 100 B/C*

Sources	PATHWAY				
	Surface Geophysics/ Soil Gas	Groundwater	Vadose Zone	Surface Water/ Sediments	Source Total Cost**
116-B-1	(1) $25,000 (2) $1,500	(3) $2,200,000 (4) $4,200 (5) $6,000 (8) $147,700	(6) $12,600 (7) $1,182,400	(9) $62,400	$3,681,800
116-B-4	(1) $13,600 (2) $800	(3) $2,200,000 (4) $4,200 (5) $6,000 (8) $147,700	(6) $12,600 (7) $945,900	(9) $62,400	$3,433,200
116-C-1	(1) $64,800 (2) $3,800	(3) $2,200,000 (4) $4,200 (5) $6,000 (8) $147,700	(6) $12,600 (7) $945,900	(9) $62,400	$3,487,400
116-C-2	(1) $38,700 (2) $2,200	(3) $2,200,000 (4) $4,200 (5) $6,000 (8) $147,700	(6) $25,200 (7) $2,364,700	(9) $62,400	$4,891,100

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-12.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 100 KE/KW* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
I 100-KW*1 100-KW*2	(1) $17,300 (2) $1,000	(3) $2,180,000 (4) $4,200 (5) $6,000 (8) $147,700	(6) $11,400 (7) $878,100	(9) $62,400	$3,348,100
II 100-KE*1 100-KE*2	(1) $17,300 (2) $1,000	(3) $2,180,000 (4) $4,200 (5) $6,000 (8) $147,700	(6) $11,400 (7) $702,500	(9) $62,400	$3,172,500

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-12.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 100 KE/KW* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
116-K-1	(1) $98,800 (2) $5,700	(3) $2,180,000 (4) $4,200 (5) $6,000 (8) $147,700	(6) $11,400 (7) $702,500	(9) $62,400	$3,258,700
116-K-2	(1) $375,200 (2) $21,800	(3) $2,180,000 (4) $4,200 (5) $6,000 (8) $147,700	(6) $11,400 (7) $702,500	(9) $62,400	$3,551,200
116-KE-2	(1) $17,300 (2) $1,100	(3) $2,180,000 (4) $4,200 (5) $6,000 (8) $147,700	(6) $11,400 (7) $878,100	(9) $62,400	$3,348,200

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-12.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 100 F* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
116-F-1	(1) $274,300 (2) $16,000	(3) $2,500,000 (4) $4,200 (5) $6,250 (8) $147,700	(6) $20,500 (7) $2,528,000	(9) $62,400	$5,599,350
116-F-2	(1) $47,000 (2) $2,700	(3) $2,500,000 (4) $4,200 (5) $6,250 (8) $147,700	(6) $10,250 (7) $821,600	(9) $62,400	$3,642,100
116-F-3	(1) $26,100 (2) $1,500	(3) $2,500,000 (4) $4,200 (5) $6,250 (8) $147,700	(6) $10,250 (7) $632,000	(9) $62,400	$3,430,400
I 116-F-6 116-F-10	(1) $68,900 (2) $4,000	(3) $2,500,000 (4) $4,200 (5) $6,250 (8) $147,700	(6) $20,500 (7) $1,327,200	(9) $62,400	$4,181,150

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-12.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 100 F* (Continued)

Sources	Pathway				
	Surface Geophysics/ Soil Gas	Groundwater	Vadose Zone	Surface Water/ Sediments	Source Total Cost**
116-F-9	(1) $56,700 (2) $3,300	(3) $2,500,000 (4) $4,200 (5) $6,250 (8) $147,700	(6) $10,250 (7) $1,137,600	(9) $62,400	$3,968,400

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-12.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 100 H* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
116-H-1	(1) $34,700 (2) $2,000	(3) $2,495,500 (4) $4,200 (5) $6,250 (8) $147,700	(6) $9,850 (7) $510,700	(9) $62,400	$3,313,300
116-H-2	(1) $52,800 (2) $3,000	(3) $2,495,500 (4) $4,200 (5) $6,250 (8) $147,700	(6) $9,850 (7) $510,700	(9) $62,400	$3,332,400
116-H-3	(1) $13,500 (2) $800	(3) $2,495,500 (4) $4,200 (5) $6,250 (8) $147,700	(6) $9,850 (7) $408,600	(9) $62,400	$3,188,800

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-12.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 100 D/DR* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost
116-DR-1	(1) $41,000 (2) $2,400	(3) $2,530,000 (4) $4,200 (5) $6,250 (8) $147,700	(6) $12,000 (7) $1,059,950	(9) $62,400	$3,905,900
116-DR-2	(1) $28,900 (2) $1,700	(3) $2,530,000 (4) $4,200 (5) $6,250 (8) $147,700	(6) $12,000 (7) $1,059,950	(9) $62,400	$3,893,100
116-DR-1B	(1) $25,100 (2) $1,500	(3) $2,530,000 (4) $4,200 (5) $6,250 (8) $147,700	(6) $12,000 (7) $741,950	(9) $62,400	$3,571,100
116-DR-6	(1) $25,100 (2) $1,200	(3) $2,530,000 (4) $4,200 (5) $6,250 (8) $147,700	(6) $12,000 (7) $847,950	(9) $62,400	$3,676,800

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-12.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 100 D/DR* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
116-DR-7	(1) $17,500 (2) $1,000	(3) $2,530,000 (4) $4,200 (5) $6,250 (8) $147,700	(6) $12,000 (7) $847,950	(9) $62,400	$3,669,000

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-12.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 200 EAST* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
I 216-B-43 216-B-44 216-B-45 216-B-46 216-B-48 216-B-49 216-B-50	(1) $63,800 (2) $3,700	(3) $6,136,000 (4) $4,200 (5) $16,300 (8) $138,100	(6) $25,400 (7) $4,182,200	(9) $93,600	$10,703,300
II 216-B-7A&B	(1) $18,900 (2) $1,100	(3) $2,360,000 (4) $1,400 (5) $6,300 (8) $52,400	(6) $25,400 (7) $3,345,800	(9) $93,600	$5,944,900
III 216-B-2-2	(1) $200,300 (2) $11,600	(3) $2,360,000 (4) $1,400 (5) $6,300 (8) $52,400	(6) $25,400 (7) $3,345,800	(9) $93,600	$6,136,800
IV 216-B-5	(1) $13,200 (2) $800	(3) $2,832,000 (4) $2,100 (5) $7,500 (8) $57,700	(6) $25,400 (7) $2,509,300	(9) $93,600	$5,581,600

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-13.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 200 EAST* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
V 216-B-10-A 216-B-6	(1) $32,100 (2) $1,900	(3) $3,304,000 (4) $2,100 (5) $8,800 (8) $71,700	(6) $25,400 (7) $4,182,200	(9) $43,600	$7,711,800
VI 216-C-1 216-C-10	(1) $39,200 (2) $2,200	(3) $2,360,000 (4) $1,400 (5) $6,300 (8) $52,400	(6) $25,400 (7) $5,018,600	(9) $43,600	$7,589,100
VII 216-B-16	(1) $30,400 (2) $1,800	(3) $2,360,000 (4) $1,400 (5) $6,300 (8) $52,400	(6) $25,400 (7) $3,345,800	(9) $43,600	$5,907,100
VIII 216-A-40	(1) $49,900 (2) $2,900	(3) $2,360,000 (4) $1,400 (5) $6,300 (8) $52,400	(6) $25,400 (7) $3,345,800	(9) $43,600	$5,927,700

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-13.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 200 EAST* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
IX 216-A-24	(1) $129,100 (2) $7,500	(3) $2,360,000 (4) $1,400 (5) $6,300 (8) $52,400	(6) $50,800 (7) $5,018,600	(9) $43,600	$7,709,700
X 216-A-9	(1) $51,500 (2) $3,000	(3) $2,360,000 (4) $1,400 (5) $6,300 (8) $52,400	(6) $50,800 (7) $5,018,600	(9) $43,600	$7,627,600
XI 216-A-7	(1) $18,200 (2) $1,100	(3) $2,360,000 (4) $1,400 (5) $6,300 (8) $52,400	(6) $25,400 (7) $1,672,900	(9) $43,600	$4,221,300
XII 216-A-28	(1) $15,600 (2) $900	(3) $2,360,000 (4) $1,400 (5) $6,300 (8) $52,400	(6) $25,400 (7) $1,672,900	(9) $43,600	$4,218,500

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-13.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 200 EAST*

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
XIII 216-A-4 216-A-5 216-A-21 216-A-27 216-A-36A	(1) $122,500 (2) $7,100	(3) $4,720,000 (4) $3,500 (5) $12,500 (8) $104,900	(6) $50,800 (7) $13,383,000	(9) $43,600	$18,487,900
XIV 216-A-6	(1) $34,500 (2) $2,000	(3) $2,360,000 (4) $1,400 (5) $6,300 (8) $52,400	(6) $25,400 (7) $3,345,800	(9) $43,600	$5,911,400

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-13.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 200 W* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
I 216-S-5 216-S-6 216-S-17 216-S-16P 216-S-16D	(1) $1,354,100 (2) $78,600	(3) $3,396,000 (4) $6,300 (5) $7,700 (8) $173,000	(6) $42,300 (7) $12,807,200	(9) $43,600	$17,948,800
II 216-S-1&2 216-S-7 216-S-3 216-S-9	(1) $125,500 (2) $7,300	(3) $4,528,000 (4) $8,400 (5) $10,200 (8) $230,600	(6) $42,300 (7) $10,245,800	(9) $43,600	$15,281,700
III 216-S-20	(1) $27,400 (2) $1,600	(3) $4,528,000 (4) $8,400 (5) $10,200 (8) $230,600	(6) $21,150 (7) $2,561,400	(9) $43,600	$7,472,350
IV 216-S-4 216-S-21	(1) $38,300 (2) $2,200	(3) $2,830,000 (4) $4,200 (5) $6,400 (8) $157,300	(6) $42,300 (7) $5,122,900	(9) $43,600	$8,287,200

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-13.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 200 W* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
V 216-U-11	(1) $360,400 (2) $20,900	(3) $2,830,000 (4) $4,200 (5) $6,400 (8) $157,300	(6) $21,150 (7) $2,561,400	(9) $43,600	$6,045,350
VI 216-U-3	(1) $13,900 (2) $800	(3) $2,830,000 (4) $4,200 (5) $6,400 (8) $157,300	(6) $21,150 (7) $2,561,400	(9) $43,600	$5,678,750
VII 216-Z-1&2	(1) $21,400 (2) $1,200	(3) $2,830,000 (4) $4,200 (5) $6,400 (8) $157,300	(6) $21,150 (7) $2,561,400	(9) $43,600	$5,686,650
VIII 216-U-1&2	(1) $25,200 (2) $1,500	(3) $2,830,000 (4) $4,200 (5) $6,400 (8) $157,300	(6) $21,150 (7) $2,561,400	(9) $43,600	$5,690,750

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-13.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 200 W* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
IX 216-U-4 216-U-4A 216-U-4B	(1) $40,600 (2) $2,400	(3) $2,830,000 (4) $4,200 (5) $6,400 (8) $157,300	(6) $21,150 (7) $3,842,200	(9) $43,600	$6,987,850
X 216-Z-7 216-Z-10	(1) $51,400 (2) $3,000	(3) $2,830,000 (4) $4,200 (5) $6,400 (8) $157,300	(6) $21,150 (7) $2,561,400	(9) $43,600	$5,718,450
XI 216-T-19	(1) $61,900 (2) $3,600	(3) $2,830,000 (4) $4,200 (5) $6,400 (8) $157,300	(6) $21,150 (7) $2,561,400	(9) $43,600	$5,729,550
XII 216-T-7	(1) $53,700 (2) $3,100	(3) $2,830,000 (4) $4,200 (5) $6,400 (8) $157,300	(6) $21,150 (7) $2,561,400	(9) $43,600	$5,720,850

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-13.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 200 W* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
XIII 216-T-28	(1) $21,400 (2) $1,200	(3) $2,830,000 (4) $4,200 (5) $6,400 (8) $157,300	(6) $21,150 (7) $2,561,400	(9) $43,600	$5,686,650
XIV 216-T-3	(1) $13,200 (2) $800	(3) $3,396,000 (4) $6,300 (5) $7,700 (8) $173,000	(6) $21,150 (7) $2,561,400	(9) $43,600	$6,263,150
XV 216-T-2 216-T-8	(1) $34,300 (2) $2,000	(3) $3,396,000 (4) $6,300 (5) $7,700 (8) $173,000	(6) $21,150 (7) $3,842,200	(9) $43,600	$7,566,250

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-13.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

TABLE 2-23. SUMMARY OF STAGES II,III, AND V SITE CHARACTERIZATION COSTS BY SOURCE AREA - 300* (Continued)

Sources	Pathway: Surface Geophysics/ Soil Gas	Pathway: Groundwater	Pathway: Vadose Zone	Pathway: Surface Water/ Sediments	Source Total Cost**
316-1	(1) $159,100 (2) $9,200	(3) $1,008,000 (4) $2,800 (5) $7,900 (8) $135,800	(6) $9,900 (7) $683,800	(9) $62,400	$2,118,900
316-2	(1) $223,500 (2) $13,000	(3) $1,008,000 (4) $2,800 (5) $7,900 (8) $135,800	(6) $9,900 (7) $797,800	(9) $62,400	$2,301,100
316-3	(1) $63,100 (2) $3,700	(3) $756,000 (4) 2,100 (5) 5,900 (8) $101,800	(6) $9,900 (7) $683,800	(9) $62,400	$1,728,700

Source Characterization Activity Cost Code:

(1). Soil Gas (see Note 1)
(2). Surface Geophysics (see Note 2)
(3). Cluster Wells (Installation/Development/Split Spoon Analysis (see Note 3)
(4). Aquifer (Slug) Tests (see Note 4)
(5). Borehole Geophysics (see Note 5)
(6). Lysimeters (Installation/Data Collection) (see Note 6)
(7). Soil Borings (see Note 7)
(8). Groundwater Sampling (Well Cluster Sample Collection/Analysis) (see Note 8)
(9). Ephemeral Overflow Sampling (Water and Sediment Sample Collection/Analysis) (see Note 9)

* Source Characterization cost elements presented in this table were derived as follows: source characterization activity unit costs were multiplied by the number of units (well clusters, survey acreages, soil borings, etc.) specified for each source. Unit costs derivations appear in Notes 1 through 9 to this table. Number of units for each square is specified in Table 2-14.

** Source Total Cost include Work Plan preparation ($8,000) and Remedial Investigation Report preparation ($32,000) for each source.

NOTE 1

ESTIMATED SOIL GAS SURVEY COSTS

- Assume 50 ft. centers; 17 samples per acre per day.
- Costs below are per acre, with on-site GC analysis.

Mobilization/Demobilization (pro-rated)	$ 100
Field Work 10 hours/day @ $250/hr	2,500
Direct Expenses 1 day @ $75/day vehicle, pipes, supplies	75
Per Diem 2 persons for 1 day @ $75/person/day	150
Report Preparation	N/C
1 Supervisor for 1 day o Labor o Expenses o Field Analysis	625
Total Soil Gas Surveys	$ 3,450 per Acre

NOTE 2

ESTIMATED SURFACE GEOPHYSICS SURVEY COSTS

o Assume 100 ft. centers; 35 acres per day at 10.0 hrs per day

Mobilization/Demobilization	Negligible
Electromagnetics (all inclusive)	$ 100/acre
Magnetometer (all inclusive)	$ 100/acre
Total Surface Geophysics Surveys	$ 200 per Acre

N... 3

ESTIMATED STAGE II AND III COSTS PER CLUSTER
FOR SHALLOW MONITORING WELL DRILLING/INSTALLATION/SPLIT SPOON SAMPLING AND ANALYSIS

Area	Individual/ Total Well Footage	Drilling/ Install. w/Mat'ls @ $100/ft.	Drums @ $225/100 ft.	Drilling Subtotal/ Cluster	# Spoons Per Deep Well	Avg. S.S. Collection/ Analysis Costs*	Tot.Cost/ Cluster**
100 B/C	108/206/304 = 618'	$ 61,800	$ 1,391	$ 63,191	61	$ 6,015	$ 439,256 (439,000)
100 KE/KW	86/195/304 = 585'	58,500	1,320	59,820	61	6,015	435,885 (436,000)
100 D/DR	97/226/354 = 677'	67,700	1,525	69,225	71	6,015	505,440 (506,000)
100 H	56/205/354 = 615'	61,500	1,385	62,885	71	6,015	499,100 (499,000)
100 F	64/209/354 = 627'	62,700	1,411	64,111	71	6,015	500,326 (500,000)
200 E	354'	35,400	797	36,197	71	6,015	472,412 (472,000)
200 W	272/325/380 977'	97,700	2,250	99,950	76	6,015	566,240 (566,000)
300	57/85 142'	14,200	324	14,524	17	6,015	125,929 (126,000)

* Assumes collection cost of $150/spoon; 1/2 clusters installed/sampled in Stage II @ $6800/analysis (full suite) + 1/2 installed in Stage III @ $3400/analysis + 15% for Duplicates/Replicates.

** Includes drilling/installation costs, drilling "non-footage" costs, and total split spoon analytical cost. Non-footage costs are constant for any well, as follows:

o Development - 5 hrs x 2 men x $50/hr	
o Stick-ups, guard posts	$ 300
o Clean-up	200
o Geologist and H&S person - 2 men x 24 hrs/well x $50/hr	2,400
o Surveying - $150/well	150
Per any well	$ 3,050
Per cluster	$ 9,150

NOTE 4

ESTIMATED STAGE II AND III AQUIFER COST

- Assume costs to conduct and interpret data
- Assume only 1/3 or 1/2 of the clusters at a given site would be slug tested. Wells are sufficiently close that data from that proportion will be adequately representative for entire site.

4 hrs/test

Labor

2 staff @ 4 hrs/test = 8 hours x $50/hr =	$ 400 per well
Data Analysis 4 hrs/well x 50/hr =	200 per well
Miscellaneous expendables and all equipment inclusive	100 per well
	$ 700 per well or $2,100 per cluster

NOTE 5

ESTIMATED DOWNHOLE GEOPHYSICS COST FOR STAGE II AND III
GROUNDWATER MONITORING WELLS

Assumptions for equipment/operator time, labor, etc., as footnoted below; footage costs are area-specific. This is a per cluster cost, although downhole geophysics will only be run on deepest well of each cluster.

Area	Footage of Deepest Well	Total Cost x $1/ft + Fixed Cost of $900*
100 B/C	300	$ 1,200
100 KE/KW	300	$ 1,200
100 D/DR	350	$ 1,250
100 H	350	$ 1,250
100 F	350	$ 1,250
200 E	350	$ 1,250
200 W	380	$ 1,280
300	85	$ 985

* Downhole Geophysics; Shallow (Unconfined) Aquifer

Assume

- o $1/foot for suite of tools applied against depth of deepest well in cluster in each area.

Equipment & Engineer - $450 per cluster	$ 450
H & S person 4 hrs - $50/hr - $200 per cluster	200
Misc. charges per cluster - $250 per cluster	250
	$ 900 fixed cost

Prorated Mobilization
Per diem
Computer Logs

NOTE 6

ESTIMATED LYSIMETER INSTALLATION COSTS *

Area	Footage to Groundwater	Boring $ @ $49/ft.	Drums $225/100 feet	Fixed** Costs	Lysimeter Cost	Borehole Geophys.***	Unit Cost of a Lysimeter Cost each Area
100 B/C	94	$ 4,606	$ 215	$5,000	$ 1,750	$ 994	$12,565 (12,600)
100 KE/KW	72	3,528	162	5,000	1,750	972	11,412 (11,400)
00 D/DR	83	4,067	187	5,000	1,750	983	11,987 (12,000)
00 H	42	2,058	95	5,000	1,750	942	9,845 (9,850)
00 F	50	2,450	113	5,000	1,750	950	10,263 (10,250)
00 E	340	16,660	765	5,000	1,750	1,240	25,415 (25,400)
00 W	258	12,642	581	5,000	1,750	1,158	21,131 (21,150)
300	43	2,107	97	5,000	1,750	943	9,897 (9,900)

* Lysimeter installation costs were derived by modifying the Estimated Soil Boring Costs to reflect the additional labor of lysimeter installation in the open borehole and the lysimeter material costs.

** Fixed Costs - Additional Labor (over soil boring cost) for installation of lysimeters:

3 men x 10 hrs/day x 2 days x $50/hr = $3,000

*** $900 per hole fixed rate and $1/ft per Borehole Geophysics costing sheet

NOT

ESTIMATED STAGE II AND III SOIL BORING COSTS

Area	Footage to Groundwater	Boring $ @ $49/ft.	Drums $225/100 ft.	Fixed* Costs	Total Cost per Boring	No. Split Spoons	Avg. S.S. Analysis Cost	Tot.Cost/Boring w/S.S. Analysis
100 B/C	94	$ 4,606	$ 212	$2,000	$ 6,818 (6,800)	19	$ 5,865	$ 118,235
100 KE/KW	72	3,528	162	2,000	5,690 (5,700)	14	5,865	84,810
100 D/DR	83	4,067	187	2,000	6,254 (6,250)	17	5,865	105,955
100 H	42	2,058	95	2,000	4,153 (4,150)	8	5,865	51,070
100 F	50	2,450	113	2,000	4,563 (4,550)	10	5,865	63,200
200 E	340	16,660	765	2,000	19,425 (19,400)	68	5,865	418,220
200 W	258	12,642	581	2,000	15,223 (15,200)	52	5,865	320,180
300	43	2,107	97	2,000	4,204 (4,200)	9	5,865	56,985

* "Non-footage Costs" (Constant for any Boring - Assumed)

- o Driller labor for decon, clean-up, etc.
  3 hrs x $150/hr = $450/boring
- o Drilling expendables (grout, H&S equipment, etc.) = $200/boring
- o Surveying = $150/boring
- o Geologist and H&S Specialist
  2 men x 12 hrs/day x $50/hr = $1,200/boring

Total = $2,000/boring

NOTE 8. STAGE II & III
TOTAL COSTS FOR GROUNDWATER SAMPLING LABOR AND ANALYSIS

source	stage 2 cluster*	stage 2 gw sample*	per cluster labor cost**	stage 2 sampling labor***	stage 2 analysis cost (#samples X $7130) ****	stage 3 gw clusters*	stage 3 gw samples*	stage 3 sampling labor ***	stage 3 analysis cost (#samples X $3570) ****	total stage 2 + 3 costs
100 B/C	12	36	3750	$45,000	$256,680	20	60	$75,000	$214,200	$590,880
					$0					$0
116-B-1	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-B-4	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-C-1	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-C-2	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
					$0			$0	$0	$0
100 KE/KW	21	63	3750	$78,750	$449,190	35	105	$131,250	$374,850	$1,034,040
					$0					$0
100-KW*1	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
100-KW*2	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
100-KE*1	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
100-KE*2	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-K-1	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-K-2	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-KE-2	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
					$0					$0
100 D/DR	15	45	3750	$56,250	$320,850	25	75	$93,750	$267,750	$738,600
					$0					$0
116-DR-1	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-DR-2	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-DR-1B	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-DR-6	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-DR-7	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
					$0					$0
100 H	9	27	3750	$33,750	$192,510	15	45	$56,250	$160,650	$443,160
					$0					$0
116-H-1	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-H-2	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-H-3	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
					$0					$0
100 F	18	54	3750	$67,500	$385,020	30	90	$112,500	$321,300	$886,320
					$0					$0
116-F-1	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-F-2	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720

NOTE 8. STAGE II & III
TOTAL COSTS FOR GROUNDWATER SAMPLING LABOR AND ANALYSIS (Continued)

source	stage 2 cluster*	stage 2 gw sample*	per cluster labor cost**	stage 2 sampling labor***	stage 2 analysis cost (#samples X $7130) ****	stage 3 gw clusters*	stage 3 gw samples*	stage 3 sampling labor ***	stage 3 analysis cost (#samples X $3570) ****	total stage 2 + 3 costs
116-F-3	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-F-6	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-F-9	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
116-F-10	3	9	3750	$11,250	$64,170	5	15	$18,750	$53,550	$147,720
					$0					$0
200 EAST	51	51	1650	$84,150	$363,630	83	83	$136,950	$296,310	$881,040
					$0					$0
Source I	8	8	1650	$13,200	$57,040	13	13	$21,450	$46,410	$138,100
216-B-43				$0	$0			$0	$0	$0
216-B-44				$0	$0			$0	$0	$0
216-B-45				$0	$0			$0	$0	$0
216-B-46				$0	$0			$0	$0	$0
216-B-48				$0	$0			$0	$0	$0
216-B-49				$0	$0			$0	$0	$0
216-B-50				$0	$0			$0	$0	$0
Source II	3	3	1650	$4,950	$21,390	5	5	$8,250	$17,850	$52,440
216-B-7a&7b				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source III	3	3	1650	$4,950	$21,390	5	5	$8,250	$17,850	$52,440
216-B-2-2				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source IV	3	3	1650	$4,950	$21,390	6	6	$9,900	$21,420	$57,660
216-B-5				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source V	4	4	1650	$6,600	$28,520	7	7	$11,550	$24,990	$71,660
216-B-10-A				$0	$0			$0	$0	$0
216-B-6				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source VI	3	3	1650	$4,950	$21,390	5	5	$8,250	$17,850	$52,440
216-C-1				$0	$0			$0	$0	$0
216-C-10				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source VII	3	3	1650	$4,950	$21,390	5	5	$8,250	$17,850	$52,440
216-B-16				$0	$0			$0	$0	$0

NOTE 8. STAGE II & III
TOTAL COSTS FOR GROUNDWATER SAMPLING LABOR AND ANALYSIS (Continued)

source	stage 2 cluster*	stage 2 gw sample*	per cluster labor cost**	stage 2 sampling labor***	stage 2 analysis cost (#samples X $7130) ****	stage 3 gw clusters*	stage 3 gw samples*	stage 3 sampling labor ***	stage 3 analysis cost (#samples X $3570) ****	total stage 2 + 3 costs
Source VIII	3	3	1650	$4,950	$21,390	5	5	$8,250	$17,850	$52,440
216-A-40				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source IX	3	3	1650	$4,950	$21,390	5	5	$8,250	$17,850	$52,440
216-A-24				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source X	3	3	1650	$4,950	$21,390	5	5	$8,250	$17,850	$52,440
216-A-9				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source XI	3	3	1650	$4,950	$21,390	5	5	$8,250	$17,850	$52,440
216-A-7				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source XII	3	3	1650	$4,950	$21,390	5	5	$8,250	$17,850	$52,440
216-A-28				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source XIII	6	6	1650	$9,900	$42,780	10	10	$16,500	$35,700	$104,880
216-A-4				$0	$0			$0	$0	$0
216-A-5				$0	$0			$0	$0	$0
216-A-21				$0	$0			$0	$0	$0
216-A-27				$0	$0			$0	$0	$0
216-A-36A				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source XIV	3	3	1650	$4,950	$21,390	5	5	$8,250	$17,850	$52,440
216-A-6				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
200 WEST	48	141	4950	$237,600	$1,005,330	84	252	$415,800	$899,640	$2,558,370
				$0	$0			$0	$0	$0
Source I	3	9	4950	$14,850	$64,170	6	18	$29,700	$64,260	$172,980
216-S-5				$0	$0			$0	$0	$0
216-S-6				$0	$0			$0	$0	$0
216-S-17				$0	$0			$0	$0	$0
216-S-16P				$0	$0			$0	$0	$0
216-S-16D				$0	$0			$0	$0	$0

NOTE 8. STAGE II & III

TOTAL COSTS FOR GROUNDWATER SAMPLING LABOR AND ANALYSIS (Continued)

source	stage 2 cluster*	stage 2 gw sample*	per cluster labor cost**	stage 2 sampling labor***	stage 2 analysis cost (#samples X $7130) ****	stage 3 gw clusters*	stage 3 gw samples*	stage 3 sampling labor ***	stage 3 analysis cost (#samples X $3570) ****	total stage 2 + 3 costs
Source II	4	12	4950	$19,800	$85,560	8	24	$39,600	$85,680	$230,640
216-S-1&2				$0	$0			$0	$0	$0
216-S-7				$0	$0			$0	$0	$0
216-S-3				$0	$0			$0	$0	$0
216-S-9				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source III	4	12	4950	$19,800	$85,560	8	24	$39,600	$85,680	$230,640
216-S-20				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source IV	3	9	4950	$14,850	$64,170	5	15	$24,750	$53,550	$157,320
216-S-4				$0	$0			$0	$0	$0
216-S-21				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source V	3	9	4950	$14,850	$64,170	5	15	$24,750	$53,550	$157,320
216-U-11				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source VI	3	9	4950	$14,850	$64,170	5	15	$24,750	$53,550	$157,320
216-U-3				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source VII	3	9	4950	$14,850	$64,170	5	15	$24,750	$53,550	$157,320
216-Z-1&2				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source VIII	3	9	4950	$14,850	$64,170	5	15	$24,750	$53,550	$157,320
216-U-1&2				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source IX	3	9	4950	$14,850	$64,170	5	15	$24,750	$53,550	$157,320
216-U-4				$0	$0			$0	$0	$0
216-U-4A				$0	$0			$0	$0	$0
216-U-4B				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source X	3	9	4950	$14,850	$64,170	5	15	$24,750	$53,550	$157,320
216-Z-7				$0	$0			$0	$0	$0
216-Z-10				$0	$0			$0	$0	$0

NOTE 8. STAGE II & III
TOTAL COSTS FOR GROUNDWATER SAMPLING LABOR AND ANALYSIS (Continued)

source	stage 2 cluster*	stage 2 gw sample*	per cluster labor cost**	stage 2 sampling labor***	stage 2 analysis cost (#samples X $7130) ****	stage 3 gw clusters*	stage 3 gw samples*	stage 3 sampling labor ***	stage 3 analysis cost (#samples X $3570) ****	total stage 2 + 3 costs
Source XI	3	9	4950	$14,850	$64,170	5	15	$24,750	$53,550	$157,320
216-T-19				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source XII	3	9	4950	$14,850	$64,170	5	15	$24,750	$53,550	$157,320
216-T-7				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source XIII	3	9	4950	$14,850	$64,170	5	15	$24,750	$53,550	$157,320
216-T-28				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source XIV	3	9	4950	$14,850	$64,170	6	18	$29,700	$64,260	$172,980
216-T-3				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
Source XV	3	9	4950	$14,850	$64,170	6	18	$29,700	$64,260	$172,980
216-T-2				$0	$0			$0	$0	$0
216-T-8				$0	$0			$0	$0	$0
				$0	$0			$0	$0	$0
300 AREA	11	22		$0	$156,860	22	44	$0	$157,080	$313,940
				$0	$0			$0	$0	$0
316-1	4	8	1800	$7,200	$57,040	8	16	$14,400	$57,120	$135,760
				$0	$0			$0	$0	$0
316-2	4	8	1800	$7,200	$57,040	8	16	$14,400	$57,120	$135,760
				$0	$0			$0	$0	$0
316-3	3	6	1800	$5,400	$42,780	6	12	$10,800	$42,840	$101,820

* Numbers of clusters/groundwater samples per source per stage were derived from Table 3-2.
** See Note 8A.
*** Number of clusters sampled X per cluster sampling cost.
**** See Note 8C.

NOTE 8A

ESTIMATED COSTS FOR STAGE V
WELL CLUSTER SAMPLING

Area	Depth/Cost*	Depth/Cost*	Depth/Cost*	Per Cluster Total**
100 B/C	108/$900	206/$1200	304/$1650	$ 3,750
100 KE/KW	86/$900	195/$1200	304/$1650	3,750
100 D/DR	97/$900	226/$1200	354/$1650	3,750
100 H	56/$900	205/$1200	354/$1650	3,750
100 F	64/$900	209/$1200	354/$1650	3,750
200 E	354/$1650	---	---	1,650
200 W	272/$1650	325/$1650	380/$1650	4,950
300	57/$900	85/$900	---	1,800

* Per well labor/materials cost breakdown, as detailed in Note 8B.

** This represents the cost to sample any one cluster of wells in the area in question.

NOTE 8B

ESTIMATED COSTS FOR STAGE II & III
WELL CLUSTER SAMPLING (Continued)

1. Average 80' Well

o Install pump/purge/withdraw pump 3 hrs x 3 men x $50/hr		$ 450
o Decon and Sample 1 hr x 3 men x $50/hr		150
o Dedicated bailer $200		200
o Equipment rental/expendables		100
	Total	$ 900

2. Average 150-175' Well

o 5 hrs x 3 men x $50/hr		$ 705
o 1 hr x 3 men x $50/hr		150
o $200		200
o Equipment rental/expendables		100
	Total	$1,200

3. Average 300-330' Well

o 7 hrs x 3 men x $50/hr		$ 1,050
o 2 hrs x 3 men x $50/hr		300
o $200		200
o Equipment rental/expendables		100
	Total	$ 1,650

NOTE 8C

ESTIMATED LABORATORY ANALYTICAL COSTS FOR SOILS AND WATER

Assume Laboratory Analysis Per Sample; Entire Appendix, 9 suite, Radionuclides, 4 pesticides*

Compound	Cost in Soil	Cost in Water
Organics		
VOX	580	500
Semi VOC	1,020	950
Chlorine Dioxius	1,000	850
Ferunds		
Inorganics	590	440
Pesticides		
Organo chlorine PCB Pesticide	360	300
Orthophosphate Pesticides	360	300
Radionuclides (complete suite on the Hanford Reservation)	2,855 $ (6,800)	2,855 $ 6,200
Subtotal	6,765	
Total Analytical Cost per Sample for Stage II Analysis**	$ 7,820	$ 7,130
Total Analytical Cost per Sample for Stage III Analysis***	$ 3,910	$ 3,570

* Note: Herbicides are not included in the Totals for soil and water: Soil cost 275 each species and water cost 200 each species.

** Assumes 15% increase for duplicates and replicates

**** It is assumed that by Stage III, the suite of analytes required can be reduced based upon evaluation of Stage II findings. A cost reduction of 50% is assumed.

NOTE 9

ESTIMATED "EPHEMERAL OVERFLOWS" SURFACE WATER/SEDIMENT SAMPLES COLLECTION COSTS

Per Sample Pt. (1 Surface Water + 1 Sediment), Excluding Analysis

o 2 Men x 6 hrs x $50/hr	$ 600
o Expendables	50
Sample Collection Cost Per Point	$ 650
o Analytical Cost (per estimated laboratory Analytical costs for Soils and Water Sheet)	$14,950
	$15,600

TABLE 2-23. SUMMARY OF UNCONFINED AQUIFER CHARACTERIZATION COSTS *

Area	Pathway
	Groundwater
100 B/C	$959,100
100K KE/KW	$959,100
100 D/DR	$959,100
100 H	$959,100
100 F	$959,100
200 E	$959,100
200 W	$959,100
300	$959,100
Total	$7,672,800

*Costs include estimated well installation, development, borehole geophysics, sampling and laboratory analysis. (see Notes A, B, C and D)

NOTE A

ESTIMATED BASALT GROUNDWATER MONITORING WELL
INSTALLATION/DEVELOPMENT COSTS

o Estimated 1100' : 300' to basalt w/8" surf. casing cemented in; 800' into basalt - open hole completion	
o Drill & Set 8" Surface Casing w/Tricone bit 300' x $200/ft*	$ 60,000
o Drill additional 400' w/hammer bit 800' x $200/ft*	$160,000
o Well Development - Air first, then Pump 6 hrs x $200/hr	$ 1,200
o Guard Posts - $300	$ 300
o Clean-up - $200	$ 200
o Stand-by - $200/hr x 2 hrs	$ 400
o Drums	
11" hole x 300' = 198 cu. ft. 6" hole x 400' = 78 cu. ft. 276 cu. ft. x 1.3 Expansion Factor = 359 cu. ft.	
359 cu. ft./7 cu. ft./drum = 51 drums per well 51 drums x $75/drum	$ 3,825
o Geologist and H & S person labor	
Surface casing 2 men x 36 hrs x $50/hr	$ 3,600
Deep hole in basalt 2 men x 8 days x 12 hrs/day x $50/hr	$ 9,600
Development 2 men x 6 hrs x $50/hr	$ 600
o Expendables	$ 200
o Surveying	$ 250
TOTAL COST PER BASALT WELL	$240,175

*Assumes safety facility included with drilling.

NOTE B

ESTIMATED BASALT GROUNDWATER MONITORING WELL
SAMPLING COSTS

Assume Average Well Depth = 700 feet

o Install pump/purge/withdraw pump 8 hours x 3 men x $50/hour		$1200
o Decon and sample 4 hours x 3 men x $50/hour		600
o Dedicated bailer		200
o Equipment rental/expendables		500
	Total	$2500/well

NOTE C

ESTIMATED DOWNHOLE GEOPHYSICS COSTS FOR STAGE IV GROUNDWATER MONITORING WELLS

o $1/foot - Average well depth = 700 ft. Assume 8 hours per hole drop $700 per suite per well	$ 700
o Engineers and Equipment	900
o H & S - 8 hr - $50/hr	400
o Miscellaneous	300
	$ 2,300 per well

ESTIMATED STAGE IV AQUIFER TEST COSTS

- o Assume costs to conduct and interpret data
- o 48 pump tests
- o Assume that no discharged well water will be contained

Labor

2 staff @ 55 hrs/test = 8 hrs X $50/hr	=	$ 5,500 per well
Data Analysis 4 hrs/well X $50/hr	=	200 per well
Miscellaneous expendables and all equipment inclusive	=	2,000 per well
		$ 5,700 per well

NOTE D

ESTIMATED BASALT GROUNDWATER AND CORE ANALYTICAL LABORATORY COSTS

Assume 4 water samples from the basalts

o 4 water samples @ $7,130	$28,520
Assume a sample every 5 ft. from a 400 ft length of coring	
o 80 samples per well @ $7,820	$625,600

Total Cost per Well	$654,120

develop assumptions on the lateral and vertical migration of the wastes in order to determine which of the selected remedial alternatives, or combination of alternatives would be applied: The remedial alternatives and their associated unit costs are:

Alternative	Unit Cost
Cap/Cover Systems	$45/Sq Yd of Surface Area
Grouting In-Situ	$60/Cu Yd of Contaminated Soil
In-Situ Vitrification	$389/Cu Yd of Contaminated Soil
Soil Flushing	$35/Cu Yd of Contaminated Soil
Groundwater treatment	$47/Cu Yd of Soil Treated
Excavation	$365/Cu Yd excavated(1)

(1)$689/Cu Yd if thermal treatment is required prior to disposal.

The Waste Management Operations Report, Vol. 2, was reviewed and site 216-S-1&2 was selected to develop a representative scenario. Because a description of the extent of contaminant spread was not available for the other 80 sites, the information available for site 216-S-1&S was generalized in an attempt to describe the remaining sites. The application of the available site 216-S-1&2 information was applied to the remaining sites using the following assumptions:

- Lateral migration appeared to be mainly caused by the occurrence of clay lenses or caliche at depths of 30 to 50 feet under many of the sites

- The sites were not lined and the seepage of liquids from the site into and through the soil column was expected to be similar

- Except for ponds and reverse wells, it was assumed that disposal conditions (hydraulic head, geologic substrat, rate of seepage ...) at each unit type were roughly the same

- Because records did not indicate that a perched water table was created beneath a disposal pond or that sites near disposal ponds were inundated by subsurface lateral flow from ponds, it was assumed that the seepage from ponds was able to penetrate, dissolve and pass through discontinuities in the caliche or clay semi-permeable layers. Some lateral spread was expected, but, because additional information was unavailable, the same spread dimension described at site 216-S-1&2 was used. (Because the pond dimension are so large, the addition of this spread dimension is relatively insensitive for an order-of-magnitude analysis).

- Reverse wells and dry wells are assumed to penetrate through the caliche layer but may lie within or above clay lenses that promote lateral spread. A clay lens is not expected to reduce vertical migration as much as a continuous caliche layer will. For this reason, and because of the large hydraulic pressures expected from these diagonal types, the lateral extent of contamination was again expected to be similar to site 216-S-1&2.

The lateral migration of radionuclides at site 216-S-1&2 is about 115 feet on each side (the concentration of radionuclides decreased to $\leq 10^{-4}$ uCi/gm outside that point) and it appears to be about average. Using the 115 feet as the average extent of lateral migration, we then calculated an approximate area for cap/cover or volume for excavation as follows:

$$A = (L + 230 + D)(W + 230 + D) \text{ and} \qquad (1)$$

$V = A \times D$ where

L = Length

W = Width

D = Depth of excavation

and site slopes are assumed to be 1:1. The maximum depth of excavation was limited to 60 feet to negate the need for shoring.

For the in-situ treatment processes (grout-in-place, in-situ vitrification and solution mining) the volume of soil treated is given by:

$$Vol = (L + 230)(W + 230)Z \qquad (2)$$

Where Z = the thickness of the soil column to be treated

This volume was adjusted by the soil void fraction for the solution mining alternative, which was taken as 0.20. For solution mining it was further assumed that ten volume charges would be required to completely flush the soil.

Other assumptions used include:

Cap/Cover:	An additional 20 feet on each side beyond the contaminated zone.
Grout-in-Place:	The maximum depth was 160 feet or to the ground water elevation which ever was less. This limit of 160 feet is based on the available data from the S1&2 site which shows a maximum depth of concentrated contaminants of 150 feet. The recommended depth for grouting is 10 feet below this contaminated zone.
In-Situ Vitrification:	The vitrification zone extended from 10 feet above the waste, (i.e., bottom of crib, pond, etc.) to a maximum depth of 50 feet.
Excavation/ Disposal:	Available information regarding the chemicals disposed of in each site was reviewed and only those sites containing chemical wastes which can be thermally destroyed were assumed to be treated in such a manner, otherwise direct disposal following packaging was assumed.

Soil Flushing: Soil flushing was assumed to be used only to a depth of 250 feet or to the depth of the ground water, whichever was less.

Groundwater Recovery and Treatment: Costs associated with recovery and treatment of contaminated groundwater were estimated from the soil flushing scenario. Treatment costs were added.

The "No Action" cost is given whenever the original contaminants may have already been flushed through the soil. For these sites a cost associated with fencing the site was identified including a 200 foot buffer around the estimated laterally contaminated area, and monitoring the site. Monitoring costs are annual costs incurred during each of the assumed 100 years of institutional control.

For some of the sites where more than one technology was identified as being applicable, we have developed cost that reflect this combination of technologies. An example would be a site where excavation to 60 feet was identified along with solution mining to 250 feet. Since solution mining may not be highly efficient, especially for the non-soluble contaminants, and excavation would not reach the contaminants below 60 feet, we have calculated the combined cost of excavating to 60 feet followed by solution mining the from 60 feet to 250 feet below grade.

Using these assumptions a table was developed identifying all of the costs associated wtih each of the technologies previously identified as appropriate for each site. Table 2-24 shows these costs and identifies the range of costs.

Hanford Inactive Waste Site Study.

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

			Unit Type (feet)				CAPPING TECHNIQUE					
	Site No. (1)	Unit Type (12)	Depth	Length	Width	Diameter	Surface Area (sq yd)	FS ($)	ENG ($)	RA ($)	Mon ($)	Total Cost ($)
1	116-B-1	Trench	20	100	10		11,511	200,000	77,700	518,000	1,800,000	2,595,700
2	116-B-4	French Drain	20			4	0	0	0	0	0	0
3	116-C-1	Trench	25	500	50		0	0	0	0	0	0
4	116-C-2	Crib	20	140	100		16,856	300,000	75,850	758,500	1,800,000	2,934,350
5	116-D-1B	Trench	15	100	10		11,511	200,000	77,700	518,000	1,800,000	2,595,700
6	116-DR-1	Trench	20	300	15		0	0	0	0	0	0
7	116-DR-2	Trench	20	150	10		0	0	0	0	0	0
8	116-DR-6	Trench	10	50	10		9,956	100,000	89,600	448,000	1,800,000	2,437,600
9	116-DR-7	Crib	10	5	5		8,403	100,000	75,625	378,125	1,800,000	2,353,750
10	116-F-1	Trench	10	3000	40		112,633	300,000	506,850	5,068,500	1,800,000	7,675,350
11	116-F-2	Trench	15	300	50		0	0	0	0	0	0
12	116-F-3	Trench	8	100	20		11,922	200,000	80,475	536,500	1,800,000	2,616,975
13	116-F-6	Trench	10	300	100		0	0	0	0	0	0
14	116-F-9	Trench	10	500	15		0	0	0	0	0	0
15	116-F-10	French Drain	10			3	6,504	100,000	58,535	292,675	1,800,000	2,251,210
16	116-H-1	Trench	15	200	25		0	0	0	0	0	0
17	116-H-2	Trench	6	275	100		22,406	300,000	100,825	1,008,250	1,800,000	3,209,075
18	116-H-3	French Drain	15			3	6,504	100,000	58,535	292,675	1,800,000	2,251,210
19	100 KE*1	Dry Well (11&12)	4	4	4		8,342	100,000	75,076	375,380	1,800,000	2,350,456
20	100 KE*2	French Drain (12)	3	0	0	3	6,504	100,000	58,535	292,675	1,800,000	2,251,210
21	100 KW*1	Dry Well (11&12)	4	4	4		8,342	100,000	75,076	375,380	1,800,000	2,350,456
22	100 KW*2	French Drain (12)	3			3	6,504	100,000	58,535	292,675	1,800,000	2,251,210
23	116-K-1	Crib	30			400	0	0	0	0	0	0
24	116-K-2	Trench	20	4000	50		0	0	0	0	0	0
25	116-KE-2	Crib	32	16	16		9,088	100,000	81,796	408,980	1,800,000	2,390,776
26	216-B-43	Crib	15									
27	216-B-44	Crib (12)	15									
28	216-B-45	Crib (12)	15									
29	216-B-46	Crib (12)	15	150	300		0	0	0	0	0	0
30	216-B-48	Crib (12)	15									
31	216-B-49	Crib (12)	15									
32	216-B-50	Crib (12)	15									
33	216-B-2-2	Ditch	8	2350	15		0	0	0	0	0	0
34	216-B-5	Reverse Well	302			0.67	0	0	0	0	0	0
35	216-B-6	Reverse Well	75			0.5	6,385	100,000	57,468	287,339	1,800,000	2,244,807
36	216-B-7 A&B	Crib	14	14	14		0	0	0	0	0	0
37	216-B-10A	Crib	20	14	14		8,962	100,000	80,656	403,280	1,800,000	2,383,936

Hanford Inactive Waste Site Study.

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

GROUT-IN-PLACE TECHNIQUE

	Site No. (1)	Unit Type (12)	Unit Type (feet) Depth	Length	Width	Diameter	Surface Area (sq yd)	Grouting Depth (yd)	FS ($)	ENG ($)	RA ($)	Mon ($)	Total Cost ($)
1	116-B-1	Trench	20	100	10		8,800	0	0	0	0	0	0
2	116-B-4	French Drain	20			4	4,778	24	100,000	1,357,055	6,785,275	1,800,000	10,042,330
3	116-C-1	Trench	25	500	50		22,711	14	300,000	1,700,000	18,623,111	1,800,000	22,423,111
4	116-C-2	Crib	20	140	100		13,567	0	0	0	0	0	0
5	116-D-1B	Trench	15	100	10		8,800	0	0	0	0	0	0
6	116-DR-1	Trench	20	300	15		14,428	19	200,000	1,800,000	16,159,111	1,800,000	19,959,111
7	116-DR-2	Trench	20	150	10		10,133	19	200,000	1,702,400	11,349,333	1,800,000	15,051,733
8	116-DR-6	Trench	10	50	10		7,467	0	0	0	0	0	0
9	116-DR-7	Crib	10	5	5		6,136	0	0	0	0	0	0
10	116-F-1	Trench	10	3000	40		96,900	4	300,000	1,700,000	25,194,000	1,800,000	28,994,000
11	116-F-2	Trench	15	300	50		16,489	0	0	0	0	0	0
12	116-F-3	Trench	8	100	20		9,167	0	0	0	0	0	0
13	116-F-6	Trench	10	300	100		19,433	12	300,000	1,399,200	13,992,000	1,800,000	17,491,200
14	116-F-9	Trench	10	500	15		19,872	17	200,000	1,800,000	19,872,222	1,800,000	23,672,222
15	116-F-10	French Drain	10			3	4,738	0	0	0	0	0	0
16	116-H-1	Trench	15	200	25		12,183	14	200,000	1,535,100	10,234,000	1,800,000	13,769,100
17	116-H-2	Trench	6	275	100		18,517	0	0	0	0	0	0
18	116-H-3	French Drain	15			3	4,738	0	0	0	0	0	0
19	100 KE*1	Dry Well (11&12)	4	4	4		6,084	0	0	0	0	0	0
20	100 KE*2	French Drain (12)	3	0	0	3	4,738	0	0	0	0	0	0
21	100 KW*1	Dry Well (11&12)	4	4	4		6,084	0	0	0	0	0	0
22	100 KW*2	French Drain (12)	3			3	4,738	0	0	0	0	0	0
23	116-K-1	Crib	30			400	34,636	0	0	0	0	0	0
24	116-K-2	Trench	20	4000	50		131,600	11	300,000	1,700,000	89,488,000	1,800,000	93,288,000
25	116-KE-2	Crib	32	16	16		6,724	23	100,000	1,828,928	9,144,640	1,800,000	12,873,568
26	216-B-43	Crib	15										
27	216-B-44	Crib (12)	15										
28	216-B-45	Crib (12)	15										
29	216-B-46	Crib (12)	15	150	300		22,378	53	300,000	1,700,000	71,608,889	1,800,000	75,408,889
30	216-B-48	Crib (12)	15										
31	216-B-49	Crib (12)	15										
32	216-B-50	Crib (12)	15										
33	216-B-2-2	Ditch	8	2350	15		70,233	53	300,000	1,700,000	224,746,667	1,800,000	228,546,667
34	216-B-5	Reverse Well	302			0.67	4,643	53	100,000	1,900,000	14,858,658	1,800,000	18,658,658
35	216-B-6	Reverse Well	75			0.5	4,636	0	0	0	0	0	0
36	216-B-7 A&B	Crib	14	14	14		6,615	53	100,000	1,900,000	21,168,356	1,800,000	24,968,356
37	216-B-10A	Crib	20	14	14		6,615	53	100,000	1,900,000	21,168,356	1,800,000	24,968,356

Hanford Inactive Waste Site Study.

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

	Site No. (1)	Unit Type (12)	Unit Type (feet) Depth	Length	Width	Diameter	VITRIFICATION TECHNIQUE Vitrif. Depth (yd)	FS ($)	ENG ($)	RA ($)	Mon ($)	Total Cost ($)
1	116-B-1	Trench	20	100	10		0	0	0	0	0	0
2	116-B-4	French Drain	20			4	13	100,000	1,900,000	24,783,773	1,800,000	28,583,773
3	116-C-1	Trench	25	500	50		9	300,000	1,700,000	76,566,726	1,800,000	80,366,726
4	116-C-2	Crib	20	140	100		0	0	0	0	0	0
5	116-D-1B	Trench	15	100	10		0	0	0	0	0	0
6	116-DR-1	Trench	20	300	15		0	0	0	0	0	0
7	116-DR-2	Trench	20	150	10		0	0	0	0	0	0
8	116-DR-6	Trench	10	50	10		0	0	0	0	0	0
9	116-DR-7	Crib	10	5	5		0	0	0	0	0	0
10	116-F-1	Trench	10	3000	40		0	0	0	0	0	0
11	116-F-2	Trench	15	300	50		10	300,000	1,700,000	64,141,778	1,800,000	67,941,778
12	116-F-3	Trench	8	100	20		0	0	0	0	0	0
13	116-F-6	Trench	10	300	100		12	300,000	1,700,000	90,714,800	1,800,000	94,514,800
14	116-F-9	Trench	10	500	15		0	0	0	0	0	0
15	116-F-10	French Drain	10			3	0	0	0	0	0	0
16	116-H-1	Trench	15	200	25		12	200,000	1,800,000	58,451,572	1,800,000	62,251,572
17	116-H-2	Trench	6	275	100		0	0	0	0	0	0
18	116-H-3	French Drain	15			3	0	0	0	0	0	0
19	100 KE*1	Dry Well (11&12)	4	4	4		0	0	0	0	0	0
20	100 KE*2	French Drain (12)	3	0	0	3	0	0	0	0	0	0
21	100 KW*1	Dry Well (11&12)	4	4	4		0	0	0	0	0	0
22	100 KW*2	French Drain (12)	3			3	0	0	0	0	0	0
23	116-K-1	Crib	30			400	10	300,000	1,700,000	134,734,270	1,800,000	138,534,270
24	116-K-2	Trench	20	4000	50		0	0	0	0	0	0
25	116-KE-2	Crib	32	16	16		9	100,000	1,900,000	24,412,603	1,800,000	28,212,603
26	216-B-43	Crib	15									
27	216-B-44	Crib (12)	15									
28	216-B-45	Crib (12)	15									
29	216-B-46	Crib (12)	15	150	300		15	300,000	1,700,000	130,574,333	1,800,000	134,374,333
30	216-B-48	Crib (12)	15									
31	216-B-49	Crib (12)	15									
32	216-B-50	Crib (12)	15									
33	216-B-2-2	Ditch	8	2350	15		0	0	0	0	0	0
34	216-B-5	Reverse Well	302			0.67	0	0	0	0	0	0
35	216-B-6	Reverse Well	75			0.5	0	0	0	0	0	0
36	216-B-7 A&B	Crib	14	14	14		0	0	0	0	0	0
37	216-B-10A	Crib	20	14	14		13	100,000	1,900,000	34,310,376	1,800,000	38,110,376

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Table 2-24

EXCAVATION and DISPOSAL TECHNIQUES

	Site No. (1)	Excavation Volume (cu yd)	Excavation & Disposal FS ($)	ENG ($)	RA ($)	Total Cost (E/D only) ($)	Excavation & Incineration FS ($)	ENG ($)	RA ($)	Total Cost (E/D + INCIN) ($)	Mon ($)
1	116-B-1	0	0	0	0	0	0	0	0	0	0
2	116-B-4	161,296	100,000	1,900,000	58,873,167	62,573,167	0	0	0	0	1,800,000
3	116-C-1	392,554	300,000	1,700,000	143,282,115	146,782,115	0	0	0	0	1,800,000
4	116-C-2	243,572	300,000	1,700,000	88,903,739	92,403,739	300,000	1,700,000	167,821,031	171,621,031	1,800,000
5	116-D-1B	275,556	200,000	1,800,000	100,577,778	104,177,778	0	0	0	0	1,800,000
6	116-DR-1	0	0	0	0	0	0	0	0	0	0
7	116-DR-2	0	0	0	0	0	0	0	0	0	0
8	116-DR-6	241,111	100,000	1,900,000	88,005,556	91,705,556	0	0	0	0	1,800,000
9	116-DR-7	206,722	100,000	1,900,000	75,453,611	79,153,611	0	0	0	0	1,800,000
10	116-F-1	0	0	0	0	0	0	0	0	0	0
11	116-F-2	0	0	0	0	0	0	0	0	0	0
12	116-F-3	0	0	0	0	0	0	0	0	0	0
13	116-F-6	533,333	300,000	1,700,000	194,666,667	198,166,667	0	0	0	0	1,800,000
14	116-F-9	0	0	0	0	0	0	0	0	0	0
15	116-F-10	160,237	100,000	1,900,000	58,486,481	62,186,481	0	0	0	0	1,800,000
16	116-H-1	0	0	0	0	0	0	0	0	0	0
17	116-H-2	0	0	0	0	0	0	0	0	0	0
18	116-H-3	160,237	100,000	1,900,000	58,486,481	62,186,481	0	0	0	0	1,800,000
19	100 KE*1	205,369	100,000	1,900,000	74,959,644	78,659,644	0	0	0	0	1,800,000
20	100 KE*2	160,237	100,000	1,900,000	58,486,481	62,186,481	0	0	0	0	1,800,000
21	100 KW*1	205,369	100,000	1,900,000	74,959,644	78,659,644	0	0	0	0	1,800,000
22	100 KW*2	160,237	100,000	1,900,000	58,486,481	62,186,481	0	0	0	0	1,800,000
23	116-K-1	0	0	0	0	0	0	0	0	0	0
24	116-K-2	3,344,444	300,000	1,700,000	1,220,722,222	1,224,222,222	0	0	0	0	1,800,000
25	116-KE-2	221,902	100,000	1,900,000	80,994,311	84,694,311	0	0	0	0	1,800,000
26	216-B-43										
27	216-B-44										
28	216-B-45										
29	216-B-46	600,000	300,000	1,700,000	219,000,000	222,500,000	300,000	1,700,000	413,400,000	417,200,000	1,800,000
30	216-B-48										
31	216-B-49										
32	216-B-50										
33	216-B-2-2	0	0	0	0	0	0	0	0	0	0
34	216-B-5	0	0	0	0	0	0	0	0	0	0
35	216-B-6	0	0	0	0	0	0	0	0	0	0
36	216-B-7 A&B	219,102	100,000	1,900,000	79,972,311	83,672,311	100,000	1,900,000	150,961,431	154,761,431	1,800,000
37	216-B-10A	0	0	0	0	0	0	0	0	0	0

Hanford Inactive Waste Site Study.

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

	Site No. (1)	Water Vol (cu yd)	(of entire soil column) FS ($)	ENG ($)	RA ($)	Total Cost (SF only) ($)	Soil Flushing (with excavating) FS ($)	ENG ($)	RA ($)	Total Cost (SF + E/D) ($)	Mon ($)
1	116-B-1	120,267	200,000	847,880	5,652,533	8,500,413	0	0	0	0	1,800,000
2	116-B-4	0	0	0	0	0	0	0	0	0	0
3	116-C-1	310,385	300,000	1,458,810	14,588,104	18,146,914	0	0	0	0	1,800,000
4	116-C-2	0	0	0	0	0	0	0	0	0	0
5	116-D-1B	0	0	0	0	0	0	0	0	0	0
6	116-DR-1	269,319	200,000	1,800,000	12,657,970	16,457,970	0	0	0	0	1,800,000
7	116-DR-2	189,156	200,000	1,333,547	8,890,311	12,223,858	0	0	0	0	1,800,000
8	116-DR-6	0	0	0	0	0	0	0	0	0	0
9	116-DR-7	0	0	0	0	0	0	0	0	0	0
10	116-F-1	419,900	300,000	1,700,000	19,735,300	23,535,300	0	0	0	0	1,800,000
11	116-F-2	192,370	300,000	904,141	9,041,407	12,045,548	0	0	0	0	1,800,000
12	116-F-3	0	0	0	0	0	0	0	0	0	0
13	116-F-6	0	0	0	0	0	0	0	0	0	0
14	116-F-9	331,204	200,000	1,800,000	15,566,574	19,366,574	0	0	0	0	1,800,000
15	116-F-10	0	0	0	0	0	0	0	0	0	0
16	116-H-1	170,567	200,000	1,202,495	8,016,633	11,219,128	0	0	0	0	1,800,000
17	116-H-2	259,233	300,000	1,218,397	12,183,967	15,502,363	0	0	0	0	1,800,000
18	116-H-3	0	0	0	0	0	0	0	0	0	0
19	100 KE*1	0	0	0	0	0	0	0	0	0	0
20	100 KE*2	0	0	0	0	0	0	0	0	0	0
21	100 KW*1	0	0	0	0	0	0	0	0	0	0
22	100 KW*2	0	0	0	0	0	0	0	0	0	0
23	116-K-1	577,268	300,000	1,700,000	27,131,580	30,931,580	0	0	0	0	1,800,000
24	116-K-2	1,491,467	300,000	1,700,000	70,098,933	73,898,933	0	0	0	0	1,800,000
25	116-KE-2	0	0	0	0	0	0	0	0	0	0
26	216-B-43										
27	216-B-44										
28	216-B-45										
29	216-B-46	1,633,578	300,000	1,700,000	76,778,156	80,578,156	300,000	1,700,000	1,918,462,200	1,922,262,200	1,800,000
30	216-B-48										
31	216-B-49										
32	216-B-50										
33	216-B-2-2	5,969,833	300,000	1,700,000	280,582,167	284,382,167	0	0	0	0	1,800,000
34	216-B-5	484,454	100,000	1,900,000	22,769,345	26,569,345	0	0	0	0	1,800,000
35	216-B-6	0	0	0	0	0	0	0	0	0	0
36	216-B-7 A&B	531,414	100,000	1,900,000	24,976,455	28,776,455	100,000	1,900,000	657,434,183	661,234,183	1,800,000
37	216-B-10A	0	0	0	0	0	0	0	0	0	0

Hanford Inacti

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Table 2-24

	Site No. (1)	(with vitrification) FS ($)	ENG ($)	RA ($)	Total Cost (SF + VITRIF) ($)	Mon ($)	No Action Perimeter (yd)	FS ($)	RA ($)	Mon ($)	Total Cost ($)
1	116-B-1	0	0	0	0	1,800,000	433	100,000	18,915	6,000,000	6,118,915
2	116-B-4	0	0	0	0	0	287	100,000	12,525	6,000,000	6,112,525
3	116-C-1	0	0	0	0	1,800,000	727	100,000	31,719	6,000,000	6,131,719
4	116-C-2	0	0	0	0	0	520	100,000	22,698	6,000,000	6,122,698
5	116-D-1B	0	0	0	0	0	433	100,000	18,915	6,000,000	6,118,915
6	116-DR-1	0	0	0	0	1,800,000	570	100,000	24,881	6,000,000	6,124,881
7	116-DR-2	0	0	0	0	1,800,000	467	100,000	20,370	6,000,000	6,120,370
8	116-DR-6	0	0	0	0	0	400	100,000	17,460	6,000,000	6,117,460
9	116-DR-7	0	0	0	0	0	367	100,000	16,005	6,000,000	6,116,005
10	116-F-1	0	0	0	0	1,800,000	2,387	100,000	104,178	6,000,000	6,204,178
11	116-F-2	0	0	0	0	1,800,000	593	100,000	25,899	6,000,000	6,125,899
12	116-F-3	0	0	0	0	0	440	100,000	19,206	6,000,000	6,119,206
13	116-F-6	0	0	0	0	0	627	100,000	27,354	6,000,000	6,127,354
14	116-F-9	0	0	0	0	1,800,000	703	100,000	30,701	6,000,000	6,130,701
15	116-F-10	0	0	0	0	0	286	100,000	12,479	6,000,000	6,112,479
16	116-H-1	0	0	0	0	1,800,000	510	100,000	22,262	6,000,000	6,122,262
17	116-H-2	0	0	0	0	1,800,000	610	100,000	26,627	6,000,000	6,126,627
18	116-H-3	0	0	0	0	0	286	100,000	12,479	6,000,000	6,112,479
19	100 KE*1	0	0	0	0	0	365	100,000	15,947	6,000,000	6,115,947
20	100 KE*2	0	0	0	0	0	286	100,000	12,479	6,000,000	6,112,479
21	100 KW*1	0	0	0	0	0	365	100,000	15,947	6,000,000	6,115,947
22	100 KW*2	0	0	0	0	0	286	100,000	12,479	6,000,000	6,112,479
23	116-K-1	0	0	0	0	1,800,000	702	100,000	30,626	6,000,000	6,130,626
24	116-K-2	0	0	0	0	1,800,000	3,060	100,000	133,569	6,000,000	6,233,569
25	116-KE-2	0	0	0	0	0	381	100,000	16,645	6,000,000	6,116,645
26	216-B-43										
27	216-B-44										
28	216-B-45										
29	216-B-46	300,000	1,700,000	1,730,294,533	1,733,794,533	1,800,000	660	100,000	28,809	6,000,000	6,128,809
30	216-B-48										
31	216-B-49										
32	216-B-50										
33	216-B-2-2	0	0	0	0	1,800,000	1,937	100,000	84,536	6,000,000	6,184,536
34	216-B-5	0	0	0	0	1,800,000	283	100,000	12,372	6,000,000	6,112,372
35	216-B-6	0	0	0	0	0	283	100,000	12,365	6,000,000	6,112,365
36	216-B-7 A&B	0	0	0	0	1,800,000	379	100,000	16,529	6,000,000	6,116,529
37	216-B-10A	0	0	0	0	0	379	100,000	16,529	6,000,000	6,116,529

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

	Site No. (1)	Unit Type (12)	Unit Type (feet) Depth	Length	Width	Diameter	Vol. Disp.	CAPPING TECHNIQUE Surface Area (sq yd)	FS ($)	ENG ($)	RA ($)	Mon ($)	Total Cost ($)
38	216-B-16	Crib (12)	12	80	80		5,600,000	0	0	0	0	0	0
39	216-C-1	Crib	13	27	12		23,400,000	0	0	0	0	0	0
40	216-C-10	Crib	7	32	5		897,000	9,228	100,000	83,050	415,250	1,800,000	2,398,300
41	216-A-9	Crib (12)	12	420	20		981,000,000	0	0	0	0	0	0
42	216-A-40	Trench	16	400	20		946,000	21,589	200,000	145,725	971,500	1,800,000	3,117,225
43	216-A-4	Crib (11&12)	25	20	20		6,210,000	0	0	0	0	0	0
44	216-A-5	Crib (12)	32	35	35		1,630,000,000	10,336	200,000	69,769	465,125	1,800,000	2,534,894
45	216-A-6	Crib (12)	19	100	100		3,400,000,000	0	0	0	0	0	0
46	216-A-7	Crib (12)	15	10	10		326,000	8,711	100,000	78,400	392,000	1,800,000	2,370,400
47	216-A-21	Crib (11&12)	19	60	16		77,800,000	0	0	0	0	0	0
48	216-A-24	Crib (12)	15	1400	20		820,000,000	0	0	0	0	0	0
49	216-A-27	Crib (11&12)	14	200	10		23,100,000	0	0	0	0	0	0
50	216-A-28	French Drain	11			20	30,000	7,339	200,000	49,539	330,260	1,800,000	2,379,799
51	216-A-36A	Crib	22	100	11		1,070,000	0	0	0	0	0	0
52	216-S-5	Crib	15	210	210		4,100,000,000	0	0	0	0	0	0
53	216-S-6	Crib	15	210	210		4,470,000,000	0	0	0	0	0	0
54	216-S-16D	Ditch	3	3000	4		400,000,000	99,553	300,000	447,990	4,479,900	1,800,000	7,027,890
55	216-S-16P	Pond	3			1250	40,700,000,000	201,620	300,000	907,292	9,072,920	1,800,000	12,080,212
56	216-S-17	Pond	10	958	958		6,430,000,000	0	0	0	0	0	0
57	216-U-11	Ditch	7	4510	10			148,711	300,000	669,200	6,692,000	1,800,000	9,461,200
58	216-S-1&2	Crib	35	90	40		160,000,000	0	0	0	0	0	0
59	216-S-3	French Drain	6	100	10		4,200,000	0	0	0	0	0	0
60	216-S-4	French Drain	20			2.5	1,000,000	6,480	100,000	58,321	291,604	1,800,000	2,249,924
61	216-S-7	Crib	22	100	50		390,000,000	0	0	0	0	0	0
62	216-S-9	Crib	30	300	30		50,300,000	0	0	0	0	0	0
63	216-S-20	Crib	30	90	40		135,000,000	0	0	0	0	0	0
64	216-S-21	Crib	21	50	50		87,100,000	0	0	0	0	0	0
65	216-U-1&2	Crib	24	78	28		15,900,000	11,523	200,000	77,778	518,520	1,800,000	2,596,298
66	216-U-3	French Drain	12			6	791,000	6,648	100,000	59,828	299,142	1,800,000	2,258,971
67	216-U-4	Reverse Well (11&12)	75			0.5	300,000	0	0	0	0	0	0
68	216-U-4A	French Drain (11&12)	10			4.3	545,000	6,566	100,000	59,094	295,469	1,800,000	2,254,562
69	216-U-4B	French Drain (11&12)	10			4.3	33,000	6,566	100,000	59,094	295,469	1,800,000	2,254,562
70	216-Z-1&2	Crib	21	30	30		38,900,000	0	0	0	0	0	0
71	216-Z-7	Crib	5	210	44		79,900,000	0	0	0	0	0	0
72	216-Z-10	Reverse Well	150			0.5	1,000,000	6,385	100,000	57,468	287,339	1,800,000	2,244,807
73	216-T-2	Reverse Well	75			0.5	6,000,000	6,385	100,000	57,468	287,339	1,800,000	2,244,807

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

			Unit Type (feet)				GROUT-IN-PLACE TECHNIQUE						
	Site No. (1)	Unit Type (12)	Depth	Length	Width	Diameter	Surface Area (sq yd)	Grouting Depth (yd)	FS ($)	ENG ($)	RA ($)	Mon ($)	Total Cost ($)
38	216-B-16	Crib (12)	12	80	80		10,678	0	0	0	0	0	0
39	216-C-1	Crib	13	27	12		6,910	53	100,000	1,900,000	22,113,422	1,800,000	25,913,422
40	216-C-10	Crib	7	32	5		6,841	53	100,000	1,900,000	21,891,556	1,800,000	25,691,556
41	216-A-9	Crib (12)	12	420	20		18,056	53	200,000	1,800,000	57,777,778	1,800,000	61,577,778
42	216-A-40	Trench	16	400	20		17,500	0	0	0	0	0	0
43	216-A-4	Crib (11&12)	25	20	20		6,944	53	100,000	1,900,000	22,222,222	1,800,000	26,022,222
44	216-A-5	Crib (12)	32	35	35		7,803	53	200,000	1,800,000	24,968,889	1,800,000	28,768,889
45	216-A-6	Crib (12)	19	100	100		12,100	53	200,000	1,800,000	38,720,000	1,800,000	42,520,000
46	216-A-7	Crib (12)	15	10	10		6,400	0	0	0	0	0	0
47	216-A-21	Crib (11&12)	19	60	16		7,927	0	0	0	0	0	0
48	216-A-24	Crib (12)	15	1400	20		45,278	53	300,000	1,700,000	144,888,889	1,800,000	148,688,889
49	216-A-27	Crib (11&12)	14	200	10		11,467	0	0	0	0	0	0
50	216-A-28	French Drain	11			20	5,454	0	0	0	0	0	0
51	216-A-36A	Crib	22	100	11		8,837	0	0	0	0	0	0
52	216-S-5	Crib	15	210	210		21,511	53	300,000	1,700,000	68,835,556	1,800,000	72,635,556
53	216-S-6	Crib	15	210	210		21,511	53	300,000	1,700,000	68,835,556	1,800,000	72,635,556
54	216-S-16D	Ditch	3	3000	4		83,980	0	0	0	0	0	0
55	216-S-16P	Pond	3			1250	191,148	0	0	0	0	0	0
56	216-S-17	Pond	10	958	958		156,816	53	300,000	1,700,000	501,811,200	1,800,000	505,611,200
57	216-U-11	Ditch	7	4510	10		126,400	0	0	0	0	0	0
58	216-S-1&2	Crib	35	90	40		9,600	53	200,000	1,800,000	30,720,000	1,800,000	34,520,000
59	216-S-3	French Drain	6	100	10		8,800	53	200,000	1,800,000	28,160,000	1,800,000	31,960,000
60	216-S-4	French Drain	20			2.5	4,717	0	0	0	0	0	0
61	216-S-7	Crib	22	100	50		10,267	53	200,000	1,800,000	32,853,333	1,800,000	36,653,333
62	216-S-9	Crib	30	300	30		15,311	53	200,000	1,800,000	48,995,556	1,800,000	52,795,556
63	216-S-20	Crib	30	90	40		9,600	53	200,000	1,800,000	30,720,000	1,800,000	34,520,000
64	216-S-21	Crib	21	50	50		8,711	53	200,000	1,800,000	27,875,556	1,800,000	31,675,556
65	216-U-1&2	Crib	24	78	28		8,829	0	0	0	0	0	0
66	216-U-3	French Drain	12			6	4,860	0	0	0	0	0	0
67	216-U-4	Reverse Well (11&12)	75			0.5	4,636	53	100,000	1,900,000	14,836,765	1,800,000	18,636,765
68	216-U-4A	French Drain (11&12)	10			4.3	4,791	53	100,000	1,900,000	15,329,992	1,800,000	19,129,992
69	216-U-4B	French Drain (11&12)	10			4.3	4,791	53	100,000	1,900,000	15,329,992	1,800,000	19,129,992
70	216-Z-1&2	Crib	21	30	30		7,511	53	100,000	1,900,000	24,035,556	1,800,000	27,835,556
71	216-Z-7	Crib	5	210	44		13,396	53	200,000	1,800,000	42,865,778	1,800,000	46,665,778
72	216-Z-10	Reverse Well	150			0.5	4,636	0	0	0	0	0	0
73	216-T-2	Reverse Well	75			0.5	4,636	0	0	0	0	0	0

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

			Unit Type (feet)				VITRIFICATION TECHNIQUE					
	Site No. (1)	Unit Type (12)	Depth	Length	Width	Diameter	Vitrif. Depth (yd)	FS ($)	ENG ($)	RA ($)	Mon ($)	Total Cost ($)
38	216-B-16	Crib (12)	12	80	80		0	0	0	0	0	0
39	216-C-1	Crib	13	27	12		16	100,000	1,900,000	42,114,552	1,800,000	45,914,552
40	216-C-10	Crib	7	32	5		17	100,000	1,900,000	44,353,204	1,800,000	48,153,204
41	216-A-9	Crib (12)	12	420	20		0	0	0	0	0	0
42	216-A-40	Trench	16	400	20		0	0	0	0	0	0
43	216-A-4	Crib (11&12)	25	20	20		11	100,000	1,900,000	30,615,741	1,800,000	34,415,741
44	216-A-5	Crib (12)	32	35	35		0	0	0	0	0	0
45	216-A-6	Crib (12)	19	100	100		0	0	0	0	0	0
46	216-A-7	Crib (12)	15	10	10		0	0	0	0	0	0
47	216-A-21	Crib (11&12)	19	60	16		14	100,000	1,900,000	42,140,802	1,800,000	45,940,802
48	216-A-24	Crib (12)	15	1400	20		0	0	0	0	0	0
49	216-A-27	Crib (11&12)	14	200	10		15	200,000	1,800,000	68,394,844	1,800,000	72,194,844
50	216-A-28	French Drain	11			20	0	0	0	0	0	0
51	216-A-36A	Crib	22	100	11		13	200,000	1,800,000	43,541,202	1,800,000	47,341,202
52	216-S-5	Crib	15	210	210		0	0	0	0	0	0
53	216-S-6	Crib	15	210	210		0	0	0	0	0	0
54	216-S-16D	Ditch	3	3000	4		0	0	0	0	0	0
55	216-S-16P	Pond	3			1250	0	0	0	0	0	0
56	216-S-17	Pond	10	958	958		0	0	0	0	0	0
57	216-U-11	Ditch	7	4510	10		0	0	0	0	0	0
58	216-S-1&2	Crib	35	90	40		8	200,000	1,800,000	31,120,000	1,800,000	34,920,000
59	216-S-3	French Drain	6	100	10		17	200,000	1,800,000	57,053,333	1,800,000	60,853,333
60	216-S-4	French Drain	20			2.5	0	0	0	0	0	0
61	216-S-7	Crib	22	100	50		13	200,000	1,800,000	50,587,289	1,800,000	54,387,289
62	216-S-9	Crib	30	300	30		13	200,000	1,800,000	77,428,289	1,800,000	81,228,289
63	216-S-20	Crib	30	90	40		10	200,000	1,800,000	37,344,000	1,800,000	41,144,000
64	216-S-21	Crib	21	50	50		13	200,000	1,800,000	44,052,089	1,800,000	47,852,089
65	216-U-1&2	Crib	24	78	28		0	0	0	0	0	0
66	216-U-3	French Drain	12			6	0	0	0	0	0	0
67	216-U-4	Reverse Well (11&12)	75			0.5	0	0	0	0	0	0
68	216-U-4A	French Drain (11&12)	10			4.3	0	0	0	0	0	0
69	216-U-4B	French Drain (11&12)	10			4.3	0	0	0	0	0	0
70	216-Z-1&2	Crib	21	30	30		13	100,000	1,900,000	37,983,689	1,800,000	41,783,689
71	216-Z-7	Crib	5	210	44		17	200,000	1,800,000	86,847,852	1,800,000	90,647,852
72	216-Z-10	Reverse Well	150			0.5	0	0	0	0	0	0
73	216-T-2	Reverse Well	75			0.5	0	0	0	0	0	0

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

			EXCAVATION and DISPOSAL TECHNIQUES									
				Excavation & Disposal			Total Cost		Excavation &	Incineration	Total Cost	
	Site No. (1)	Unit Type	Excavation Volume (cu yd)	FS ($)	ENG ($)	RA ($)	(E/D only) ($)	FS ($)	ENG ($)	RA ($)	(E/D + INCIN) ($)	Mon ($)
38	216-B-16	Crib (12)	320,889	200,000	1,800,000	117,124,444	120,924,444	200,000	1,800,000	221,092,444	224,892,444	1,800,000
39	216-C-1	Crib	0	0	0	0	0	0	0	0	0	0
40	216-C-10	Crib	225,022	100,000	1,900,000	82,133,111	85,933,111	100,000	1,900,000	155,040,311	158,840,311	1,800,000
41	216-A-9	Crib (12)	0	0	0	0	0	0	0	0	0	0
42	216-A-40	Trench	0	0	0	0	0	0	0	0	0	0
43	216-A-4	Crib (11&	227,556	100,000	1,900,000	83,057,778	86,857,778	0	0	0	0	1,800,000
44	216-A-5	Crib (12)	0	0	0	0	0	0	0	0	0	0
45	216-A-6	Crib (12)	0	0	0	0	0	0	0	0	0	0
46	216-A-7	Crib (12)	213,556	100,000	1,900,000	77,947,778	81,747,778	100,000	1,900,000	147,139,778	150,939,778	1,800,000
47	216-A-21	Crib (11&	252,800	100,000	1,900,000	92,272,000	96,072,000	100,000	1,900,000	174,179,200	177,979,200	1,800,000
48	216-A-24	Crib (12)	0	0	0	0	0	0	0	0	0	0
49	216-A-27	Crib (11&	344,444	200,000	1,800,000	125,722,222	129,522,222	200,000	1,800,000	237,322,222	241,122,222	1,800,000
50	216-A-28	French Dr	178,722	200,000	1,800,000	65,233,426	69,033,426	0	0	0	0	1,800,000
51	216-A-36A	Crib	276,444	200,000	1,800,000	100,902,222	104,702,222	0	0	0	0	1,800,000
52	216-S-5	Crib	578,000	300,000	1,700,000	210,970,000	214,770,000	0	0	0	0	1,800,000
53	216-S-6	Crib	578,000	300,000	1,700,000	210,970,000	214,770,000	0	0	0	0	1,800,000
54	216-S-16D	Ditch	0	0	0	0	0	0	0	0	0	0
55	216-S-16P	Pond	4,193,154	300,000	1,700,000	1,530,501,038	1,534,301,038	0	0	0	0	1,800,000
56	216-S-17	Pond	3,516,809	300,000	1,700,000	1,283,635,244	1,287,435,244	0	0	0	0	1,800,000
57	216-U-11	Ditch	3,313,556	300,000	1,700,000	1,209,447,778	1,213,247,778	0	0	0	0	1,800,000
58	216-S-1&2	Crib	0	0	0	0	0	0	0	0	0	0
59	216-S-3	French Dr	275,556	200,000	1,800,000	100,577,778	104,377,778	200,000	1,800,000	189,857,778	193,657,778	1,800,000
60	216-S-4	French Dr	0	0	0	0	0	0	0	0	0	0
61	216-S-7	Crib	0	0	0	0	0	0	0	0	0	0
62	216-S-9	Crib	0	0	0	0	0	0	0	0	0	0
63	216-S-20	Crib	0	0	0	0	0	0	0	0	0	0
64	216-S-21	Crib	0	0	0	0	0	0	0	0	0	0
65	216-U-1&2	Crib	0	0	0	0	0	0	0	0	0	0
66	216-U-3	French Dr	0	0	0	0	0	0	0	0	0	0
67	216-U-4	Reverse W	0	0	0	0	0	0	0	0	0	0
68	216-U-4A	French Dr	0	0	0	0	0	0	0	0	0	0
69	216-U-4B	French Dr	0	0	0	0	0	0	0	0	0	0
70	216-Z-1&2	Crib	242,000	100,000	1,900,000	88,330,000	92,130,000	0	0	0	0	1,800,000
71	216-Z-7	Crib	389,867	200,000	1,800,000	142,301,333	146,101,333	0	0	0	0	1,800,000
72	216-Z-10	Reverse W	0	0	0	0	0	0	0	0	0	0
73	216-T-2	Reverse W	0	0	0	0	0	0	0	0	0	0

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

			(of entire soil column)				SOIL FLUSHING TECHNIQUES (with excavation)				
	Site No. (1)	Water Vol (cu yd)	FS ($)	ENG ($)	RA ($)	Total Cost (SF only) ($)	FS	ENG ($)	RA ($)	Total Cost (SF + E/D) ($)	Mon ($)
38	216-B-16	1,203,030	200,000	1,800,000	56,542,393	60,342,393	0	0	0	0	1,800,000
39	216-C-1	649,582	100,000	1,900,000	30,530,344	34,330,344	0	0	0	0	1,800,000
40	216-C-10	0	0	0	0	0	0	0	0	0	0
41	216-A-9	1,769,444	200,000	1,800,000	83,163,889	86,963,889	0	0	0	0	1,800,000
42	216-A-40	0	0	0	0	0	0	0	0	0	0
43	216-A-4	0	0	0	0	0	0	0	0	0	0
44	216-A-5	814,090	200,000	1,800,000	38,262,221	42,062,221	0	0	0	0	1,800,000
45	216-A-6	1,169,667	200,000	1,800,000	54,974,333	58,774,333	0	0	0	0	1,800,000
46	216-A-7	0	0	0	0	0	0	0	0	0	0
47	216-A-21	0	0	0	0	0	0	0	0	0	0
48	216-A-24	3,652,407	300,000	1,700,000	171,663,148	175,463,148	0	0	0	0	1,800,000
49	216-A-27	0	0	0	0	0	0	0	0	0	0
50	216-A-28	0	0	0	0	0	0	0	0	0	0
51	216-A-36A	0	0	0	0	0	0	0	0	0	0
52	216-S-5	1,290,667	300,000	1,700,000	60,661,333	64,461,333	300,000	1,700,000	1,302,874,000	1,306,674,000	1,800,000
53	216-S-6	1,290,667	300,000	1,700,000	60,661,333	64,461,333	300,000	1,700,000	1,302,874,000	1,306,674,000	1,800,000
54	216-S-16D	0	0	0	0	0	0	0	0	0	0
55	216-S-16P	11,468,908	300,000	1,700,000	539,038,656	542,838,656	300,000	1,700,000	1,828,857,038	1,832,657,038	1,800,000
56	216-S-17	9,408,960	300,000	1,700,000	442,221,120	446,021,120	300,000	1,700,000	9,243,615,404	9,247,415,404	1,800,000
57	216-U-11	0	0	0	0	0	0	0	0	0	0
58	216-S-1&2	630,400	200,000	1,800,000	29,628,800	33,428,800	0	0	0	0	1,800,000
59	216-S-3	557,333	200,000	1,800,000	26,194,667	29,994,667	200,000	1,800,000	673,769,778	677,569,778	1,800,000
60	216-S-4	0	0	0	0	0	0	0	0	0	0
61	216-S-7	691,289	200,000	1,800,000	32,490,578	36,290,578	0	0	0	0	1,800,000
62	216-S-9	1,046,259	200,000	1,800,000	49,174,185	52,974,185	0	0	0	0	1,800,000
63	216-S-20	665,600	200,000	1,800,000	31,283,200	35,083,200	0	0	0	0	1,800,000
64	216-S-21	522,667	200,000	1,800,000	24,565,333	28,365,333	0	0	0	0	1,800,000
65	216-U-1&2	0	0	0	0	0	0	0	0	0	0
66	216-U-3	0	0	0	0	0	0	0	0	0	0
67	216-U-4	0	0	0	0	0	0	0	0	0	0
68	216-U-4A	0	0	0	0	0	0	0	0	0	0
69	216-U-4B	0	0	0	0	0	0	0	0	0	0
70	216-Z-1&2	0	0	0	0	0	0	0	0	0	0
71	216-Z-7	0	0	0	0	0	0	0	0	0	0
72	216-Z-10	0	0	0	0	0	0	0	0	0	0
73	216-T-2	0	0	0	0	0	0	0	0	0	0

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

		SOIL FLUSHING TECHNIQUES (after vitrification)			Total Cost		No Action				
	Site No. (1)	FS ($)	ENG ($)	RA ($)	(SF + VITRIF) ($)	Mon ($)	Perimeter (yd)	FS ($)	RA ($)	Mon ($)	Total Cost ($)
38	216-B-16	0	0	0	0	1,800,000	467	100,000	20,370	6,000,000	6,120,370
39	216-C-1	100,000	1,900,000	720,277,928	724,077,928	1,800,000	386	100,000	16,849	6,000,000	6,116,849
40	216-C-10	0	0	0	0	0	385	100,000	16,791	6,000,000	6,116,791
41	216-A-9	0	0	0	0	1,800,000	653	100,000	28,518	6,000,000	6,128,518
42	216-A-40	0	0	0	0	0	640	100,000	27,936	6,000,000	6,127,936
43	216-A-4	0	0	0	0	0	387	100,000	16,878	6,000,000	6,116,878
44	216-A-5	0	0	0	0	1,800,000	407	100,000	17,751	6,000,000	6,117,751
45	216-A-6	0	0	0	0	1,800,000	493	100,000	21,534	6,000,000	6,121,534
46	216-A-7	0	0	0	0	0	373	100,000	16,296	6,000,000	6,116,296
47	216-A-21	0	0	0	0	0	411	100,000	17,926	6,000,000	6,117,926
48	216-A-24	0	0	0	0	1,800,000	1,307	100,000	57,036	6,000,000	6,157,036
49	216-A-27	0	0	0	0	0	500	100,000	21,825	6,000,000	6,121,825
50	216-A-28	0	0	0	0	0	304	100,000	13,256	6,000,000	6,113,256
51	216-A-36A	0	0	0	0	0	434	100,000	18,944	6,000,000	6,118,944
52	216-S-5	0	0	0	0	1,800,000	640	100,000	27,936	6,000,000	6,127,936
53	216-S-6	0	0	0	0	1,800,000	640	100,000	27,936	6,000,000	6,127,936
54	216-S-16D	0	0	0	0	0	2,363	100,000	103,130	6,000,000	6,203,130
55	216-S-16P	0	0	0	0	1,800,000	1,592	100,000	69,479	6,000,000	6,169,479
56	216-S-17	0	0	0	0	1,800,000	1,637	100,000	71,470	6,000,000	6,171,470
57	216-U-11	0	0	0	0	0	3,373	100,000	147,246	6,000,000	6,247,246
58	216-S-1&2	200,000	1,800,000	628,057,600	631,857,600	1,800,000	447	100,000	19,497	6,000,000	6,119,497
59	216-S-3	200,000	1,800,000	578,189,333	581,989,333	1,800,000	433	100,000	18,915	6,000,000	6,118,915
60	216-S-4	0	0	0	0	0	285	100,000	12,456	6,000,000	6,112,456
61	216-S-7	200,000	1,800,000	710,692,889	714,492,889	1,800,000	460	100,000	20,079	6,000,000	6,120,079
62	216-S-9	200,000	1,800,000	1,081,301,289	1,085,101,289	1,800,000	580	100,000	25,317	6,000,000	6,125,317
63	216-S-20	200,000	1,800,000	678,950,400	682,750,400	1,800,000	447	100,000	19,497	6,000,000	6,119,497
64	216-S-21	200,000	1,800,000	523,076,089	526,876,089	1,800,000	427	100,000	18,624	6,000,000	6,118,624
65	216-U-1&2	0	0	0	0	0	431	100,000	18,799	6,000,000	6,118,799
66	216-U-3	0	0	0	0	0	289	100,000	12,616	6,000,000	6,112,616
67	216-U-4	0	0	0	0	0	283	100,000	12,365	6,000,000	6,112,365
68	216-U-4A	0	0	0	0	0	287	100,000	12,538	6,000,000	6,112,538
69	216-U-4B	0	0	0	0	0	287	100,000	12,538	6,000,000	6,112,538
70	216-Z-1&2	0	0	0	0	0	400	100,000	17,460	6,000,000	6,117,460
71	216-Z-7	0	0	0	0	0	529	100,000	23,105	6,000,000	6,123,105
72	216-Z-10	0	0	0	0	0	283	100,000	12,365	6,000,000	6,112,365
73	216-T-2	0	0	0	0	0	283	100,000	12,365	6,000,000	6,112,365

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

			Unit Type (feet)					CAPPING TECHNIQUE					
	Site No. (1)	Unit Type (12)	Depth	Length	Width	Diameter	Vol. Disp.	Surface Area (sq yd)	FS ($)	ENG ($)	RA ($)	Mon ($)	Total Cost ($)
74	216-T-3	Reverse Well	206			0.75	11300000	6	100,000	54	270	0	100,324
75	216-T-7	Crib & Tile Field	26	310	84		110,000,000	0	0	0	0	0	0
76	216-T-8	Crib	25	28	28		500,000	9,867	100,000	88,804	444,020	1,800,000	2,432,824
77	216-T-19	Crib & Tile Field	23	390	85		455,000,000	0	0	0	0	0	0
78	216-T-28	Crib	15	30	30		42,300,000	0	0	0	0	0	0
79	316-1	Pond (11&12)	9	600	375		10,000,000,000	62,350	300,000	280,575	2,805,750	1,800,000	5,186,325
80	316-2	Pond (11&12)	10	620	600		10,000,000,000	86,033	300,000	387,150	3,871,500	1,800,000	6,358,650
81	316-3	Trench	20	600	10		1,000,000,000	27,067	200,000	182,700	1,218,000	1,800,000	3,400,700

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

			Unit Type (feet)				GROUT-IN-PLACE TECHNIQUE						
	Site No. (1)	Unit Type (12)	Depth	Length	Width	Diameter	Surface Area (sq yd)	Grouting Depth (yd)	FS ($)	ENG ($)	RA ($)	Mon ($)	Total Cost ($)
74	216-T-3	Reverse Well	206			0.75	4,647	0	0	0	0	0	0
75	216-T-7	Crib & Tile Field	26	310	84		18,840	53	300,000	1,700,000	60,288,000	1,800,000	64,088,000
76	216-T-8	Crib	25	28	28		7,396	0	0	0	0	0	0
77	216-T-19	Crib & Tile Field	23	390	85		21,700	53	300,000	1,700,000	69,440,000	1,800,000	73,240,000
78	216-T-28	Crib	15	30	30		7,511	53	100,000	1,900,000	24,035,556	1,800,000	27,835,556
79	316-1	Pond (11&12)	9	600	375		55,794	11	300,000	1,700,000	37,940,222	1,800,000	41,740,222
80	316-2	Pond (11&12)	10	620	600		78,389	11	300,000	1,700,000	53,304,444	1,800,000	57,104,444
81	316-3	Trench	20	600	10		22,133	14	200,000	1,800,000	19,034,667	1,800,000	22,834,667

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

			Unit Type (feet)				VITRIFICATION TECHNIQUE					
	Site No. (1)	Unit Type (12)	Depth	Length	Width	Diameter	Vitrif. Depth (yd)	FS ($)	ENG ($)	RA ($)	Mon ($)	Total Cost ($)
74	216-T-3	Reverse Well	206			0.75	0	0	0	0	0	0
75	216-T-7	Crib & Tile Field	26	310	84		11	300,000	1,700,000	83,059,280	1,800,000	86,859,280
76	216-T-8	Crib	25	28	28		0	0	0	0	0	0
77	216-T-19	Crib & Tile Field	23	390	85		12	300,000	1,700,000	104,109,367	1,800,000	107,909,367
78	216-T-28	Crib	15	30	30		15	100,000	1,900,000	43,827,333	1,800,000	47,627,333
79	316-1	Pond (11&12)	9	600	375		11	300,000	1,700,000	245,979,107	1,800,000	249,779,107
80	316-2	Pond (11&12)	10	620	600		11	300,000	1,700,000	345,590,481	1,800,000	349,390,481
81	316-3	Trench	20	600	10		14	200,000	1,800,000	123,408,089	1,800,000	127,208,089

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

		EXCAVATION and DISPOSAL TECHNIQUES									
			Excavation & Disposal			Total Cost		Excavation & Incineration		Total Cost	
	Site No. (1)	Excavation Volume (cu yd)	FS ($)	ENG ($)	RA ($)	(E/D only) ($)	FS ($)	ENG ($)	RA ($)	(E/D + INCIN) ($)	Mon ($)
74	216-T-3	0	0	0	0	0	0	0	0	0	0
75	216-T-7	0	0	0	0	0	0	0	0	0	0
76	216-T-8	0	0	0	0	0	0	0	0	0	0
77	216-T-19	590,333	300,000	1,700,000	215,471,667	219,271,667	0	0	0	0	1,800,000
78	216-T-28	242,000	100,000	1,900,000	88,330,000	92,130,000	0	0	0	0	1,800,000
79	316-1	0	0	0	0	0	0	0	0	0	0
80	316-2	0	0	0	0	0	0	0	0	0	0
81	316-3	620,000	200,000	1,800,000	226,300,000	230,100,000	0	0	0	0	1,800,000

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

			(of entire soil column)			Total Cost	SOIL FLUSHING TECHNIQUES (with excavation)			Total Cost	
	Site No.	Water Vol (cu yd)	FS ($)	ENG ($)	RA ($)	(SF only) ($)	FS	ENG ($)	RA ($)	(SF + E/D) ($)	Mon ($)
74	216-T-3	385,664	100,000	1,900,000	18,126,199	21,926,199	0	0	0	0	1,800,000
75	216-T-7	1,199,480	300,000	1,700,000	56,375,560	60,175,560	300,000	1,700,000	1,043,980,920	1,047,780,920	1,800,000
76	216-T-8	0	0	0	0	0	0	0	0	0	0
77	216-T-19	1,367,100	300,000	1,700,000	64,253,700	68,053,700	300,000	1,700,000	1,399,575,567	1,403,375,567	1,800,000
78	216-T-28	0	0	0	0	0	0	0	0	0	0
79	316-1	632,337	300,000	1,700,000	29,719,841	33,519,841	0	0	0	0	1,800,000
80	316-2	888,407	300,000	1,700,000	41,755,148	45,555,148	0	0	0	0	1,800,000
81	316-3	0	0	0	0	0	0	0	0	0	0

Hanford Inactive Waste Site Study. (continued)

Table 2-24

81 Priority Sites Recommended for Phase II Characterization.

		(with vitrification)			Total Cost		No Action				
	Site No. (1)	FS ($)	ENG ($)	RA ($)	(SF + VITRIF) ($)	Mon ($)	Perimeter (yd)	FS ($)	RA ($)	Mon ($)	Total Cost ($)
74	216-T-3	0	0	0	0	1,800,000	284	100,000	12,376	6,000,000	6,112,376
75	216-T-7	0	0	0	0	1,800,000	623	300,000	27,179	6,000,000	6,327,179
76	216-T-8	0	0	0	0	0	397	100,000	17,344	6,000,000	6,117,344
77	216-T-19	300,000	1,700,000	1,380,004,267	1,383,804,267	1,800,000	677	300,000	29,537	6,000,000	6,329,537
78	216-T-28	0	0	0	0	0	400	100,000	17,460	6,000,000	6,117,460
79	316-1	0	0	0	0	1,800,000	1,010	300,000	44,087	6,000,000	6,344,087
80	316-2	0	0	0	0	1,800,000	1,173	300,000	51,216	6,000,000	6,351,216
81	316-3	0	0	0	0	0	767	200,000	33,465	6,000,000	6,233,465

KEY and SUMMARY to CERCLA TABLES

Key to abbreviations

BLS	Below land surface
ENG	Engineering and design
FS	Feasibility Study
MON	Post Remedial Action monitoring
RA	Remedial Action

Summary of methods and assumptions

* The area or volume of measure used to calculate the costs of a technique is generally included along with the associated costs.

* Feasibility Study costs range from $100,000 to $300,000 depending on the size of the site. (See section 3.3).

* Engineering and design costs are a percentage of the Remedial Action costs, but, the sum of the engineering and design costs (ENG) and the Feasibility Study (FS) costs must be less than or equal to $1,200,000. (See section 3.3).

* Remedial Action costs are a function of the technology costs and the unit of measure for a given site, i.e., square yards or cubic yards.

* Some sites have a combination of technologies identified, such as soil flushing following excavation and disposal. The combination of Feasibility Study and engineering and design costs retain the $2,000,000 maximum limit, however, the Remedial Action costs are combined. The Remedial Action labeled Soil Flushing Techniques (with excavation) has a RA cost of the RA the flushing costs for the site after excavation plus the excavation and disposal cost.

* Total costs are a sum of the Feasibility Study, engineering and design, Remedial Action, and post Remedial Action costs.

* Post Remedial Action monitoring is carried out semi-annually for 30 years for all remediated sites. Sites that received No Action are monitored for 100 years on a semi-annual basis.

Reference List:

(1)	Table 5.1, page 5.2
(2)	Table 3.4, page 3.13
(3)	Table 3.7, page 3.16
(4)	Table 3.9, page 3.19
(5)	Page 3.22
(6)	Table 3.12, page 3.24
(7)	Table 3.14, page 3.27
(8)	Table 3.16, page 3.30
(9)	Page 3.31
(10)	Page 3.35
(11)	Page 4.7
(12)	Table C.1, page C.14
(13)	Table 4.2, page 4.10
(14)	Table 3.2, page 3.3

From: DOE 1986a

2.8 ESTIMATED SCHEDULES AND MANPOWER

This section provides a description of the schedules and manpower needed to complete site characterization and remedial action for the CERCLA sites. This effort was necessary to ultimately produce a master schedule for addressing both RCRA and CERCLA sites as described in Section 4. The methods used to develop estimates of manpower and scheduling recommended for characterization and remediation are also provided in this section.

Characterization of the CERCLA sources assumes an 18 month period to complete any one source. Each source will involve two drilling rigs: one for soil boring and the other for well installation. Staff for each drilling rig will involve a supervisory geologist, driller, and a health and safety or sampling specialist per drilling location. Additional characterization activities such as lysimeter installation, soil gas sampling, and water quality sampling will each involve additional staff ranging from 1 to 3 persons. In addition, one field manager coordinating the overall operation will be necessary.

The remediation of the CERCLA sites will involve the preparation of a Feasibility Study report, engineering analysis and design of the selected remediation approach, conduct of the remedial action, and post-remedial action monitoring. For the purposes of this study, a period of nine months was scheduled for completion of the feasibility study. Six additional months were added for the review of the feasibility study by EPA and the State of Washington. Thus, a total of 15 months was scheduled to complete this task. This is consistent with the requirements promulgated under SARA. The total number of manweeks required to complete the feasibility study can be determined based on the costs considered for the feasibility study as outlined earlier in Section 2.7. An average labor rate of $60/hr was used based on the level of scientific and engineering expertise needed to perform the study. The feasibility study costs vary by the type of site being remediated, but the total manweeks for each site may be estimated by dividing the feasibility study costs for each site by the average labor rate.

After the feasibility study has been completed, reviewed, and approved by EPA and the State, engineering analysis of the recommended remedial alternatives can be started. It is assumed that a period of one year (52 weeks) is required to conduct the engineering analysis which includes initial engineering design and review, cost estimates, and construction management. Based on the costs required to perform this activity (as identified in Section 2.7), the total manpower requirement can be calculated as for the feasibility study using the $60/hr labor cost. The total manpower requirement will vary significantly on a site-by-site basis and with each different remediation technology considered in this analysis.

The scheduling and manpower requirements for remediating each site are based on the estimated volume of waste, soil, or water identified as requiring remediation or treatment at each unit. These requirements are presented in Appendix A for each of the remediation technologies.

After a unit has been remediated, it will be necessary to perform post-remedial action groundwater monitoring. A 30-year groundwater monitoring program is recommended so that the site cleanup program will be consistent with the RCRA post-closure monitoring program. Under the RCRA program, land disposal facilities that have undergone closure are required to perform groundwater sampling at the facility on a semi-annual basis for a period of 30 years. The objective of this program is to verify that the remediation or closure action has resulted in either the elimination of hazardous constituents from the environment or the reduction of constituent concentrations to levels below the applicable regulatory standards. Under this program, semi-annual groundwater sampling for hazardous constituents will be performed at one upgradient and three downgradient wells at each remediated site. Each of the wells will be purged and sampled, the samples analyzed, and a report prepared. This will require a total of 8 weeks to complete on a twice-yearly basis. Clerical support, well maintenance support, and monthly well inspection will also be required. The total manpower required on a yearly basis would be 216 hours or 162 manweeks over a period of 30 years.

Based on the above analyses, the unit master schedule for a CERCLA site would be as follows:

Characterization	Feas. Study	Eng.	Remedial Action	Post-RA Mon.
18 mo.	15 mo.	12 mo.	variable	30 yrs

3.0 ASSESSMENT DOCUMENT FOR RCRA 3004(u) SITES

This assessment document presents an evaluation of the possible characterization and remediation needs of RCRA 3004(u) sites at Hanford. The purpose of this effort is to develop an estimate of the costs and time required for addressing these sites.

Sections 3004(u) and (v) and 3008(h) of RCRA were added by the Hazardous and Solid Waste Amendments of 1984 (HSWA). These "corrective action" provisions of RCRA authorize the EPA to require corrective action to be undertaken to address releases of hazardous constituents at sites located at either interim status facilities or facilities that will require a RCRA permit. Consequently, for any federal facility that will require a RCRA permit for one or more treatment, storage, or disposal units, releases from solid waste management units (SWMUs) at that facility can be addressed by the EPA under RCRA authorities. SWMUs include both past and presently operating facilities whether or not their operations were before 1980.

The RCRA corrective action authority is a redundant authority that EPA could use at DOE facilities. The RCRA authorities are broader than the CERCLA authorities because the standard that must be met in order to invoke the authority is as low as [under Section 3004(u)] the mere existence of a release, whether or not any person or any part of the environment is threatened by the release. EPA is not required by Sections 3004(u), 3004(v), or 3008(h) to show an "imminent and substantial endangerment," as required under CERCLA.

The corrective action programs already in place under CERCLA and RCRA 40 CFR Part 264 Subpart F are the foundation for the 3004(u) program. Sections 104 and 106 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) authorize EPA to take response actions, including removal or remedial measures, when a release or threat of release of a hazardous substance is discovered which may effect health or welfare. Generally, these authorities are used in situations where contamination has occurred at abandoned sites. Where contamination is related to activities at hazardous waste management facilities that are currently operating or

related to former waste management units at currently operating facilities, both RCRA and CERCLA potentially apply. EPA has usually chosen, as a matter of policy, to initiate action under RCRA rather than CERCLA at many facilities.

The Hazardous Solid Waste Act (HSWA) corrective action regulations, when they become available, will represent the most important set of RCRA standards (ARARs) for CERCLA remedial actions. As such, a primary goal in development of the RCRA regulations will be to establish, to the maximum extent possible, a consistent approach between the RCRA and CERCLA programs in remediating environmental problems.

Existing RCRA regulations for groundwater corrective action (40 CFR Part 264 Subpart F) prescribe a specific approach for detection, characterization, and cleanup of contaminated groundwater from permitted land disposal units that received waste after July 26, 1982 (40 CFR Part 265 Subpart F, for interim status facilities). Subpart F requires that groundwater be removed or treated in-place within a reasonable period of time when a pre-determined performance standard has been exceeded at a point of compliance (waste unit boundary). The performance standard may be defined as background concentrations, a generic drinking water standard applicable to all facilities (maximum concentration limits or MCLs), or a health-based standard calculated on the basis of actual facility conditions (alternate concentration limits or ACLs).

RCRA standards for closure of operating hazardous waste management units are also related to establishing cleanup remedy standards for 3004(u) corrective action. Many corrective actions are likely to involve measures designed to control sources of contamination. RCRA closure regulations specify how wastes in waste management units may be removed or decontaminated or otherwise subjected to post-closure care requirements. Although the concept of RCRA "closure" of operating waste management units is in some ways different from cleanup of old, abandoned waste management units or contaminated areas, the approach to regulating corrective action is taken to be consistent with the principles of RCRA closure.

EPA has not resolved how it will apply the CERCLA and RCRA corrective action authorities. Many situations, at least over the short-term, can be addressed by orders under either authority, thus leaving EPA with a choice of tools. But, over the long-term, for active sites that will eventually require a permit, the Administrator of EPA is required by Section 3004(u) of RCRA to put conditions in the permit that require corrective actions to address releases from SWMUs. Thus, even if all SWMUs that score above 28.5 on the HRS (or the required score on the new HRS replacement that SARA requires) are addressed by DOE under CERCLA, DOE could later be required under RCRA to address releases from any sites that did not qualify for the NPL. Therefore, it is unclear for the present whether CERCLA or RCRA will apply at uncontrolled DOE waste sites. This decision is one that EPA Region X will most likely retain responsibility for making rather than DOE.

The Washington State Regulations for Dangerous Waste (173-303 WAC) will apply to all dangerous waste interim management units, dangerous waste permitted waste management units, and units seeking a closure/post-closure permit as a dangerous waste management unit. The corrective action provisions under this regulation include groundwater monitoring corrective action (interim and final status land disposal units) and closure requirements (clean up contamination to background or close as a "RCRA" landfill). These regulations are equivalent to 40 CFR 264.100, 264.112, 264.117, 265.93, 265.112, 265.117, and 265.118.

Corrective action of solid waste management units can only be mandated by EPA under RCRA 3004(u). Any facility seeking a dangerous waste permit (final status or closure/post-closure) will be subject to the corrective action provisions of the 1984 RCRA amendments. EPA currently has sole authority for the 3004(u) corrective action program. No states have been delegated this authority. Under the EPA 3004(u) corrective action program, special conditions will be included in the permit specifying remediation or verification sampling to be performed and a schedule for the meeting these requirements.

In order to plan for addressing potential RCRA 3004(u) sites in addition to CERCLA sites, a preliminary assessment was performed. The statement of work for this assessment required the development of both a characterization strategy for potential 3004(u) sites and a remediation strategy. To develop the characterization strategy, a feasibility and scoping effort was performed to identify the types of potential RCRA 3004(u) sites from the inactive waste site or past spill information provided by Westinghouse. As outlined in the statement of work, these sites were evaluated to determine generalized facility types to serve as the analysis base.

The characterization strategy involved evaluations of wastes managed at specific sites and waste characteristics. This information served as the basis of an assessment of the potential for past, present, or future release of hazardous constitutents to the environment and an assessment as to whether remediation may be required or whether verification of the absence of releases or hazardous constituents through site characterization was a potential action. The activities that might be performed with characterization and the costs associated with these activities were estimated.

The remediation strategy under the statement of work required two alternatives be considered: (1) exhumation in all cases, and (2) one in-place remediation technique for each type of site. In-place remediation techniques were evaluated and one technique selected for each type of waste site. The activities and costs associated with exhumation and the in-place remediation techniques were described and estimated. Finally, implementation schedules were developed for 3004(u) site characterization and remediation.

The preliminary assessment presented in this section represents a site-by-site analysis of characterization and remediation. Grouping sites together on a more regional scale will realize significant cost savings and will be more practical for characterization and remediation given the complex waste management unit interactions at Hanford. These issues are addressed in Section 4.

This section presents the preliminary assessment of the RCRA 3004(u) sites for budgetary costing and scheduling purposes. Section 3.1 describes the feasibility and scoping effort. Section 3.2 presents the characterization strategy. Section 3.3 presents the remediation strategy. Section 3.4 presents the estimated manpower and scheduling requirements. Section 3.5 describes support activities for characterization and remediation. Section 3.6 describes data limitations associated with this analysis.

3.1 FEASIBILITY AND SCOPING

Figure 3-1 presents an overview of the evaluation process used to determine whether a waste management unit is potentially subject to RCRA 3004(u) and to determine the need for characterization or remediation action. This section addresses the scoping process for determining which inactive Hanford sites are potentially subject to RCRA 3004(u) corrective action prior to the application of a characterization strategy and a remediation strategy. The need for action evaluation is presented in Section 3.2.

The scoping process consists of identifying sites that are subject to RCRA 3004(u) corrective action. SAIC has reviewed the information provided on inactive waste sites at the Hanford Reservation to determine the potential applicability of RCRA 3004(u) corrective action requirements to those sites. The information provided included inactive sites with CERCLA HRS/mHRS scores less than 28.5, reactor buildings, other radioactively contaminated structures, inactive waste management sites, past waste spills, and areas denoted as having radioactive contamination.

In order to make each decision required in the process outlined in Figure 3-1, certain criteria are used to examine available data. Criteria-based evaluations are conducted at the following points:

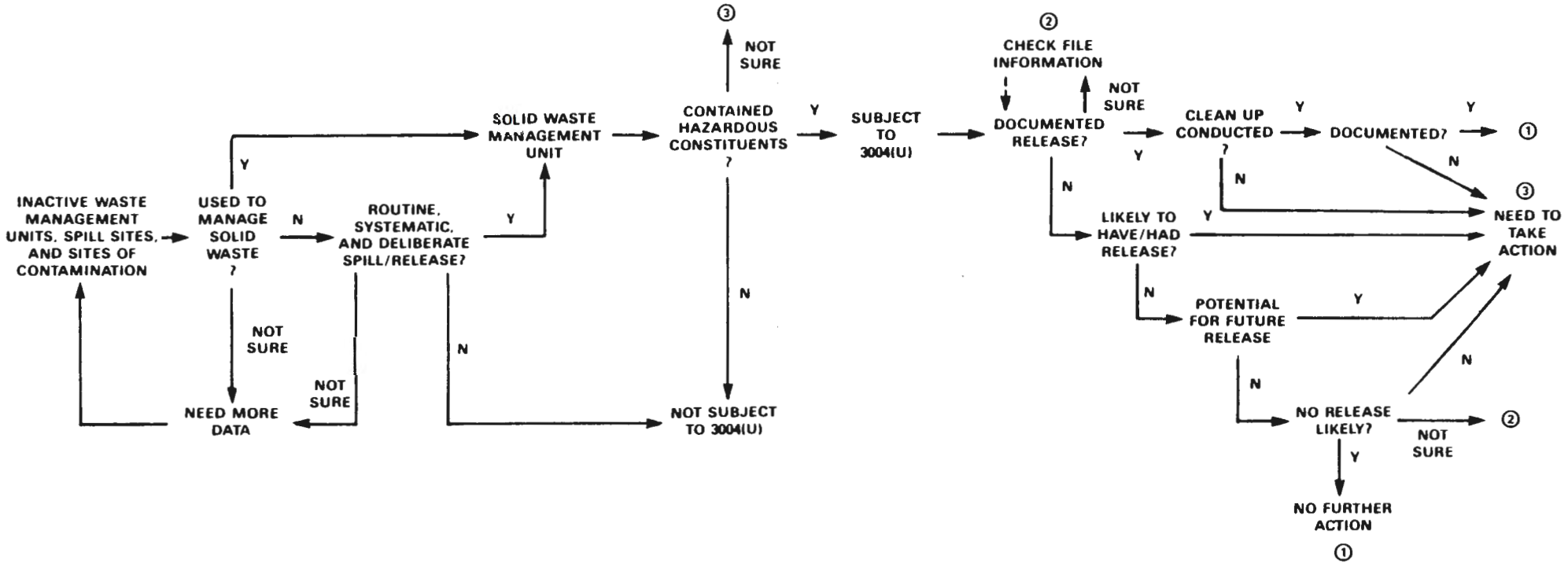


FIGURE 3-1. RCRA 3004(u) Need for Action

o Unit Used to Manage Solid Waste

Inactive waste management units, process units, material storage areas, spill sites, and sites of contamination are evaluated to determine whether the unit or site was used (or is now used) to manage solid waste. This evaluation relies on the definition of solid waste as presented in 40 CFR 261.2. Solid waste includes any discarded material that is abandoned, recycled, or inherently waste-like. Figure 3-2 presents a summary decision chart outlining the process for determining whether a material is a solid waste. The regulatory definition of solid waste excludes materials such as domestic sewage; untreated sanitary wastes mixed with other wastes for discharge to a POTW for treatment; point source discharges regulated under the CWA; irrigation return flows; source, special nuclear, or byproduct material subject to the AEA of 1954; materials subjected to in-situ mining techniques; pulping liquors that are reclaimed; and spent sulfuric acid used to produce virgin sulfuric acid. These exclusions are presented in 40 CFR 261.4. **It should be noted, however, that units or sites containing mixtures of low level byproduct materials and hazardous waste are considered to be units used to manage solid wastes.**

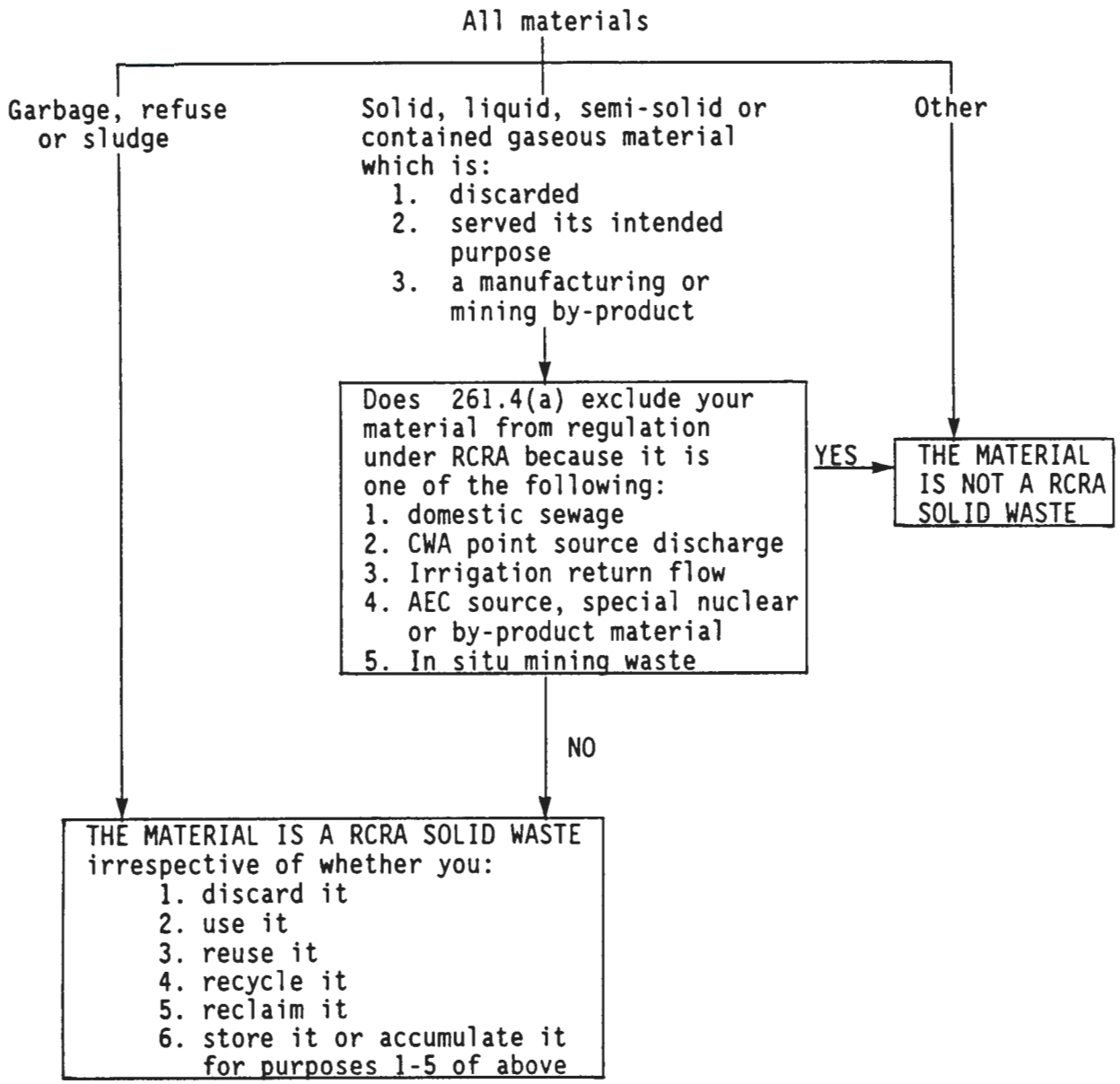
Another factor considered in the evaluation is whether the site is any discernible waste management unit from which hazardous constituents might migrate. This includes containers, tanks, surface impoundments, waste piles, land treatment units, landfills, incinerators, underground injection wells, recycling units, wastewater treatment units, other treatment units, etc.

o Routine, Systematic, and Deliberate Spill/Release

Under certain circumstances, process units, waste lines, and other facility activities or materials management units/systems may potentially be subject to RCRA 3004(u). Spills and/or releases from process units and production areas not associated with regulated discharges or waste management units are potential candidates. In

FIGURE 3-2

DEFINITION OF A SOLID WASTE



general, spills or releases from process/production areas and units which are routine, systematic, and deliberate may be considered further. This evaluation relies on engineering judgment and the "pattern" and history of materials management or spill remediation evident at the facility.

Criteria used in the evaluation include the frequency of spill occurance, the period of time overwhich the practice occurred, the immediacy of remedial action taken (e.g., in repairing active leaks), and the alternative management or mitigation measures applied to prevent environmental contamination. Some examples of routine, systematic, and deliberate spills are: discharging residual wastes from tank cars of railroad cars after the bulk of the waste volume has been transferred; discharging residual product chemicals (e.g., solvents, acids) after unloading the products into process storage tank cars or railroad cars; spreading solvents or waste oils for weed control; allowing line leakage to occur over an extended period of time (months or years) without repairs; allowing line leakage to occur over an extended period of time (months or years) while collecting some of the leakage but not repairing the line. In such cases, the concern is with continued releases to the environment which subsequently provide a "source" for further hazardous constituent release to the environment; if the discharges occurred within a containment structure (such as a concrete trench), then such discharges would not be subject to corrective action although the trench could be so considered. As a whole, this category of "units" excludes accidental spills from process or production areas and excludes one-time or short term (days) spills which would generally be addressed under best management practices or the National Contingency Plan.

o <u>Unit Contained Hazardous Constituents</u>

A solid waste management unit (SWMU) is not considered subject to RCRA 3004(u) corrective action unless it contained hazardous constituents. Hazardous constituents are those identified in 40 CFR

261, Appendix VIII or IX and also include the hazardous waste characteristics of ignitability, corrosivity, reactivity, and EP toxicity (as defined in 40 CFR 261.21-24). If available data are insufficient to determine that a unit contained hazardous constituents, then characterization action must be taken to make that determination.

The sites identified as potential RCRA 3004(u) sites are listed in Appendix D-1. Sites excluded from consideration are those that are active, are part of a unit seeking a Dangerous Waste or Closure Permit, or are out of the scope of this project as identified in the original Request for Proposal. Also included in Appendix D-1 is a list of sites that have been excluded from consideration and the basis for the exclusion. Additional sites listed in the Appendix are those identified as not falling under the jurisdiction of either RCRA or CERCLA.

Approximately 500 units or sites at the Hanford Reservation have been identified as potential RCRA 3004(u) sites. Table 3-1 presents a summary of the sites by Hanford area and by unit type. It should be noted that the numbers on the table represent the number of sites and not necessarily the number of individual units. For instance, a tank farm composed of 16 individual tanks is represented as one site and not as 16 individual units.

The data provided in Table 3-1 indicate that approximately 60 percent of the 3004(u) sites are located in the 200 East and 200 West areas, with approximately equal numbers of sites in each area. The data compilation also indicates that trenches are the most prevalent waste unit followed by cribs, tanks, diversion boxes, burial grounds, and french drains. These six types of sites represent 54 percent of the total number of sites. Section 3.2 provides further refinement of the different types of sites into 15 generic types of sites for subsequent evaluation.

Table 3-1. Summary of 3004(u) Inactive Waste Sites

SITE TYPE*	AREA 100 B	AREA 100 B/C	AREA 100 C	AREA 100 D	AREA 100 D/DR	AREA 100 DR	AREA 100 F	AREA 100 H	AREA 100 K	AREA 100 KE	AREA 100 KE/KW	AREA 100 KW	AREA 100 N	AREA 105 KE/KW	AREA 200 E	AREA 200 N	AREA 200 W	AREA 300	AREA 400	AREA 600	AREA 700	AREA 1100	TOTAL
ACCESS AREA																		1					1
ACID SPILL *?*																		1					1
BASIN																	2						2
BASIN TRENCH					1	1																	2
BOX															1		1						2
BURIAL GARDEN *?*																	1						1
BURIAL GROUND		7		3	3		6	4	1						10		9			3			46
B.GROUND/TRENCH																				2			2
BURIAL TUNNEL															1								1
BURIAL VAULT							1								2								3
BURNING PIT		1			1		1	2	1				1										7
COMPARTMENT *?*																	1						1
CONTROL ROD -		1												2									3
STORAGE CAVE *?*																							0
CRIB		6			4		2	2		1		1			21		19	1		3			60
CRIB & TRENCH													1										1
CRIB SANDFILTER		1																					1
CRIB/T. FIELD															1								1
CRIB/TRENCH															1								1
DITCH															3		9						12
DITCH & POND															1								1
DIVERSION BOX															25		22						47
DIVERSION BOX *?*															1								1
DIVERTER STATION															2								2
DRAIN FIELD	1														1			3					4
DRY WELL																	2						3
EVAPORATOR															1			1					2
FILTER MONITOR *?*																	1						1
FRENCH DRAIN		1			3		4		2				2		14		3		2				31
GRAVEL PIT																		1					1
GROUND CONTAM. *?*																	1						1
GROUND DISPOSAL																						1	1
GROUND SPILL																	1						1
GROUND SPILL *?*																	2						2
INCINERATOR																	1						1
LANDFILL																				8			8
LEACHING PIT															1								1
LEAK													1										1
LINE LEAK*?*													6				1						7
PIPE TRENCH-																		1					1
SYSTEM																							0
PIT		1					1	2					1		2		3			1		2	13
PIT*?*															2								2
POND																3	5	1	1	1			11
PROCESS LINE*?*																	1						1
PROCESS TANK																	1						1
VENT LINES*?*																							0
PUMPING STATION					3			1															4
RECEIVING VAULT															2								2
RETENTION BASIN		2			2		1	1	2														8
REVERSE WELL															2								2
SEWER																	1						1
SEWER PIPE																		1					1
SPILL										1													1
SPILL SITE															2								2
SPILL SITE *?*															2								2
STORAGE PAD					1																		1
SUMP		1																					1
SURFACE IMPOUNDMENT																	1						1
TANK			1		1						14				20		23	2	1	4	1	1	68
TANK *?*																	5						5
TANK/CRIB OVERFLOW*?*																	1						1
TANK/DRAINFIELD													5										5
TANK/TILEFIELD		4			2		5	3															14
TESTING UNIT																		1					1
TILE FIELD																	1						1
TRANSFER BOX *?*																	1						1
TRANSFER LINE *?*																	1	1					2
TRENCH		1													32	4	25	2	1	9			74
TRENCH & PITS																				1			1
UNDERGROUND TANKS																		2					2
UNDERGROUND TANKS/																		1					1
PIPING																							0
VAULT															1		5						6
WASTE LINE															1		5						6
WASTE LINE *?*																	1						1
WASTE PILE																				1			1
WEIR BOX																	3						3
TOTAL	1	26	1	3	21	1	21	15	6	2	14	1	17	2	152	7	159	20	5	33	1	4	

- A specified site type may contain more than one individual unit. For example, a "tank" site might contain 16 individual tanks.

? - Indicates sites requiring further clarification.

3.2 CHARACTERIZATION STRATEGY

The characterization strategy has been developed based on identification of RCRA 3004(u) corrective action issues. Approximately 500 potential RCRA 3004(u) sites have been identified. These sites have been identified by Hanford area (100 N, 200 east, 600, etc.) as an initial grouping because of the generally distinct geographic distribution of the sites within the Hanford area (see Appendix D-1).

3.2.1 Determining the Need for Remediation

Figure 3-1 presented an overview of the characterization strategy process for evaluating the 3004(u) sites. This approach has been developed based on the 3004(u) requirements outlined in Section 3.1. At a RCRA 3004(u) site, the need for action includes remediation or simply verification of the absence of a problem (past, present, or future release; absence of hazardous constituents; or residual contamination). No further action may also be selected for a given site if no hazardous constituents are present or where no present or future contamination problem is likely. A site will require verification if it needs to be determined that:

- No hazardous constituents are present in the unit
- No release of hazardous constituents has/will occur
- No residual contamination remains from insufficiently documented cleanups or past/present releases.

In each case, the characterization needs will differ largely in terms of the extent of sampling or other information collection that may be needed. Additionally, if sampling during characterization reveals that a problem exists, the site would be shifted to a new characterization category prior to remedial planning activities.

The need for action depends upon a number of factors. These include:

- Containment provided by the waste management unit itself in preventing release to the environment

- Past, present, or future adequacy of the containment provided by the unit

- Nature of the wastes disposed (solid, liquid, gas) as an indicator of the likelihood of transport in the subsurface environment

- Constituents of concern in the wastestream disposed and their behavior in the environment (e.g., subject to subsurface transport or partitioning in the vadose zone)

- Potential exposure hazards, potential media impacted, and pathways of migration

- Evidence of past release to the environment and nature of action taken

- Adequacy of data and documentation to support need for action decisions or to demonstrate the absence of a problem.

Overall, the need for action is a function of the release potential of a unit and the waste constituents present in that unit. These two areas are the basis of the characterization evaluations conducted. This evaluation focused on the development of two matrices: a waste constituents matrix and a need for action matrix. These matrices and the supporting evaluations are described in more detail in the following sections. The purpose of these evaluations is to assess potential characterization needs to establish budgetary needs and timeframes.

3.2.1.1 Waste Constituents Matrix

Each site was evaluated to determine the type of unit involved (function and structure) and the characteristics of the wastes/materials present. The analysis proceeded on a site-by-site basis within a given Hanford area. Tables 3-2 through 3-15 present the waste constituent matrices completed for the inactive RCRA 3004(u) sites that have been identified in the following areas: 100 B/C, 100 D/DR, 100 F, 100 H,

KEY TO TABLES 3-2 TO 3-15

Site Type Code (Column two of the Waste Constituents Matrices)

A - aboveground covered landfill
B - aboveground uncovered landfill
C - belowground covered landfill
D - belowground uncovered landfill
E - surface impoundments
F - ditches
G - underground dispersion systems
H - aboveground tank
I - underground tank
J - spills
K - underground vault
L - burning pit
M - incinerator
N - process sewer
O - other

pH Codes

A = acid
B = base
Y = corrosives present but type could not be determined

Other Codes

? = presumed
ND = no data
NS = not suspected

TABLE 3-2 100 B/C WASTE CONSTITUENTS MATRIX

100 B/C Waste Constituent Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	MATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	Comments
Burial Ground	C	110-B-1	105-B Burial Ground 116-B-1	Y	ND	ND	ND	?	Y	ND	Y	Y	Y	1.00E+06 KG		Y		METALLIC AND REACTOR WASTES
Burial Ground	C	110 C-1	105-C Burial Ground 110-C-1	Y	ND	ND	ND	?	Y	NS	Y		?	1.00E+06 KG		Y		MISC. SOLID WASTE INCLUDING CONTROL RODS, REACTOR HARDWARE, PROCESS TUBES, AND ALUMINUM SPACERS.
Burial Ground	C	110-B-7	111-B Solid Waste Burial Site	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		?		MISC. SOLID WASTES: DECONTAMINATION MATERIALS AND ASSOCIATED MATERIALS
Burial Ground	C	110-B-3	Construction Burial Ground 82	Y	ND	ND	ND	ND	ND	ND	ND	ND	?	9.00E+06 KG		?		SOLID WASTE: FROM EFFLUENT LINE AND REACTOR
Burial Ground	C	110 B-9	105-B Spacer Burial Ground	Y	ND				Y		ND	ND	?	2.00E+05 KG			?	FUEL SPACERS: PRESUMED TO BE STAINLESS STEEL.
Burial Ground	C	110-B-6	100-B Solid Waste Burial Ground	ND		ND	ND	ND	ND	ND		Y	?	1.00E+04 KG			?	TRITIUM WASTES (LABORATORY)
Burial Ground	C	110 B-2	Construction Burial Ground 81	Y	ND	ND	ND	ND	ND	ND	ND	ND	?	8.00E+04 KG		?		DRY WASTE FROM 107-B BASIN REPAIR WORK AND 115-B ALTERATIONS
Burial Ground	C	110 B-5	Ball 3X Burial Ground 110-B-5	Y		ND	ND	ND	ND	ND	ND	ND	?	2.00E+04 KG			?	"HIGHLY CONTAMINATED WASTES"...OLD THIMBLES, STEP PLUGS, ETC.
Burning Pit	C	100B/C	100 B/C Burning Pit	Y	I	Y	Y	Y	ND	ND				ND	Y			NONRADIOACTIVE COMBUSTIBLE MATERIALS: INCLUDES PAINTS AND SOLVENTS
Crib	G	116-B-5	106-B Crib 116-B-5 (9)	Y	ND	?	?	?	?	?	Y	Y	Y	1.00E+07 L		?		FISSION PRODUCT WASTES FROM CONTAMINATED MAINTENANCE SHOP AND DECONTAMINATION PAD
Crib	G	116 B-6 1	111-B Crib 81 116-B-6-1	Y	I	?		Y	Y	ND	Y	Y	Y	5.00E+03 L		Y		DECONTAMINATION WASTES
Crib	G	117-B#	117-B Crib	Y	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.20E+05 L		?		DRAINAGE FROM CONFINEMENT SYSTEM: 117 BLDG. SEAL PITS.
Crib	G	117-C#	117-C Crib	Y	ND	ND	ND	ND	ND		ND	ND	ND	4.80E+05 L		?		DRAINAGE FROM CONFINEMENT SYSTEM IN THE 117 BLDG. SEAL PITS.
Crib	G	116-B-6-2	111-B Crib 82 116-B-6-2	Y	I	?	ND	Y	Y	ND	Y	Y	Y	5.00E+03 L		?		EQUIPMENT DECONTAMINATION WASTES
Crib	G	116-B-3	105-B Pluto Crib 116-B-3	Y	I	ND	ND	Y	?	ND	Y	Y	Y	4.00E+03 L		Y		EFFLUENT FROM REACTOR TUBES; BORON SUSPECTED.
Crib Sandfilter	G	116-C-2-2	105-C Pluto Crib Sandfilter	Y	ND	ND	ND	ND	ND	ND	Y	Y	Y	3.50E+06 L		?		WASTES FROM DECONTAMINATION OF FUEL ELEMENTS
Dry Well	G	116-B-10	108-B Dry Well, Quench Tank	Y	ND	ND	ND	ND	ND	ND	ND	ND	?	5.00E+06 L		?		LIQUID FROM DECONTAMINATION WASTES: TUBE EXAM AND EXPERIMENTAL FACILITY
French Drain	G	116-B-9	104-B-2 French Drain	Y	ND	ND	ND	ND	ND	ND	ND	ND	?	4.00E+05 L		?		WASTE FROM P-10 STORAGE BLDG. DRAIN.
Pit	E	184-B#	184-B Powerhouse Ash Pit (3)	Y	ND				?					ND	Y			COAL ASH SLUICED WITH RIVER WATER. TESTING SHOWS NOT EP TOXIC.
Retention Basin	E	107-B#	107-B Retention Basin	Y	ND	NS	NS	Y	NS	NS	ND	ND	Y	ND			Y	RECEIVED COOLING WATER FROM 105 REACTOR.
Sump Tanks	E	107-C#	107-C Retention Basin	Y	ND	NS	NS	Y	NS	NS	Y	Y	?	ND			Y	COOLING WATER FROM 105 REACTOR.
Sump	E	105-B#	105-B Battery Acid Sump (3)	Y	Y			Y	?					ND	Y			BATTERY ACID
Tank	I	110-C-2	105-C Ball Storage Tank	ND	ND			Y	Y		ND	ND	Y	ND			Y	RADIOACTIVE BORON STEEL BALLS
Tank/Tile Field	I	1607-B3#	1607-B3 Septic Tank (3)	Y	ND	ND	ND	ND	ND	ND				ND	Y			SANITARY SEWAGE FROM 184-B POWERHOUSE. OPERATIONS FEEDING TO THIS SYSTEM NOT SPECIFIED.
Tank/Tile Field	I	1607 B#A	1607-B8 Septic Tank (3)	Y	ND	ND	ND	ND	ND	ND				ND	Y			SANITARY SEWAGE FROM 190-C PUMPHOUSE. OPERATIONS LEADING TO THIS SYSTEM NOT SPECIFIED.
Tank/Tile Field	I	1607-B7#	1607-B7 Septic Tank (3)	Y	ND	ND	ND	ND	ND	ND				ND	Y			SAME AS 1607-B8.
Tank/Tile Field	I	1607 B1#	1607-B1 Septic Tank (3)	Y	ND	ND	ND	ND	ND	ND				ND	Y			SANITARY SEWAGE FROM FIRE STATION, OFFICES, CHANGE ROOMS AND SECURITY CHECKPOINT.
Trench	C	116-B-2	105-B Storage Basin Trench	Y	ND			?			Y	Y	?	9.00E+06 L			?	CONTAMINATED WASTE WATER FROM 105-B STORAGE BASIN: FUEL ELEMENT WASTE; BORON SUSPECTED

KEY:
Y yes
ND- no data
# : official number not assigned but identified by unit number
blank= no
I= incomplete data

TABLE 3-4 100 F WASTE CONSTITUENTS MATRIX

100 F Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste: Source Identified	Waste: Chemicals Identified	Chemical Components: Organics	Chemical Components: Volatiles	Chemical Components: Inorganics	Chemical Components: Metals	Chemical Components: pH	Other Residual: Fission Products	Other Residual: Radio-nuclides	Other Residual: Radio-Activity	Waste Volume Disposed	Initial UF Waste: Solid-Haz. Waste	Initial UF Waste: Mixed Waste	Initial UF Waste: Rad. Only	Comments
Burial Ground	C	118-F-4	115-F Pit 118-F-4	Y	NO	?	NO	?	NO	NO	NO	NO	?	1.00E+04 M3		?		SILICA GEL FROM FILTERS.
Burial Ground	C	118-F-3	Burial Ground #2 118-F-3	Y	NO	NO	NO	NO	Y	NO	Y	NO	Y	7.00E+03 M3		?		[illegible] WASTES CONTAINERS, SLEEVES REMOVED FROM 105-F PILE.
Burial Ground	C	118-F-1	Burial Ground #1 118-F-1	Y	NO	NO	NO	NO	?	NO	Y	NO	Y	1.00E+02 M3		?		MISCELLANEOUS RAD. SOFT WASTES, REACTOR COMPONENTS AND HARDWARE.
Burial Ground	C	118-F-2	Burial Ground #2 118-F-2	Y	NO	NO	NO	NO	?	NO	Y	?	Y	1.00E+04 M3		?		MISCELLANEOUS RAD. SOFT WASTES, REACTOR COMPONENTS AND HARDWARE.
Burial Ground	C	118-F-6	PNL Solid Waste Burial Ground	Y	I	?	NO	?	?	NO	Y	NO	Y	1.00E+04 M3		?		ANIMAL AND BIOLOGY LABORATORY WASTES.
Burial Ground	C	118-F-5	PNL Sawdust Repository 118-F-5	Y	Y						Y	Y	?	1.00E+04 M3			Y	LOW LEVEL ACTIVITY SAWDUST FROM PENS.
Burial Vault	B	118-F-7	100F Miscellaneous Hardware	Y	NO	NO	NO	NO	NO	NO	Y	?	Y	1000 ft3 (cap)			?	MISCELLANEOUS REACTOR HARDWARE.
Burning Pit	L	100-F6	100-F Burning Pits #2	Y	I	?	?	?	?	NO				NO	Y			NON-RAD. COMBUSTIBLE MATERIALS, PAINT WASTE, CHEMICAL SOLVENTS, OFFICE WASTES.
Crib	G	116-F-4	105-F Pluto Crib 116-F-4 (3)	Y	NO	NO	NO	Y	?	NO	Y	Y	Y	4.00E+05 LITR		?		EFFLUENT FROM TUBES WITH FAILED FUEL ELEMENTS.
Crib	G	116-F-5	Ball Washer Crib 116-F-5	Y	NO	NO	NO	NO	NO	NO	Y	NO	Y	3.00E+05 LITR		?		DECON. WASTE FOR 60MM STEEL BALLS.
French Drain	G	116-F-12	140-F French Drain 116-F-12	Y	NO						NO	NO	?	1.00E+04 LITR			?	RECOVERED EFFLUENT PUMP PRIME.
French Drain	G	116-F-11	105-F Cushion Corridor French	Y	NO	NO	NO	NO	NO	NO	NO	NO	?	2.00E+05 LITR		?		CUSHION CORRIDOR DECON WASTE.
French Drain	G	116-F-15	1705-F Experimental Garden	Y	NO	NO	NO	NO	NO	NO	NO	NO	?	1.00E+04 LITR		?		EFFLUENT WATER FROM BOTANY EXPERIMENT.
French Drain	G	116-F-7	117-F Crib 116-F-7	Y	NO	NO	NO	NO	NO	NO	Y	Y	Y	3.00E+05 LITR			?	DRAINAGE FROM CONTAINMENT SEAL PITS.
Pit	E	104-F6	104-F Powerhouse Ash Pit (3)	Y	NO				?					NO	Y			COAL ASH SLURRED WITH RIVER WATER. ASH TESTS AS NOT EP TOXIC.
Pumping Station	D	1600-F6	1600-F Wastewater Pumping	Y	Y	Y		Y		A	?	?	?	NO			Y	BUILDING DRAINS: LOW-LEVEL RAD. AND DECON. CHEMICALS.
Retention Basin	E	107-F6	107-F Retention Basin	Y	NO			?			?	?	Y	NO			?	REACTOR COOLING WATER EFFLUENT.
Tank/Tile Field	G	1607-F6	1607-F6 Septic Tank	Y	NO									NO	Y			SANITARY WASTE FROM BUILDINGS AND HOTAW. FARMS.
Tank/Tile Field	G	1607-F1	1607-F1 Septic Tank	Y	NO									NO	Y			SANITARY WASTE FROM FIRE STATION, CHANGE ROOMS, OFFICES.
Tank/Tile Field	G	1607-F5	1607-F5 Septic Tank	Y	NO									NO	Y			SANITARY WASTE FROM PUMPHOUSE.
Tank/Tile Field	G	1607-F3	1607-F3 Septic Tank	Y	NO									NO	Y			SANITARY WASTE FROM PUMP STATION, WATER TREATMENT PLANT, AND SUBSTATION.
Tank/Tile Field	G	1607-F4	1607-F4 Septic Tank	Y	NO									NO	Y			SANITARY WASTE FROM GAS RECIRCULATION BUILDING.

KEY: Y yes; NO no data; a = official number not assigned but identified by unit number; blank: no; I: incomplete data

TABLE 3-5 100 H WASTE CONSTITUENTS MATRIX

100 H Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	Chemical Components: Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	Nature of Waste: Solid/Haz. Waste	Mixed Waste	Rad. Only	Comments
Burial Ground	C	110-H 2	H 1 Loop Burial Area, 100-H	ND	ND			ND	Y	ND	Y	ND	Y	1.00E+05 KG		?		CONCRETE VAULT'S RECEIVED STEEL TUBE FROM REACTOR AND SMALL AMOUNTS OF CONTAMINATED PIPE(1955-1965).
Burial Ground	C	110-H 3	Construction Burial Ground	Y	ND	ND	ND	ND	Y	ND	Y	ND	Y	3.00E+06 KG		?		BASIN GROUND RECEIVED CONTAMINATED PIPE, REACTOR HARDWARE AND COMPONENTS(1953-1957).
Burial Ground	C	110-H 4	Ball 3X Burial Ground 110-H-4	Y	ND			ND	Y	ND	Y	ND	Y	1.00E+04 KG		?		BASIN GROUND RECEIVED IRRADIATED SOLID WASTE EG.,THIMBLES AND GUIDES(1955-1959).
Burial Ground	C	110-H 1	100-H Burial Ground #1 110-H-1	ND	ND	ND	ND	ND	Y	ND	Y	ND	Y	1.06E+06 KG		?		BASIN GROUND CONTAINING MISC. SOFT WASTES, REACTOR COMPONENTS AND HARDWARE(1949-1965). TRITIUM.
Burning Pit	L	100-H2a	100-H2 Burning Pit for Residues	ND	I	Y	?	?.	?	ND				ND	Y			DISPOSAL/COMBUSTION OF OFFICE AND PAINT WASTES, AND CHEMICAL SOLVENTS. RESIDUAL CONTAMINATION W/INCOMPLETE COMBUSTION POSSIBLE. 1948-1965
Burning Pit	L	100-H6	100-H Burning Pit	Y	I	Y	?	Y	?	ND				ND	Y			DISPOSAL/BURNING OF NON-HAZARDOUS COMBUSTIBLE WASTE EG., PAINT AND OFFICE WASTES, AND CHEMICAL SOLVENTS(1949-1965)
Crib	G	117-H	Crib 117-H	Y	ND	ND	ND	ND	ND	ND	ND	ND	?	3.00E+06 L		?		CRIB RECEIVED DRAINAGE FROM CONTAINMENT SYSTEM SEAL PITS(1960-1965). SAMPLING IN 1970: NO CONTAMINATION ABOVE BACKGROUND.
Crib	G	110-H-4	105-H Plute Crib 1h.H 4 (4)	ND		ND	ND	Y	ND	ND	?	?	ND	1.00E+03 L		?		CRIB RECEIVED EFFLUENT FROM TUBES CONTAINING FAILED FUEL ELEMENTS(1950-1952). CRIB EXHUMED IN 1960 AND MOVED TO 110-H-5 BURIAL GROUND.
Pit	C	110-H 5	105-H Thimble Pit 110-H-5	Y	I	ND	ND	Y	Y	ND	Y	ND	Y	1.00E+03 KG		?		BASIN GROUND RECEIVED THIMBLE ASSEMBLY AND PLUG CONTAINING NA ND. 1953-1961. INCLUDES SODIUM DICHROMATE.
Pit	E	104-H4	104-H Powerhouse Ash Pit (3)	Y	Y	ND	ND	?	?					ND	Y			COAL ASH SLUICED INTO OPEN PITS WITH RAW RIVER WATER. ASH DID NOT EXCEED OF TOXICITY LIMITS. 1948-1965
Pumping Station	G	1608-H4	1608-H Waste Water Pumping	ND		Y	ND	Y	ND	A	ND	ND	?	ND		Y		PUMPING UNIT RECEIVED REACTOR WATER AND DECONTAMINATION CHEMICALS(1949-1965). FACILITY IS INACTIVE AND EMPTY. RELEASE WITH DATA ON HANDOUT. INVENTORY NOT AVAILABLE.
Retention Basin	E	107-H4	100-H Retention Basin 107-H	Y	ND	ND	ND	?	ND	ND	?	?	Y	ND			?	CONCRETE-LINED BASIN RECEIVED COOLING WATER FROM REACTOR. BASIN BACKFILLED ONLY TO A DEPTH OF 4 FT.ABOVE FLOOR. SOIL CONTAMINATION SURROUNDING BASIN...WALLS ARE ALSO RADIOACTIVE. UPR ALSO OCCURRED. 1949-1965. TRITIUM.
Tank/Tile Field	G	1607-H 4A	1607-H4 Septic Tank	Y	ND	ND	ND	ND	ND					ND	Y			UNIT RECEIVED SANITARY WASTEWATER FROM WAREHOUSE AND FIRE STATION(1948-1960).
Tank/Tile Field	G	1607-H 2A	1607-H2 Septic Tank	Y	ND	?	ND	?	ND	?	NS	NS	NS	ND	Y			UNIT RECEIVED SANITARY WASTEWATER FROM OFFICE AND MAINTENANCE BUILDINGS(1949-1965)
Tank/Tile Field	G	1607-H-3A	1607-H3 Septic Tank	Y	ND	ND	ND	ND	ND		NS	NS	NS	ND	Y			UNIT RECEIVED SANITARY WASTEWATER FROM PUMPHOUSE(1948-1965)

Key:

Y: yes
ND: no data

A - official number not assigned but identified by unit number

blank: no
I: incomplete data

TABLE 3-6 100 KE/KW WASTE CONSTITUENTS MATRIX

100 KE/KW Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	NATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	Comments
Burial Ground	C	116-K	100-K Burial Ground 116 K	Y	ND	ND	ND	ND	Y	ND	Y	Y	Y	1.00E+04 M3 1.00E+06 KG			?	UNIT COMPRISED OF NUMEROUS PITS, TRENCHES, SILOS. USED FOR RADIOACTIVE SOLID WASTE DISPOSAL INCLUDING STAINLESS STEEL.
Burning Pit	L	100-KR	100-K Burning Pit	?	ND	?	?	?	ND	ND	ND	ND	ND	ND	?			UNIT WAS USED FOR DISPOSAL OF NON RAD. MATERIALS SUCH AS PAINT WASTE, OFFICE WASTES, & CHEMICAL SOLVENTS FROM 55 TO 71. NO DATA ON THE AMOUNT OF WASTE DISPOSED OF.
Crib	G	116-KW-1	115-KW Condensate Crib	ND	ND	ND	ND	ND	ND	ND	Y	Y	Y	8.00E+05 L			?	RECEIVED CONDENSATE AND OTHER WASTE WATER FROM REACTOR GAS PURIFICATION PROCESS. TRITIUM PRESENT.
Crib	G	116-KE-1	115-KE Condensate Crib	ND	ND	ND	ND	ND	ND	ND			Y	8.00E+06 L			?	RECEIVED CONDENSATE AND OTHER WASTE WATER FROM REACTOR GAS PURIFICATION PROCESS. RETIRED IN 71 DOES NOT SEEMS TO HAVE RADIOACTIVE METALS. H-3 AND C-14 ONLY. SOME BETA VALUES.
French Drain	G	116-KW-2	105-KW Storage Basin Fr Drain	Y	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	SITE RECEIVED 105 KW STORAGE BASIN SUBDRAINAGE. RETIRED IN 70. NO INFO ON TYPE OR QUANTITY OF WASTE.
French Drain	G	116-KE-3	105-KE Storage Basin Fr Drain	Y	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	RECEIVED SUBDRAINAGE FROM 105 KE STORAGE BASIN. RETIRED IN 71. NO INFO ON TYPE OR QUANTITY OF WASTE.
Retention Basin	I	107-KE*	107-KE Retention Basin	Y	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	RECEIVED COOLING WTR FROM 105 REACTOR. NOX RAD. INVENTORY IS IN THE SOIL AROUND THE UNIT.
Retention Basin	I	107-KW*	107-KW Retention Basin	Y	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	SAME AS ABOVE.
Tank	H	183-KE*	183-KE Liq. Alum Storage Tank	Y	Y			Y						1.00E+05 gal (cap)	Y			STORAGE OF LIQUID. NO ACTUAL QUANTITY AVAILABLE.
Tank	I	105-KE*	105-KE Emergency Diesel Fuel	Y	Y	Y	?							2.00E+03 gal (cap)	Y			STORAGE OF DIESEL FUEL. TANK IS NOW EMPTY.
Tank	I	166-KW*	166-KW Oil Storage Tank	Y	Y	Y	?							1.65E+06 gal (cap)	Y			1.65 M. GAL CAP. TANK USED FOR STORAGE OF OIL FROM 55 TO 70. 2000 GAL OF HEEL REMAINS IN TANK. (R3-8)
Tank	I	182-K*	182-K Emergency Cooling Flow	Y	Y	Y	?							3.50E+04 gal (cap)	Y			USED FOR STORAGE OF DIESEL OIL FROM 55 TO 71. TANK IS EMPTY NOW.
Tank	H	183-KE1*	183-KE1 Sulfuric Acid Storage	Y	Y			Y		A				1.00E+04 gal (cap)	Y			SULFURIC ACID.
Tank	I	166-KE*	166-KE Oil Storage Tank	Y	Y	Y	?							1.65E+06 gal (cap)	Y			FUEL OIL.
Tank	H	183-KW2*	183-KW2 Sulfuric Acid Storage	Y	Y			Y		A				1.00E+04 gal (cap)	Y			SULFURIC ACID
Tank	H	183-KW1*	183-KW1 Sulfuric Acid Storage	Y	Y			Y		A				1.00E+04 gal(cap)	Y			SULFURIC ACID
Tank	H	183-KE2*	183-KE2 Sulfuric Acid Storage	Y	Y			Y		A				1.00E+04 gal (cap)	Y			SULFURIC ACID
Tank	H	183-KW*	183-KW Sodium Dichromate	Y	Y			Y						ND	Y			SODIUM DICHROMATE
Tank	I	1717-K*	1717-K Waste Oil Storage Tank	Y	Y	Y	?		?					ND	Y			MOTOR OIL
Tank	H	183-KE*	183-KE Sodium Dichromate Tank	Y	Y			Y						ND	Y			SODIUM DICHROMATE
Tank	I	1717-K*	1717-K Gas Storage Tank (3)	Y	Y	Y	Y							ND	Y			GASOLINE STORAGE TANK
Tank	I	105-KW*	105-KW Emergency Diesel Fuel	Y	Y	Y	?							2.00E+03 gal (cap)	Y			DIESEL FUEL
Trench	F	100-KE*3	183-KE Acid Filter Facility	Y	Y			Y		A				ND	Y			SULFURIC ACID SLUDGE-WATER SLURRY FROM ACID STORAGE TANKS. NO INFO ON QUANTITY DISPOSED.

KEY: Y= yes; ND= no data; A = official number not assigned but identified by unit number; blank= no; I= incomplete data

TABLE 3-7 100 N WASTE CONSTITUENTS MATRIX

100 N Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	NATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	Comments
Burning Pit	L	120-N-1	100-N Burning Pit (120-N 1)	ND	ND	?	ND	?	?	ND	ND	ND	ND	ND	?			NO INFO ON WASTE TYPE DISPOSED OF. WASTE GENERALLY CONSISTED OF NUISANCE VEGETATION AND COMBUSTIBLE WASTE. COMPLETE COMBUSTION IS NOT EXPECTED IN ALL CASES. (1982-86)
French Drain	G	120-N-6	104-N Acid Tank Vent French	Y	Y			Y		A				ND	Y			CONDENSATE FROM SULFURIC TANKS AND LINES. 3 UNITS RECEIVED WASTE FROM 63 TO 67, AND 2 OTHERS FROM 82 TO 87.
French Drain	G	120-N-7	Acid Unloading Facility	Y	Y			Y		A				ND	Y			WASTE FROM RAILROAD CAR UNLOADING FACILITY. INTERMITTENT DISCHARGE OF SULFURIC ACID.
Line Leak	J	UN-116-N-22	184-N Diesel Oil Supply Line	Y	Y	Y	?							1.00E+03 GAL	Y			EXTERNAL CORROSION OF TANK CAUSED RELEASE.
Line Leak	J	UN-116-N-23	184-N Diesel Oil Supply Line	Y	Y	Y	?							2.00E+02 GAL	Y			DIESEL OIL LEAK IN 87.
Pit	G	120-N-3	163-N Neutralization Pit/Drains	Y	ND	ND	ND	Y	ND	Y				ND	Y			(R3-20) RECEIVED CORROSIVE LIQUIDS SUCH AS NAOH & SULFURIC ACID pH NOT DETERMINED, FROM 1/63-3/87. INTERMITTENT DISCHARGES OF UNKNOWN QUANTITIES.
Tank/Drain Field	G	124-N-4	124-N-4 Septic Tank	ND	ND	ND	ND	ND	ND	ND				3.00E+04 GPD	Y			(R3-12) RECEIVED SANITARY SEWAGE FROM 63 TO 87.
Tank/Drain Field	G	124-N-7	124-N-7 Septic Tank	ND	ND	ND	ND	ND	ND	ND				5.20E+03 GPD	Y			(R3-15) RECEIVED SANITARY SEWAGE FROM 84 TO 87
Tank/Drain Field	G	124-N-8	124-N-8 Septic Tank	ND	ND	ND	ND	ND	ND	ND				9.00E+02 GPD	Y			(R3-16) RECEIVED SANITARY SEWAGE FROM 83-87.
Tank/Drain Field	G	124-N-6	124-N-6 Septic Tank	ND	ND	ND	ND	ND	ND	ND				ND	Y			(R3-14) RECEIVED UNKNOWN QUANTITY OF SANITARY SEWAGE FROM 79 TO 84.
Tank/Drain Field	G	124-N-5	124-N-5 Septic Tank	ND	ND	ND	ND	ND	ND	ND				3.00E+03 GPD	Y			(R3-13) RECEIVED SANITARY SEWAGE FROM 81 TO 87.

KEY: Y= yes; ND= no data; A = official number not assigned but identified by unit number; blank= no; I= incomplete data

TABLE 3-8 200 E WASTE CONSTITUENTS MATRIX

200 East Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	NATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	Comments
box	I	216-A-524	216-A-524 Control Structure		NO	NO	NO	NO	NO	NO	NO	Y	?	NO		NO	?	RADIOACTIVELY CONTAMINATED PIPING & CEMENT
burial ground	C	218-E-8	218-E-8, 200 East Construction	Y	NO	NO	NO	NO	NO	NO	Y	Y	Y	8.00E+04 CU FT		?		NFP/TBU WASTE, REPAIR AND CONSTRUCTION WASTES.
burial ground	C	218-E-13	218-E-13 Burial Ground		NO	NO	NO	NO	NO	NO	NO	NO	?	NO	NO	NO	?	CONTAMINATED CONCRETE
burial ground	C	218-E-6	218-E-6 Burial Ground	Y	NO	NO	NO	NO	NO	NO	NO	NO		NO		NO	?	CONTAMINATED WOODEN ITEMS; INCLUDED ASHES
burial ground	C	218-E-2	218-E-2, 200 East Industrial		NO	NO	NO	NO	NO	NO	Y	Y	Y	3.10E+05 CU M		?		MIXED NFP/TBU
burial ground	C	218-E-5	218-E-5 Burial Ground		NO	NO	NO	Y	NO	NO	Y	Y	Y	1.10E+05 CU M		?		INDUSTRIAL DRY WASTE, UNH-CONTAMINATED RAILROAD CARS
burial ground	C	218-E-5A	218-E-5A, 200 East Industrial	Y	I	NO	NO	NO	NO	NO	Y	Y	Y	2.20E+05 CU M		?		FAILED EQUIPMENT AND INDUSTRIAL WASTES. WASTE BOXES DAMAGED AND PUSHED INTO TRENCH.
burial ground	C	218-E-3	218-E-3 Burial Ground	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	
burial ground	C	218-E-4	218-E-4, 200 East/Waste No. 4	Y	NO	NO	NO	NO	NO	NO	Y	Y	Y	5.60E+04 CU FT		?		REPAIR AND CONSTRUCTION WASTES. AT ONE TIME CONTAMINATED EQUIPMENT STORED ABOVE GROUND. IT IS UNCLEAR WHETHER THESE WASTES WERE DEPOSITED.
burial ground	C	218-E-1	218-E-1, 200 East Dry Waste		NO	NO	NO	NO	Y	NO	Y	Y	Y	1.10E+05 CU FT		?		RECEIVED MIXED NFP/TBU DRY WASTES. FILLED WITH CINDERS AND TOPPED WITH GRAVEL.
burial ground	C	218-E-12B	218-E-12B, 200 East Dry Waste	Y	I	NO	NO	?	NO	A	Y	Y	Y	NO		Y		ACID SOAKED WASTES; DRY WASTES FROM 200E.
burial tunnel	O	218-E-14	218-E-14 Purex Tunnel No. 1			NO	NO	NO	NO	NO	Y	Y	Y	2.00E+04 CU FT			?	HIGHLY CONTAMINATED MATERIALS STORED ON RAILROAD FLAT CARS IN TUNNEL. LARGE EQUIPMENT.
burial vault	B	216-E-9	216-E-9,Equip. Stor. Area No.9	Y	NO	NO	NO	NO	NO	NO	Y	NO	?	NO			?	REGULATED EQUIPMENT STORAGE; FISSION PRODUCT EQUIPMENT FROM URANIUM RECOVERY PROGRAM.
burial vaults (3)	E	218-E-7	218-E-7, 200 East/222-B Vaults	Y	I	NO	NO	NO	NO	NO	Y	Y	Y	6.00E+03 CU FT		?		LAB WASTES AND MIXED NFP/TBU WASTE IN ONE WOODEN AND TWO CONCRETE VAULTS.
burning pit	L		200 East Burning Pit			Y	Y	?	?	NO				2.50E+03 CU M	Y			CHEMICALS, SOLVENTS, PAINTS, CONSTRUCTION AND OFFICE WASTES. 1950-70.
crib	G	216-A-39	216-A-40 CRIB/TRENCH	Y		NO	NO	Y	NO	NO	Y	NO	Y	2.00E+01 LITERS		?		CRIB AND 2 TRENCHES RECEIVED FLOOR DRAINAGE FROM 241-AX-001-B BLDG(TANK 103AX PRESSURE LEAK) FILLED WITH GRAVEL AND BACKFILLED. 6/66.
crib	G	216-B-47	216-BV-5 CAVEBV/CRIB	Y	Y	?	NO	Y	Y	NO	Y	Y	Y	3.71E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG. TRENCH BACKFILLED. 9/55-9/55.
crib	G	216-B-51	216-BV-9 CRIB	Y	I	NO	NO	Y	NO	NO	NO	NO	?	1.00E+03 LITERS	NO	NO	NO	RECEIVED FLUSH DRAINAGE FROM BC CRIB PIPELINE. SITE RETIRED IN 1/58.
crib	G	216-B-15	216-BC-2 Crib	Y	Y	Y	NO	Y	NO	NO	Y	Y	Y	6.32E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG.
crib	G	216-A-10	216-A-10 crib	Y	I	NO	NO	Y	NO	A	Y	Y	Y	2.90E+09 LITERS		Y		UNIT RECEIVED WASTES UNTIL 1987 (MARCH).
Crib	G	216-C-5	216-C-5 crib	Y		NO	NO	Y	NO	NO	Y	Y	Y	3.70E+04 LITERS		Y		201-C COLD RUN WASTE
crib	G	216-A-22	216-A-22 French Drain	Y	I	NO	NO	Y	NO	NO	NO	NO	?	1.00E+04 LITERS		?		SUMP WASTE FROM 203 A BLDG, HEATING COIL CONDENSATE, TRUCK LOADING DRAINAGE.
crib	G	216-B-14	216-B-14	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	8.71E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG.
crib	G	216-A-41	216-A-41 Crib	Y	I	NO	NO	Y	NO	A	NO	NO	?	1.00E+04 LITERS		?		296-A-13 STACK DRAINAGE (SLIGHTLY ACIDIC).
crib	G	216-C-6	241-CX Crib	Y		NO	NO	NO	NO	Y	Y	Y	Y	5.30E+05 LITERS		?		
crib	G	216-A-32	216-A-32	Y	I	NO	NO	NO	NO	NO	NO	NO	?	4.00E+03 LITERS		?		202-A CRANE MAINTENANCE FLOOR, SINK, AND SHOWER DRAINAGE.
Crib	G	216-C-4	216-C-4 crib	Y	Y	Y	NO	Y	NO	NO	Y	Y	Y	1.00E+05 LITERS		?		RECEIVED CONTAMINATED ORGANIC WASTES FROM 276-C BLDG.
crib	G	216-A-31	216-A-32 Crib	Y	I	Y	NO	Y	NO	N	Y	Y	Y	1.00E+04 LITERS		?		ORGANIC WASTES FROM 202-A BLDG.

KEY: Y= yes
NO= no date

A = official number not assigned but identified by unit number

blank= no
I= incomplete data

TABLE 3-8 200 E WASTE CONSTITUENTS MATRIX (continued)

200 East Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Shipped	MIXTURE OF WASTE Solid/Non. Waste	Mixed Waste	Rad. Only	Comments
crib	6	216-B-100	216-B-100 CRIB, 222-B-2 CRIB	Y	I	NO	NO	Y	NO	N	Y	Y	Y	0.00E+04 LITERS		Y		DECONTAMINATED SAMPLE AND SINK WASTE FROM 221-B.
crib	6	216-B-60	216-B-60 Crib	Y		NO	NO	NO	NO	NO	Y	Y	Y	1.09E+04 LITERS		Y		221-B BLDG SOLID + LIQUID CELL CLEANOUT WASTE. CRIBS SEALED WITH CONCRETE COVERED BY 225-B FACILITY.
crib	6	216-A-3	216-A-3 Crib	Y	I	NO	NO	Y	NO	?	Y	Y	?	2.00E+05 LITERS		Y		SILICA GEL REGENERATION WASTE FROM 203-A, WAM STORAGE PIT DRAINAGE, AND 203-A PUMPHOUSE.
crib	6	216-C-6	216-C-6	Y		NO	NO	Y	NO	N	Y	Y	Y	5.30E+05 LITERS		Y		PROCESS CONDENSATE AND 241-CX VAULT FLOOR DRAINAGE.
crib	6	216-B-19	216-BC-6 Crib	Y	Y	?	NO	Y	NO	NO	Y	Y	Y	6.40E+05 LITERS		Y		WASTE FROM 221-U URANIUM RECOVERY (TBP SOLVENT EXTRACTION); CYANIDE.
crib	6	216-B-8	216-B-8 Crib	Y	I	NO	NO	NO	NO	NO	Y	Y	?	2.72E+07 LITERS		Y		SECOND CYCLE WASTE (AND OTHER LIQUID WASTES.
crib	6	216-B-18	216-BC-5 Crib	Y	Y	?	NO	Y	NO	NO	Y	Y	Y	0.50E+05 LITERS		Y		WASTE FROM 221-U URANIUM RECOVERY (TBP SOLVENT EXTRACTION). FILLED WITH GRAVEL FOLLOWING CAVE IN; CYANIDE.
crib	6	216-A-1	216-A-1 Cavern	Y	NO	NO	NO	NO	NO	NO	Y	Y	?	9.0E+04 LITERS			?	DEACTIVATED URANIUM WASTE FROM COLD START-UP IN 202-A.
crib	6	216-A-2	216-A-2 Cavern	Y		Y	NO	Y	NO	NO	Y	Y	Y	2.30E+05 LITERS		Y		DRAINED WASTE FROM 202A (FURED).
crib	6	216-B-57	216-B-57 Crib	Y	I	NO	NO	Y	NO	NO	Y	Y	Y	0.4E+07 LITERS		Y		WASTE STORAGE TANK CONDENSATE FROM THE ITS 02 UNIT IN 241-BY TANK FARM.
crib	6	216-B-17	216-BC-4 Crib	Y	I	NO	NO	Y	NO	NO	Y	Y	Y	3.41E+05 LITERS		Y		URANIUM RECOVERY WASTE FROM 221-U (TBP SOLVENT EXTRACTION); CYANIDE.
cribs - 3	6	216-B-12	216-ER-1, 2, 3 cribs, 216-ER	Y	I	?	NO	Y	NO	NO	Y	Y	Y	8.20E+08 LITERS		Y		PROCESS CONDENSATE FROM EVAPORATORS.
crib/tile field	6	216-B-9	216-B-361, 241-B-361	Y	I	NO	NO	Y	NO	NO	Y	Y	Y	3.60E+07 LITERS		Y		RECEIVED CELL DRAINAGE AND OTHER WASTES VIA TANK S-6 IN 221-B.
crib/trench	E	216-B-58	216-B-58 TRENCH, 216-B-59 CRIB	Y		NO	NO	Y	NO	NO	Y	Y	Y	4.13E+05 LITERS		Y		RECEIVED BATTELLE NW LAB WASTE FROM 300 AREA.
ditch	E	216-A-34	216-A-34 Crib	Y	NO	NO	NO	NO	NO	NO	NO	NO	?	NO			?	CONTACT CONDENSER COOLING WATER
ditch	E	216-B-2-1	216-B-2, B DITCH	Y	NO	NO	NO	NO	NO	NO	Y	Y	?	1.9E+11 LITERS		Y		WAS CONTAMINATED BY A COIL FAILURE IN BLDG 221-B. DITCH WAS COVERED WITH CLEAN FILL AND PLASTIC WEED ROOT BARRIER. INCLUDES UPR-200-E-32. USED FOR STEAM CONDENSATE, PROCESS COOLING WATER, AND CHEMICAL SEWER WASTE.
ditch	E	216-B-3-2	216-B-2-3E, B SWAMP DITCH	Y	NO	NO	NO	NO	NO	NO	Y	Y	NO	1.9E+11 LITERS		Y		PROCESS VESSEL COOLING WATER, VAULT COOLING WATER, AND CHEMICAL SEWER WASTE.
ditch and pond	E	216-B-3-1	B SWAMP DITCH, 216-B-2	Y	NO	NO	NO	NO	NO	NO	Y	NO	NO	1.9E+11 LITERS		Y		SAME AS 216-B-3-2.
diversion box	I	241-B-151	241-B-151 diversion box	N	NO	NO	NO	NO	NO	NO	Y	Y	?	NO		Y		LEAKAGE IDENTIFIED VIS UPR-200-E-4 + 73. SOME CONTAMINATED SOILS REMOVED AND REPLACED.
diversion box	I	241-C-252	241-C-252 diversion box	N	NO	NO	NO	NO	NO	NO	NO	Y	?	NO		Y		ASSOCIATED W/ CATCH TANK 241-301-C
diversion box	I	241-C-154	241-C-154 diversion box	N	NO	NO	NO	NO	NO	NO	NO	Y	?	NO		Y		
diversion box	I	241-AY-152	241-AY-152 diversion box	N	NO	NO	NO	NO	NO	NO	NO	Y	?	NO		Y		
diversion box	I	241-AR-152	241-AR-152 diversion box	N	NO	NO	NO	NO	NO	NO	NO	Y	?	NO		Y		
diversion box	I	241-CR-152	241-CR-152 diversion box	N	NO	NO	NO	NO	NO	NO	NO	Y	?	NO		Y		
diversion box	I	241-CR-153	241-CR-153 diversion box	N	NO	NO	NO	NO	NO	NO	NO	Y	?	NO		Y		
diversion box	I	241-BXR-153	241-BXR-153 diversion box	N	NO	NO	NO	NO	NO	NO	NO	Y	?	NO		Y		
diversion box	I	241-BYR-151	241-BYR-151 diversion box	N	NO	NO	NO	NO	NO	NO	NO	Y	?	NO		Y		
diversion box	I	241-B-202	241-B-202 diversion box	N	NO	NO	NO	NO	NO	NO	NO	Y	?	NO		Y		ASSOCIATED W/ CATCH TANK 241-B-301-B

KEY: Y= yes, NO= no data; N = official number not assigned but identified by unit number; blank= no; I= incomplete data

TABLE 3-8 200 E WASTE CONSTITUENTS MATRIX (continued)

[illegible]

Unit Type	Site Code	Official Number	Site Name Description	Waste Source Identified	Chemical Identified	Organics	Volatiles	Inorganics	Metals	pH	Discrete Products	Other Radio Nuclide	Radioactive Radioactivity	Waste Volume Disposed	Method of Waste Disposal Waste	Mixed Waste	Rad. Only	Comments
diversion box	I	[illegible] 151	291-B-151 diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		[illegible]
diversion box	I	291-[illegible] 151	291-[illegible] 151 diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		:CONTAMINATION FROM [illegible] :[illegible] :TO PROPERLY FIX POSSIBLE CONTAMINATION.
diversion box	I	291-B-152	291-B-152 diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		:BYSAN.INTED W/ CATCH TANK 291-B-302 B
diversion box	I	291-B-152	291-B-152 diversion box	N	ND	ND	ND	ND	ND	ND	Y	Y	?	:ND		Y		:LEAKAGE REPORTED BY UPK [illegible] :DW 216-[illegible]. SOME SOIL REMOVED AND [illegible] COVERED
diversion box	I	291-BXR-153	291-BXR-153 diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		
diversion box	I	291-B-154	291-B-154 diversion box	N	ND	ND	ND	ND	Y	ND	Y	Y	?	:ND		Y		:BYSAN.INTED W/ CATCH TANK 291-B-302 B. :OPERATION: CONTAMINATION DISCOVERED WITH [illegible] :SOILS REMOVED. REPORTED BY UPK 200-E-[illegible]. :LEAKAGE REPORTED BY UPK 200-E-77. SITE COVERED.
diversion box	I	291-[illegible]-152	291-[illegible]-152 diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		:BYSAN.INTED W/ CATCH TANK 291-B-[illegible]. CONTAMINATION :INCIDENT REPORTED BY UPK 200-E-81. :COVERED WITH GRAVEL.
diversion box	I	291-BX-155	291-BX-155 diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		:BYSAN.INTED W/ CATCH TANK 291-BX-[illegible]
diversion box	I	291-[illegible]-153	291-[illegible]-153 diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		:BYSAN.INTED W/ CATCH TANK 291-B[illegible]
diversion box	I	291-BX-151	291-BX-151 diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		:BYSAN.INTED W/ CATCH TANK 291-BX-[illegible]
diversion box	I	291-BXR-[illegible]	291-BXR-[illegible] diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		
diversion box	I	291-BXR-[illegible]	291-BXR-[illegible] diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		
diversion box	I	291-BX-154	291-BX-154 diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		:BYSAN.INTED W/ CATCH TANK 291-BX-[illegible]
diversion box	I	291-B-153	291-B-153 diversion box	N	ND	ND	ND	ND	ND	ND	Y	Y	?	:ND		Y		:BYSAN.INTED W/ CATCH TANK 291-B[illegible]. CONTAMINATION :REPORTED BY UPK 200-E-75 AND UPK 200-E-[illegible]. :COVERED WITH GRAVEL.
diversion box	I	291-BXR-154	291-BXR-154 diversion box	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		
diversion box [illegible]	I	291-B-153	291-B-153 diversion box [illegible]	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		
diverter station	I	291-HV-152	291-HV-152 diverter station	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		
diverter station	I	291-HZ-151	291-HZ-151 diverter station	N	ND	ND	ND	ND	ND	ND	ND	Y	?	:ND		Y		:BYSAN.INTED W/ CATCH TANK 291-HZ-151
drain field	G		Sanitary waste drain field [illegible]	Y	ND	Y	ND	ND	ND	ND			NS	:2.[illegible] :CU FT/M				:[illegible] REMAINS USED TO [illegible] SUPPORTED BY [illegible] UNIT.
evaporator	H	291-B	291-B Evaporator [illegible]	Y	I	ND	ND	Y	ND	ND	Y	Y	?	:7.17[illegible] :GAL.		Y		:151 [illegible] :VARIOUS COMPONENTS.
French drain	G	216-B-2A	216-B-2A French Drain	Y	I	ND	ND	Y	ND	ND	ND	ND	?	:1.[illegible] :LITERS		?		:291-B FOR CONTROL [illegible]
French drain	G	216-B-16	216-B-16 Dry Well	Y	I	ND	ND	Y	ND	ND	ND	ND	?	:1.[illegible] :LITERS		?		:291-B 431 BLDG STACK & FLOOR DRAINS
French drain	G	216-B-17	216-B-17 Dry Well	Y	I	ND	ND	Y	ND	ND	ND	ND	?	:6.[illegible] :LITERS		?		:291-B 431 BLDG STACK & FLOOR DRAINS
French drain	G	216-B-35	216-B-35 Dry Well	Y	I	ND	ND	Y	ND	ND	ND	ND	?	:1.[illegible] :LITERS			?	:SINK COOLING WATER FROM [illegible] :VACUUM PUMPS.
French drain	G	216-B-31	216-B-31 Dry Well	Y	I	ND	ND	Y	ND	ND	ND	ND	?	:ND			?	:BEARING COOLANT FROM 291-B-1 STACK [illegible] :EXHAUST. UNITED STATES [illegible].
French drain	G	216-[illegible]-8	271-UR crib, 216-[illegible] drain	Y	I	ND	ND	Y	ND	Y	ND	ND	?	:1.[illegible] :LITERS		?		:271-UR BLDG ION EXCHANGE [illegible]
French drain	G	216-B-12	216-B-12 French Drain	Y	I	ND	ND	Y	ND	ND	ND	ND	?	:1.[illegible] :LITERS		?		:2[illegible] B BLDG STEAM TRAP PIT [illegible]
French drain	G	216-B-290	216-B-290 French Drain	Y	I	ND	ND	Y	ND	ND	ND	ND	?	:6.[illegible] :LITERS		?		:291-B 431 DEMINERALIZER [illegible] :FLUSH.
French drain	G	216-B-19	216-B-19 French Drain	Y	I	ND	ND	Y	ND	ND	ND	Y	ND	:1.[illegible] :LITERS		?		:2[illegible] B WAL. CLEANER FILTER & BOILER FIL [illegible]
French drain	G	216-B-290	216-B-290 French Drain	Y	I	ND	ND	Y	ND	ND	ND	ND	?	:6.[illegible]		?		:291-B 431 DEMINERALIZER [illegible]

KEY: Y = yes; ND = no data; * = official number not assigned but identified by unit number; Blank = no; I = incomplete data

TABLE 3-3 100 D/DR WASTE CONSTITUENTS MATRIX

Unit Type	Site Code	Unit Number	Site Name Description	Waste Source Identified	Chem. Id. Identified	Common Contents Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio nuclides	Residual Radio Activity	Waste Volume Disposed	Nature of Waste Solid/Haz. Waste	Mixed Waste	Rad Only	Comments
Basin Trench	I	100-D-1	105-DR Storage Basin Trench	Y	ND			?			Y	Y	Y	9.00E+06 L			Y	CONTAMINATED STORAGE AND WATER FROM FUEL STORAGE BASIN, INCLUDED TRITIUM.
Basin Trench	I	100-D-10	105-D Storage Basin Trench 81	Y	ND	ND	ND	Y	ND		ND	ND	Y	2.00E+05 L			?	CONTAMINATED WATER AND SOLIDS FROM 105-D STORAGE BASIN.
Burial Ground	I	100-D-3	100-D Burial Ground 83 110-D-3	Y	I	ND	ND	ND	Y		Y		Y	7.00E+04 KG		?		BURIAL GROUND FOR DEBRIDED SOLID WASTES WITH INCLUDED TRITIUM AND BORE SOLID WASTE.
Burial Ground	I	100-D-4	Construction Burial Ground	Y	ND				?		Y	ND	Y	1.00E+03 KG		?		BURIAL GROUND: CONTAMINATED MATERIAL FROM REACTOR BLDG....COMPONENTS AND HARDWARE
Burial Ground	I	100-D-1	100-D Burial Ground 81 110-D-1	Y	ND	ND	ND	ND	Y		Y	ND	Y	1.00E+06 KG		?		BURIAL GROUND FOR DEBRIDED SOLID WASTE AND METALLIC WASTE BUT STATED THAT THESE TRENCHES WERE CLOSED ASSUMED SO HOWEVER.
Burial Ground	I	100-D-2	100-D Burial Ground 82 110-D-2	ND	ND	ND	ND	ND	Y		Y	ND	Y	1.00E+06 KG		?		BURIAL GROUND FOR CONTAMINATED/DEBRIDED SOLID WASTE AND METAL WASTE, DOUBLE WASTE, TOO.
Burial Ground	I	100-D-5	Wall 3K Burial Ground 110-D-5	Y	ND				Y		Y	ND	Y	6.00E+03 KG			?	BURIAL GROUND FOR THINGS FROM REACTOR BLDG.
Burial Ground	I	100-DR-1	105-DR Gas Loop Burial Ground	Y	ND				Y		Y	ND	Y	1.00E+04 KG			?	IRRADIATED METAL ASSEMBLIES.
Burning Pit	I	100-D-DR	100 D/DR Burning Pit	Y	I	Y	Y	?	?	ND				1.00E+03 M3	Y			BURNING OF PAINT WASTES, SOLVENTS, OTHER CHEMICALS.
Crib	G	116-DR	116-D Crib	Y	ND	ND	ND	ND	ND	ND	ND	ND		9.00E+05 L		ND	ND	DRAINAGE FROM CONTAINMENT SYSTEM 1970 ANALYSIS: NO RADIOACTIVITY ABOVE BACKGROUND
Crib	G	116-DR-9	105-DR Pluto Crib 116-DR-9	Y	ND			?	ND	ND	Y	Y	Y	9.00E+03 L		?		EFFLUENT FROM TUBES CONTAINING FAILED FUEL ELEMENTS.
Crib	G	116-DR-8	116-DR Crib	Y	ND	ND	ND	ND	ND	ND	ND	ND	Y	2.00E+05 L		?		DRAINAGE FROM CONTAINMENT SYSTEM SOIL PITS.
Crib	G	116-D-2	105-D Pluto Crib 116-D-2	Y	I	ND		Y	ND	ND	ND	ND		9.00E+03 L		?		WASTES FROM FAILED FUEL ELEMENTS. SODIUM DICHROMATE NOW IDENTIFIED
French Drain	G	116-D-3	100-D Crib 81 116-D-3	Y	ND	?	ND	?	?	?	Y	ND	?	3.00E+05 L		?		WASTES FROM CONTAMINATED MAINTENANCE SHOP AND CASK DECONT. PAD.
French Drain	G	116-D-4	100-D Crib 82 116-D-4	Y	ND	?	ND	?	?	?	Y	ND	Y	3.00E+05 L		?		WASTES FROM CONTAMINATED MAINTENANCE SHOP AND CASK DECONT. PAD
French Drain	G	116-D-6	105-D Cushion Corridor French	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	1.00E+06 L		?		DOWNSTREAM WATER FROM CHANGE ROOM, AND WATER FROM MASK DECONT. STATION.
Pumping Station	G	1608-DR	1608 DR Waste Water Pumping	Y	Y	Y		Y		N	Y	Y	?	ND		Y		PUMPING UNIT RECEIVING WATER FROM REACTOR BLDG. DRAINS...TRACE AMTS OF LOW LEVEL RADIONUCL. AND DECONTAM. CHEMICALS. RADIONUCL. INFORMATION AVAILABLE BUT NOT DETAILED IN SUMMARY.
Pumping Station	G	1608-D	1608 D Waste Water Pumping	Y	Y	Y		Y		N	Y	Y	?	ND		Y		PUMPING UNIT RECEIVING WATER FROM REACTOR BLDG. DRAINS...LOW LEVEL RADIONUCL. AND DECONTAM. CHEMICALS.
Retention Basin	I	107-D-8	107-D Retention Basin	Y	ND			?			ND	ND	Y	ND		?		CONCRETE LINED, REINFORCED BASIN. RECEIVED REACTOR COOLING WATER EFFLUENT PRIOR TO DISCHARGE TO COLUMBIA RIVER.
Retention Basin	I	107-DR-8	107-DR Retention Basin	Y	ND				ND		ND	ND	Y	ND		?		CONCRETE LINED BASIN. RECEIVED REACTOR COOLING WATER EFFLUENT. CONTAMINATED/RADIOACTIVE BASIN WALLS AND SURROUNDING SOIL.
Storage Pad	G	100-D-8	100-D Cask Storage Pad (3)	ND	ND	?	ND	?	ND	? N	ND	ND	Y	ND		?		STORAGE PAD RECEIVED RADIONUCL. AND DECONTAM. CHEMICALS. TRACE AMOUNT. RESIDUAL PAD DISCHARGES TO PROCESS SEWER. PAD CONTAINS ONE CONTAMINATED DRAIN.
Tank	I	1706-DR	1706 D Gas Storage Tank (3)	Y	Y	Y	Y								Y			STORAGE TANK CONTAINED BUILDING...NOT INFILLED AND FILLED WITH WATER. PRESENTLY CONTAINS WATER.
Underfile Field	G	1607-D1a	1607 D1 Septic Tank	Y	ND	ND	ND	ND	ND					ND	Y			SEPTIC TANK RECEIVED SANITARY WASTEWATER FROM SECURITY CHECKPOINT, BARGEHOUSE AND OTHER BUILDINGS.
Underfile Field	G	1607-D4a	1607 D4 Septic Tank	Y	ND	ND	ND	ND	ND					ND	Y			SEPTIC TANK RECEIVED SANITARY WASTEWATER FROM GAS DISTRIBUTION BLDG.

KEY: Y - yes; ND - no data; * - official number not assigned but identified by unit number; Blank - no; I - incomplete data

TABLE 3-8 200 E WASTE CONSTITUENTS MATRIX (continued)

200 East Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	NATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	Comments
														LITERS				FLUSH
french drain	G	216-A-11	216-A-11 French Drain	Y	I	ND	ND	Y	ND	ND	ND		?	1.00E+05 LITERS		?		202-A BLDG TRAP PIT DRAINAGE 81 1/55-1972.
french drain	G	216-A-15	216-A-15 French Drain	Y	I	ND	ND	Y	ND	A	ND		?	1.00E+07 LITERS		?		ACIDIC FILTER AND BLOWER PIT DRAINAGE (202-A BLDG).
french drain	G	216-A-13	216-A-13 French Drain	Y	I	ND	ND	Y	ND	ND	ND		?	1.00E+04 LITERS			?	202-A SEAL WATER FROM AIR SAMPLER VAC. PUMP
french drain	G	216-B-13	291-B CRIB, 216-B-B CRIB	Y	I	ND	ND	Y	ND	T	ND	?	?	2.10E+04 LITERS		?		291-B-1 STACK DRAINAGE. 1945-76.
leaching pit	E	216-C-3	201-C Leaching Pit	Y	Y	ND	ND	Y	ND	A	Y	Y	Y	5.00E+06 LITERS		Y		ACID WASTE FROM 201-C, 219-C, 271-C. NITRIC ACID 1/53-3/54.
pit	D		200 Area Construction Waste	Y										ND	T			CONSTRUCTION DEBRIS 1945-55.
pit #7#	D	UPR-200-E-124	UPR-200-E-124, B-13 Pit	Y	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		?		B-13 PIT; CHECK 10-1 WASTE LINE (154 BX DIVERSION BOXO.
receiving vault	I	244-CR#	244-CR receiving vault	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		?		ASSOCIATED W/ CATCH TANK 244-CR AND 241-C TANK FARM.
receiving vault	I	244-BXR#	244-BXR receiving vault	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		?		ASSOCIATED W/ CATCH TANK 244-BXR AND 241-BX TANK FARM.
reverse well	G	216-B-11-A & B	242-B-1 CRIB, 216-B-11 CRIB	Y	ND	ND	ND	?	ND	ND	Y	Y	Y	2.96E+07 LITERS		?		242-B EVAPORATOR PROCESS CONDENSATE
reverse well	G	216-B-4	216-B-4 FRENCH DRAIN/DRY WELL	Y	I	ND	ND	Y	ND	A	ND	Y	Y	1.00E+04 LITERS		Y		291-B STACK DRAINAGE, 292-B BLDG FLOOR DRAINAGE
spill site	J	UN-216-E-69	UN-216-E-69 Railroad Car Flush	Y	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		?		RAILROAD BURIAL CAR FLUSH WATER
spill site	C	UN-216-E-72	UN-216-E-72	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		ND	ND	UNCOVERED BURIED WASTE
spill site#7#	J	UPR-200-E-44/103	UPR-200-E-44/103, BCS CRIB LIN	Y	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		ND	ND	BCS CRIB LINE LEAKAGE SOUTH OF A-17 CHANGE HOUSE
tank	I	241-BX-302-B	catch tank 241-BX-302-B	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		Y		ASSOCIATED W/ THE 241-BX-154 DIVERSION BOX
tank	I	241-A-302-B	catch tank 241-A-302-B	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		Y		ASSOCIATED WITH 241-A-152 DIVERSION BOX
tank	I	241-BX-302-A	catch tank 241-BX-302-A	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		Y		ASSOCIATED W/ 241-BX-153 DIVERSION BOX
tank	I	241-AZ-151	catch tank 241-AZ-151	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		Y		ASSOCIATED W/ 241-AZ-151 DIVERTER STATION
tank	I	241-B-301-B	catch tank 241-B-301-B	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		Y		ASSOCIATED W/ 241-B-252 DIVERSION BOX
tank	I	244-CR#	catch tank 244-CR	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		Y		ASSOCIATED W/ 244-CR RECEIVING VAULT
tank	H	270-E#	270-E Condensate neutral.	ND	ND	ND	ND	ND	ND	Y	ND	ND	Y	ND		?		270-E CONDENSATE
tank	I	241-CX-72	241-CX-72 Tank	ND	ND	ND	ND	ND	ND	ND	ND	Y	Y	ND			?	SOLID RADIOACTIVE WASTE
tank	I	244-BXR#	catch tank 244-BXR	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		Y		ASSOCIATED W/ 244-BXR RECEIVING VAULT
tank	I	241-301-C	CATCH TANK 241-301-C	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		Y		
tank	I	241-B-361	241-B-361 settling tank	ND	ND	ND	ND	ND	ND	ND	ND	Y	Y	ND		?		SETTLED RAD. CONTAMINATED LIQUID
tank	I	241-BX-302-C	catch tank 241-BX-302-C	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		Y		ASSOCIATED W/ 241-BX-155 DIVERSION BOX
tank	I	241-CX-70	241-CX-70 tank	ND	ND	ND	ND	ND	ND	ND	ND	Y	Y	ND		?		RECEIVED RADIOACTIVELY CONTAMINATED SLUDGE
tank	I	241-B-302-B	catch tank 241-B-302-B	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		Y		ASSOCIATED W/ 241-B-154 DIVERSION BOX
tanks	I	241-AX#	241-AX tank farm	Y	ND	Y	ND	?	Y	A	Y	Y	?	ND		Y		PUREX ACID WASTE, CLADDING WASTE, ORGANIC WASH. CONTAMINATION REPORTED AS UPR-200-E-115,119.
tanks	I	241-BY#	241-BY tank farm	Y	ND	ND	ND	?	Y	ND	Y	Y	?	ND		Y		BISMUTH PHOSPATE PROCESS, TRIBUTYL PHOSPHATE, PUREX, ETC. SALT WELLS WERE INSTALLED TO REMOVE LIQUIDS ASSOCIATED WITH SPILLS REPORTED AS UPR-200-E-134, UPR-200-E-135. ADDITIONAL RELEASE REPORTED AS UPR-200-E-110.
tanks	I	241-A#	241-A tank farm	Y	ND	Y	ND	?	Y	A	Y	Y	?	ND		Y		PUREX ACID WASTE, CLADDING WASTE, ORGANIC WASH. CONTAMINATION REPORTED AS UPR-200-E-125,126,48,47.
tanks	I	241-BX#	241-BX tank farm	Y	ND	ND	ND	?	Y	ND	Y	Y	?	ND		Y		BISMUTH PHOSPATE PROCESS, ETC. CONTAMINATION REPORTED AS UPR-200-E-3,5,70,89,131,133.

KEY: Y= yes; ND= no data; A = official number not assigned but identified by unit number; blank= no; I= incomplete data

TABLE 3-8 200 E WASTE CONSTITUENTS MATRIX (continued)

200 East Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	NATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	Comments
tanks	I	241-B#	241-B tank farm	Y	NO	NO	NO	?	Y	NO	Y	Y	?	NO		Y		BISMUTH PHOSPHATE PROCESS, ETC. CONSTRUCTION OF A SALT WELL AND ASPHALTING WERE REPORTED IN UPR-200-E-127-130,108,109.
tanks	I	241-C#	241-C tank farm	Y	NO	Y	NO	Y	NO	NO	Y	Y	?	NO		Y		BISMUTH PHOSPHATE PROCESS, TRIBUTYL PHOS, PUREX, REDOX. CONSTRUCTION OF A SALT WELL AND SOIL REMOVAL WERE REPORTED ASSOCIATED "X" WITH UPR-200-E-16,30,91,136,137 AND UN-216-E-91.
tanks	H	224-B#	224-B CONC. FACILITY (40 TANKS)	NO	Y	Y	NO	?	Y	NO	Y	Y	Y	NO		Y		INACTIVE PRODUCT TREATMENT UNIT WITH RAD. CONTAMINATION AND HAZ. CONST.'S INCLUDING: PCB'S, MERCURY, AND CLEANERS. WASTE RECEIPT PRIOR TO 1976.
tanks	H	205-A#	205-A SILICA GEL FACILITY (9 tanks)	Y	NO	NO	NO	NO	NO	NO	NO	Y	Y	NO		?		INACTIVE RAD. MATERIALS PROCESSING UNIT. WASTE RECEIPT PRIOR TO 1976.
trench	E	216-A-18	216-A-18 Excavation	Y	I	NO	NO	Y	NO	NO	Y	Y	Y	4.00E+05 LITERS			?	DEPLETED URANIUM WASTE FROM 202-A COLD STARTUP. 12/56. PARTIALLY BACKFILLED
trench	E	216-B-30	216-BN-4 Trench	Y	Y	NO	NO	Y	NO	B	Y	Y	Y	1.43E+06 LITERS		?		FIRST CYCLE SUPERNATANT WASTE FROM 221-B BLDG.
trench	E	216-B-28	216-BC-14 TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	5.05E+05 LITERS		?		URANIUM RECOVERY WASTE (TBP SOLVENT RECOVERY) FROM 221-U. CYANIDE.
trench	E	216-B-53-B	216-B-53B TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	1.51E+04 LITERS		?		BLDG 321 WASTES (HANFORD LABORATORIES OPERATIONS).
trench	E	216-B-31	216-BC-18 TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	4.74E+06 LITERS		?		URANIUM RECOVERY WASTE (TBP SOLVENT RECOVERY) FROM 221-U. CYANIDE.
trench	E	216-B-33	216-BC-20 TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	4.74E+06 LITERS		?		URANIUM RECOVERY WASTE (TBP SOLVENT RECOVERY) FROM 221-U. CYANIDE.
trench	E	216-B-22	216-BC-9 TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	4.74E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG. CYANIDE.
trench	E	216-A-19	216-A-19 Grave/Sump/Test hole	Y		NO	NO	Y	NO	NO	Y	Y	Y	1.10E+08 LITERS		?		RECEIVED 241-A-431 BLDG CONTACT CONDENSER H2O, 202-A BLDG COLD START-UP U WASTE.
trench	E	216-B-42	241-BN-8 Grave,216-BN-8 Trench	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	1.50E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG. TRENCH BACKFILLED. CYANIDE.
trench	E	216-B-54	216-B-54 Trench	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	9.90E+05 LITERS		?		BLDG 321 WASTES (HANFORD LABORATORIES OPERATIONS).
trench	E	216-B-52	216-B-52 Trench	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	8.53E+06 LITERS		?		URANIUM RECOVERY WASTE (TBP SOLVENT RECOVERY) FROM 221-U. CYANIDE.
trench	E	216-B-34	216-BC-21 Trench	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	4.07E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG. TRENCH BACKFILLED. CYANIDE.
trench	E	216-B-20	216-BC-7 Trench	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	4.68E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG. CYANIDE.
trench	E	216-B-27	216-BC-14 TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	4.42E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG. CYANIDE.
trench	E	216-B-53A	216-B-53A Trench	NO	NO	NO	NO	NO	NO	NO	Y	Y	Y	5.49E+05 LITERS		?		WASTES FROM 300 AREA OPERATIONS OF THE HANFORD LABORATORIES.
trench	E	216-B-35	216-BN-1 Trench	Y	Y	NO	NO	Y	NO	B	Y	Y	Y	1.05E+06 LITERS		?		FIRST CYCLE SUPERNATANT WASTE FROM 221-B BLDG.
trench	E	216-B-23	216-BC-10 TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	4.52E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG. CYANIDE.
trench	E	216-B-37	216-BN-3 TRENCH	Y	Y	NO	NO	Y	NO	B	Y	Y	Y	4.31E+06 LITERS		?		FIRST CYCLE (BOTTOM SUPERNATANT WASTE FROM THE WASTE EVAP. AND 242-B. EVAP.
trench	E	216-B-41	241-BN-7 Grave,216-BN-7 Trench	Y	Y	NO	NO	Y	NO	B	Y	Y	Y	1.44E+06 LITERS		?		FIRST CYCLE SUPERNATANT WASTE FROM 221-B BLDG.
trench	E	216-B-30	216-BC-17 TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	4.70E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG. CYANIDE.
trench	E	216-B-24	216-BC-11 TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	4.70E+06 LITERS		?		TBP SUPERNATANT WASTE FROM 221-U BLDG. CYANIDE.
trench	E	216-A-20	216-A-20 GRAVE/SUMP/TEST HOLE	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	9.61E+05		?		RECEIVED 241-A-431 BLDG CONTACT CONDENSER WATER.

KEY: Y= yes; NO= no data; # = official number not assigned but identified by unit number; blank= no; ?= incomplete data

TABLE 3-8 200 E WASTE CONSTITUENTS MATRIX (continued)

200 E Waste Constituents Matrix

Unit Type	Site Code	Unit Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	Chemical Components: Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radionuclides	Nonradioactive Radioactivity	Waste Volume Disposed	Volume of Waste: Solid/Haz. Waste	Mixed Waste	Rel. Only	Comments
trench	E	216-B-28	216-BX 12, 216 B-28	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	LITERS		?		216-B BLDG LAND SINCE UP UNKNOWN DATE. TEMP SUPERNATANT WASTE FROM 221-B BLDG. CYANIDE.
trench	E	216-B-29	216-BX-16 trench	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	LITERS		?		TEMP SUPERNATANT WASTE FROM 221 B BLDG. CYANIDE.
trench	E	216-B-26	216-BX 13 TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	LITERS		?		TEMP SUPERNATANT WASTE FROM 221-B BLDG. CYANIDE.
trench	E	216-B-30	216-BX-19 TRENCH	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	LITERS		?		TEMP SUPERNATANT WASTE FROM 221-B BLDG. CYANIDE.
trench	E	216-B-40	241-BX 6 trench/Trench	Y	Y	NO	NO	Y	NO	B	Y	Y	Y	LITERS		?		FIRST CYCLE SUPERNATANT WASTE FROM 221 B BLDG. TRENCH DRAINILLED.
trench	C	216-A-24	BAG. EQUIP. STORAGE SITE 6 2B			NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	200E DRY WASTE TRENCH AND BURN GROUND EQUIPMENT STORAGE. SITE MATERIAL & STABILIZED. SERVICE DATES UNKNOWN.
trench	E	216-B-39	241-BX-5 trench,216-BX-5 trench	Y	Y	NO	NO	Y	NO	B	Y	Y	Y	LITERS		?		FIRST CYCLE SUPERNATANT WASTE FROM 221-B BLDG.
trench	E	216-B-21	216-BX 8 trench	Y	Y	NO	NO	Y	NO	NO	Y	Y	Y	LITERS		?		TEMP SUPERNATANT WASTE FROM 221-B BLDG. CYANIDE.
trench	E	216-B-36	216-BX 2 trench/trench	Y	Y	NO	NO	Y	NO	B	Y	Y	Y	LITERS		?		FIRST CYCLE SUPERNATANT WASTE FROM 221-B BLDG. TRENCH DRAINILLED.
vault	A	241-CR-72 7	241-CR-72 Vault	NO	NO	NO	NO	NO	NO	NO	NO	Y	?	NO			?	SOLID RADIOACTIVE WASTE. USED PRIOR TO 1970. DECOMMISSIONED IN SITU IN 1980.
waste line	J	UPK-200 E 80.1	B-5 waste line	Y		NO	NO	NO	NO	NO	Y	NO	?	NO		NO	NO	B-5 WASTE LINE LEADING AREA WASTE FROM BLDG 221-B.
waste line	J	UPK-200 E 7	UPK-200 E 7	Y		NO	NO	NO	NO	NO	NO	NO	?	5.0E+03 GAL.		NO	NO	CELL WORK HAS LEAKED FROM WASTE LINE BETWEEN 221-B BLDG & 241 B-361. CONTAMINATION CLEANED AND POSTED "UNDER GROUND CONTAMINATION"

KEY: Y: yes
NO: no data

B = official number not assigned but identified by unit number

blank: no
I: incomplete data

TABLE 3-9 200 W WASTE CONSTITUENTS MATRIX

[illegible]

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	Chemical Constituents: Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	Nature of Waste: Solid/Haz. Waste	Mixed Waste	Rad. Only	Comments
basin	C	203-S	203-S basin at 203-S uranium	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND	ND	ND	ND	
basin	C	204-S	204-S basin at the uranium	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND	ND	ND	ND	
box	E	2904-S-160	2904-S-160 Control Structure	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND	ND	ND	ND	
burial ground	C	218-W-1A	Industrial Burial Ground No. 1	ND	ND	ND	ND	ND	ND	ND			V	ND			?	
burial ground	B/L	218-W-11	Solid waste burial and regul-	ND	ND	ND	ND	?	?		?	?	?	ND			?	ABOVE GROUND STORAGE AREA, TRENCHES W MAIN CONTAIN
burial ground	C		New Red Burial Ground	ND	ND	ND	ND	?	?	ND				ND	V			
burial ground	C	218-W-5	218-W-5	ND	ND	ND	ND	ND	V	ND	?	?	?	ND		?		
burial ground	C	218-W-6/8	218-W-6/8 burial ground	ND	ND	ND	ND	?	?	ND	V	V	?	10.0PE+05		V		
burial ground	C	218-W-9A	218-W-9A and UPR 200-W 72	ND	ND	ND	ND	?	V	ND	V	V	V	6.3E5 FT3		V		ANY WASTE CONT. AND & POSSIBLY OTHER SOLID WASTE; INCLUDES UPR-200-W-72; LAB WASTE DISPOSED.
burial ground	C	218-W-1	218-W-1	ND	ND	ND	ND	ND	?	ND	V	V	V	2.5E5 FT3			?	ANY WASTE CONT. AND & POSSIBLY OTHER SOLID WASTE
burial ground	C	218-W-10	Industrial Waste burial ground	ND	ND	ND	ND	?	?	ND	V	V	V	4.0E10 FT			?	ANY WASTE CONT. AND & POSSIBLY OTHER SOLID WASTE
burial ground	C	218-W-2	218-W-2	ND	ND	ND	ND	ND	ND	ND	V	V	V	2.5E5 FT3			?	ANY WASTE CONT. AND & POSSIBLY OTHER SOLID WASTE
burial ground	C	218-W-3	218-W-3	ND	ND	ND	ND	ND	ND	ND	V	V	V	3.5E5 FT3	ND	ND	ND	ANY WASTE CONT. AND & POSSIBLY OTHER SOLID WASTE
compartment	I	UPR-200-W-137	UPR-200-W-137	ND	I	?	ND	?	?	ND	ND	ND	?	ND		?		NEED MORE INFO - COMPARTMENT
crib	6	216-T-10	216-T-10 crib	V	V			V			V	V	V	1.0E6 LIT		?		RINSE CYCLE SCAVENGED WASTE
crib	6	231-W-6	231-W-6 Crib, 216-W-6,	V	I			V		N	V	V	V	9.0E4 LIT		V		
crib	6	216-T-29	216-T-29	V	V			V	ND	N	ND	ND	?	7.4E4 LIT		?		
crib	6	216-S-23	216-S-23 crib	V	I	ND	ND	V		N	V	V	V	3.4E7 LIT		V		STATED NEUTRAL/BASIC BUT NITRIC ACID SAMP UP?
crib	6	216-Z-12	216-Z-12	V	V	?		?	?	N	V	V	V	2.0E10 LIT		?		
crib	6	216-T-36	216-T-36	ND	V			V	?	N	V	V	V	5.2E5 LIT		V		
Crib	6	216-Z-3	216-Z-3 culvert, 234-5 (3)	ND	V	V		V	ND	ND	V	V	?	9.0E3 LIT		V		
crib	6	216-T-32	216-T-32	V	I	?	ND	V	?	ND	V	V	V	5.7E6 LIT		V		
crib	6	216-T-27	216-T-27	V	I	?	ND	V	?	N	V	V	V	7.2E6 LIT		V		
crib	6	216-T-34	216-T-34	V	I	?	ND	V	?	N	V	V	V	1.7E7 LIT		V		
crib	6	216-T-32	216-T-32	I	V			V	ND	N	V	V	V	2.9E7 LIT		V		NEED MORE INFO WHEN 34 G.
crib	6	216-T-33	216-T-33	VR	I	ND	ND	V	ND	N	V	V	V	1.9E6 LIT		V		ALL CONT. WASTE FROM 216-T
crib	6	216-S-13	216-S-13 crib	V	V	V	V	V	?	N	V	V	V	5E6 LITR		V		
crib	6	216-Z-16	cribs 216 Z-16	V	ND	ND	ND	ND	ND	ND		V	?	1.0E10 LIT			?	WASTE NEUTRAL/BASIC BUT NO OTHER DESCRIPTION TO SITE
crib	6	216-U-10	216-U-10 crib	V	I	ND	ND	ND	ND	ND	V	V	?	1.2E11		?		BLOWDOWN (BD) FOR ANL. DATA
crib	6	216-T-6	216-T-6 crib	V	V	ND	ND	V	ND	N	V	V	V	4.9E7 LIT		V		
crib	6	216-T-26	216-T-26	V	V	?	ND	V	ND	N	V	V	V	1.2E7 LIT		V		
crib	6	216-Z-9	216-Z-9, 231-W-1-2 cribs	V	V	ND	ND	V	ND		V	V	V	3.0E7 LIT		V		CANDIDATE TEST
crib	6	216-S-22	216-S-22 crib	V	I			V	ND	N	V	V	?	100000 LIT		V		10.0M HOMES
Cribs 3	6	216-U-8	216-UR-1, 2, 3 Cribs, 216-U-9	V	V			V	?	N	V	V	V	3.7E10 LIT		V		
Cribs 5	6	216-Z-10	cribs - 5 parallel	ND	V	V	V	V	ND	N		V	V	3.0E6 LIT		V		CANDIDATE TEST
ditch	F	216-T-4-2 (B)	216-T-4-2 (B)	V	I	V	ND	V	?		?	?	?	ND		V		
Ditch	E	216-Z-17	216-Z-17 Ditch or French	V	ND	ND	ND	?	?	N		V	V	3.6E7 LIT		?		FRENCH-WASTE IS NEUT/BASIC BUT NO OTHER DESCRIPTION TO SITE
ditch	F	UPR-200-W-139	UPR-200-W-139	ND	ND	ND	ND	ND	ND	ND	ND	ND	?	ND		?		
ditch	F	216-Z-19	216-Z-19 ditch	V	ND	ND	ND	?	?	?	V	V	V	1.2E11 LIT		?		ARLA 200 LIQUID DISCH REPT FOR RNO DATA
Ditch	F	216-U-9	216-U-6 U-Sump 5	V	ND	ND	ND	?	?	?	V	V	V	ND		?		REF TO POND 216-U-10, INCLUDES UPR 200-W 10.

KEY: V = yes; ND = no data; R = official number not assigned but identified by unit number; Blank = no; I = incomplete data

TABLE 3-9 200 W WASTE CONSTITUENTS MATRIX (continued)

200 WEST AREA WASTE CONTAMINATION MATRIX

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	NATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	COMMENTS
Ditch	F	216-Z-11	216-Z-1 ditch, Z plant ditch	Y	ND	ND	ND	?	?	ND		Y	Y	ND		?		REF TO POND 216-U-10
Ditch	F	216-Z-1 (D)	Drain Ditch to U-Sump, Z	Y	ND	ND	ND	?	?	ND		Y	Y	ND		?		
ditch	F	216-T-4-1 (D)	216-T-4-1 (D)	Y	ND	ND	ND	?	?	ND	Y	?	Y	4.9E10 L		?		ENNUMED FROM SWMP 216-T- DITCH BACKFILLED
diversion box	I	241-TX-153	241-TX-153 incl. UPR	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		INCLUDES UPR-200-W-99, 126.
diversion box	I	241-UR-152	241-UR-152 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		VERY GENERAL NEED MORE INFO
diversion box	I	241-UR-154	241-UR-154 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		DIVERSION BOX - PROCESS,SOURCE, STRUC + TYPE
diversion box	I	241-U-153	241-U-153 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		DIVERSION BOX - PROCESS,SOURCE, STRUC + TYPE
diversion box	I	241-U-252	241-U-252 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		
diversion box	I	241-SX-151	241-SX-151 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		INCLUDES UPR-200-W-114
diversion box	I	241-UR-153	241-UR-153 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		
diversion box	I	241-SX-152	241-SX-152 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		INCLUDES UPR-200-W-114
diversion box	I	241-T-152	241-T-152 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		INCLUDES UPR-200-W-7
hversion box	I	241-TY-153	241-TY-153 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		
diversion box	I	240-S-151	240-S-151 (waste transfer)	Y	I	ND	ND	Y	Y	ND	ND	Y	Y	500000GAL/ YR		Y		1950-87 PASS-THROUGH; INCLUDES UPR-200-W-20, 51, 52; WATER ADDED FOR CONTAMINATION CLEANUP
diversion box	I	241-TXR-155	241-TXR-155 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		
diversion box	I	241-T-151	241-T-151 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		INCLUDES UPR-200-W-7
diversion box	I	241-TXR-151	241-TXR-151 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		
diversion box	I	241-TR-152	241-TR-152 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		
diversion box	I	241-TXR-244	241-TXR-244 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		
diversion box	I	240-S-152	240-S-152 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		MAY INCLUDE UPR-200-W-52
diversion box	I	241-TXR-152	241-TXR-152 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		
diversion box	I	241-TR-153	241-TR-153 (waste transfer)	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		
diversion box	I	241-S-152	241-S-152 (waste transfer)	ND	ND	ND	ND	ND	ND	NEI	ND	ND	Y	ND		Y		
diversion box	I	241-TXR-153	241-TXR-153 (waste transfer)	ND	ND	ND	ND	ND	ND	NEI	ND	ND	Y	ND		ND		
dry well	0	241-SX-402	dry well at 241-SX-402	ND	ND	ND	ND	ND	ND	NEI	ND	ND	?	ND	ND	ND	ND	DRYWELL IN THE BUILDING
dry well	6	241-SX-401	dry well at 241-SX-401	ND	ND	ND	ND	ND	ND	NEI	ND	ND	?	ND	ND	ND	ND	DRYWELL IN THE BUILDING
filter monitor	0	2718-S#	2718-S sand filter monitor	ND	ND	ND	ND	ND	ND	NEI	ND	ND	Y	ND	ND	ND	ND	APP. E FOR RELEASE + ASSESSMENT INFO
french drain	6	216-U-7	216-U-7	Y	I			Y	ND	NEI	ND	ND	?	7000LITR		?		
french drain	6	216-T-31	216-T-31	ND	ND	ND	ND	ND	ND	NEI	ND	ND	ND	ND	ND	ND	ND	WASTE ENNUMED DISPOSED IN 200W DRYWASTE BURL GRND
French Drain	6	216-Z-8	216-Z-8 Crib, 234-5 Recuplex	ND	Y	Y		Y	Y	NEI		Y	Y	9590 LITR		Y		
ground contam.	6	UPR-200-W-135	UPR-200-W-135	ND	ND	ND	ND	ND	ND	NEI	ND	ND	?	ND	ND	ND	ND	
ground spill	J	UPR-200-W-117	UPR-200-W-117	ND	ND	ND	ND	ND	ND	NEI	ND	ND		ND	ND	ND	ND	CONTAMINATION DECAYED TO BACKGROUND LEVELS
ground spill	J	UPR-200-W-69	UPR-200-W-69	ND	ND	ND	ND	ND	ND	NEI	ND	ND	?	ND	ND	ND	ND	
incinerator	H	232-Z#	232-Z waste incineration	ND	ND	ND	NEI	ND	ND	NEI	ND	ND	ND	ND	ND	ND	ND	
pit	E	UPR-200-W-30	UPR-200-W-30	Y	ND	ND	ND	?	?	NEI	Y	?	Y	ND		?		
pit	L		200 West burning pit	ND	ND	?	?	?	?	?				ND	?			
pit	E	216-T-20	Disposal Trench/Pit	Y	Y			Y		N	Y	Y	?	1.09E9 L		Y		SAME AS 216-T-27, P 514 R9
pond	E	216-S-15	216-S-15	Y	I	ND	ND	Y	?	N	?		?	ND		?		
pond	E	216-U-10	216-U-10 pond	Y	ND	ND	ND	?	?	NEI	Y	Y	?	1.21E11 L		?		INCLUDES UPR-200-W-107
pond	E	216-S-11	216-S-11 pond	Y	I	?	ND	?	?	NEI	Y	Y	Y	3.22E10 L		Y		

KEY: Y= yes; ND= no data; # = official number not assigned but identified by unit number; blank= no; I= incomplete data

TABLE 3-9 200 W WASTE CONSTITUENTS MATRIX (continued)

200 WEST AREA WASTE CONTAMINATION MATRIX

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	NATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	COMMENTS
pond	E	216-T-4A	216-T-4A	Y	NO	?	NO	?	?	?	Y	Y	?	4.25E10L I		?		WASTE EXAMINED DISPOSED IN 216-W-2A TRENCH 7
pond	E	216-S-19	216-S-19 pond	Y	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	DOE RL 86
proc. tnk vent lines	J	UPR-200-W-102	UPR-200-W-102	Y	NO	NO	NO	?	?	NO	NO	Y	Y	NO		?		DRUMS W/ SOIL CONTAINING 290 PU DISPOSL LOCAT UNKNOWN
sewer	H		REDOX chemical sewer at 203-S,	NO	NO	NO	NO	NO	NO	NO	Y	Y	?	NO		?		REDOX CHEMICAL SEWER; RAW SOLUTION, OTHER WASTES NOT SPECIFIED.
surface impoundment	E	207-S#	207-S retention basin (3)	Y	NO	NO	NO	?	?	NO	NO	NO	Y	NO		?		CONCRETE BASIN BACKFILLED - SOIL & WEEDICIDE
tank	I	241-S#	241-S tank farm	Y	I	?		?	?	NO	Y	Y	Y	NO		?		INCLUDES UPR-200-W-80,81; CYANIDES, METALS, ORGANICS, INORGANICS
tank	I	241-T#	241-T tank farm	Y	I	?		?	?	NO	Y	Y	Y	NO		?		INCLUDES UPR-200-W-148; CYANIDES, METALS, ORGANICS, INORGANICS.
tank	H	241-SX-402	241-SX-402 condenser shield-	NO	NO	NO	NO	?	?	NO	Y	Y	?	NO		?		INCLUDES 2 TANKS AND A DRY WELL. LOCATED IN 241-SX TANK FARM.
tank	E	276-U#	276-U solvent handling	NO	NO	Y	Y	NO	NO	NO	Y	Y	?	NO	NO		NO	BASIN OF 3 TANKS & PIPE; CYANIDES, METALS, ORGANICS, INORGANICS.
tank	I	276-S-142	underground tank 276-S-142	Y	I	Y	Y	Y			?	?	Y	12.7E3 GA		Y		2C4 - ORIGINAL
tank	I	241-U-361	241-U-361 settling tank	NO	NO	NO	NO	NO	NO	NO	?	Y	Y	27.5E3 GA		?		CONTAMINATED LIQUID AND SLUDGE
tank	I	241-SX	241-SX tank farm	Y	I	?		?	?	NO	Y	Y	Y	NO		?		INCLUDES UPR-200-W-49, 90, 114, 80, 81; CYANIDES, METALS, ORGANICS, INORGANICS.
tank	I	241-TY-302-B	catch tank 241-TY-302-B at	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		?		DIVERSION BOX - PROCESS,SOURCE, STRUC + TYPE
tank	I	241-TX-302-A	catch tank 241-TX-302-A at	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		?		DIVERSION BOX - PROCESS,SOURCE, STRUC + TYPE
tank	I	241-TX-302-B	catch tank 241-TX-302-B at	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		?		DIVERSION BOX - PROCESS,SOURCE, STRUC + TYPE
tank	I	241-U-301	catch tank 241-U-301 at	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		?		CATCH TANKS TABLE 1
tank	I	241-301-B	catch tank 241-301-B at tank	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		?		
tank	I	240-S-302	catch tank 240-S-302 at	Y	I	NO	NO	Y		NO		Y	?	5E4 G/YR		?		FROM 1950 - 1987
tank	I	241-TX#	241-TX tank farm	Y	I	?		?	?	NO	Y	Y	Y	NO		?		INCLUDES UPR-200-W-149, 100; CYANIDES, METALS, ORGANICS, INORGANICS.
tank	I	276-S-141	underground tank 276-S-141	NO	Y	Y	Y	Y			?	?	Y	10E3 GAL		Y		2C4 - ORIGINAL
tank	I	241-TY#	241-TY tank farm	Y	I	?		?	?	NEI	Y	Y	Y	NO		?		INCLUDES UPR-200-W-150, 153, 151, 152; CYANIDES, METALS, ORGANICS, INORGANICS.
tank	I	241-T-361	241-T-361 Settling tank	NO	NO	NO	NO	NO	NO	NEI	?	Y	Y	28E3 GAL		?		CONTAMINATED LIQUID AND SLUDGE
tank	I	241-Z-361	241-Z-361 settling tank	NO	NO	NO	NO	NO	NO	NEI	?	Y	Y	32E3 GAL		?		
tank	I	241-SX-302	catch tank 241-SX-302 at	NO	NO	NO	NO	NO	NO	NEI	NO	NO	NO	NO		?		
tank	H	241-SX-401	241-SX-401 condenser shield-	NO	NO	NO	NO	?	?	NEI	NO	NO	?	NO		?		INCLUDES 2 TANKS AND A DRY WELL. IN 241-SX TANK FARM.
tank	I	241-TY-302-A	catch tank 241-TY-302-A at	NO	NO	NO	NO	NO	NO	NEI	NO	NO	NO	NO		?		
tank	I	241-U#	241-U tank farm	Y	I	?		?	?	NEI	Y	Y	Y	NO		?		INCLUDES UPR-200-W-154, 155, 156, 157; CYANIDES, METALS, ORGANICS, INORGANICS.
tank(s)	H	242-T#	242-T Evaporator (batch then	Y	I	NO	NO	Y	?	FI	Y	Y	?	3.37E+07 GAL		?		GALLONS; INCLUDES UPR-200-W-12.
tanks	H	276-S#	276-S Solvent Handling Facility	Y	NO	?	?	NO	NO	NEI	?	?	Y	NO		Y		
tile field	G	216-Z-1A	234-5 tile field, 216-Z-7;	Y	I	NO	NO	Y	NO	FI	Y	Y	?	1.E6 LIT		?		
trench	C	UPR-200-W-110	UPR-200-W-110	NO	I	NO	NO	NO	Y	NEI	NO	Y	?	NO			?	
trench	E	216-S-12	216-S-12	Y	Y			Y	NO	NEI	Y	Y	?	6.81E4 LI		?		
trench	E	216-S-8	216-S-8	Y	I	NO	NO	Y	NO	NEI	Y	Y	Y	1E7 LITR		Y		
trench	E	216-T-11	Equipment Decontamination	NO	NO	NO	NO	NO	NO	NEI	NO	NO		NO	NO	NO	NO	EXAMINED, TRANSF TO 216-T-13, NO RAD OR CHEM BUILDUP
trench	E	216-S-14	216-S-14	Y	Y	Y	Y	NO	NO	NEI	NO	NO	?	NO		Y		MEMORE (CONTAM.) NO DATA ON RAD COMPONENT

KEY: Y= yes; NO= no data; # = official number not assigned but identified by unit number; blank= no; I= incomplete data

TABLE 3-9 200 W WASTE CONSTITUENTS MATRIX (continued)

[illegible]

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	Chemical Components: Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radionuclides	Non-Rad Radio-activity	Waste Volume Disposed	Volume of Waste Solid/Haz. Waste	Mixed Waste	Haz. Only	Comments
trench	E	216-T-12	216-T-12	Y	ND	ND	ND	Y	Y	B	Y	Y	Y	582 LITR		Y		SLUDGE REMOVED FROM RETENTION POND 207-T
trench	E	216-T-10	216-T-10	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	REMOVED TRANSFER TO 216-T-13
trench	E	216-T-14	216-T-14	Y	Y			Y		B	Y	Y	Y	166 LITR		Y		SAME CHEM AS IN 216-T 15,16
trench	E	216-T-9	216-T 9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	REMOVED, TRANSFER TO 216 T-13. NO MAP OR LOGS [illegible]
trench	E	216-T-16	216-T 16	Y	Y			Y		B	Y	Y	Y	166 LITR		Y		COMMENTS ON 216-T-14
trench	E	216-T-22	241-TX-2 trench, 216-TX 2 trench	Y	Y			Y		B	Y	Y	Y	1.5366 LIT		Y		SAME CHEM COMP AS 216-T-24
trench	E	216-T-21	241-TX-1 trench, 216-TX-1 trench	Y	Y			Y		B	Y	Y	Y	19.6656 LIT		Y		
trench	E	216-T 5	216-T-5	Y	Y			Y	Y	B	Y	Y	Y	2.666 LITR		Y		
trench	E	216-T-25	216-T-25	Y	Y			Y		B	Y	Y	Y	1.257 LITR		Y		
trench	E	216-T-24	241-TX-4 trench, 216 TX-4 trench	Y	Y			Y	Y	B	Y	Y	Y	1.5366 LIT		Y		COMMENTS ON 216-T22
trench	C	UPR-200-W-111	UPR-200 W 111	Y	ND	ND	ND	Y	Y	A	ND	Y	Y	27 YD3		Y		SLUDGE FROM RETENTION BASIN 207-U [illegible]
trench	E	216-T-23	241-TX-3 trench, 216 TX-3 trench	Y	Y			Y		B	Y	Y	Y	1.4966 LIT		Y		
trench	E	216-T 13	216-T-13	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	REMOVED, NO INFO CONCERN TRANSFER TO
trench	E	216-U-6	216-U Cold U trench 81	Y	I	ND	ND	Y	Y	ND	Y	Y	Y	2.7566 LIT		Y		COMMENTS ON 216-U-5
trench	E	216-T-17	216-T-17	Y	Y			Y		B	Y	Y	Y	7.0056 LIT		Y		
trench	E	216-Z-4	216-Z-4	Y	I	ND	ND	Y	Y	A	Y	Y	Y	1.1596 LIT		Y		
trench	E	216-S-10	216-S-10	ND	ND	ND	ND	ND	ND	ND	Y	Y		ND	ND	ND	ND	
trench	E	UPR-200-W-112	UPR-200-W-112	Y	I	ND	ND	Y	Y	A	ND	Y	Y	ND		Y		SLUDGE FROM RETENTION BASIN 207-U [illegible]
trench	E	216-Z-9	216-Z 9 Crane, 234-5 Recupera	Y	Y	Y		Y	Y	A	Y	Y	Y	19.1656 LIT		Y		ORGANICS INCLUDING CARBON TETRACHLORIDE, TBP, DEHP
trench	E	216-T-15	216-T-15	Y	Y			Y		B	Y	Y	Y	166 LITR		Y		COMMENTS ON 216-T-14
trench	E	216-U-5	221-U Cold U trench 82	Y	I	ND	ND	Y		ND	Y	Y	Y	2.2566 LIT		Y		SAME CHEMICAL AMOUNT AS 216 U 6
Tanchive	E	216-U-13	241-UR Steam Cleaning Pit,	ND	ND	ND	ND	Y	ND	A	Y	Y	Y	ND		Y		SITE REMOVED, WASTE TRANSFER TO 216-T 13, 200W DATA [illegible]
vault	E	216-W-8	218-W-8	Y	I	Y	ND	Y	Y	ND	Y	Y	Y	2.455 FT3		Y		LABORATORY WASTES
vault	E	216-W-7	218 W 7	Y	ND	ND	ND	Y	Y	ND	Y	Y	Y	ND		Y		
vault	E	200-S8	200-S vault at the crossroad	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
vault	E	241-UR8	241-UR vault	ND	ND	ND	ND	Y	Y	ND	ND	ND	Y	ND		Y		INCLUDES UPR 200 W-241 INCLUDES CONCRETE WASTE WITH STAINLESS STEEL TANKS.
vault	E	241-UR8	241-UR vault	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		INCLUDES CONCRETE BASIN WITH STAINLESS STEEL TANKS.
waste line	J	UPR-200-W-2	UPR-200-W-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND		Y		
waste line	J	UPR-200-W-113	UPR-200-W-113	ND	ND	ND	ND	Y	ND	A	ND	ND	Y	ND		Y		NITRIC ACID SPILL & OTHER LEAK
water box	I	2904-S-171	2904-S-171 water box	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND	ND	ND	ND	
water box	I	2904 S-170	2904-S-170 water box	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND	ND	ND	ND	
water box	I	216-S-172	216-S-172 water box	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y	ND	ND	ND	ND	

KEY: Y- yes
NO- no data
A - official number not assigned but identified by unit number
Blank- no
I- incomplete data

TABLE 3-10 200 N WASTE CONSTITUENTS MATRIX

[illegible]

Unit Type	Unit Number	Site Name Description	Waste Source Identified	Waste Source Not Identified	CHEMICAL COMPONENTS: Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	NATURE OF WASTE: Solid/Haz. Waste	Mixed Waste	Rad. Only	Comments
Trench	1	216-N-3 Trench, 212-N Trench (5)	Y				?	NS		Y			7.57E+06 liters			Y	Storm water and sludge from 212-N building; boron sprayed; fuel storage
Pond	1	216-N-1 Sump, 216-N-1 Sump, 216-N-1 Lined Pond (5)	Y				?	NS		Y			9.5E+04 liters			Y	Storm overflow from 212-N building, fuel storage; boron sprayed
Trench	1	216-N-2 216-N-2 Trench, 216-N-2 Trench (5)					?	NS		Y			7.57E+06 liters			Y	Storm water and sludge; fuel storage; boron sprayed
Pond	1	216-N-4 212-N Sump, 216-N-4 Sump (5)	Y				?	NS		Y			9.46E+06 liters			Y	Storm water and sludge from 212-N building; boron sprayed
Trench	1	216-N-5 212-N Trench, 216-N-5 Trench (5)	Y				?	NS		Y			7.57E+06 liters			Y	Storm water and sludge from 212-N building; fuel storage; boron sprayed
Pond	1	216-N-6 212-N Sump, 216-N-6 Sump (5)	Y				?	NS		Y			9.46E+06 liters			Y	Overflow from 212-R basin; fuel storage; boron sprayed
Trench	1	216-N-7 212-N Trench, 212-N-7 Trench (5)	Y				?	NS		Y			7.57E+06 liters			Y	Storm water and sludge cleanout waste from 212-R basin; fuel storage; boron sprayed

KEY: Y = yes; NS = no data; # = unitized number not assigned but identified by unit number; blank = no; ? = incomplete data

TABLE 3-11 300 AREA WASTE CONSTITUENTS MATRIX

[illegible] Waste Constituent Matrix

Unit Type	Site Code	Historical Number	Site Name/ Description	Waste Source Identified	Chemical Identified	Chemical Constituents: Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio nuclides	Residual Radio Activity	Waste Volume Disposed	Method of Waste Solid/Haz. Waste	Mixed Waste	Rad. Only	Comments
[illegible] spill	J		Uranium Acid Waste Piping [illegible]	Y	Y			Y	Y	N	Y	Y	Y	ND		Y		Two-fluoride. Nitric and sulfuric acid with uranium in solution. Waste with acids: nitric, hydrofluoric, and chromic acids with uranium, copper, and zirconium metals in solution.
[illegible]	G	[illegible]	300 North Crib	Y	Y	Y	Y	Y		ND	ND	Y	Y	[illegible] 1st		Y		Water contaminated with uranyl bearing uranium nitrates and other uranium bearing wastes from 3321 building.
[illegible]	G		331 Site Sciences Laboratory	ND	ND	ND	ND	ND	ND	ND				[illegible] gal/hr	Y			Sanitary wastewater.
[illegible]	G		Retired 315 Sanitary Drain	ND	ND	ND	ND	ND	ND	ND				ND	Y			Sanitary wastewater from office buildings.
[illegible]	G		Retired 315/316 Sanitary	ND	ND	ND	ND	ND	ND	ND				ND	Y			Sanitary wastewater from office buildings.
[illegible] pit	E		300 Area Interim Filter	Y	I	ND	ND	Y	ND	ND				[illegible] gal	Y			Water and nonhazardous alum from backwashing filters used to filter water for sanitary and process use. Analysis shows backwash to be nonhazardous; test results not provided in report.
pipe trench system	J	[illegible]	Pipe Trench System, 311	ND	Y			Y	Y	N	ND	Y	Y	ND		Y		Spill of uranium bearing acid waste containing nitric, sulfuric, hydrofluoric, and chromic acids with copper, uranium, and zirconium in solution.
pond	E		Retired Filter Backwash Pond	Y	Y			Y						[illegible] gal/yr	Y			Water and nonhazardous alum from backwashing filters. Backwash analysis is nonhazardous.
sewer pipe	H		Retired Liq. Waste Sewer	Y	Y	Y	Y	Y	Y	N/A	ND	ND	Y	ND		Y		Radioactive wastes from fuel fabrication and research and development laboratories: laboratory chemicals, decontamination solutions, acids and bases, and fuel fabrication aqueous solutions.
tank	H		331 Land Farm Waste Acid Tank	Y	Y	ND	ND	Y	ND	N	ND	Y	Y	ND		Y		Waste acids from fuel fabrication process con- taining nonrecoverable uranium. Previously used for incoming chemical storage (neutralized).
tanks	H		321 Tanks (4)	ND	Y	ND	ND	Y	ND	N	ND	Y	Y	ND		Y		Uranium contaminated water and acid solutions from reprocessing research and development. Small volume of liquid may remain in one tank.
testing unit	D		In Situ Vitrification Test	ND	I	ND	ND	ND	ND	ND	Y	Y		ND			Y	Vitrification test on wastes containing radio- nuclides. Contaminated soil removed to background levels.
transfer line	J	[illegible]	Transfer Line Tank	Y	ND	ND	ND	Y	ND		Y	Y	Y	ND			Y	Waste transfer line from retention basins to crib waste system.
trench	G		331 Site Sci. Lab. ([illegible])	Y	ND	ND	ND	ND	ND	ND				[illegible] gal/hr	Y			Sanitary wastewater from 331 Site Sciences Lab.
trench	G		331 Site Sci. Lab. ([illegible])	Y	ND	ND	ND	ND	ND	ND				[illegible] gal/hr	Y			Sanitary wastewater from 331 Site Sciences Lab.
underground tank	I		Methanol Storage (313 Bldg)	Y	Y	Y	Y							ND	Y			Aqueous solution of methanol (8-2%). 600 gal remain in tank.
underground tank	I		Methanol Stor. (311 Tank Farm)	Y	Y	Y	Y							ND	Y			Aqueous solution of methanol (up to 5%) used to clean aluminum. 10,000 gal remain.
underground tanks	I		300 IN Tanks (3)	Y	I	ND	ND	ND	ND	ND	Y	Y	Y	[illegible] to [illegible] gal (cap)		Y		Aqueous nonhazardous radioactive wastes from plutonium recycle test reactor. Tanks are empty Residual radioactive contamination remains.

KEY: Y - yes; ND - no data; N - Historical number not assigned but identified by unit number; blank - no; I - incomplete data

TABLE 3-12 400 AREA WASTE CONSTITUENTS MATRIX

400 AREA Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	NATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	COMMENTS
french drains	G		French Drain South of 4722-C	V	V	?	?	?	?					2.00E+03 gal/yr	V			latex paint
french drains	G		400 Retired French Drains	ND	ND	ND	ND	ND	ND	ND				ND	V			washwater from construction component cleaning
ponds	E		400 Area Retired Sanitary Ponds	V	ND	ND	ND	ND	ND	ND				1.20E+04 gal/day	V			
tank	H		Retired Septic Tanks (3)	ND	ND	ND	ND	ND	ND	ND				ND	V			Sanitary wastes from offices. Verify if aboveground or belowground.
trench	E		400 Area Retired Sand Trench		ND	ND	ND	?	?	ND				ND	V			cooling tower blowdown

KEY: V= yes
ND= no data

x = official number not assigned but identified by unit number

blank= no
I= incomplete data

TABLE 3-13 600 AREA WASTE CONSTITUENTS MATRIX

600 Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	MATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	COMMENTS
burial ground	C	610-11	300 Hyo Burial Ground	ND	ND	ND	ND	ND	ND		Y	Y	?	ND		?		INCLUDES ACCIDENTAL RELEASE UPR-600-6-10. INCLUDES RADIOCHEMISTRY WASTES.
burial ground	C		J.A. Jones No. 2 (9)	ND	ND	ND	ND	ND	ND					ND	Y (a)			SITE EXHUMED: MOVED TO BURIAL GROUND IN 1971.
burial ground	C	610-10	300 North SW Burial Ground	Y	ND	ND	ND	ND	ND		Y	Y	?	ND			?	FIRE OCCURRED AT 610-10 BURIAL GROUND. CONTAMINATION SPREAD 300 YARDS OUTSIDE BURIAL GROUND.
burial ground	C		Army Munitions Burial Site	Y	ND	ND	ND	ND	ND					ND	Y			SITE EXHUMED: CONTENTS TRANSPORTED TO YAKIMA FIRING RANGE FOR DESTRUCTION.
burial ground	C	USBR-2, 4-DA	USBR-2, 4-D burial ground	Y	Y	Y			Y	P				50 YD3	Y			500 GALLONS OF 2,4-D LEAKED INTO 50 YD3 OF SOIL. 10 LEAKING TANKS FLATTENED AND BURIED THERE.
burning pit	L	610-5	Burial Ground No. 5	Y	I	ND	ND	ND	ND	ND	ND	Y	?	ND			?	URANIUM-BEARING TRASH AND NON-RADIOACTIVE TRASH.
crib	G	P-11	116-F-6 Crib	Y	ND	ND	ND	ND	ND		ND	Y		ND		?		SITE EXHUMED.
crib	G	213-J and K	Gable Mountain Cribs	ND	ND	ND	ND	ND	ND		ND	ND	ND			?		UNIDENTIFIED RADIOACTIVE LIQUIDS.
crib	G		Pickling Acid Crib (9)	Y	Y	NS	NS	Y	?	A				ND	Y			NITRIC AND HYDROFLUORIC ACID TO PICKLE GALVANIZED PIPING FOR CONSTRUCTION.
landfill	C		Hanford Trailer Camp (9)	Y	I	?	ND	?	?	ND				ND	Y			DOMESTIC WASTES USED IN CONSTRUCTION OF HANFORD FACILITIES. COULD EXPECT METALS, SOME CHEMICALS, AND GENERAL REFUSE.
landfill	C		Horn Rapids Disposal	Y	I	Y	Y	Y	?	ND				ND	Y			PAPER, OFFICE, AND MINOR CONSTRUCTION WASTES (SOLVENTS, PAINT CANS, OILS)
landfill	C		Sodium Dichromate Barrel	Y	Y			Y	Y					ND	Y			SODIUM DICHROMATE
landfill	C		White Bluffs City Landfill	Y	I	?	?	?	?	?				ND	Y			COMMERCIAL AND DOMESTIC WASTES TYPICAL OF PERIOD 1850-1943. CAN EXPECT BROAD SPECTRUM OF CHEMICAL WASTES.
landfill	C		J.A. Jones No. 1 (9)	Y	I	ND	ND	ND	ND	ND				ND	Y (a)			WOOD SCRAPS, CONCRETE, MISCELLANEOUS CONSTRUCTION WASTES.
landfill	C		City of Hanford Landfill	Y	I	?	?	?	?	?				ND	Y			SAME AS WHITE BLUFFS CITY LANDFILL.
landfill	C		Midway Landfill No. 1 (9)	Y	I	?	?	?	?	?				ND	Y			HOUSEHOLD REFUSE. CAN EXPECT BROAD RANGE OF CHEMICALS.
landfill	C		East White Bluffs City Landfill	Y	I	?	?	?	?	?				ND	Y			SAME AS WHITE BLUFFS CITY LANDFILL.
landfill	C		Midway Landfill No. 2 (9)	Y	I	?	?	?	?	?					Y			HOUSEHOLD REFUSE. MAY INCLUDE SPENT SOLVENTS, EMPTY HERBICIDE CONTAINERS, AND CAPACITORS (PCBs?).
pits	C	610-4	Burial Ground No. 4	ND	ND	ND	ND	ND	ND	ND	ND	Y	?	ND		ND	ND	INCLUDES UPR-600-15.
pond	C	610-12	North Process Pond Scraping Disposal Area	Y	I	ND	ND	ND	ND	ND	ND	Y	?	ND		ND	ND	URANIUM-CONTAMINATED SOIL FROM 316-2 AND FROM 321 BUILDING.
tank	I	6652-G*	6652-G ALE Field Storage	ND	ND	ND	ND	ND	ND	ND				ND	Y			SANITARY SEWAGE FROM "HAMM FACILITIES."
tank	I		Army Bunkers Septic Tank (3)	ND	ND	ND	ND	ND	ND	ND				ND	Y			SOURCES NOT SPECIFIED. MAY/MAY NOT BE SOLELY SANITARY WASTE.
tank	I	6652-C*	6652-C Space Science Lab.	ND	I	ND	ND	ND	ND	ND				ND	Y			SANITARY SEWAGE FROM "HAMM FACILITIES."
trench	D	610-6	Burial Ground No. 6	Y	ND	ND	ND	ND	ND	ND	ND	Y				ND	ND	URANIUM WASTE (SULIO).
trench	C	610-3	Burial Ground No. 3	Y	ND	ND	ND	ND	ND	ND	ND	Y	?	ND		?		CONTAMINATED BUILDING MATERIAL.
trench	C	610-9	300 West Burial Ground	Y	I	Y	?	ND	ND	ND	ND	Y	?	9.0E3 gal		Y		DRUMS OF URANIUM-CONTAMINATED ORGANIC SOLVENT.
	C	610-8	Early Waste Burial Ground	Y	ND	ND	ND	ND	ND	ND	ND	Y	?	ND		?		URANIUM CONTAMINATION. SW FROM REACTOR FUELS MANUFACTURING.
trench	C	610-7	Burial Ground No. 7	Y	I	ND	ND	ND	Y	N	Y	Y	?	ND		Y		MATERIALS FROM FUEL ELEMENT MANUFACTURING.

KEY: Y= yes; ND= no data; a = official number not assigned but identified by unit number; blank= no; I= incomplete data

TABLE 3-13 600 AREA WASTE CONSTITUENTS MATRIX (continued)

600 Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	CHEMICAL COMPONENTS Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-Activity	Waste Volume Disposed	NATURE OF WASTE Solid/Haz. Waste	Mixed Waste	Rad. Only	COMMENTS
trench	C		Original Central Landfill (9)	V	I	?	ND	?	?	ND				ND	V			GENERAL OFFICE WASTES, GLASS, ELECTRICAL, AND SOME METAL WASTES.
trench	C	610-2	SW Burial Ground No. 2	V	I	ND	ND	ND	ND	ND	V	V	V	ND			?	URANIUM-CONTAMINATED. EQUIPMENT AND MATERIALS; INCLUDES URANIUM OXIDE CUTTINGS.
trench and pits	C	610-1	SW Burial Ground No. 1	V	I	?	ND	?	?	ND	V	V	V	ND		?		FUEL FABRICATION AND LAB WASTES (SM).
waste pile	A	610-13	303 Area Contaminated Soil	V	I	ND	ND	ND	ND	ND	ND	?	?	ND			?	TOP SOIL FROM 303 AREA.

KEY: V= yes; ND= no data; A = official number not assigned but identified by unit number; blank= no; I= incomplete data

TABLE 3-14 700 AREA WASTE CONSTITUENTS MATRIX

700 Area Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemical Identified	LEACHING COMPONENTS: Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radionuclides	Bulk Radioactivity	Waste Volume Disposed	Nature of Mobile Solid Waste	Liquid Waste	Haz. Only	COMMENTS
tank	1		Underground Waste Solv Tank		V	V			V					18,000 Gal	V			Toxic, EP toxic, combustible solution

SYM

V- yes
NR- no data

N = official number not assigned but identified by unit number

blank- no
I: incomplete data

TABLE 3-15 1100 AREA WASTE CONSTITUENTS MATRIX

1100 MDA Waste Constituents Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Waste Source Identified	Chemicals Identified	Chemical Components: Organics	Volatiles	Inorganics	Metals	pH	Fission Products	Other Radio-nuclides	Residual Radio-activity	Waste Volume Disposed	Waste Solid/Hzd. Waste	Waste Mixed Waste	Rad. Only	Comments
ground disposal	J	UPN-1100-2	disposal onto railroad tracks	V	I	V	V	/	V					11.88x10^2 gal/yr	V			spent thinners and solvents
pit	E	UPN-1100-1	sand pit	V	V				V	N				ND	V			battery acid
pit	E	UPN-1100-3	sand pit	V	I	V	V	ND	ND	ND				ND	V			contaminant, degreaser solvents, wash water from engine cleaning
tank	I	UPN-1100-4	underground disposal tank	V	V	V	.							ND	V			contaminant in unknown quantity

KEY: V- yes
ND- no data
# = official number not assigned but identified by unit number
blank= no
I= incomplete data

100 KE/KW, 100 N, 200 North, 200 West, 200 East, 300, 400, 600, 700, and 1100. The codes used in the matrices are presented in a key preceding 14 tables and on the matrices. These data are subsequently used to evaluate release potential and to identify potential remediation/characterization needs for each site.

The waste constituents matrices completed include the identification of a general type of designation for each site listed as a potential RCRA 3004(u) site (i.e., landfill, surface impoundment, underground dispersion system, aboveground tank, etc.). This preliminary determination was made to enable later site groupings, and to develop generalized units descriptions for each unit type to enable remediation and characterization costings to be performed. The waste constituents analysis focused on the type of waste placed in the unit. This included "checkoffs" for whether the waste source and constituent chemicals were specifically identified; identification of chemical components (organics, volatiles, inorganics, metals, pH); identification of radionuclide components (fission products, other radionuclides, residual radioactivity); waste volume disposed; and identification of the nature of the waste (solid/hazardous waste, mixed waste, or radioactive only waste). These data serve to identify the nature of the wastes disposed/released and, in a broad sense, a summary of their potential behavior in the environment.

In evaluating the waste constituent matrices, nonradioactive chemical characteristics were evaluated separately from radionuclides. The chemical characteristics focused on identifying basic components of the wastes managed and disposed that move differently or "behave" differently in the environment. As mentioned above, these components are: organics, volatiles, incorganics, metals, and pH. Metals (as a chemical component) did not include radionuclides that are also metals (e.g., uranium). Radioactive components were addressed in a separate analysis. pH was included in the evaluation because the disposal of acidic or basic materials can substantially alter behavior of other components in the environment (e.g., metals mobility). Radionuclides were identified as being fission products or other radionuclides. Fission products included strontium, cobalt, and cesium while other radionuclides included uranium and plutonium. The comments section of the matrices notes where tritium is included as "other" radionuclides.

Exhumed sites were evaluated as if the wastes were still present for the purposes of waste characterization. The release potential evaluation conducted subsequent to this step considers the fact that the wastes, as a source of continuing release to the environment, have been removed.

3.2.1.2 Release Potential and Need for Action Matrix

Each site was evaluated for its release potential, i.e., the past, present, or future potential for release of hazardous constituents to the environment from the unit in question. This evaluation addresses releases to soil, groundwater, surface water, and air as well as the generation of subsurface gas (toxic or methane). This information serves as the basis for determining the need for action as well as site groupings. Sites that are in the same vicinity and affecting the same pathways could be grouped together.

The release potential analysis is a best professional judgement analysis that considers the following factors:

- Unit Characterizations
  - type
  - design features
  - past and present operating practices
  - period of operation
  - age of unit
  - location of unit
  - general physical conditions
  - method(s) used to close the unit

- Waste Characteristics
  - type of wastes/materials placed in the unit
  - migration and dispersal characteristics
  - physical and chemical characteristics

- o Migration Pathways
  - geologic setting
  - hydrogeologic setting
  - atmospheric conditions
  - topographic characteristics
- o Evidence of Release.

Under RCRA 3004(u) programs, exposure potential is considered only in determining if immediate action should be taken. In accordance with the Statement of Work, the characterization assessment proceeded on the basis of approximately 2000 pages of information from the Draft Phase I Installation Assessment Report and the Waste Management Units Report.

Tables 3-16 through 3-31 present the release potential and need for action matrices for the following areas: 100 B/C, 100 D/DR, 100 F, 100 H, 100 KE/KW, 100 N, 200 North, 200 West, 200 East, 300, 400, 600, 700, and 1100. The codes identified on the matrices are defined in the key associated with each matrix. The comments column presents a brief summary of key information or technical issues that affected the decisions presented in the matrix.

A preliminary assessment of the need for action at each site has been performed to provide a basis for the costing analysis. A final determination on remedial action cannot be made until the completion of the formal remedial investigation/feasibility study process. The need for action is defined for each site. There are five categories of action identified for the inactive 3004(u) sites: remediation, verify no release, verify no hazardous constituents, verify no residual contamination, and no further action. Remediation is selected where the waste constituents are particularly toxic, are affecting a broad spectrum of media, are continuing to be released in the environment, or pose a hazard which may be eliminated or reduced by taking action. This will involve characterization of the site in question and will generally follow the RI/FS process for CERCLA sites except that cost will not be a factor of the analysis for the RCRA sites. Verification of no release is selected where wastes remain in place but no release to the environment is believed to have occured either through the

KEY TO TABLES 3-16 TO 3-29

The three-digit codes shown in Column Two (Site Code) of the Release Potential and Need for Action Matrices represents the following:

First digit - Need for Action code

- 1 - Remediation
- 2 - Verify No Release
- 3 - Verify No Hazardous Constituents
- 4 - Verify No Residual Contamination

Second digit - Type Type Code

- A - aboveground covered landfill
- B - aboveground uncovered landfill
- C - belowground covered landfill
- D - belowground uncovered landfill
- E - surface impoundments
- F - ditches
- G - underground dispersion systems
- H - aboveground tank
- I - underground tank
- J - spills
- K - underground vault
- L - burning pit
- M - incinerator
- N - process sewer
- O - other

Third digit - Waste Types

- Q - Solid Waste/Hazardous Wastes
- M - Mixed Radioactive/Chemical Wastes
- R - Radioactive Waste Only

TABLE 3-16 100 B/C RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

100 B/C Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	POTENTIAL: Soil	POTENTIAL: Ground Water	POTENTIAL: Surface Water	POTENTIAL: Subsurface Gas	POTENTIAL: Air	Residual Radioactive Structures	Remediation	NEED FOR ACTION: Verify No Release	NEED FOR ACTION: Verify No Hazardous Constituents	NEED FOR ACTION: Verify No Residual Contamination	NEED FOR ACTION: No Further Action Required	Comments
Burial Ground	2LM	110-B 1	105-B Burial Ground 110-B-1	1973	SS	NS	NS	ND	ND			X				SEALED REACTOR AND METALLIC WASTES BURIED IN TRENCHES/SPENT SILOS
Burial Ground	2LM	110-C-1	105-C Burial Ground 110-C-1	1969	P-SS	NS	NS	NS	ND			X				MISC. SOLID WASTE/CONTAMINATED WASTES
Burial Ground	4LR	110-B 7	111-B Solid Waste Burial Site	1960	P-SS	ND	ND	ND	ND					X		MISC. SOLID WASTES/DECONTAMINATION MATERIALS
Burial Ground	3LM	110-B-3	Construction Burial Ground B2	1960	P-SS	NS	NS	ND	NS				X			REACTOR-GENERATED SOLID WASTES.
Burial Ground	5LR	110-B 4	105-B Spacer Burial Ground	1960	NS	NS	NS	NS	NS						X	DISPOSAL OF FUEL SPACERS; STAINLESS STEEL UNLIKELY TO DECOMPOSE - RADIOACTIVITY WOULD REMAIN IN SPACER.
Burial Ground	4LR	110-B-6	108-B Solid Waste Burial Ground	1953	P-SS	ND	NS	ND	NS					X		TRITIUM SPILLED IN CONCRETE PIPES. LIGHT METAL CAPS OVER PIPES.
Burial Ground	3LM	110-B-2	Construction Burial Ground B1	1956	P-SS	NS	NS	ND	NS				X			DRY WASTES FROM BASIN REPAIR AND CONSTRUCTION. COVERED WITH SOIL.
Burial Ground	4LR	110-B 5	Ball 3X Burial Ground 110-B-5	1953	P-SS	NS	NS	ND	ND					X		CONTAMINATED THIMBLES, PLUGS, ETC. FROM BLDG. 105-B. COVERED WITH 5 FT. OF SOIL.
Burning Pit	2LO	1000/1a	100 B/C Burning Pit	1968	S	ND	NS	NS	P			X				COMBUSTIBLE MATERIALS: PRIME WASTE, CHEMICAL SOLVENTS; COVERED OVER IN 1976.
Crib	4LM	116-B 5	100-B Crib 116-B-5 (9)	1967	SS	P	P	ND	NS					X		
Crib	4LM	116-B-6 1	111-B Crib B1 116-B-6-1	1960	SS	P	P	ND	ND					X		PAST RELEASE OF LIQUID RADIOACTIVE WASTES TO SOIL
Crib	4LM	117-B4	117-B Crib	1960	SS	P	P	ND	ND					X		RELEASED FROM RADIATION ZONE STATUS. POTENTIAL CHEMICAL CONTAMINATION NOT ADDRESSED.
Crib	4LM	117-C4	117-C Crib	1969	SS	P	P	NS	NS					X		DRAINAGE FROM CONTAINMENT SYSTEM. SAMPLED IN 1978 - CONTAM. BELOW BACKGROUND. POTENTIAL CHEM. CONTAMINATION NOT ADDRESSED.
Crib	4LM	116-B-6 2	111-B Crib B2 116-B-6-2	1953	SS	P	P	NS	NS					X		NOT USED IN 34 YEARS.
Crib	4LM	116-B 3	105-B Pluto Crib 116-B-3	1952	SS	P	P	NS	NS					X		NOT USED IN 35 YEARS.
Crib Sandfilter	4LM	116-C 2-2	105-C Pluto Crib Sandfilter	1969	SS	P	P	NS	NS	Y				X		CONCRETE BOX WITH OPEN BOTTOM COVERED WITH SAND. COVERED WITH CONCRETE LIDS.
Dry Well	4LM	116-B-10	108-B Dry Well, Quench Tank	1960	SS	P	P	ND	P	Y				X		DRAIN TILE MOUNTED ON CONCRETE PAD.
French Drain	4LM	116-B-9	104 B 2 French Drain	1954	SS	P	P	ND	ND					X		
Pit	5LO	184-B4	184-B Powerhouse Ash Pit (3)	1969	P-SS	P	P	NS	NS						X	COAL ASH SLUICED TO DISPOSAL PIT. (LIES BELOW GW TOXIC. ASSUMES 1% REPRESENTATIVE SAMPLE THRU OF WASTES AND SOIL.
Retention Basin	1LR	107-B4	107-B Retention Basin	1960	B-SS	P	P	ND	P	Y	X					CONTAMINATED CONCRETE RECEIVING BASINS AND SURROUNDING SOIL. RELEASED TO THE COLUMBIA RIVER. PAST LEAKAGE FROM EFFLUENT LINES AND BASIN BREAK. BACKFILLED WITH SOIL. 80% OF RAD. INVENTORY IN NEARBY SOIL.
Sump Tanks	MR	107-C4	107-C Retention Basin	1969	B-SS	P	P	ND	ND	Y	X					CONTAMINATED TANKS AND SURROUNDING SOIL. RELEASED TO THE COLUMBIA RIVER. 80% RAD. INVENTORY IN SOILS AROUND BASIN. LARGE TANKS (5-10,000 GAL/MIN). TANKS BACKFILLED WITH SOIL TO 4 FEET.
Sump	2LO	105-B4	105-B Battery Acid Sump (3)	1969	P-SS	ND	ND	NS	NS			X				CONCRETE SUMP. CLEANED AND NEUTRALIZED 1966. ANY CONCERN LEAKAGE?
Tank	5LR	110-C-2	105-C Ball Storage Tank	1969	P	ND	NS	ND	NS	P					X	IMMEDIATELY BOXED STEEL WASTE PRESENTLY BURIED IN UNDERGROUND TANKS. MELD TO SET SCHEDULE FOR WHEN WASTE IS DECAYED AND SUITABLE FOR REMOVAL.
Tank/Tile Field	3LO	1607-B3a	1607-B3 Septic Tank (3)	1974	SS	P	P	P	ND				X			INCLUDES TILE FIELD. IF NO HAZARDOUS CONSTITUENTS, THEN NO FURTHER ACTION REQUIRED.
Tank/Tile Field	3LO	1607-B0a	1607-B0 Septic Tank (3)	1969	SS	P	P	P	ND				X			SAME AS 1607-B3.
Tank/Tile Field	3LO	1607-B7a	1607-B7 Septic Tank (3)	1969	SS	P	P	P	ND				X			SAME AS 1607-B3.
Tank/Tile Field	3LO	1607-B1a	1607-B1 Septic Tank (3)	1960	SS	P	P	P	ND				X			FIRE STATION MAY HAVE BEEN SOURCE OF CHEMICALS. OTHERWISE, SAME 1607-B3.
Trench	4LR	116-B-2	105-B Storage Basin Trench	194[illegible]	S,SS	P	P	NS	P		NS			X		WASTEWATER FROM FUEL ELEMENT STORAGE BASIN. PAST RELEASE TO SOIL. FILLED IN WITH 6-15 FEET OF SOIL IN 194[illegible].

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TABLE 3-17 100 D/DR RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

100 D/DR Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radio-active Structures	NEED FOR ACTION: Remedi-ation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
Basin Trench	4LR	116-DR-3	105-DR Storage Basin Trench	1955	P-SS	P	P	NS	P					X		DISPOSAL OF CONTAMINATED SLUDGE AND WATER ...STOPPED IN 1955. ANY RESIDUAL SOIL-BOUND CONTAMINATION?
Basin Trench	4LR	116-D-1A	105-D Storage Basin Trench 01	1952	P-SS	P	P	NS	P					X		COVERED WITH 6 FT OF SOIL.
Burial Ground	2CR	118-D-3	100 D Burial Ground 03 118-D-3	1973	P-SS	ND	ND	ND	ND			X				DISPOSAL OF IRRADIATED SOLID WASTE... DISCONTINUED IN 1973.
Burial Ground	2CR	116-D-4	Construction Burial Ground	1967	P-SS	ND	ND	ND	ND			X				DISPOSAL CONTAMINATED REACTOR BLDG. COMPONENTS AND HARDWARE. NEED TO DETERMINE IF RELEASE OF RADIOACTIVE ELEMENTS TO SOIL IS STILL OCCURING.
Burial Ground	2CR	118-D-1	100 D Burial Ground 01 118-D-1	1967	P-SS	ND	NS	NS	NS			X				DISPOSAL OF IRRIGATED SOLID WASTE...NEED TO DETERMINE IF MATERIAL IS STILL RADIOACTIVE OR METALS LEACHING. WHAT OTHER MATERIALS PRESENT?
Burial Ground	2CR	118-D-2	100 D Burial Ground 02 118-D-2	1970	P-SS	ND	NS	ND	ND			X				DISPOSAL OF IRRIGATED SOLID WASTE...NEED TO DETERMINE IF MATERIAL IS STILL RADIOACTIVE OR METALS LEACHING. WHAT OTHER MATERIALS PRESENT?
Burial Ground	2CR	118-D-5	Ball 3X Burial Ground 118-D-5	1954	P-SS	ND	NS	ND	ND			X				BURIAL OF THIMBLES FROM REACTOR BLDG. NEED TO DETERMINE IF MATERIALS ARE STILL RADIOACTIVE OR IF METALS LEACHING.
Burial Ground	2CR	118-DR-1	105-DR Gas Loop Burial Ground	1964	P-SS	ND	NS	ND	ND			X				BURIAL OF IRRIDATED METAL ASSEMBLIES. NEED TO DETERMINE IF MATERIALS ARE STILL RADIOACTIVE OR METAL RELEASE TO ENVIRONMENT.
Burning Pit	4LQ	100-D/DR*	100 D/DR Burning Pit	1967	P-S,SS	ND	NS	ND	P,CP					X		DISPOSAL OF PAINT WASTES, SOLVENTS, AND OTHER CHEMICALS. NEED TO DETERMINE IF CHEMICAL CONTAMINANTS ARE STILL PRESENT.
Crib	4QQ	117-D*	117-D Crib	1967	V-SS	P	P	ND	NS					X		DISPOSAL OF DRAINAGE FROM CONFINEMENT SYSTEM. SHOULD ALSO EVALUATE IF CHEMICAL CONTAMINANTS ARE STILL PRESENT. FILLED WITH GRAVEL, COVERED TO GRADE WITH CLEAN SOIL.
Crib	4GM	116-DR-4	105-DR Plute Crib 116-DR-4	1953	V-SS	P	P	NS	NS					X		DISPOSAL OF EFFLUENT FROM TUBES CONTAINING FAILED FUEL ELEMENTS. NEED TO DETERMINE IF RESIDUAL RADIOACTIVITY REMAINS. SAMPLING SHOULD ALSO BE CONDUCTED FOR CHEMICAL CONTAMINANTS. COVERED TO GRADE WITH CLEAN SOIL.
Crib	4GM	116-DR-8	117-DR Crib	1964	V-SS	P	P	ND	NS					X		DISPOSAL OF DRAINAGE FROM CONFINEMENT SEAL PITS. NEED TO DETERMINE IF RESIDUAL RADIOACTIVITY REMAINS. ALSO,..OLD CRIB RECEIVE CHEMICAL CONTAMINANTS WHICH REMAIN IN SURROUNDING SOIL?
Crib	4GM	116-D-2	105-D Plute Crib 116-D-2	1954	V-SS	P	P	ND	NS					X		DISPOSAL OF INORGANIC CHEMICALS AND WASTES FROM FAILED FUEL ELEMENTS. NEED TO EVALUATE PRESENCE OF RESIDUAL CONTAMINATION (CHEM/RAD).
French Drain	4GM	116-D-3	108-D Crib 01 116-D-3	1967	V-SS	P	P	P	NS					X		DISPOSAL OF WASTES FROM CONTAMINATED MAINTENANCE SHOP AND CASK DECONTAMINATION PAD. NEED TO EVALUATE IF CHEMICAL AND RADIOACTIVE MATERIALS REMAIN AT SITE.
French Drain	4GM	116-D-4	108-D Crib 02 116-D-4	1957	V-SS	P	P	P	NS					X		DISPOSAL OF WASTES FROM CONTAMINATED MAINTENANCE SHOP AND CASK DECONTAMINATION PAD. NEED TO EVALUATE IF CHEMICAL AND RADIOACTIVE MATERIALS REMAIN AT SITE.
French Drain	4GM	116-D-6	105-D Cushion Corridor French Drain	1967	V-SS	P	P	ND	ND					X		DISPOSAL OF DOMESTIC WATER FROM CHANGING ROOM, AND EFFLUENT FROM MASK DECONTAMINATION STATION. NEED TO EXAMINE THE DRAIN/SITE FOR RESIDUAL RADIOACTIVITY AND CHEMICAL CONTAMINATION.
Pumping Station	2GM	1608-DR*	1608-DR Waste Water Pumping	1964	P	ND	ND	NS	ND	P		X				INACTIVE AND EMPTY. PUMPED TO EFFLUENT LINES TO COLUMBIA RIVER. NO DATA ON UNIT LEAKAGE IF ANY.
Pumping Station	5GM	1608-D*	1608-D Waste Water Pumping	1965	P	ND	ND	NS	ND						X	FACILITY DEMOLISHED IN SITU BY 100 AREA DECOMMISSIONING PROGRAM.
Retention Basin	1EM	107-D*	107-D Retention Basin	1967	D-S,SS	P	P	ND	PP,C	V	X					70% RADIATION INVENTORY IN SURROUNDING SOIL. CONCRETE WALLS. CONTAMINATED/ RADIOACTIVE BASIN WALLS AND SURROUNDING SOIL. UPR EARLY IN 1950S CONTAMINATED EFFLUENT REACHED SURFACE.

KEY: * = official number not assigned but identified by unit number; D= documented; P= suspected; ND= no date; NS= not suspected; SS= subsurface soil; S= surface soil; P= past air release; C= current air release; F= future air release; V= yes; Blank= no

TABLE 3-17 100 D/DR RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

100 D/DR Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radio-active Structures	NEED FOR ACTION: Remedi-ation	Verify No Release	Verify No Hazardous Conditions	Verify No Residual Contamination	No Further Action Required	Comments
Retention Basin	16M	107-DR*	107-DR Retention Basin	1964	D-S,SS	P	P	ND	P	Y	X					CONTAMINATED RETENTION BASIN (WALLS) AND SURROUNDING SOIL. CONCRETE WALLS. 70% RADIATION INVENTORY IN SURROUNDING SOIL.
Storage Pad	40M	100-D*	100-D Cask Storage Pad (3)	1975	P-S,SS	ND	ND	ND	ND	Y				X		PAD IS EMPTY. SURFACE CONTAMINATION IS FIXED SOIL AND CHEMICAL CONTAMINATION NOT ADDRESSED.
Tank	21Q	1706-D*	1706-D Gas Storage Tank (3)	1966	P-SS	ND	ND	ND	ND			X				STORAGE TANK ORIGINALLY FILLED WITH GASOLINE NOW CONTAINS WATER. NEED TO DETERMINE IF HAZARDOUS CONSTITUENTS REMAIN. TANK LEAKED IN PAST. HOSES COULD CONTAIN SEEPAGE.
Tank/Tile Field	3GQ	1607-D1*	1607-D1 Septic Tank	1965	D-SS	P	ND	P	ND				X			SEPTIC TANK RECEIVED SANITARY WASTEWATER FROM WAREHOUSE/CHECKPOINT, 1701-D BUILDING, AND 1709-D BUILDING.
Tank/Tile Field	3GQ	1607-D4*	1607-D4 Septic Tank	1966	D-SS	P	ND	P	ND				X			

KEY: * = official number not assigned but identified by unit number; D= documented; P= suspected; ND= no data; NS= not suspected; SS= subsurface soil; S= surface soil; P= past air release; C= current air release; F= future air release; N= yes; Blank= no

TABLE 3-18 100 F RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

100 F Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	Remediation	NEED FOR ACTION: Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
Burial Ground	4UR	110-F-4	115-F Pit 110-F-4	1979	F-SS	NS	NS	NS	NS					X		COVERED WITH 6 FT. SOIL IN 1979. SILICA GEL MAY HAVE DECOMPOSED.
Burial Ground	2UR	110-F-3	Burial Ground 02 110-F-3	1952	F-SS	NS	NS	NS	NS			X				
Burial Ground	2UR	110-F-1	Burial Ground 01 110-F-1	1965	F-SS	NS	NS	NS	NS			X				
Burial Ground	2UR	110-F-2	Burial Ground 02 110-F-2	1965	F-SS	NS	NS	NS	NS			X				
Burial Ground	2UR	110-F-6	PNL Solid Waste Burial Ground	1973	F-SS	NS	NS	P	ND			X				MAXIMUM TO 110-F-1. NATURE OF CHEMICALS NOT AVAILABLE.
Burial Ground	5UR	110-F-5	PNL Sawdust Repository 110-F-5	1975	F-SS	NS	NS	NS	NS						X	NEED TO DETERMINE SOIL COVER DEPTH.
Burial Vault	1UR	110-F-7	100F Miscellaneous Hardware	1965	ND	ND	ND	ND	ND	V	X					CONCRETE VAULT WITH WOODEN COVER. TEMPORARY WASTE STORAGE. WASTE STILL PRESENT AFTER 20 YRS. NEED TO REMOVE WASTES.
Burning Pit	4UR	100-F-6	100-F Burning Pits 02	1965	SS	P	ND		P P					X		SITE NOT USED IN 20 YEARS.
Crib	4UR	116-F-4	105-F Plute Crib 116-F-4 (9)	1952	D-SS	P	P	ND	ND					X		COVERED TO GRADE WITH SOIL IN 1952. CHEMICALS NOT ADDRESSED.
Crib	4UR	116-F-5	Ball Washer Crib 116-F-5	1964	D-SS	P	P	ND	ND					X		CHEMICALS NOT ADDRESSED.
French Drain	4UR	116-F-12	140-F French Drain 116-F 12	1964	D-SS	P	P	ND	ND					X		
French Drain	4UR	116-F-11	105-F Cushion Corridor French	1965	D-SS	P	P	ND	ND					X		
French Drain	5UR	116-F-15	1705-F Experimental Garden	1976	D-SS	P	P	ND	ND				X			
French Drain	4UR	116-F-7	117-F Crib 116-F-7	1965	D-SS	P	P	ND	ND					X		
Pit	5UR	184-F-6	184-F Powerhouse Ash Pit (3)	1965	S,SS	P	P	ND	ND						X	RAM TESTS AS NOT EP TOXIC. ASSUME >1 REPRESENTATIVE SAMPLE TAKEN OF ASH AND SOIL.
Pumping Station	2UR	1608-F-P	1608-F Wastewater Pumping	1965	P	ND	ND	ND	P P			X				INACTIVE AND EMPTY.
Retention Basin	1UR	107-F-6	107-F Retention Basin	1965	S,SS	P	P		P P	V	X					CONCRETE BASIN. BACKFILLED TO 5 FT. SOIL FILLED TO COVER WALLS. RELEASES OCCURED DURING USE. 70% RADIATION INVENTORY IN SOILS.
Tank/Tile Field	3UR	1607-F6-P	1607-F6 Septic Tank	1975	SS	P	P	P	ND				X			IF NO HAZ. CONSTIT., THEN NO FURTHER ACTION.
Tank/Tile Field	3UR	1607-F1-P	1607-F1 Septic Tank	1960	SS	P	P	P	ND				X			IF NO HAZ. CONSTIT., THEN NO FURTHER ACTION.
Tank/Tile Field	3UR	1607-F5-P	1607-F5 Septic Tank	1965	SS	P	P	P	ND				X			IF NO HAZ. CONSTIT., THEN NO FURTHER ACTION.
Tank/Tile Field	3UR	1607-F3-P	1607-F3 Septic Tank	1965	SS	P	P	P	ND				X			IF NO HAZ. CONSTIT., THEN NO FURTHER ACTION.
Tank/Tile Field	3UR	1607-F4-P	1607-F4 Septic Tank	1965	SS	P	P	P	ND				X			IF NO HAZ. CONSTIT., THEN NO FURTHER ACTION.

KEY:

A - official number not assigned but identified by unit number

D= documented
P= suspected

ND= no data
NS= not suspected

SS- subsurface soil
S= surface soil

P= past air release
C= current air release

F- future air release
X- yes

Blank= no

TABLE 3-19 100 H RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

100 H Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	Remediation	NEED FOR ACTION: Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
Burial Ground	2CH	110-H-2	D-1 Loop Burial Area, 180-H	1965	P-SS	NO	NO	NO	NO	Y		X				CONCRETE VAULTS RECEIVED RADIOACTIVE STEEL TUBES, AND PIPES. NEED TO EVALUATE RESIDUAL RADIOACTIVITY. INCLUDES TWO CONCRETE VAULTS.
Burial Ground	2CH	110-H-3	Construction Burial Ground	1957	P-SS	NO	NO	NO	NO			X				BURIAL GROUND RECEIVED CONTAMINATED HARDWARE. NEED TO EVALUATE RESIDUAL RADIOACTIVITY. COVERED WITH 6 FT. SOIL.
Burial Ground	2CH	110-H-4	Bell 3X Burial Ground 110-H-4	1963	P-SS	NO	NO	NO	NO			X				BURIAL GROUND RECEIVED IRRADIATED SOLID WASTE. NEED TO EXAMINE RESIDUAL RADIOACTIVITY.
Burial Ground	2CH	110-H-1	200 H Burial Ground 01 110-H-1	1965	P-SS	NO	NO	NO	NO			X				BURIAL GROUND RECEIVED REACTOR COMPONENTS, AND HARDWARE.
Burning Pit	4LB	180-H2H	180-H2 Burning Pit for Residue	1965	P-S	NO	NO	NO	P P					X		BURNING/DISPOSAL OF PAINT AND OFFICE WASTES, AND CHEMICAL SOLVENTS. NEED TO EXAMINE RESIDUAL SOIL CONTAMINATION.
Burning Pit	4LB	180-H	200 H Burning Pit	1965	D-S	P	P	NO	P P					X		BURNING/DISPOSAL OF PAINT AND OFFICE WASTES, AND CHEMICAL SOLVENTS. NEED TO EXAMINE RESIDUAL SOIL CONTAMINATION.
Crib	4BH	117-HX	Crib 117-H	1964	D-SS	P	P	NO	NO					X		CRIB RECEIVED DRAINAGE FROM CONTAINMENT SEAL PITS. MONITORING IN 1970 INDICATED NO RADIO-ACTIVITY ABOVE BACKGROUND. MUST EVALUATE HOWEVER, IF CHEMICAL CONTAMINATION REMAINS IN SURROUNDING SOIL. REMOVED FROM RADIATION ZONE STATUS.
Crib	4BH	116-H-4	105-H Pluto Crib 116-H-4 (3)	1952	D-SS	P	P	NO	NO					X		CRIB EXAMINED IN 1960 AND MOVED TO 110-H-4 BURIAL GROUND. USED FOR ONLY 2 YEARS THEN COVERED WITH SOIL.
Pit	2CH	110-H-5	105-H Thimble Pit 110-H-5	1961	P-SS	P	P	NO	NO			X				BURIAL GROUND RECEIVED THIMBLE ASSEMBLY AND PLUTO CRIB. NEED TO DETERMINE IF THERE IS RESIDUAL RADIOACTIVITY/CHEMICALS.
Pit	3CB	184-HX	184-H Powerhouse Ash Pit (3)	1965	D-SS	P	P	NO	NO				X			COAL ASH SLUICED WITH RAW RIVER WATER. ASH DID NOT EXCEED EP TOX. LIMITS. STILL NEED TO EVALUATE IF OTHER CHEMICAL CONTAMINANTS REMAIN IN SOIL. ASSUME >1 REPRESENTATIVE SAMPLE TAKEN OF WASTE AND SOIL.
Pumping Station	2BH	1608-HX	1608-H Waste Water Pumping	1965	NO	NO	NO	NO	NO	P		X				PUMPING UNIT RECEIVED REACTOR WASTE AND DECON. CHEMICALS. PRESENTLY INACTIVE AND EMPTY, BUT MUST EVALUATE RESIDUAL RADIOACTIVITY. DID UNIT LEAK?
Retention Basin	4CB	107-HX	100-H Retention Basin 107-H	1965	D-S,SS	P	P	NO	P	Y	X					RECEIVING BASIN AND SURROUNDING SOIL ARE RADIOACTIVE. EXPOSURE POTENTIAL SIGNIFICANT. SITE REMEDIATION/DECONTAMINATION IS NECESSARY. FOR RADIATION INVENTORY IN SOIL. LEAKAGE IN PAST UP TO 5000-10000 GPM.
Tank/Tile Field	3BB	1607-H-4H	1607-H4 Septic Tank	1965	D-SS	P	P	P	NO				X			SEPTIC TANK RECEIVED SANITARY WASTEWATER FROM WAREHOUSE AND FIRE STATION. NEED TO EXAMINE IF HAZARDOUS CHEMICALS ARE PRESENT IN SURROUNDING SOIL.
Tank/Tile Field	3BB	1607-H-2H	1607-H2 Septic Tank	1965	D-SS	P	P	P	NO				X			RECEIVED SANITARY WASTEWATER FROM OFFICE AND MAINTENANCE BUILDINGS. NEED TO DETERMINE IF HAZARDOUS CHEMICALS PRESENT IN SURROUNDING SOIL.
Tank/Tile Field	3BB	1607-H-3H	1607-H3 Septic Tank	1965	D-SS	P	P	P	NO				X			RECEIVED SANITARY WASTEWATER FROM PUMPHOUSE. NEED TO DETERMINE IF HAZARDOUS CHEMICALS PRESENT IN SURROUNDING SOIL.

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TABLE 3-20 100 KE/KW RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

100 KE/KW Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name Description	Date Last Used	Release Potential: Soil	Release Potential: Ground Water	Release Potential: Surface Water	Release Potential: Subsurface Gas	Release Potential: Air	Residual Radioactive Structures	Need for Action: Remediation	Need for Action: Verify No Release	Need for Action: Verify No Hazardous Constituents	Need for Action: Verify No Residual Contamination	Need for Action: No Further Action Required	Comments
Burial Ground	[illegible]	[illegible]	100 K Burial Ground 100 K	[illegible]	[illegible]	ND	ND					X				:NEED TO DETERMINE IF WASTE IS MOVING :STATE WASTE IN THE TRENCHES, OR COULD MOVE :UP GROUND WATER TABLE OVER, 20 FT FROM SURFACE :SINCE NO WASTE WAS BURIED NEAR THE BOTTOM OF THE :WATER, RELEASE FROM GRD WTR TO SURFACE WAS COULD :ALSO BE POSSIBLE.
Burning Pit	[illegible]	[illegible]	100 K Burning Pit	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]					X		:BURNING OF WASTE PAINT AND CHEMICAL SOLVENTS MAY :NOT BE TARGETED. RESIDUAL CONTAMINATION COULD :REMAIN WITH THE ASH. PAST RELEASE TO AIR DURING :BURNING.
Crib	[illegible]	[illegible]	115 KE Condensate Crib	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		X					:REMEDIATION MAY OR NEEDED FOR THIS UNIT SINCE :WASTE CONTAMINANTS MAY STILL REMAIN IN THE CRIB :RELEASE TO AIR CAN ALSO OCCUR SINCE THERE IS A :PRESSURE OR TRITIUM.
Crib	[illegible]	[illegible]	115 KE Condensate Crib	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		X					:MAY HAVE RELEASE TO AIR AS EXPERIMENTAL WORK. :NO CHEMICAL DATA.
French Drain	[illegible]	[illegible]	105 KE Storage Basin Drain	[illegible]	[illegible]	[illegible]					X					:NO INFO ON TYPE OR QUANTITY OF WASTE. REMEDIA :TION MAY OR NEEDED SINCE THE WASTE IS RELATIVE :DISPOSED OF.
French Drain	[illegible]	[illegible]	105 KE Storage Basin Drain	[illegible]	[illegible]	[illegible]					X					:SAME AS 0000
Retention Basin	[illegible]	[illegible]	102 KE Retention Basin	[illegible]	[illegible]	[illegible]				Y	X					:SUBSURFACE SOIL IS KNOWN TO BE CONTAMINATED :DURING STILL THAT 30 YEARS OLD. INCIDENTAL :WITH [illegible] DUE TO [illegible] DEEP. CONCRETE WALL :MONITORED. LEAKS FROM THE BASIN A SECONDARY LINE :TO REDUCE TRENCH COLD AMOUNT TO 5000 TO 10,000 :GPM. LEAKAGE DIVERTED TO OPEN CHANNEL A DISPOSED TO :RIVER.
Retention Basin	[illegible]	[illegible]	102 KE Retention Basin	[illegible]	[illegible]	[illegible]				Y	X					:SAME AS 0000
Tank	[illegible]	[illegible]	101 KE Liquid Fuel Storage Tank	[illegible]	[illegible]	ND	ND	ND	ND			X				:NEED TO DETERMINE IF THERE STILL IS FUEL :CHEMICAL IN THE TANK. IF THEY IS, IT SHOULD :BE REMOVED.
Tank	[illegible]	[illegible]	105 KE Emergency Diesel Fuel	[illegible]	[illegible]	ND	ND	ND	ND			X				:TANK IS EMPTY. NEED TO VERIFY THAT THERE HAS :BEEN NO RELEASE.
Tank	[illegible]	[illegible]	104 KE Oil Storage Tank	[illegible]	[illegible]	ND	ND	ND	ND		X					:NEED TO REMOVE 2000 GAL OIL OUT HELL IN THE TANK, AND :VERIFY THAT THERE HAS BEEN NO RELEASE TO SOIL.
Tank	[illegible]	[illegible]	107 KE Emergency Cooling Tower	[illegible]	ND	ND	ND	ND	ND			X				:TANK IS EMPTY. NEED TO VERIFY FOR NO RELEASE FROM :TANK AND NO RESIDUAL MATERIALS.
Tank	[illegible]	[illegible]	103 KE Sulfuric Acid Storage	[illegible]	[illegible]	[illegible]								X		:TANK IS EMPTY AND NEUTRALIZED. HAD PAST LEAKAGE. :SOME SOIL WAS NEUTRALIZED. NEED TO VERIFY NO :RESIDUAL CONTAMINATION DUE TO UNDERGROUND LINES.
Tank	[illegible]	[illegible]	106 KE Oil Storage Tank	[illegible]	[illegible]	ND			ND		X					:NEED TO REMOVE 2000 GAL OIL OUT HELL FROM THE TANK, :AND VERIFY FOR NO RELEASE.
Tank	[illegible]	[illegible]	103 KE2 Sulfuric Acid Storage	[illegible]	[illegible]	ND						X				:TANK IS EMPTY AND NEUTRALIZED. NEED TO VERIFY THAT :THERE HAS NO RELEASE FROM TANK.
Tank	[illegible]	[illegible]	103 KE1 Sulfuric Acid Storage	[illegible]	[illegible]	[illegible]								X		:LEAKAGE DURING OPERATION. TANK IS EMPTY, AND SOME :SOILS WERE NEUTRALIZED. NEED TO VERIFY FOR NO :RESIDUAL CONTAMINATION. TANK NOT NEUTRALIZED.
Tank	[illegible]	[illegible]	101 KE2 Sulfuric Acid Storage	[illegible]	[illegible]	ND						X				:TANK IS EMPTY. NEED TO VERIFY FOR NO RELEASE. :TANK NOT NEUTRALIZED?
Tank	[illegible]	[illegible]	103 KE Sodium Dichromate Tank	[illegible]	[illegible]	[illegible]								X		:TANK WAS DRAINED AND REMOVED FROM THE SITE TO 300 :AREA FOR REUSE. NEED TO VERIFY THAT RETENTION :CONTAMINATION DUE TO SPILLS IS WITHIN ALLOWABLE :CONCENTRATION.
Tank	[illegible]	[illegible]	1717 K Waste Oil Storage Tank	[illegible]	ND	ND			ND		X					:MOTOR OIL WILL NEED TO BE REMOVED FROM TANK. :VERIFY NO RELEASES FROM TANK.
Tank	[illegible]	[illegible]	103 KE Sodium Dichromate Tank	[illegible]	[illegible]	[illegible]								X		:SAME COMMENTS FOR 103 KE UNIT.
Tank	[illegible]	[illegible]	1717 K Gas Storage Tank [illegible]	[illegible]	ND	ND			ND			X				:TANK DRAINED AND FILLED WITH WATER. NEED TO :VERIFY FOR NO PAST RELEASE. IF TANK LEAKS, WATER :MAY SPREAD PAST RELEASE.

KEY:
- * = [illegible] not specified but identified by unit number
- D = documented
- Z = suspected
- ND = no data
- No = not suspected
- SS = subsurface soil
- S = surface soil
- P = past air release
- C = current air release
- F = future air release
- X = yes
- Blank = no

TABLE 3-20 100 KE/KW RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

[illegible]

[illegible]	Site Code	Official Number	Site Name/ Description	Date Last Used	Release Potential: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	Remediation	NEED FOR ACTION: Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
Tank	[illegible]	[illegible]	105-KW Emergency Diesel Fuel	70	ND	ND			ND			X				NO INFO ON THE PRESENT STATUS OF THE TANK. NEED TO VERIFY FOR NO RESIDUAL CONTAMINATION IN THE TANK OR RELEASE TO GROUND.
Trench	[illegible]	[illegible]	105-KE Filter Water Facility	70	SS	?					X					NO INFO ON QUANTITY OF WASTE DEPOSITED. HOWEVER, ACID SLUDGE-WATER SLURRY MAY STILL REMAIN AT THE BOTTOM OF THE TRENCH AND IN THE SURROUNDING SOIL. REMEDIATION IS RECOMMENDED.

KEY: [illegible] D- documented, ?- suspected, ND- no data, N- not suspected, SS- subsurface soil, S- surface soil, P- past air release, C- current air release, F- future air release, X= yes, Blank- [illegible]

TABLE 3-21 100 N RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

100 N Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	NEED FOR ACTION: Remediation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
Burning Pit	100	120-N-1	100-N Burning Pit (120-N 1)	86	S, ? SS	ND	ND		P,C,F		X					WASTE CONSTITUENTS ARE NOT DEFINED AND USED FOR MORE THAN 20 YEARS.
French Drain	100	120-N-6	108-N Acid Tank Vent French	87	SS	?	?				X					WASTE IS CORROSIVE. LAST USED IN 87. ALTHOUGH DISCHARGE IS ABOUT 1 GAL EACH TIME, HOWEVER, NO INFO ON THE TOTAL NUMBER OF DISCHARGES. ASSUME SULFATE FORMATION AND PH ALTERATION IN SOIL. OTHER DISCHARGES? TO BE CHARACTERIZED 5/87.
French Drain	100	120-N-7	Acid Unloading Facility	87	SS	?	?				X					SAME AS ABOVE
Line Leak	100	UN-116-N-22	184-N Diesel Oil Supply Line	86	D,SS	D	?				X					PIPE LEAK DISCHARGING DIESEL OIL. SHOW UP IN GROUNDWATER WELL SAMPLE. OCCURED IN '86. GW PUMPING HAS BEEN PERFORMED.
Line Leak	100	UN-116-N-23	184-N Diesel Oil Supply Line	87	D,SS	D	?				X					CONTAMINATION APPEARS IN GRD WTR SAMPLE. GW PUMPING HAS BEEN PERFORMED. NEED PERMANENT REMEDIATION. LEAK CAUSED BY CORROSION. LEAK LOCATED AND EXHUMED.
Pit	100	120-N-3	165-N Neutralization Pit/Drain	87	SS	?	?	?			X					WASTE IS DISPOSED FOR 29 YEARS. CORROSIVE SOLUTIONS THAT SHOULD REACT TO FORM SULFATES AND OTHER SALTS. WASTE SHOULD STILL BE IN THE GROUND. PH ALTERATION.
Tank/Drain Field	300	124-N-4	124-N-4 Septic Tank	87	SS	?	?	?					X			FOR SEPTIC TANKS AND DRAIN FIELDS, IT IS ASSUMED THAT WASTE IS MOSTLY SEWAGE TYPE. NEED ONLY TO CONFIRM THAT THERE IS NO HAZARDOUS OR RADIOACTIVE CONTAMINATION. IF THIS IS TRUE, THEN NO FURTHER ACTION IS REQUIRED.
Tank/Drain Field	300	124-N-7	124-N-7 Septic Tank	87	SS	?	?	?					X			SAME AS ABOVE
Tank/Drain Field	300	124-N-8	124-N-8 Septic Tank	87	SS	?	?	?					X			SAME AS ABOVE
Tank/Drain Field	300	124-N-6	124-N-6 Septic Tank	84	SS	?	?	?					X			SAME AS ABOVE
Tank/Drain Field	300	124-N-5	124-N-5 Septic Tank	87	SS	?	?	?					X			SAME AS ABOVE

KEY: N = official number not assigned but identified by unit number; D= documented; ?= suspected; ND= no date; NS= not suspected; SS= subsurface soil; S= surface soil; P= past air release; C= current air release; F= future air release; X= yes; Blank= no

TABLE 3-22 200 E RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

200 East Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	Remediation	NEED FOR ACTION: Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
Box	II	216-A-5,9	216-A-5,9 Control Structure	1976	D-SS	ND	NS	NS	NS	Y	X					REMOVE CONTAMINATED STRUCTURES AND VERIFY IF RELEASE(S) HAS OCCURRED
burial ground	4C	216-E-8	216-E-8, 200 East Construction	1959	D-SS	ND	NS	?	?P					X		RETIRED AND BACKFILLED.
burial ground	4C	216-E-13	UN 216-E-13 Burial Ground	1964	D-SS	NS	NS	NS	?P					X		
burial ground	4C	216-E-6	216-E-6 Burial Ground	1955	D-SS	ND	NS	NS	NS					X		SITE EXHUMED.
burial ground	4C	216-E-2	216-E-2, 200 East Industrial	1953	D-SS	ND	NS	NS	?P					X		RETIRED AND STABILIZED (BURIED), CAVING IN NOTED CONTAMINATED TUMBLEWEEDS.
burial ground	4C	216-E-5	216-E-5 Burial Ground	1954	DSS	NS	NS	ND	NS					X		SITE BACKFILLED AND STABILIZED IN 1979. SOME SINKING OF SURFACE.
burial ground	4C	216-E-5a	200 East Industrial Waste Bin	1959	DSS	ND	NS	ND	?P					X		NO DATA ON COMPOSITION OF THE BURIAL BOXES. SITE RECEIVED D-2 COLUMN FROM PUREX A CELL.
burial ground	4C	216-E-3	216-E-3 Burial Ground	1954	NS	NS	NS	NS	?P					X		SITE HAS BEEN EXHUMED, VERIFY THAT THERE IS NO CONTAMINATION OR BULK RESIDUALS REMAINING
burial ground	4C	216-E-4	216-E-4, 200 East/Minor No. 2	1954	?SS,?S	NS	NS	?	?P					X		CONTAMINATED EQUIP. STORED ABOVE GROUND MAY HAVE CONTAMINATED SURFACE SOILS & AIR. REPAIR AND CONSTRUCTION WASTES MAY CONTAIN ORGANICS (EG., PAINTS AND SOLVENTS)
burial ground	4C	216-E-1	216-E-1, 200 East Dry Waste	1953	D-SS	ND	NS	NS	?P					X		
burial ground	4C,D	216-E-1,R	216-E-1,R, 200 East Dry Waste	1967	?S,SS	ND	NS	?	?P					X		WASTE WAS DISTURBED AT SURFACE IN THE PAST. CONTAIN- RD SOLID WASTES AND DRY WASTES FROM 200E BLDG. BACKFILLED, COVERED WITH POWER PLANT ASH & GRAVEL.
burial tunnel	2D	216-E-14	216-E-14 PUREX TUNNEL NO. 1	1964	ND	NS	NS	NS	ND	Y		X				DETERMINE NEED TO REMOVE WASTES.
burial vault	2D	216-E-9	216-E-9, 200 East Regulated	1959	D-S	NS	NS	NS	ND			X				REGULATED EQUIPMENT STORAGE.
burial vaults (3)	4C	216-E-7	216-E-7, 200 East/222-B	1952	D-SS	ND	ND	?	NS	Y				X		UNSPECIFIED LAB WASTES AND MIXED NP/RCRA WASTES. 2 WOODEN VAULTS AND 1 CONCRETE VAULT. WOODEN VAULTS WERE OPEN AT BOTTOM.
burning pit	4C,U		200 East Burning Pit	1970	D-SS	ND	NS	NS	D-P					X		IN VARIETY OF NON RAD. WASTES BURNED INCLUDING PAINTS AND SOLVENTS. NO REMEDIATION OR MONITORING NOTED.
crib	4C	216-A-39	216-A-40 CRIB/TRENCH	1968	D-SS,S	NS	NS	NS	D-P					X		BACKFILLED.
crib	1C	216-A-4	216-BY-5 CAVERN/CRIB	1955	D-SS	?	ND	NS	NS		X					COVERED WITH PLASTIC AND SAND.
crib	4C	216-A-51	216-BY-9 CRIB	1950	D-SS	ND	NS	NS	NS					X		HAS WOOD COVER WITH VENT HOLES.
crib	1C	216-A-15	216-BC-2 Crib	1957	D-SS,S	?	NS	NS	NS		X					CRIB MAY COLLAPSE. CONTAMINATED RUBBLE (POSSIBLY (RADIOACTIVE) ON SURFACE.
crib	1C,D	216-A-10	216-A-10 crib	1987	D-SS	?	NS	NS	NS		X					UNIT USED TO DISPOSE MIXED WASTES UNTIL 3/87 ACIDITY MOBILIZING Sr WHICH HAS BEEN DETECTED IN GROUNDWATER.
crib	4C,D	216-A-5	216-A-5 crib	1955	D-SS	ND	NS	NS	NS					X		
crib	4C	216-A-27	216-A-27 French Drain	1950	D-SS	NS	NS	NS	NS					X		BACKFILLED.
crib	1C	216-A-19	216-A-19	1954	D-SS,S	?	ND	NS	NS		X					CRIB STRUCTURE MAY COLLAPSE. RELEVANT GREATER AMOUNT OF RADIOACTIVITY IN ANY SITE AT HANFORD.
crib	4C	216-A-41	216-A-41 Crib	1979	D-SS	NS	NS	NS	NS					X		BACKFILLED.
crib	4C	216-A-32	216-A-32	1972	D-SS	NS	NS	NS	NS					X		202 A FORMR MAINTENANCE FLOOR, SINK, AND SEWER DRAINAGE. NO KNOWN CONTAMINANTS BUT RAD. WASTE MAY HAVE BEEN DISPOSED. BACKFILLED.
crib	4C	216-C-4	216-C-4 crib	1965	D-SS	ND	NS	?	NS					X		CONTAMINATED ORGANIC WASTES.
crib	4C	216-A-31	216-A-32 Crib	1966	D-SS	NS	NS	?	NS					X		ORGANIC WASTES FROM 202 A.
crib	1C,D	216-B-10B	216-B-10B	1973	D-SS	ND	NS	NS	NS		X					CRIB STRUCTURE MAY COLLAPSE.
crib	4C	216-B-60	216-B-60 Crib	1967	D-SS	NS	NS	NS	NS					X		CRIBS WERE SEALED WITH CONCRETE AND SITE IS COVERED BY 2/5 B EVAPORATION FACILITY.
crib	4C	216-A-3	216-A-3 CAVERN	1967	D-SS	?	ND	NS	NS					X		SILICA GEL REGENERATION WASTE, NAA STORAGE PIT DRAINAGE AND 203-A POWERHOUSE LIQUID WASTE.
crib	4C,D	216-C-6	216-C-6	1964	D-SS	?	ND	NS	NS					X		

KEY:
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D- documented
?- suspected
ND- no data
NS- not suspected
SS- subsurface soil
S- surface soil
P- past air release
C- current air release
F- future air release
X- yes
Blank - no

TABLE 3-22 200 E RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

Unit Type	Unit Code	Unit Identification	Site Name/ Description	Date Last Used	Release Potential: Soil	Release Potential: Ground Water	Release Potential: Surface Water	Release Potential: Subsurface Gas	Release Potential: Air	Residual Radioactive Structures	Remedial Action	Release	Release Not Recommended Contaminants	Release Not Recommended Contamination	Not Feasible Action Required	Comments
crib	U-	216-U-14	216-U-14 crib	1954	U-SS,S	P	ND	NS	NS		X					CRIB STRUCTURE MAY COLLAPSE. CONTAMINATED DROP PINGS ALONG SURFACE.
crib	U-	216-U-8	241-U-3 CRIB	1954	U-S	P	ND	NS	NS		X					CRIB STRUCTURE MAY COLLAPSE.
crib	U-	216-U-10	216-U-5 crib	1954	U-S,SS	P	NS	NS	P-P		X					SOME VOLUME OVER SOME FENCED RESULTED IN CRIB IN NS IN U FILLED W/ GRAVEL. CRIB COLLAPSE EXPECTED TO OCCUR. CONTAMINATED DROPPINGS ALONG SURFACE.
crib	U-	216-U-1	216-U-1 Cribs	1955	U-S	ND	NS	NS	NS		X					BACKFILLED.
crib	U-	216-U-2	216-U-2 Cribs	1963	U-S	P	NS	P	NS		X					GROUND: WASTE FROM 202-U STORAGE; PRV NOW BACKFILLED. GROUND CONTAMINATION FOUND IN SS IN BACKFILL AGGREGATE. 1984 STUDY FOUND CONTAMINATED RADIONUCLIDES AT 150-250 FT ABOVE WATERTABLE. CONTAM DROPPINGS ON SURFACE.
crib	U-	216-U-5	216-U-5 Crib	1973	U-S	P	ND	NS	NS					X		
crib	U-	216-U-17	216-U-9 Crib	1954	U-SS,SS	P	ND	NS	NS		X					CRIB STRUCTURE MAY COLLAPSE. CONTAMINATED DROPPING ON SURFACE.
crib	U-	216-U-1	216-UR-1, 2, 3 cribs, 216-U-	1973	U-SS,S	U	ND	NS	P-P		X					THREE CRIBS, ONE COLLAPSED AND HAS BACKFILLED. CRIBS WITH PLASTIC AND STABILIZED. GROUNDWATER SAMPLES IN 1974 SHOWED CONTAMINATION.
underground tank	U-	216-U-9	216-U-9 Tk, 241-U-361	1951	U-S	P	ND	NS	NS		X					CRIB STRUCTURE MAY COLLAPSE.
underground	U	216-U-50	216-U-50 TRENCH, 216-U-55 CRIB	1967	U-SS,S	ND	NS	NS	P-P					X		LABORATORY WASTES.
ditch	U	216-U-14	216-U-14 Crib	1957	U-SS	ND	ND	NS	ND					X		CONTACT CONDENSER COOLING WATER; SOIL BACKFILLED.
ditch	U	216-U-2-1	216-U-2, U DITCH	1963	U-SS,S	P	ND	NS	P-P		X					WASTES HANDLED INCLUDED CONTAM SOILS. WAS CONTAMINATED BY A COIL FILLED. IN 221-U BLDG. DITCH COVERED W/ CLEAN FILL & PLASTIC HAD BUT BARRIER. DITCH AREA SCANNED BEFORE COVERED. LINE LOOD FT IS COMMON WITH 216-U-2-2 DITCH CONTAMINATED, CONTAM
ditch	U	216-U-2-2	216-U-2-2, U SWAMP DITCH	1970	U-SS,S	P	ND	NS	P-P					X		DITCH WAS BACKFILLED WITH CLEAN SOIL, COVERED WITH 10 MILS. PLASTIC SHEETING, SOIL AND GRAVEL. MINOR CONTAMINATION INCIDENT IN 1970.
ditch and pond	U	216-U-3-1	216-U-2, U SWAMP DITCH	1969	U-SS,S	P	ND	NS	P-P					X		DITCH WAS BACKFILLED AND COVERED W/ PLAS-TIC BOW BARRIER, SAND & GRAVEL. DITCH FEEDS SWAMP.
diversion box	UR	241-U-151	241-U-151 diversion box	1984	U-SS,S		NS	NS	P-P	V				X		LEAKAGE RESULTED IN SOME SOIL BEING REMOVED AND ADDITION OF NEW SOIL COVER. VERIFY IF ANY CONTAMINATION REMAINS.
diversion box	21R	241-C-252	241-C-252 diversion box	1985	I-SS	P	NS	NS	ND	V		X				
diversion box	21R	241-C-154	241-C-154 diversion box	1985	I-SS	P	NS	NS	ND	V		X				
diversion box	21R	241-UR-152	241-UR-152 diversion box	1985	I-SS	P	NS	NS	ND	V		X				
diversion box	21R	241-UR-152	241-UR-152 diversion box	1984	I-SS	P	NS	NS	ND	V		X				
diversion box	21R	241-UR-152	241-UR-152 diversion box	1985	I-SS	P	NS	NS	ND	V		X				
diversion box	21R	241-UR-153	241-UR-153 diversion box	1985	I-SS	P	NS	NS	ND	V		X				
diversion box	21R	241-UVR-153	241-UVR-153 diversion box	1984	I-SS	P	NS	NS	ND	V		X				
diversion box	21R	241-UVR-151	241-UVR-151 diversion box	1984	I-SS	P	NS	NS	ND	V		X				
diversion box	21R	241-U-252	241-U-252 diversion box	1984	I-SS	P	NS	NS	ND	V		X				
diversion box	21R	241-UR-151	241-UR-151 diversion box	ND	I-SS	P	NS	NS	ND	V		X				
diversion box	21R	241-C-151	241-C-151 diversion box	1985	U-SS,S	P	NS	NS	U-P	P		X				IN 1985 A SPILL RESULTED IN THIS UNIT BEING FLUSHED AND SPRAYED W/ FIRED FABRI-CATION TO PHYSICALLY FIX CONTAMINATION. VERIFY THAT NO FURTHER RELEASE HAS OR WILL OCCUR.
diversion box	21R	241-U-152	241-U-152 diversion box	1984	I-SS	P	NS	NS	ND	V		X				
diversion box	UR	241-U-152	241-U-152 diversion box	1984	U-SS,S	P	NS	NS	P-P	V				X		LEAKAGE RESULTED IN SOME SOIL BEING REMOVED AND ADDITION OF NEW SOIL COVER. VERIFY IF ANY CONTAMINATION REMAINS.
diversion box	UR	241-UVR-153	241-UVR-153 diversion box	1984	I-SS	P	NS	NS	ND	V		X				
diversion box	UR	241-U-154	241-U-154 diversion box	1984	U-SS,S	P	NS	NS	P-P	V				X		LEAKAGE RESULTED IN SOME SOIL BEING REMOVED AND ADDITION OF NEW SOIL COVER. VERIFY IF ANY

Key: A = unit id number not assigned but identified by unit number; D- documented; P= suspected; ND- no data; NS= not suspected; SS subsurface soil; S= surface soil; P= past air release; C= current air release; F= future air release; N= yes; Blank- no

TABLE 3-22 200 E RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

200 East Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	NEED FOR ACTION: Remediation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
																CONTAMINATION REMOVED.
diversion box	21A	241-C-152	241-C-152 diversion box	1980	D-SS	?	NS	NS	? P	Y	X					CONTAMINATION REPORTED BUT NO REMEDIATION NOTED.
diversion box	21A	241-BX-155	241-BX-155 diversion box	1984	?-SS	?	NS	NS	NO	Y		X				
diversion box	21A	241-C-153	241-C-153 diversion box	1985	?-SS	?	NS	NS	NO	Y		X				
diversion box	21A	241-BX-153	241-BX-153 diversion box	1981	?-SS	?	NS	NS	NO	Y		X				
diversion box	21A	241-BXR-152	241-BXR-152 diversion box	1984	?-SS	?	NS	NS	NO	Y		X				
diversion box	21A	241-BXR-152	241-BXR-152 diversion box	1984	?-SS	?	NS	NS	NO	Y		X				
diversion box	21A	241-BX-154	241-BX-154 diversion box	1985	?-SS	?	NS	NS	NO	Y		X				
diversion box	21A	241-B-153	241-B-153 diversion box	NO	D-SS,S	?	NS	NS	? P	Y	X					CONTAMINATION REPORTED BUT NO REMEDIATION NOTED
diversion box	21A	241-BXR-154	241-BXR-154 diversion box	1984	?-SS	?	NS	NS	NO	Y		X				
diversion box	21A	241-A-153	241-A-153 diversion box (?)	1985	?-SS	?	NS	NS	NO	Y		X				
diverter station	21A	241-BY-152	241-BY-152 diverter station	NO	?-SS	?	NS	NS	NO	Y		X				
diverter station	21A	241-BZ-151	241-BZ-151 diverter station	NO	?-SS	?	NS	NS	NO	Y		X				
drain field	3A		sanitary waste drain field	1963	D-SS	NO	NS	NO	NS				X			LABORATORY REMAINS USED IN FACILITY LOCATED BY THIS UNIT. VERIFY THAT UNIT REFLECTS NO HAZARDOUS CONSTITUENTS.
evaporator	11A	241-B-B	241-B Evaporator	1980	NO	NO	NS	NS	?-P,C	Y	X					NO DECONTAMINATION OF UNIT NOTED.
french drain	1C	216-H-26	216-H-26 French Drain	1965	D-SS	NS	NS	NS	NS		X					DRAIN ENCLOSURE REMOVED IN 1965.
french drain	4C	216-H-16	216-H-16 Dry Well	1969	D-SS	NO	NS	NS	NS					X		
french drain	4C	216-H-17	216-H-17 Dry Well	1969	D-SS	NS	NS	NS	NS					X		
french drain	4C	216-H-35	216-H-35 Dry Well	1966	D-SS	NS	NS	NS	NS					X		
french drain	4C	216-H-33	216-H-33 Dry Well	1969	SS	NO	NO	NS	NS					X		
French Drain	4C	216-C-8	271-CR crib, 216-C-8 crib	1965	D-SS	NS	NS	NS	NS					X		
french drain	4C	216-H-12	216-H-12 French Drain	1972	D-SS	NO	NS	NS	NS					X		
french drain	4C	216-H-2A	216-H-2A French Drain	1969	D-SS	NS	NS	NS	NS					X		
french drain	4C	216-H-14	216-H-14 French Drain	1972	D-SS	NS	NS	NS	NS					X		
french drain	4C	216-H-2B	216-H-2B French Drain	1969	D-SS	NS	NS	NS	NS					X		
french drain	4C	216-H-11	216-H-11 French Drain	1972	D-SS	NO	NS	NS	NS					X		
french drain	4C	216-H-15	216-H-15 French Drain	1972	D-SS	NO	NO	NS	NS					X		
french drain	4C	216-H-13	216-H-13 French Drain	1962	D-SS	NS	NS	NS	NS					X		
french drain	4C	216-H-13	216-H-13	1976	D-SS	NO	NS	NS	NS					X		FILLED WITH CRUSHED LIMESTONE.
leaching pit	4A	216-C-3	216-C-3, 201-C Leaching Pit	1954	D-SS	NO	NS	NS	NS					X		
pit	3C		200 Area Construction Waste	1955	NS	NS	NS	NS	NS				X			GRAVEL PIT USED FOR CONSTRUCTION DEBRIS DISPOSAL.
pit	1C	UPF-200-E-85/124	UPF-200-E-85/124, R-13 Pit	1972	D-SS,S	NO	NS	NS	NO		X					RAD. CONTAMINATION NOTED BUT NO INDICATION THAT REMEDIATION WAS COMPLETED. NO CHEMICAL DATA.
receiving vault	21	244-CR	244-CR receiving vault	NO	NO	NO	NS	NS	NS	?		X				
receiving vault	21	244-BXR	244-BXR receiving vault	1985	NO	NO	NS	NS	NS	?		X				
reverse well	4C	216-B-11 n/a	216-B-11 CRIB, 241-B-1 CRIB	1954	D-SS	?	NO	NS	NS					X		
reverse well	4A/A	216-B-4	216-B-4	1949	D-SS	NS	NS	NS	NS					X		
spill site	1A	UN-216-E-69	UN-216-E-69 Railroad Car Flush	1949	D-S,SS	NO	NO	NS	?-P		X					DETERMINE CONSTITUENTS OF CONCERN & REMEDIATE
spill site	1C	UN-216-E-72	UN-216-E-72 (UNCOVERED WASTE)	1985	D-SS,S	NO	NO	NO	?-P		X					CONTAMINATION SOURCE WAS STABILIZED WITH FIBCO FOAM-FILM IN PLACE. DETERMINE IF ADDITIONAL ACTION IS REQUIRED & WHAT WASTES ARE.
spill site	21	UPF-200-E-99/103	UPF-200-E-99/103/123 BKS LINE	1972	D-SS,S	NO	NS	NS	?-P,C		X					CRIB LINE LEAKAGE RESULTED IN 8 CUBS IN. NO REMEDIATION OF CONTAMINATED AREA I. NOTED.
tank	11A	241-BX-302-B	catch tank 241-BX-302-B	1985	NO	NO	NS	NS	NS	Y	X					

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X = yes

Blank = no

TABLE 3-22 200 E RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

Inactive Release Potential and Need for Action Matrix

Unit Type	Site Code	Original Number	Site Name/ Description	Date Last Used	Potential Pollution: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	Remediation	Verify No Release	Need for Action: Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
tank	IIA	241-B 302 B	catch tank 241 B 302 B	NU	NU	NO	NS	NS	NS	Y	X					
tank	IIA	241 BX 302 A	catch tank 241 BX 302 A	1985	NU	NO	NS	NS	NS	Y	X					
tank	IIA	241 BZ 151	catch tank 241 BZ 151	NU	NU	NO	NS	NS	NS	Y	X					
tank	IIA	241 B 301 B	catch tank 241 B-301-B	1984	NU	NO	NS	NS	NS	Y	X					
tank	IIA	244 CRA	catch tank 244-CR	NU	NU	NO	NS	NS	NS	Y	X					
tank	III	270 CA	270-E Condensate neutral.	1976	NU	NS	NS	NS	NU	Y	X					THAK CONTAINS 5,000 GAL. OF CONTAMINATED SOAPS.
tank	II	241 CX 72	241-CX-72 tank	1976	NU	NO	NS	NS	NS	Y	X					UNIT WAS DECOMMISSIONED IN SITU IN 1986. VERIFY THAT NO RESIDUAL CONTAMINATION REMAINS. ASSUME THAK CONTAINED LIQUID NOT SOLID WASTE.
tank	IIA	244 BXR	catch tank 244 BXR	NU	NU	NO	NS	NS	NS	Y	X					
tank	IIA	241 B 301 C	catch tank 241 B-301-C	NU	NU	NO	NS	NS	NS	Y	X					
tank	II	241-B 361	241-B 361 settling tank	1976	NU	NO	NS	NS	NS	Y	X					THAK CONTAINS AN ESTIMATED 32,000 GAL. OF SLUDGE. CONCRETE CONSTRUCTION. WASTE SHOULD BE REMOVED.
tank	IIA	241-BX-302 C	catch tank 241 BX 302-C	1985	NU	NO	NS	NS	NS	Y	X					
tank	II	241-CX-70	241-CX-70 tank	1976	NU	NO	NS	NS	NS	Y	X					STAINLESS STEEL TANK CONTAINS 4.75 FT. OF SLUDGE. INCLUDED IN THE STRONTIUM SEMIWORKS DECOMMISSIONING PROJECT. WASTE SHOULD BE REMOVED.
tank	IIA	241-B 302 B	catch tank 241-B-302 B	1985	NU	NO	NS	NS	NS	Y	X					
tanks	IIA	241 BXA	241-BX tank farm	1977	D-SS,S	P	NO	NS	NS	Y	X					INCLUDES UPR-200-E-115,119. AT LEAST ONE TANK IS LEAKED.
tanks	IIA	241 BYA	241-BY tank farm	1977	D-SS,S	P	NO	NS	NS	Y	X					AN UNDETERMINED NUMBER OF SALT WELLS HAVE BEEN INSTALLED TO REMOVE SPILLED LIQUIDS. INCLUDES UPR-200-E-110,134,135. TANKS HAVE LEAKED.
tanks	IIA	241-BA	241-B tank farm	1977	D-SS,S	P	NO	NS	NS	Y	X					INCLUDES UPR-200-E-125,126,46,47. TANKS LEAKED >1500 GALLONS.
tanks	IIA	241 BXA	241-BX tank farm	1980	D-SS,S	P	NO	NS	NS	Y	X					INCLUDES UPR-200-E-5,6,70,89,131,153. TANKS LEAKED 10,000 GALLONS.
tanks	IIA	241-BB	241-B tank farm	1977	D-SS,S	NO	NS	NS	NS	Y	X					AN UNDETERMINED NUMBER OF SALT WELLS HAVE BEEN INSTALLED TO REMOVE SPILLED LIQUIDS. ASPHALTING OF SURFACES IS ALSO REPORTED. INCLUDES UPR-200-E-127,130,148,149.
tanks	IIA	241-CA	241 C tank farm	1979	D-SS,S	NO	NS	NS	NS	Y	X					CONSTRUCTION OF A SALT WELL AND SOIL REMOVAL ARE REPORTED. INCLUDES UPR-200-E-16,50,41,136,137 AND UN-216-E-91. TANKS LEAKED >20,000 GAL.
tank	IIA	224-BB	224-B CONC. FACILITY	1976	NU	NO	NO	NS	NU	Y	X					INACTIVE PRODUCT TREATMENT UNIT.
tanks	III	205-A	205-A SILICA GEL FACILITY	1976	NU	NO	NO	NS	NU	Y	X					INACTIVE NON. MATERIALS PROCESSING UNIT.
trench	A	216-A 10	216-A 10 Excavation	1956	D-SS	NO	NS	NS	P-P					X		TRENCH PARTIALLY BACKFILLED.
trench	A	216-B-30	216-BX-9 Trench	1959	D-SS	P	NO	NS	P-P					X		TRENCH BACKFILLED.
trench	A	216-B 28	216-BC-14 TRENCH	1957	D-SS,S	P	NO	NS	P-P					X		TRENCH BACKFILLED AND BLACKTOPPED. CONTAMINATION NEAR SURFACE. BLACKTOP CRACKED. HERBICIDES APPLIED
trench	A	216-B 53B	216-B-53 TRENCH	1963	D-SS,S	NO	NO	NS	P-P					X		TRENCH BACKFILLED INCLUDING SAND W/ GRAVEL COVER. HERBICIDE APPLIED.
trench	A	216-B 31	216-BC-18 TRENCH	1957	D-SS	P	NO	NS	P-P					X		TRENCH BACKFILLED WITH SAND AND GRAVEL. HERBICIDE APPLIED.
trench	A	216-B 33	216-BC 20 TRENCH	1957	D-SS	P	NO	NS	P-P					X		TRENCH BACKFILLED WITH SAND AND GRAVEL. HERBICIDE APPLIED.
trench	A	216-B 27	216 BC-9	1956	D-SS	P	NO	NS	P-P					X		TRENCH BACKFILLED W/ GRAVEL. HERBICIDES APPLIED.
trench	A	216-B 19	216-A 19 trench/Sump/test hole	1956	D-SS	P	NO	NS	P-P					X		TRENCH BACKFILLED.
trench	A	216 B 46	241-BX-B Grave,216-BX-B trench	1955	D-SS	NO	NS	NS	P-P					X		TRENCH BACKFILLED.
trench	A	216-B-54	216-B-54 Trench	1965	D-SS	NO	NS	NS	P-P					X		TRENCH BACKFILLED INCLUDING SAND W/ GRAVEL COVER. HERBICIDE APPLIED.
trench	A	216-B 56	216-B-56 trench	1956	D-SS	P	NO	NS	P-P					X		TRENCH BACKFILLED INCLUDING SAND W/ GRAVEL COVER. HERBICIDE APPLIED.

KEY:

A = Original number not assigned but identified by unit number

D: documented
P: suspected

NU: no data
NS: not suspected

SS: subsurface soil
S: surface soil

P= past air release
C= current air release

F= future air release
X= yes

Blank= no

TABLE 3-22 200 E RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

200 East Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radio-active Structures	NEED FOR ACTION: Remedi-ation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
trench	«	216-0-34	216-UC-01 Trench	1957	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED INCLUDING SAND W/ GRAVEL COVER. HERBICIDE APPLIED.
trench	«	216-0-20	216-UC-7 Trench	1957	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED W/ GRAVEL. HERBICIDE APPLIED.
trench	«	216-0-27	216-UC-14 TRENCH	1957	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED WITH SAND & GRAVEL COVER. HERBICIDES APPLIED.
trench	«	216-0-530	216-0-UNS Trench	1946	D-SS	NO	NS	NS	?-P					X		TRENCH BACKFILLED WITH SAND & GRAVEL COVER. HERBICIDES APPLIED. CONTAIN PIPING FROM TRENCHES BURIED BETWEEN 216-0-29 AND 216-0-530.
trench	«	216-0-35	216-UA-1 Trench	1954	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED.
trench	«	216-0-23	216-UC-10 TRENCH	1956	D-SS	NO	NS	NS	?-P					X		TRENCH BACKFILLED WITH SAND & GRAVEL COVER. HERBICIDES APPLIED.
trench	«	216-0-37	216-UA-8 Trench	1954	D-SS	NO	NS	NS	?-P					X		TRENCH BACKFILLED.
Trench	«	216-0-41	241-UA-7 Grave,216-UA-7 Trench	1954	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED.
trench	«	216-0-30	216-UC-17 TRENCH	1957	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED WITH SAND & GRAVEL COVER. HERBICIDES APPLIED.
trench	«	216-0-24	216-UC-11	1956	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED WITH SAND & GRAVEL COVER. HERBICIDES APPLIED.
trench	«	216-0-20	216-0-20 Grave/Sump/Test hole	1956	D-SS	NO	NS	NS	?-P					X		TRENCH BACKFILLED.
trench	«	216-0-25	216-UC-12, 216-0-24	1956	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED WITH SAND AND GRAVEL COVER. HERBICIDE APPLIED. CONTAMINATED PIPING FROM TRENCHES BURIED BETWEEN 216-0-29 & 216-0-530.
trench	«	216-0-29	216-UC-16 Trench	1957	D-SS	?	NO	NS	?-P					X		SAME
trench	«	216-0-26	216-UC-13 TRENCH	1957	D-SS	?	NO	NS	?-P					X		SAME
trench	«	216-0-32	216-UC-19	1957	D-SS	?	NO	NS	?-P					X		SAME
Trench	«	216-0-40	241-UA-6 Grave/Trench	1954	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED.
trench	«	216-E-28	Reg. Equipment Storage	NO	D-SS	?	NS	NS	?-P					X		TRENCH BACKFILLED BUT HAS SINK HOLES.
Trench	«	216-0-39	241-UA-5 GRAVE,216-UA-5 TRENCH	1954	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED.
trench	«	216-0-21	216-UC-6 Trench	1956	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED WITH GRAVEL. HERBICIDES APPLIED.
trench	«	216-0-36	216-UA-2 Trench/Grave	1954	D-SS	?	NO	NS	?-P					X		TRENCH BACKFILLED.
vault	«	241-CX-72	241-CX-72 Vault & Tank	1976	ND	NO	NS	NS	NS	Y				X		DECOMMISSIONED IN 1976.
waste line	4J	WPR-200-E-66/1	8-3 waste line	ND	D-SS,S	NO	NO	NS	?-P					X		MOST OF THE CONTAMINATED SOIL REMOVED.
waste line	4J	070-200-E-7	Waste Line	2004	D-SS,S	NO	NO	NS	?-P					X		AREA COVERED AND POSTED AS CONTAMINATION ZONE.

REV: « = official number not assigned but identified by unit number

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F= future air release
N= yes

Blank= no

TABLE 3-23 200 W RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

[illegible] 200 W RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

Site Type	Site Code	Historical Number	Date Last Used	Site Item Description	Release Potential: Soil	Release Potential: Ground Water	Release Potential: Surface Water	Release Potential: Subsurface Gas	Release Potential: Air	Residual Radioactive Structures	Remediation	Need for Action: Verify No Release	Need for Action: Verify No Hazardous Constituents	Need for Action: Verify No Residual Contamination	Need for Action: No Further Action Required	Comments
[illegible]	[illegible]	[illegible]	76	[illegible]	SS	?				?			X			SITE IS BELOW GROUND WITH [illegible], [illegible] SOIL [illegible] MIGRATION.
[illegible]	[illegible]	[illegible]	76	[illegible]	SS	?				?			X			SAME AS ABOVE
[illegible]	[illegible]	[illegible]	76	[illegible] Control Structure	SS	?				Y	X					SOIL IS CONTAMINATED
Burial Ground	[illegible]	[illegible]	54	Industrial Burial Ground No. [illegible]	SS,S	ND	ND	ND	ND	Y				X		
Burial Ground	[illegible]	[illegible]	60	Solid Waste Burial and Repl	SS,S	MS	MS	MS	P		X					PROPERTY HAS BEEN WITHDRAWN FROM DOEGN. [illegible] PART OF GROUP ASSOCIATED WITH 216 W 10.
Burial Ground	[illegible]		50	Non Rad Burial Ground	?	MS	MS	MS	MS				X		X	SAME AS THE POSSESSES [illegible]
Burial Ground	[illegible]	[illegible]	54	216 W 9	SS	MS	MS	MS	MS			X				NATURE OF WASTE NOT KNOWN. SITE HAS BEEN STABILIZED. HOWEVER, [illegible] NOT KNOWN.
Burial Ground	[illegible]	[illegible]	85	216 W 02H Burial Ground	SS	MS	MS	MS	MS			X				SUSPECT OF [illegible] AND [illegible] MIGRATION, IF SITE NOT [illegible] CORRECTLY. INCLUDES CONTAMINATED SOIL FROM 216-[illegible] POND.
Burial Ground	[illegible]	[illegible]	63	216 W 4H, HRR 200 W 22	SS,S	MS			P,[illegible]		X					PART OF SITE COVERED WITH 10 M EFFECTIVE COVER WITH 10 INCHES GRAVEL AND SAND. STRUCTURES FOUND AND FILLED IN. WASTE WITHIN 10 INCHES OF SURFACE (MAY BE EXCEPTED).
Burial Ground	[illegible]	[illegible]	52	216 W 1	SS	[illegible]					X					WASTES WITHIN 10 INCHES OF SURFACE; CONTAMINATED WEEDS. ASSOCIATED WITH 216 W 4H.
Burial Ground	[illegible]	216 W 1H	54	Industrial Waste Burial Ground	SS	[illegible]						X				BOXES HOLDING WASTES IN GROUND HAVE COLLAPSED. METHOD OF STABILIZATION NOT SPECIFIED.
Burial Ground	[illegible]	[illegible]	56	216 W [illegible]	SS	[illegible]					X					WASTES WITHIN 10 INCHES OF SURFACE. ASSOCIATED WITH 216 W 4H.
Burial Ground	[illegible]	[illegible]	61	216 W 3	SS	[illegible]					X					WASTES SUSPECTED TO BE WITHIN 10 INCHES OF SURFACE. ASSOC WITH 216 W 4H.
[illegible]	[illegible]	HRR 200 W [illegible]	60	HRR 200 W [illegible]	SS	?						X				NO ACTION DONE
Crib	[illegible]	216 [illegible] 10	51	216 [illegible] 17 Crib	D,SS	?	MS	MS	MS	?				X		
Crib	[illegible]	216 [illegible] 6	45	216 W 4 Crib, 216 W 4,	D,SS	?				?	X					SITE HAS BEEN REFERRED FOR [illegible] CONSIDERATION. BUT CRIB STRUCTURE BELIEVED READY TO COLLAPSE. CONTAMINATION MAY REACH GROUND WATER BY HRR [illegible]. SINCE RELEASE TO SOIL IS FICTION, THERE IS NEED FOR VERIFYING THAT THERE IS NO RESIDUAL CONTAM., AND IF THERE IS, REMEDIATION IS NEEDED.
Crib	[illegible]	216 [illegible] 29	69	216 [illegible] 29	SS	?				?				X		SAME AS ABOVE
Crib	[illegible]	216 [illegible] 21	72	216 S 23 Crib	SS	?				?				X		SAME AS ABOVE
Crib	[illegible]	216 [illegible] 12	73	216 Z 12	SS	?				?				X		SO FORT SAMPLE SHOWED [illegible] REPORT.
Crib	[illegible]	216 [illegible] 36	63	216 [illegible] 36	SS	?				?				X		
Crib	[illegible]	216 Z 3	51	216 Z 3 Cutward, 219 S 83 and	SS	?				?				X		
Crib	[illegible]	216 [illegible] 35	67	216 [illegible] 35	SS	?				?				X		
Crib	[illegible]	216 [illegible] 27	65	216 [illegible] 27	SS	?				?	X					CONTAMINATION OF [illegible]; SURFACE CONTAMINATION REMOVED.
Crib	[illegible]	216 [illegible] 34	67	216 [illegible] 34	SS	?				?				X		SAME AS ABOVE; UNLOADING STATION MONITORED SHOWS CONTAMINATION.
Crib	[illegible]	216 [illegible] 32	67	216 [illegible] 32	SS	?				?	X					CONTAMINATION FROM 35 TO [illegible] FEET; CRIB STRUCTURE BELIEVED READY TO COLLAPSE.
Crib	[illegible]	216 [illegible] 33	63	216 [illegible] 33	SS					?	X					WASTE MAY HAVE BURIED IN CRIB OR CRIB LINE
Crib	[illegible]	216 [illegible] 13	72	216 S 13 Crib	SS	?				?	X					CRIB STRUCTURE BELIEVED READY TO COLLAPSE.
Crib	[illegible]	216 [illegible] 32		216 [illegible] 32	SS	?				?				X		
Crib	[illegible]	216 Z 10	77	Crib: 216 Z 10	SS	?				?				X		
Crib	[illegible]	216 W 10	67	216 W 10 Crib	SS,S	?				?	X					SINCE THE WASTE IS NEW AND [illegible]

Key:

* = [illegible] but identified by [illegible]

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Blank = no

TABLE 3-23 200 W RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

200 WEST AREA RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

Unit Type	Site Code	Official Number	Date Last Used	Site Name/ Description	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radio-active Structures	NEED FOR ACTION: Remedi-ation	Verify No Release	Verify No Hazardous Conditions	Verify No Residual Contamination	No Further Action Required	Comments
crib	4GN	216-T-6	81	216-T-6 crib	SS	?				?				X		EVAPOTRANSPIRATION MAY BE SUSPECTED AS AIR RELEASE SEE COMMENTS ON SITE 216-2-6 (EXCEPT CRIB STRUCTURE).
crib	1GN	216-T-26	86	216-T-26	SS	?				?	X					CONTAMINATION DETECTED TO 120 FT. LATERAL WASTE SPREAD BELIEVED TO HAVE OCCURRED.
crib	1GN	216-Z-5	47	216-Z-5, 231-W-1-2 cribs	SS,S	?				?	X					STRUCTURE BELIEVED READY TO COLLAPSE. WASTE MAY REMAIN WITHIN CRIB DUE TO PLUGGING BY SLUDGE.
crib	4GN	216-S-22	67	216-S-22 crib	SS	?				?				X		
Cribs - 3	1GN	216-U-8	68	216-UR-1, 2, 3 Cribs, 216-U-9;	SS	?				?	X					STRUCTURE BELIEVED READY TO COLLAPSE. PAST SINK HOLE PROBLEM. PART OF GROUP ASSOCIATED WITH 216-Z-6.
Cribs -5	1GN	216-Z-10	79	cribs - 5 parallel	SS	?				?	X					SAME AS ABOVE. 73% CARBON TET.
ditch	4FN	216-T-4-2 (D)	72	216-T-4-2 (D)	SS	?	NS	?	P					X		POSSIBLE LOCAL AREA CONTAMINATION. ALSO, VEGETATION UPTAKE COULD BE ANOTHER RELEASE POTENTIAL.
Ditch	1FN	216-Z-17	60	216-Z-17 Ditch or Trench	SS	?	NS							X		SAME AS ABOVE, PART OF GROUP ASSOC WITH 216-Z-6.
ditch	4FN	UPR-200-W-139	53	UPR-200-W-139	D,S,SS	?			P		X					
ditch	1FN	216-Z-19	81	216-Z-19 ditch	SS,S	?		NS	P,C		X					
Ditch	1FN	216-U-9	94	216-U-6 U-Sump 5	SS,S	?		NS	P		X					CONSIDER AGE OF UNIT. SAME AS ABOVE, PART OF GROUP ASSOC WITH 216-Z-19.
Ditch	1FN	216-Z-11	71	216-Z-1 ditch, Z plant ditch	SS	?					X					SAME AS ABOVE, PART OF GROUP ASSOC WITH 216-Z-19.
Ditch	1FN	216-Z-1 (D)	99	Drain Ditch to U-Sump, Z	SS	?					X					SAME AS ABOVE, PART OF GROUP ASSOC WITH 216-Z-19.
ditch	1FN	216-T-4-1 (D)	72	216-T-4-1 (D)	SS	?					X					RESIDUAL CONTAMINATION POSES PLANT UPTAKE PROBLEM.
diversion box	1IN	241-TX-153	82	241-TX-153 incl. UPR	F-SS,S	?	NS		P	V	X					
diversion box	2IN	241-UR-152	83	241-UR-152 (waste transfer)	F SS	?				V		X				DIVERSION BOXES ARE ASSUMED TO BE OF CONCRETE BOX STRUCTURES WITH INLET AND OUTLET PIPING, BURIED IN THE GROUND. LEAKS CAN OCCUR FROM THE PIPING, AND THE BOX STRUCTURE. MAIN CONCERN IS LEAKAGE FROM THE UNIT TO SUBSURFACE SOIL, EVENTUALLY TO GROUNDWATER. SINCE THEY ARE WEATHER COVERED VEGETATION UPTAKE MAY NOT BE A POTENTIAL RELEASE PATH. REC: VERIFY NO RELEASE FOR ALL OF THEM EXCEPT THOSE THAT ARE CONFIRMED LEAKER. THESE WILL EITHER REQUIRE REMEDIATION OR CONFIRMATION FOR NO RESID. CONTAMINATION. (COMMENT 1)
diversion box	2IN	241-UR-154	82	241-UR-154 (waste transfer)	F SS	?				V		X				SEE COMMENT (1)
diversion box	2IN	241-U-153	81	241-U-153 (waste transfer)	F SS	?				V		X				SEE COMMENT (1)
diversion box	2IN	241-U-252	83	241-U-252 (waste transfer)	F SS	?				V		X				SEE COMMENT (1)
diversion box	1IN	241-SX-151	83	241-SX-152 (waste transfer)	D,SS	?	NS	NS	NS	V	X					UPR-200-W-80,81,114. CONTAMINATION STILL REMAIN. NEED REMEDIAL ACTION
diversion box	2IN	241-UR-153	83	241-UR-153 (waste transfer)	F SS	?	NS			V		X				SEE COMMENT (1)
diversion box	1IN	241-SX-152	81	241-SX-151 (waste transfer)	D,SS	?	NS	NS	NS	V	X					UPR-200-W-80,81,114. SEE COMMENTS ON 241-SX-151
diversion box	1IN	241-T-152	83	241-T-152 (waste transfer)	D,SS	?				V	X					UPR-200-W-7. SEE COMMENTS ON 241-SX-151
diversion box	2IN	241-TY-153	83	241-TY-153 (waste transfer)	F SS	?				V		X				SEE COMMENT (1)
diversion box	1IN	240-S-151	87	240-S-151 (waste transfer)	D,SS,S	?				V	X					UPR-200-W-20,51,88. SEE COMMENTS ON 241-SX-151
diversion box	2IN	241-TXR-155	00	241-TXR-155 (waste transfer)	F SS	?				V		X				SEE COMMENT (1)
diversion box	1IN	241-T-151	00	241-T-151 (waste transfer)	D,SS	?				V	X					UPR-200-W-7. SEE COMMENTS ON 241-SX-151
diversion box	2IN	241-TXR-151	00	241-TXR-151 (waste transfer)	F SS	?				V		X				SEE COMMENT (1)
diversion box	1IN	241-TX-152	82	241-TX-152 (waste transfer)	F SS	?				V	X					SEE COMMENT (1), PART OF GROUP ASSOC W/ 241-T-152.
diversion box	2IN	241-TXR-244	81	241-TXR-244 (waste transfer)	F SS	?				V		X				SEE COMMENT (1)

KEY:
# = official number not assigned but identified by unit number
D= documented
?= suspected
ND= no data
NS= not suspected
SS= subsurface soil
S= surface soil
P= past air release
C= current air release
F= future air release
X= yes
Blank= no

TABLE 3-23 200 W RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

200 W-1 WASTE RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

Unit Type	Site Code	Official Number	Date Last Used	Site Name/ Description	WASTE POTENTIAL Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	NEED FOR ACTION Remediation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
diversion box	11A	241-S-152	80	241-S-152 (waste transfer)	D,SS	P				V	X					UPR-200-W-80,81. SEE COMMENTS ON 241-SX-151
diversion box	21A	241-TXR-152	80	241-TXR-152 (waste transfer)	P SS	P				V		X				SEE COMMENT (1)
diversion box	21A	241-TY-151	81	241-TY-151 (waste transfer)	P SS	P				V		X				SEE COMMENT (1)
diversion box	11A	241-TR-153	83	241-TR-153 (waste transfer)	P SS	P				V	X					SEE COMMENT (1), PART OF GROUP ISSUE W/ 241-T-152.
diversion box	11A	241-S-152	80	241-S-152 (waste transfer)	D,SS	P				V	X					UPR-200-W-82. SEE COMMENTS ON 241-SX-151
diversion box	21A	241-TXR-153	80	241-TXR-153 (waste transfer)	P SS	P				V		X				SEE COMMENT (1)
dry well	3U	241-SX-402	76	dry well at 241-SX-402	SS	P							X			DRY WELL INSIDE BUILDING. WASTE MIGHT NOT MIGRATE
dry well	3U	241-SX-401	76	dry well at 241-SX-401	SS	P							X			SAME AS ABOVE
filter monitor	4U	2718-S	76	2718-S sand filter monitor	ND	ND			ND					X		UNIT CONTAIN CONTAMINATED SOLID WASTE. NEED MORE INFO TO DECIDE REMEDIAL ACTION
french drain	4UA	216-U-7	57	216-U-7	SS	P								X		
french drain	4U	216-T-31	59	216-T-31	SS,S	P								X		WASTE REMOVED. NEED TO CONFIRM NO RES. GND.
french drain	20A	216-Z-8	62	216-Z-8 (rab, 234-5 Hexoplex	SS	P						X				CONTAMINATED SOIL/GRAVEL REMOVED.
ground contam.	1U	UPR: 200 W 135	54	UPR 200-W-135	D,S,SS	P			P,C,F		X					SITE WAS CONTAMINATED. NO INFO ON PRESENT COND. ASSUME SITE STILL CONTAMINATED. REMEDIATION NEEDED
ground spill	5U	UPR: 200 W 117	50	UPR 200-W-117	D,S,SS	NS			P						X	GND. DECAYED TO BACKGROUND LEVEL. LIQUID AND PARTICULATE MATTER DROPPED FROM RAILROAD CARS.
ground spill	1U	UPR:-200 W-69	73	UPR 200-W-69	D,S,SS	P			P,C,F		X					SEE COMMENT ON UPR-200-W 135
incinerator	2A	232-Z		232-Z waste incineration	P S	NS			P	V		X				VERIFY NO RELEASE FROM BUILDING. CONTAMINATION OF SOIL AND DISPERSE THROUGH AIR MAY BE POSSIBLE.
pit	4UA	216-U-15	57	216 U-15, 300 U dumping	SS	P								X		SITE WAS BEEN REFILLED FOR A LONG TIME. BACKFILLED IMMEDIATELY AFTER USE. LATER CORINGS SHOWED NO RADIATION CONTAMINATION. NEED TO VERIFY THE NO RESIDUAL CONTAMINATION TO DETERMINE WHETHER OR NOT REMEDIATION IS NEEDED.
pit	4UA		ND	200 West burning pit	P S	ND	ND	ND	P					X		NO INFO AVAIL. FOR THIS UNIT
pit	4UA	216-T-20	52	disposal trench/pit	SS		NS	NS	NS					X		
pit	4UA	UPR: 200 W 30	54	UPR-200-W-30 covered pit	SS	P								X		WASTE BURIED IN THE PIT IS SUSPECTED TO MIGRATE. HOWEVER, IT WAS SUCH A LONG TIME AGO THAT VERIFICATION FOR RESIDUAL CONTAMINATION IS NEEDED BEFORE MAKING DECISION FOR REMEDIATION.
pond	4UA	216-S-15	52	216 S-15	SS	P								X		POND WAS DEACTIVATED A LONG TIME AGO. BACKFILLED WITH SOIL. HOWEVER, NEED TO VERIFY THE EXTENT OF RESIDUAL CONTAMINATION TO DETERMINE WHETHER OR NOT REMEDIATION IS NEEDED.
pond	1UA	216-U-10	65	216 U 10 pond	D,S,SS	P			P		X					UPR-200-W-107. POND OVERFLOWED. NEED TO REMEDIATE SITE.
pond	4UA	216-S-11	65	216 S-11 pond	D,S,SS	P								X		SEE COMMENTS FOR 216-S-15 POND (ONLY ONE POND COVERED).
pond	4UA	216-T-4A	72	216 T 4A	P SS	P								X		SITE WAS BEEN CHANGED. NEED TO VERIFY THAT THERE IS NO RESIDUAL CONTAMINATION
pond	1U	216-S 19	84	216 S 19 pond	P SS	P					X					SITE IS NEAR DEACTIVATED. RELEASE IS EXPECTED TO REMAIN IN THE SOIL, AND PROBABLY MOVE TO GRD WATER
process tdk vent lines	1A	UPR: 200 W 102	72	UPR 200-W-102	D,S,SS	NS					X					SITE IS MARKED FOR UNKNOWN CONTAMINATION. 130 LOADS OF SOIL REMOVED.
sewer	1AA			REDOX chemical sewer at 203-S,	P SS						X					CHEMICAL SEWER SYSTEMS GENERALLY REQUIRE REMEDIATION.
surface impoundment	4UA	207-S	54	207-S retention basin (3)	P SS	NS				V				X		CONCRETE BASIN. NEED TO DETERMINE IF LEAKED OR SPILLED. RESIDUAL CONTAMINATION REMAINS. UNIT BACKFILLED.

KEY: A - official number not assigned but identified by unit number; D: documented; P: suspected; ND: no data; NS: not suspected; SS: subsurface soil; S: surface soil; P: past air release; C: current air release; F: future air release; N: yes; Blank: no

TABLE 3-23 200 W RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

[illegible]

Unit Type	Site Code	Unit Number	Date Last Used	Site Name/ Description	Potential Contents: Fuel	Terminal Waste	Waste Water	Underground Tank	Air	Residual Radioactive Structures	Remediation	Need for Action: Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
[illegible]	200	[illegible]	80	241-S tank farm	U,Z	[illegible]			P	Y	X					:UNDERGROUND TANK FARM, AND CATCH TANKS STILL :CONTAIN WASTE. THEY MAY NOT REPRESENT MORE :PRESENT, EVENTUALLY WASTE WILL LEAK FROM THE :CONTAINERS AND SEEP BY RELATED UNCHANGED RELEASE :EVENTS. RECOMMEND UNDERGROUND TANKS BE :REMEDIATED AND REMOVED AND RELEASE 6 TO AVOID :FUTURE PROBLEMS. STABILIZATION INVOLVED WASTE :CONSOLIDATION AND LIQUID REMOVAL IS NECESSARY. :(SEE COMMENT 2)
[illegible]	200	[illegible]	79	241-T tank farm	U,Z	[illegible]				Y	X					:UPR 200 W-148. SEE COMMENT (2). :LEAKED > 115,000 GAL.
[illegible]	200	[illegible]	76	241-SX-902 condenser shield	[illegible]					Y		X				:SEE COMMENT (2).
[illegible]	200	[illegible]	76	276-U solvent handling	[illegible]					Y		X				:SEE COMMENT (2)
[illegible]	200	[illegible]	69	underground tank 276-S-142	Z					Y		X				:TANKS TESTED IN 1978. NO LEAKS SEEN IN :VERIFIED AND CONTENTS REMOVED.
[illegible]	200	241-U-361	76	241-U 361 settling tank	[illegible]					Y		X				:CONCRETE TANK. WASTES REMAIN.
[illegible]	200	[illegible]	79	241-SX tank farm	U,SS,S	[illegible]			U,Z,Z	Y	X					:UPR 200 W-93,50,114. SEE COMMENT (2) :LEAKED > 100,000 GAL.
[illegible]	200	[illegible]	81	catch tank 241-TY-302-B at	[illegible]	[illegible]				Y	X					:SEE COMMENT (2)
[illegible]	200	[illegible]	82	catch tank 241-TX-302-B at	[illegible]	[illegible]				Y	X					:SEE COMMENT (2)
[illegible]	200	[illegible]	82	catch tank 241-TX-302-B at	[illegible]	[illegible]				Y	X					:SEE COMMENT (2)
[illegible]	200	[illegible]	80	catch tank 241-U-301 at	[illegible]	[illegible]				Y	X					:SEE COMMENT (2)
[illegible]	200	[illegible]	83	catch tank 241-U-301-B at tank	[illegible]	[illegible]				Y	X					:SEE COMMENT (2)
[illegible]	200	[illegible]	87	catch tank 241-S-302 at	[illegible]	[illegible]				Y	X					:SEE COMMENT (2)
[illegible]	200	241-TX	79	241-TX tank farm	U,SS,S	[illegible]			U,Z	Y	X					:UPR 200-W-93,100. SEE COMMENT (2) :LEAKED < 2,200 GAL.
[illegible]	200	[illegible]	69	underground tank 276-S-141	Z					Y		X				:TANKS TESTED IN 1978. NO LEAKS SEEN IN :VERIFIED AND CONTENTS REMOVED.
[illegible]	200	241-TY	73	241-TY tank farm	U,SS	[illegible]				Y	X					:UPR 200-W-150,151,152,153. SEE COMMENT (2) :LEAKED > 60,000 GAL. DEMONSTRATIONS EARLIER :MODED TO STABILIZE ONE TANK.
[illegible]	200	241-T-361	76	241-T-361 settling tank	[illegible]					Y		X				:CONCRETE TANK. WASTES REMAIN.
[illegible]	200	241-Z-361	76	241-Z 361 settling tank	[illegible]					Y		X				:CONCRETE TANK WITH STEEL LINER. WASTES :REMAIN.
[illegible]	200	[illegible]	83	catch tank 241-SX-302 at	[illegible]	[illegible]				Y	X					:SEE COMMENT (2)
[illegible]	200	241-SX-901	76	241-SX-901 condenser shield	[illegible]					Y		X				:SEE COMMENT (2)
[illegible]	200	241-TY-302-B	81	catch tank 241-TY-302-B at	[illegible]	[illegible]				Y	X					:SEE COMMENT (2)
[illegible]	200	241-U	80	241-U tank farm	U,SS	[illegible]				Y	X					:UPR-200-W-154,155,156,157. SEE COMMENT (2) :LEAKED > 94,000 GAL. DEMONSTRATIONS EARLIER :MODED TO STABILIZE ONE TANK.
[illegible]	200	[illegible]	85	242-T Evaporator Catch tank	Z				P	Y		X				:RESIDUAL WASTES, IF ANY, SHOULD BE :DISPOSED. EVENT RELATED TO UNIT 241-U.
[illegible]	200	276-S-8	76	tanks in 276-S Solvent facility	NU	NU			NU	*	X					:NO INFO ON THIS UNIT. REMEDIAL ACTION MAY BE :NEEDED FOR REMOVAL OF THE TANKS.
Tile field	200	[illegible]	69	234-5 tile field, 216-Z-7;	SS	[illegible]					X					:CONTAMINATION DETECTED TO 31 FEET.
Trench	200	UPR 200-W-110	71	UPR 200-W-110	U,SS	Z	NS	NS	NS			X				:BACKFILLED TRENCH CONTAINING CONTAMINATED SOIL. :VEGETATION UPTAKE COULD BE A POTENTIAL RISK
Trench	400	216-S-12	54	216-S-12	[illegible]	[illegible]								X		:FOR WASTE THAT WAS DISPOSED IN TRENCHES, MOST WERE :WERE OF LIQUID FORM. MOST OF THESE TRENCHES WERE :NOT REUSED A LONG TIME AGO. WASTE WAS :PROBABLY RETAINED IN THE SOIL AND :REACHED GROUNDWATER. INVESTIGATE, IF IS :RECOMMENDED TO VERIFY FOR RESIDUAL CONTAMINATION

KEY:

- * = [illegible] number not assigned but identified by unit name
- U = documented
- Z = suspected
- NU = no data
- NS = not suspected
- SS = subsurface soil
- S = surface soil
- P = past air release
- C = current air release
- F = future air release
- X = yes
- Blank = no

TABLE 3-23 200 W RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

200 WEST AREA RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

Unit Type	Site Code	Official Number	Date Last Used	Site Name/ Description	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radio-active Structures	NEED FOR ACTION: Remedi-ation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
																TO DETERMINE WHETHER OR NOT REMEDIATION IS REQUIRED. COMMENT 3D UNIT HAS BEEN BACKFILLED.
trench	<EX	216-S-8	92	216-S-8	D-SS	?	NS	NS	NS					X		SEE COMMENT (3D UNIT HAS BEEN BACKFILLED.
Trench	<E	216-T-11	94	Equipment Decontamination	P SS	?								X		WASTE HAS BEEN EXHUMED; RELEASED FROM RADIATION ZONE STATUS.
trench	<EX	216-S-14	92	216-S-14	P SS	?								X		SEE COMMENT (3)
trench	<EX	216-T-12	94	216-T-12	P SS	?								X		SEE COMMENT (3); BACKFILLED.
trench	<E	216-T-10	94	216-T-10	P SS	?								X		EXHUMED AND RELEASED FROM RADIATION ZONE STATUS.
trench	>EX	216-T-14	94	216-T-14	P SS	?					X					CONTAMINATION FOUND AT 30 FEET; HERBICIDES APPLIED TO SURFACE.
trench	<E	216-T-9	94	216-T-9	P SS	?								X		EXHUMED AND RELEASED FROM RADIATION ZONE STATUS.
trench	>EX	216-T-16	94	216-T-16	P SS	?					X					CONTAMINATION FOUND AT 30 FEET. BACKFILLED; HERBICIDES APPLIED TO SURFACE.
trench	>EX	216-T-22	94	241-TX-2 Trench, 216-TX-2 Grav	P SS	?					X					SEE COMMENT (3); BACKFILLED, ASSOC WITH 216-T-21.
trench	>EX	216-T-21	94	241-TX-1 trench, 216-TX-1 grav	P SS	?					X					SEE COMMENT (3); BACKFILLED; SURFACE TREATED WITH HERBICIDES. SELF-CONTAMINATION AT 35,55 AND 100 FEET.
trench	<EX	216-T-5	98	216-T-5	P SS	?								X		SEE COMMENT (3)
trench	>EX	216-T-25	94	216-T-25	P SS	?					X					SEE COMMENT (3); BACKFILLED; SURFACE TREATED WITH HERBICIDES. ASSOCIATED WITH 216-T-21.
Trench	>EX	216-T-24	84	241-TX-4 Trench, 216-TX-4 Grav	P SS	?					X					SEE COMMENT (3); BACKFILLED; SURFACE TREATED WITH HERBICIDES. ASSOCIATED WITH 216-T-21.
trench	2EX	UPR-200-W-111		UPR-200-W-111	P SS	?						X				SLUDGE FROM RETENTION BASIN 207-U WAS PLACED IN THIS TRENCH AND COVER WITH 4' OF CLEAN SOIL. VEGETATION UPTAKE COULD BE A POTENTIAL RELEASE
Trench	>EX	216-T-23	84	241-TX-3 Trench, 216-TX-3 Grav	P SS	?					X					NEED REMEDIATION SINCE PART OF GROUP ASSOCIATED WITH 216-T-21
trench	<E	216-T-13	72	216-T-13	P SS	?								X		WASTE HAS BEEN BACKFILLED AND RELEASED FROM RADIATION ZONE STATUS.
Trench	<EX	216-U-6	92	216-U Cold U Trench 01	P SS	?								X		SEE COMMENT (3D; HAS BEEN BACKFILLED.
trench	>EX	216-T-17	94	216-T-17	P SS	?					X					SEE COMMENT (3); HERBICIDES APPLIED TO SURFACE. PART OF GROUP ASSOCIATED WITH 216-T-14, 216-T-16.
trench	>EX	216-Z-4	<E	216-Z-4, 231-W-3	P SS	?					X					SEE COMMENT (3); HAS BEEN BACKFILLED. PART OF GROUP ASSOCIATED WITH 216-Z-6.
trench	<E	216-S-10	94	216-S-10	P SS	?								X		SEE COMMENT (3); EXHUMED AND REMOVED FROM RADIATION ZONE STATUS.
trench	2EX	UPR-200-W-112		UPR-200-W-112	P SS	?						X				SEE COMMENT ON UPR-200-W-111.
Trench	>EX	216-Z-9	62	216-Z-9 Cavern, 234-5 Recuplex	P SS	?					X					EST. 95% PU ACTIVITY IN FIRST 12" OF SOIL; CHEMICAL CONTAMINATION NOT ADDRESSED; MERGING OF PLUTONIUM PROPOSED IN 1970'S.
trench	>EX	216-T-15	94	216-T-15	P SS	?					X					SEE COMMENT (3); HERBICIDES APPLIED TO SURFACE. PART OF GROUP ASSOCIATED WITH 216-T-14, 216-T-16.
Trench	<EX	216-U-5	92	221-U Cold U Trench 02	P SS	?								X		SEE COMMENT (3)
Trenches	<EX	216-W-13	96	241-WR Steam Cleaning Pit,	P SS	?								X		SEE COMMENT (3)
vault	2EX	218-W-8	92	218-W-8	P SS					Y		X				VAULTS THAT CONTAIN SOLID WASTE ARE NOT EXPECTED TO RELEASE WASTE TO THE ENVIRONMENT, UNLESS THERE IS BREACH OF THE CONTAINER. RECOMMEND TO VERIFICATION OF NO RELEASE FROM THESE UNITS. IF THE STRUCTURES ARE WELL ENGINEERED FOR PERMANENT WASTE STORAGE (WITH NO POSSIBLE FUTURE WASTE RELEASE), THEN NO FURTHER ACTION IS REQUIRED.

KEY: X = official number not assigned but identified by unit number; D= documented; P= suspected; NO= no data; NS= not suspected; SS= subsurface soil; S= surface soil; P= past air release; C= current air release; F= future air release; Blank= no; X= yes

TABLE 3-23 200 W RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

200 WEST AREA RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

Unit Type	Site Code	Official Number	Date Last Used	Site Name/ Description	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radio-active Structures	NEED FOR ACTION: Remedi-ation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
																COMMENT <> HOWEVER, THIS UNIT WAS MADE OF WOODEN PLANKS. THERE IS A POSSIBILITY THAT THE WOOD WAS REMOVED AWAY, AND RELEASE OF WASTE TO SOIL IS EXPECTED. SUBJECT TO SINK HOLE FORMATION.
vault	2KH	218-W-7	68	218-W-7	? SS	?				?		X				SEE COMMENT <>
vault	2K	205-S4	76	205-S vault at the uranium	ND					?		X				SEE COMMENT <>
vault	4KH	244-UR#	76	244-UR vault	S	NS				?				X		SEE COMMENT <>
vault	2KH	241-UR#	76	241-UR vault	ND	NS				?		X				SEE COMMENT <>
waste line	4JH	UPR-200-W-2	47	UPR-200-W-2	D,S,SS				? P					X		NEED TO VERIFY FOR RESIDUAL CONTAMINATION TO DETERMINE WHETHER OR NOT REMEDIATION IS REQUIRED
waste line	4JH	UPR-200-W-113	NID 50'S	UPR-200-W-113	D,S,SS				? P					X		SAME AS ABOVE
weir box	1I	2904-S-171	76	2904-S-171 weir box	? S,SS				? P	?	X					SINCE THE WEIR BOX EXTENDS ABOVE GROUND, WITH SLUICE GATE, THERE IS A POTENTIAL FOR RELEASE TO AIR. IT IS ASSUMED THAT THIS UNIT IS NOT ENGINEERED FOR PERMANENT WASTE STORAGE. THUS, IT IS RECOMMENDED FOR REMEDIATION. LIQUID WASTE IS ALSO SUSPECTED TO BE PRESENT IN THE UNIT.
weir box	1I	2904-S-170	76	2904-S-170 weir box	? S,SS				? P	?	X					SAME AS ABOVE
weir box	1I	216-S-172	76	216-S-172 weir box	? S,SS				? P	?	X					SAME AS ABOVE, EXCEPT ONLY SOLID WASTE.

KEY: # = official number not assigned but identified by unit number; D= documented; ?= suspected; ND= no data; NS= not suspected; SS= subsurface soil; S= surface soil; P= past air release; C= current air release; F= future air release; X= yes; Blank= no

TABLE 3-24 200 N RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

200 North Release Potential and Need For Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	NEED FOR ACTION: Remediation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
Trench	4K	216-N-3	212-N-2 trench, 212-N-3 (9)	1952	D-SS	?	NS	NS	NS					X		Piping removed. Trench backfilled. Chemical contamination not addressed but site was last used 35 years ago.
Pond	4K	216-N-1	212-N Swamp, 216-N-1 Swamp, 216-N-1 covered Pond (9)	1952	D-SS	?	NS	NS	NS					X		Removed from radiation zone status. Chemical contamination not addressed but site was last used 35 years ago
Trench	4K	216-N-2	216-N-1 Trench, 216-N-2 trench (9)	1997	D-SS	?	NS	NS	NS					X		Piping removed. Trench backfilled. Chemical contamination not addressed but site was last used 40 years ago.
Pond	4K	216-N-4	212-P Swamp, 216-N-2, 216-N-4 swamp (9)	1952	D-SS	?	NS	NS	NS		X					Pond is covered. Contamination detected in subsurface soil (4 ft. deep). Chemical contamination not addressed but site last used 35 years ago.
Trench	4K	216-N-5	212-P trench, 216-N-5 trench (9)	1952	D-SS	?	NS	NS	NS					X		Piping removed. Trench backfilled. Chemical contamination not addressed but site was last used 35 years ago.
Pond	4K	216-N-6	212-N Swamp, 216-N-6 Swamp (9)	1952	D-SS	?	NS	NS	NS		X					Pond is covered. Contamination detected in subsurface soil (4 ft. deep). Chemical contamination not addressed but site last used 35 years ago.
Trench	4K	216-N-7	212-R trench, 212-N-7 trench (9)	1952	D-SS	?	NS	NS	NS					X		Trench backfilled. Chemical contamination not addressed but site last used 35 years ago.

KEY:
- official number not assigned but identified by unit number
D: documented
?: suspected
ND: no data
NS: not suspected
SS: subsurface soil
S: surface soil
P: past air release
C: current air release
F: future air release
X: yes
Blank - no

TABLE 3-25 300 AREA RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

300 AREA Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Date Last Used	Site Name/ Description	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	NEED FOR ACTION: Remediation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
acid spill	1AR		1957	Uranium/Acid Waste (Bldg. 313)	P-S,SS	P	ND		ND		X					PROCESS SEWER LINE LEAKING FOR UNKNOWN TIME. PROCESS LEAKAGE DIRECTED TO THIS TIME.
crib	1AR	318-4	1956	300 North Crib	SS	P	P	P	ND		X					USED TANKS.
drain field	3AR		1974	331 Life Sciences Laboratory	SS	P	P	P	ND	V			X			
drain field	3AR		1978	Retired 315 Sanitary Drain	SS	P	P	P	ND				X			
drain field	3AR		1978	Retired 335/336 Sanitary	SS	P	P	P	ND				X			
gravel pit	5AR		1987	300 Area Interim Filter	S,SS	P	P								X	NONHAZARDOUS FILTER BACKWASH.
pipe trench system	1AR	UPS-300-31/40	1974?	Pipe Trench System, 311	S,SS	P	P	NS	NS	V	X					SEVERE EROSION OF BOTTOM OF TRENCH; MULTIPLE DRAIN CONNECTIONS BROKEN. PREVIOUS SPILLS BELIEVED TO HAVE OCCURRED. MADE TRENCH AND PIPING REPAIRS. TRENCH FLOOR REMAINS CONTAMINATED. URANIUM FOUND IN SOIL.
pond	5AR		1987	Retired Filter Backwash Pond	SS	P	P			V					X	NONHAZARDOUS WASTE.
sewer pipe	2AR		1975	Retired Liq. Waste Sewer	P-SS	ND	ND	ND	ND			X				PIPES DRAINED AND LEFT IN PLACE. PIPING IS STAINLESS STEEL AND CONTAINS RESIDUAL RADIATION CONTAMINATION. SYSTEM REPLACED.
tank	2AR		1986	334 Tank Farm Waste Acid Tank	P-S,SS	ND	ND			V		X				LINER FAILURE CAUSED TANK LEAKAGE. DISCHARGED TO PROCESS SEWER TO WHICH WAS ADDED TO NEUTRALIZE. PREVIOUS CHEMICAL USAGE NOT KNOWN.
tanks	2AR		1968	323 Tanks (4)	ND	ND	ND	ND	ND	?		X				TANKS ENCASED IN CONCRETE VAULT. 3 OF 4 TANKS EMPTY OR FILLED WITH SAND.
testing unit	5AR		1986	In Situ Vitrification Test	S	ND	NS	NS	? P						X	DECONTAMINATION TO BACKGROUND RADIATION LEVELS. NO CHEMICALS APPEAR USED.
transfer line	4AR	UPS-300-1	1970	Transfer Line Leak	S,SS	P	ND	NS	?P,C					X		TOP 2 FT OF SOIL REMOVED. FURTHER REMOVAL POSSIBLE THREAT TO ADJACENT STRUCTURES.
trench	3AR		1974	331 Life Sci Lab (1964-1974)	SS	P	ND	P	ND				X			
trench	3AR		1969	331 Life Sci Lab (1966-1969)	SS	P	ND	P	ND				X			
underground tank	1AR		1971	National Storage (313 Bldg)	P-S	ND	ND	ND	ND		X					REMOVE WASTES
underground tank	1AR		1971	National Stor. (311 Tank Farm)	P-S	ND	ND	ND	ND		X					REMOVE WASTES
underground tank	2AR		1973	309 TN Tanks (3)	ND	ND	ND	ND	ND	V		X				WALL NOW LINTV. URANIUM STEEL PIPE LINING RADIATION CONTAMINATION. TANKS IN CONCRETE UNDERGROUND VAULT.

KEY:

A - official number not assigned but identified by unit number

D: documented
P: suspected

ND: no data
NS: not subjected

SS: subsurface soil
S: surface soil

P: past air release
C: current air release

F: future air release
N: yes

Blank - no

TABLE 3-26 400 AREA RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

400 Main Release Potential and Need for Action Matrix

Unit Type	Site Code	Historical Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	Remediation	NEED FOR ACTION: Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
trench drains	400		French Drain South of 4222-C	1965	U-SS	MS	MS	MS	MS						X	Sample from french drain was nonhazardous. Later points are nonhazardous.
trench drains	400		400 Retired French Drains	NU	U-SS	MD	MD	MD	MD				X			Type of monitoring operations not identified.
ponds	400		400 Area Retired Sanitary Pond	1969	U-SS/SS	P	MS	MD	MD				X			Source of waste feeding to treatment plant not identified. Basis for non-hazardous sludge designation not identified.
tank	400		Retired Septic Tank (S)	1983	NU	MS	MS	MD	MD				X			Received wastes from offices. Any laboratories?
trench	400		400 Area Retired Sand French	NU	U-SS	MD	MS	MS	MS				X			Constituents of cooling tower blowdown not identified. Could contain metals or inorganics

KEY: a - historical number not assigned but identified by unit number

D: documented
P: suspected

MD- no data
MS- not suspected

SS- subsurface soil
S- surface soil

P- past air release
C- current air release

F- future air release
N- yes

Blank - no

TABLE 3-27 600 AREA RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

600 Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Date Last Used	Site Name/ Description	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	Remediation	NEED FOR ACTION: Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	COMMENTS
burial ground	600	600-11	1967	300 Area Burial Ground	D-S	?	NS	ND	P,C?	NS		X				PIPE,CRISTOM STORAGE UNITS LIKELY POSTED AND RELEASING CONTAMINANTS. SURFACE SOIL CONTAMINATION. INCLUDES UPN 600 9-10. ONE CONTAMINATED AREA WASHED DOWN WITH 6000 GALLONS WATER.
burial ground	600		1955	J.A. Jones No. 2 (S)	C-S	NS	NS	NS	NS	NS					X	CONSTRUCTION MATERIAL. WASHED DOWN; CLEAN SOIL AND SOME METALLIC WASTE. SITE EXAMINED AND CONTENTS MOVED TO 200 AREA; SITE BACKFILLED IN 1971.
burial ground	600	600-10	1963	300 North SW Burial Ground	D-S	NS	NS	ND	P,C?	NS		X				PIPE STORAGE UNITS MAY HAVE POSTED THROUGH. SURFACE SOIL CONTAMINATION FOLLOWING UPN 600 11 AND 2. INCLUDES WER-LOCK-1,2,3. IMPROPER BURIAL CONTAINER USED; CONTAMINATED AREA WASHED DOWN WITH WATER.
burial ground	600		ND	Army Munitions Burial Site	NS	NS	NS	NS	NS						X	ALL MATERIALS EXHUMED/REMOVED TO YAKIMA FIRING RANGE (FBG) OR DESTROYED. MATERIAL BURIED IN CRATES ORIGINALLY.
burial ground	600	USDOE 2, 4 D	1967	USDOE-2, 4-D burial ground	S-S	NS	NS	?	? P			X				
burning pit	600	600-5	1962	Burial Ground No. 5	C-SS	NS	NS	NS	P,C?					X		URANIUM THERMA BURNING PIT. SOURCE OF CONTAMINATION/RELEASE STILL PRESENT?
crib	600	F-11	1951	116-F-6 crib	S-S	NS	NS	NS	NS					X		SITE AND STRUCTURE REMOVED IN 1979
crib	600	216-J and K	1950	Gable Mountain Cribs	D-SS	NS	NS	NS	NS	NS				X		UNDERGROUND CRIBS. RECEIVED VERY LITTLE AQUEOUS SOLUTION. PIPE FOUND TO BE FALSE OF RADIOACTIVITY ABOVE BACKGROUND FALLOUT LEVELS. REMOVED FROM RADIATION ZONE STATUS.
crib	600		1945	Pickling Acid Crib (S)	C-SS	?	NS	NS	P	NS				X		
landfill	600		1945	Hanford Trailer Camp (S)	C-S	NS	NS	NS	NS	NS					X	PRESUMED TO BE SMALL QUANTITIES OF GENERALLY NONCHEMICAL NATURE.
landfill	600		1970	Horn Rapids Disposal	C-S	NS	NS	ND	NS	NS		X				SITE CONTAINS MAINLY OFFICE WASTE AND OILS & SOLVENTS. BECAUSE OF UNKNOWN QUANTITIES OF ORGANICS, MUST EVALUATE ANY RELEASE.
landfill	600		1945	Sodium Dichromate Barrel	C-S	NS	NS	NS	P	NS				X		EMPTY CRUSHED BARRELS HAD CONTAINED SODIUM DICHROMATE. MUST VERIFY THAT HAZARDOUS CHEMICALS OR OTHER CONTAMINANTS ARE NOT CURRENTLY PRESENT. NO DATA REGARDING DECONTAMINATION OF DRUMS PRIOR TO DISPOSAL. BACKFILLED OVER DRUMS BUT SOME DEBRIS STILL VISIBLE.
landfill	600		1943	White Bluffs City Landfill	D-S F-SS	?	NS	?	P	NS				X		INDUSTRY/COMMERCIAL, DOMESTIC WASTE. QUANTITIES UNKNOWN. RELEASE MAY STILL BE OCCURING. BULLDOZED AND COVERED WITH CLEAN SOIL.
landfill	600		1979	J.A. Jones No. 1 (S)	ND	NS	NS	NS	NS	NS			X			NONRADIOACTIVE SOLID WASTE, CONSTRUCTION MATERIALS BURIED/COVERED BY CLEAN SOIL.
landfill	600		1943	City of Hanford Landfill	D-S F-SS	?	NS	?	P	NS				X		INDUSTRIAL & DOMESTIC WASTES. QUANTITIES UNKNOWN. RELEASE MAY STILL BE OCCURING. BACKFILLED AND COVERED WITH CLEAN SOIL.
landfill	600		1980	Midway Landfill No. 1 (S)	D-S F-SS	NS	NS	?	P	NS				X		DESIGNATED DISPOSAL SITE FOR "ORDINARY" HOUSEHOLD WASTE. MUST VERIFY THAT NO HAZARDOUS RELEASES OCCURING OR RESIDUAL CONTAMINATION. COMMERCIAL/DOMESTIC WASTE SINCE 1980.
landfill	600		1943	East White Bluffs City Landfill	D-S F-SS	?	NS	?	P	NS				X		
landfill	600		1970	Midway Landfill No. 2 (S)	F-S,SS	NS	NS	?	P			X				CONTAINS "SMALL QUANTITIES" OF PAINT SAMPLES, MERBICIDE CONTAINERS, CHEMICAL CELLS. QUANTITIES UNKNOWN. MUST VERIFY AMOUNT & CHECK FOR RELEASES. COVERED WITH CLEAN FILL AND VEGETATED.
pits	600	600-9	1961	Burial Ground No. 9	F-SS	ND	NS	ND	NS			X				URANIUM WASTE; NO CONTAINMENT. RELEASES CONTINUING? COVERED WITH CLEAN SOIL.
pond	600	600-12	1964	North Process Pond Scraping	D-SS	NS	NS	ND	?			X				URANIUM CONTAMINATED SOIL COVERED/BACKFILLED

KEY:

a official number not assigned but identified by unit number

D- documented
?- suspected

ND- no data
NS- not suspected

SS- subsurface soil
S- surface soil

P- past air release
C- current air release

F- future air release
X- yes

Blank- no

TABLE 3-27 600 AREA RELEASE POTENTIAL AND NEED FOR ACTION MATRIX (continued)

(600) Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Date Last Used	Site Name/ Description	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radioactive Structures	NEED FOR ACTION: Remediation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	COMMENTS
				Disposal Area												
tank	618	6652 CA	1960	665-C RCE Field Storage	[illegible]	NO	NS	NO	NO				X			WITH ADM. SITE CLOSURE INADEQUATE, EXPOSURE LIKELY.
tank	618		1950s	Army Bunker Septic Tank (3)	[illegible]	NO	NS	NO	NO				X			INACTIVE SEPTIC TANK. VERIFY NO HAZARDOUS CONSTITUENTS DISPOSED.
tank	618	6652 CA	1960	665-C Space Science Lab.	?	?	NS	NO	NS				X			INACTIVE SEPTIC TANK. VERIFY NO HAZARDOUS CONSTITUENTS DISPOSED.
trench	305	618-10	1946	Burial Ground No. 6	NS	NS	NS	NS	NS						X	SITE NO LONGER EXISTS. AT 325 BUILDING 1944-46, 300 BUILDING 1952-57, 324 BUILDING 1957-62. LAST RELOCATED TO 618-10 IN 1963. BUILDINGS CONSTRUCTED AT PREVIOUS LOCATIONS.
trench	300	618-10	1955	Burial Ground No. 5	[illegible]	NS	NS	NS	NS			X				URANIUM WASTE/CONTAMINATED BUILDING MATERIAL. IS WASTE IN MOBILE FORM? RELEASES OCCURING?
trench	100	618-10	1956	300 West Burial Ground	[illegible]	?	NS	?	NO		X					DRUMS OF URANIUM CONTAMINATED ORGANIC SOLVENT BURIED. LEAKING LIKELY. BACKFILLED AND STABILIZED CHOICE
trench	200	618-11	1949	Early Waste Burial Ground	[illegible]	NS	NS	NO	NS			X				WASTE PRESENTLY COVERED BY PARKING LOT. RELEASES OCCURING?
trench	200	618-7	1973	Burial Ground No. 7	[illegible]	NS	NS	NO	NO			X				URANIUM, THORIUM WASTES; SLIGHT CONTAMINATION. EVALUATE EXTENT OF CONTAMINATION. RELEASES OCCURING? BACKFILLED AND COVERED WITH CLEAN SOIL.
trench	200		1956	Original Central Landfill (5)	NO	NO	NS	NS	P	NS		X				IN PAST, WASTES HAVE BEEN OFF GASSING. NOW BACKFILLED TO GRADE.
trench	200	618-2	1954	SW Burial Ground No. 2	[illegible]	?	NS	NS	? P			X				URANIUM WASTES AND PLUTONIUM FISSION PRODUCTS. NO CONTAINMENT. INCLUDES DRUMS.
trench and pits	200	618-1	1956	SW Burial Ground No. 1	[illegible]	?	NS	NO	NO			X				URANIUM, PLUTONIUM FISSION PRODUCTS, LAB WASTES. NO CONTAINMENT.
waste pile	200	618-13	1950	303 Area Contaminated Soil Burial Ground	[illegible]	NS	NO	NS	P C			X				BAND OF CONTAMINATED SOIL. UNKNOWN TOTAL RADIOACTIVITY. EXPOSURE POTENTIAL SUBSTANTIAL. POSTED AS RADIATION ZONE.

Key: a - official number not assigned but identified by unit number; D: documented; I: inspected; NO- no data; NS: not subjected; SS: subsurface soil; S: surface soil; P: past air release; C: current air release; F: future air release; N: yes; Blank- no

TABLE 3-28 700 AREA RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

700 AREA Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Site Name/ Description	Date Last Used	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Radio-active Structures	NEED FOR ACTION: Remedi-ation	Verify No Release	Verify No Hazardous Compounds	Verify No Residual Contamination	No Further Action Required	Comments
Tank	-116		Underground Waste Solvent Tank 120	ND	ND	ND	ND	ND	ND					X		Tank has been emptied and triple rinsed. Tank is scheduled for removal. Waste was disposed off-site as hazardous waste. Need additional data to confirm no soil contamination.

KEY: N = official number not assigned but identified by unit number

D= documented
P= suspected

ND= no data
NS= not suspected

SS= subsurface soil
S= surface soil

P= past air release
C= current air release

F= future air release
N= yes

Blank= no

TABLE 3-29 1100 AREA RELEASE POTENTIAL AND NEED FOR ACTION MATRIX

1100 AREA Release Potential and Need for Action Matrix

Unit Type	Site Code	Official Number	Date Last Used	Site Name/ Description	RELEASE POTENTIAL: Soil	Ground Water	Surface Water	Subsurface Gas	Air	Residual Under-active Structures	NEED FOR ACTION: Remedi-ation	Verify No Release	Verify No Hazardous Constituents	Verify No Residual Contamination	No Further Action Required	Comments
ground disposal	MZB	UFD-1100-2	1988	disposal on railroad tracks	D-S	NS	P	P	P		X					cont. total disposal of 3000 gal over 30 yrs.
pit	MZB	UFD-1100-1	1977	sand pit	P	NS	NS	NS	NS		X					saturated sand removed periodically and replaced with new sand.
pit	MZB	UFD-1100-3	1988	sand pit	P	P	NS	P	P		X					materials appear to be in place. Wash water also disposed.
tank	MZB	UFD-1100-4	pre-1970	underground disposal tank	P	NS	NS	P	NS					X		antifreeze not hazardous constituent under RCRA. Can be toxic waste under HSWA. Residual waste should be removed.

KEY: X = official number not assigned but identified by unit number; D= documented; P= suspected; NS= not suspected; SS= subsurface soil; S= surface soil; P= past air release; C= current air release; F= future air release; X= yes; Blank= no

construction of the unit or the nature of the wastes or both. Verification of no hazardous constituents is selected where a solid waste generally posing little threat (such as sanitary wastewater) may have served as a source of release of hazardous constituents based on the nature of the operations served. Verification of no residual contamination is selected where action has been taken to remediate a release to the environment but documentation of findings is incomplete or chemical contamination from a mixed waste spill does not appear to have been adequately assessed/addressed by the actions identified. The time period over which the site was used, the volume of waste disposed, and the time since last use of the site were all considered in making these assessments.

The final activity in evaluating the need for action was to code each site based on the waste type and action area identified. The three digit code appears under the column "Site Code." This three digit code allows identification of each site's need for action and was used for additional site sorting and for prioritizing sites. Scheduling site priorities for the master characterization and remediation schedule.

The first digit of the code refers to the need for action; this code is a numeric code assigned as follows:

1 = Site requires remediation (and characterization prior to remediation)
2 = Site requires verification of no release
3 = Site requires verification of no hazardous constituents
4 = Site requires verification of no residual contamination
5 = No further action required.

The code was assigned to reflect the most to least "pressing" status of a unit.

The second digit of the code refers to the unit type. Each site in an area received an alphabetic code designating the unit type. The inactive sites present at Hanford cover a wide variety of designs, but many of them function in the same general manner for waste disposal or dispersion and can thus be grouped into distinctive "types." These unit type codes have been

developed to uniquely identify sites based on construction, operation, and environmental releases as a result of operations in order to select one "in-place" remediation technique for that situation. The codes developed for each type of unit are as follows:

SOLID WASTE SITES

- o A - aboveground covered landfill
- o B - aboveground uncovered landfill
- o C - belowground covered landfill
- o D - belowground uncovered landfill

LIQUID WASTE SITES

- o E - surface impoundments (includes large bottom percolation systems, ponds, etc.)
- o F - ditches (includes bottom/side dispersion systems-ditches, small trenches)
- o G - underground dispersion systems (french drains, tile fields, cribs)
- o H - aboveground tank
- o I - underground tank
- o J - spills

MISCELLANEOUS

- o K - underground vault
- o L - burning pit
- o M - incinerator
- o N - process sewer
- o O - other.

In this designation system, "covered" landfill is defined as a landfill or waste pile where some material has been placed on top of the wastes (soil, gravel, ash, etc.) rather than an engineered structure. "Uncovered" landfill is defined as a landfill or waste pile in which the wastes are exposed.

The <u>third digit</u> of the site code refers to the nature of the waste managed in the unit. The code is an alphabetic code assigned as follows:

Q = solid/hazardous wastes = nonradioactive wastes
R = radioactive waste = does not include chemical wastes
M = mixed wastes = wastes with both chemical and radioactive components.

Appendix D-2 presents a listing of the potential RCRA 3004(u) sites by Hanford Area. The sites in each area are sorted by the need for action code.

3.2.3 Characterization Costing Strategy

As described above, potential RCRA 3004(u) sites have been matched to one of the following four categories:

- o Verify no residual contamination
- o Verify no hazardous constituents
- o Verify no release
- o Characterize for remediation.

In order to develop costs for the potential 3004(u) sites, the following strategy was applied:

1. Segregate sites on the basis of the Hanford Area by hydrogeologic setting (nearby or shallow groundwater versus distant or deep groundwater). The distance to groundwater will impact the depths of groundwater monitoring wells or soil borings and thus, their costs, schedule time, and manpower requirements.

2. Estimate the dimensions of a generalized Hanford unit for each of the 15 types of units identified (A-O). Sampling and remediation strategies can then be applied to these generalized units for costing purposes.

3. Develop a sampling strategy for each of the four characterization categories.

4. Estimate sampling and characterization costs.

The following sections address each of these steps in further detail.

3.2.3.1 Classification by Hydrogeologic Setting

The potential 3004(u) sites requiring action were sorted into two groundwater regions. Table 3-30 presents the sites located near shallow groundwater (average depth to groundwater, 40 feet) or deep groundwater (average depth to groundwater, 245 feet). Tables 3-31 and 3-32 summarize the number of each type of potential 3004(u) summarize the number of each type of potential 3004(u) site in each characterization category within each of the two hydrogeologic settings.

At sites located in the region of shallow groundwater, it is assumed that liquid contaminants released on land infiltrated the sandy soil and were transported through the vadose zone to the aquifer. Once reaching the aquifer, groundwater flows towards the Columbia River transporting contaminants to the River. The shallow groundwater region is located nearest to the Columbia River and includes the 100 areas, 300 area, sections of the 600 area, the 700 area, and the 1100 area.

At sites located in the region of deeper groundwater, it is assumed that, in general, contaminants precipitate or absorb to the soil particles in the upper ten to forty feet of the soil column. Additionally, in the deep groundwater region, a caliche layer and clay lenses exist which could promote lateral spread of contaminants. Vadose zone and groundwater plumes of contamination are expected. Sampling data for some sites have shown contaminants at 130 feet below surface as well as groundwater contamination. The depth required for soil and groundwater sampling are far greater for this area than the shallower areas, will require deeper sampling, and will have a greater cost. The deep groundwater region includes the 200 areas, the 400 areas, and some of the 600 area sites.

The 600 area sites were divided into deep or shallow groundwater sites based on location. Appendix D-3 provides a listing of the 600 area sites by hydrogeologic setting.

TABLE 3-30 DISTRIBUTION OF WASTE UNIT TYPES IN AREAS WITH SHALLOW VERSUS DEEP GROUNDWATER

UNIT TYPE	(CODE)	SHALLOW GROUNDWATER AREA	DEEP GROUNDWATER AREA	TOTAL
Aboveground covered landfill	(A)	1	0	1
Abovegound uncovered landfill	(B)	0	1	1
Belowground covered landfill	(C)	41	31	72
Belowground uncovered landfill	(D)	0	2	2
Surface impoundments (includes large bottom percolation systems, ponds, trenches, etc)	(E)	10	77	87
Ditches (includes bottom/side dispersion systems)	(F)	2	8	10
Underground dispersion systems (french drains, tile fields, cribs)	(G)	54	76	130
Aboveground tank	(H)	9	9	18
Belowground tank	(I)	20	98	118
Spills	(J)	5	8	13
Underground vault	(K)	1	8	9
Burning Pit	(L)	8	2	10
Incinerator	(M)	0	1	1
Process Sewer	(N)	1	1	2
Other	(O)	4	2	6
TOTAL		156	327	480

TABLE 3-31 DEEP GROUNDWATER SITES*

Unit Type	Verify No Residual Contamination	Verify No Hazardous Constituents	Verify No Release	Characterize for Remediation	Total
A					0
B			1		1
C	13	3	9	6	31
D		1		1	2
E	60		1	16	77
F	2			6	8
G	42	7	1	26	76
H			4	5	9
I	3	3	44	51	101
J	4		1	3	8
K	3		4	1	8
L	2				2
M			1		1
N				1	1
O	1		1		2
TOTAL	130	14	67	116	327

*Includes the following Hanford Areas: 200 East, 200 West, 200 North, 400 and 600 (some)

TABLE 3-32 SHALLOW GROUNDWATER SITES*

Unit Type	Verify No Residual Contamination	Verify No Hazardous Constituents	Verify No Release	Characterize for Remediation	Total
A			1		1
B					0
C	10	3	27	1	41
D					0
E	1	1	1	7	10
F				2	2
G	25	21		8	54
H	5		4		9
I	2	4	6	8	20
J	1			4	5
K				1	1
L	6		1	1	8
M					
N			1		1
O	1		3		4
TOTAL	51	29	44	32	156

*Includes the following Hanford Areas: 100 B/C, 100 D/DR, 100 F, 100 H, 100 KE/KW, 100 N, 300, 700, 1100, and 600 (some)

3.2.3.2 Generalized Hanford Units

The next step in the characterization process was to develop a method to group all of the potential RCRA 3004(u) sites into a generic classification system based on the fifteen types of sites identified in Section 3.2.1. Providing a characterization and remediation cost for individual units was beyond the scope of this work. Therefore, generalized Hanford waste units were developed to represent the identified 3004(u) waste sites.

For each of the 15 sites, a generalized unit was developed from the data provided for actual Hanford sites. Two methods of data analysis were used: (1) if the number of sites within a given type of site is less than 20, then all sites were considered in the analysis; (2) if the type of site contains more than 20 sites, approximately only ten percent of the sites, chosen randomly among all areas of the Hanford Reservation, were considered in the analysis.

The characteristics of the generalized Hanford unit, such as the dimensions of the structure, method of waste emplacement, average service life, etc., were developed on the basis of the selected units within that type of site. For example, the dimensions of the generalized surface impoundment are calculated as an average of the dimensions of the impoundments selected under a type "E" site. Descriptions of the generalized Hanford units developed for each type of site are provided in Appendix C.

3.2.3.3 Characterization Techniques and Unit Costs

The methodologies used to characterize sites include reviewing historical data and documentation for the sites, waste unit sampling, soil sampling, and groundwater monitoring. These techniques have been selected as appropriate because these represent the basic characterization techniques used in the RCRA 3004(u) program and in RCRA closure and groundwater corrective action programs.

Table 3-33 summarizes the type of characterization technique(s) selected for each different characterization activity. In most cases, the

TABLE 3-33 CHARACTERIZATION TECHNIQUES

Characterization Categories	Characterization Techniques			
	File Search	Sample Waste Unit	Soil Sampling	Groundwater Sampling
Verify no residual contamination	X		X	
Verify no hazardous constituents	X	X		
Verify no release	X		X	
Characterize for remediation	X		X	X

same series of techniques may apply to more than activity because the characterization issues are similar. In order to estimate costs for characterization, the techniques noted in Table 3-33 were applied to the four categories of characterization for each generalized Hanford unit (as appropriate). These form the basis of the characterization cost estimates.

For all sites, the file review is recommended because it is an inexpensive method of obtaining data that can facilitate hazardous constituent release and residual contamination determinations. It may also assist in determining whether hazardous constituents are present without requiring sampling. This information also contributes to development of sampling and analysis plans and health and safety plans for field activities.

Sampling the actual waste unit is recommended only to make determinations that no hazardous constituents are present.

Soil sampling with a minimum number of four samples per site, is recommended for sites requiring characterization to verify no residual contamination, to verify no release, or to remediate.

Groundwater monitoring using minimum well configurations of at least one upgradient and three downgradient wells is recommended only for sites that will be undergoing remediation. Soil sampling is adequate to make further decisions on sites designated as requiring verification.

Table 3-34 presents an overview of the verification process based on the type verification sampling conducted. A site match into one of the categories (I, II, or III) identified in Table 3-34 as described above. The outcome of verification is to further refine the separation of sites into those that are not subject to RCRA 3004(u) that require no further action, or that require remediation. Sites identified as potentially requiring remediation will undergo an RI/FS process similar to that for CERCLA sites.

The details of the characterization techniques and the basis for estimating the number of samples, borings, or wells for each generalized Hanford unit are described below.

TABLE 3-34 NEED FOR ACTION (VERIFICATION PROCESS)

I. Verify no hazardous constituents are present

A. If present, evaluate release potential and determine additional need for action

B. If not present, site not subject to RCRA 3004(u)

II. Verify no release of hazardous constituents occurred

A. Sampling program should include the following
   1. sampling to verify release of hazardous constituents
   2. sampling to determine levels of residual contamination
   3. evaluations of potential future release that may require additional investigation as part of this effort.

B. If no contamination is found and there is no potential for future release, then no further action is required

C. If no contamination is found and there is potential for future release, then remediation must be performed to prevent future release

D. If contamination is found, then remediation must be performed to address residual contamination

III. Verify no residual contamination remains from past/present releases or insufficiently documented cleanups

A. Sampling program should include the following
   1. sampling to verify no residual contamination remains
   2. sampling to determine residual levels of contamination
   3. evaluations of potential future releases that may require additional investigation as part of this effort

B. If no contamination found and there is no potential for future release, then no further action is required

C. If no contamination is found and there is potential for future release, then remediation must be performed to prevent future release

D. If contamination is found, then remediation must be performed to address residual contamination.

Evaluation of Existing Data

Characterization of all sites first requires a review of the information available in incident reports, historical documentation, and other file materials to provide current sampling data, sampling and analytical records on decontamination or cleanup, engineering diagrams of waste flows, and waste constituents. Investigators compile the data to determine the adequacy of the data and documentation to support the development of remedial actions or to demonstrate the absence of a problem. This review may determine the need for additional environmental monitoring and would facilitate development of a sampling and analysis plan and a health and safety plan.

Sampling plans need to be developed for the inactive waste sites designated for verification of no release, verification of no hazardous constituents, and verification of no residual contamination. These plans should be developed on a site-specific basis (or within a grouping) so that the media affected and the techniques employed are most appropriate to the site situation and configuration. The sampling plans should identify the purpose of the study, the media to be sampled, the sampling locations, sampling and decontamination techniques, data management and sample chain of custody requirements, analytical parameters selected and health and safety requirements. The sampling programs should be geared towards documenting that there is no problem. If contamination problems are encountered, then the site will need to be re-evaluated for further action.

Similar sampling and analysis plans would be developed for sites being characterized for remediation. However, the focus of these plans would be in determining the nature and extent of contamination and to obtain data needed for a feasibility study.

For the purpose of developing characterization costs, this technique is assumed to cost ten percent of the total characterization cost to a maximum of $100,000. The costs associated with developing remediation activities are not included in this cost.

Waste Unit Sampling

Sampling the actual waste unit is recommended only to make determinations that no hazardous constituents are present. The cost of sampling the waste unit is assumed to result from analysis of three samples for constituents from the full RCRA 40 CFR 261 Appendix VIII or IX scan. For most units, this technique requires sampling and analysis of residual waste; however, for incinerators, since sludge is not present, the sample is a wipe from the incinerator facility and the sample frequency is increased to ten samples.

The cost of sampling the waste unit is estimated a $7,000 per sample. However, for underground units where drilling and soil removal is necessary to sample the site, the cost is increased to $8,700 per sample to cover the cost of drilling down to the the wastes. The increased cost results from the cost of drilling to a depth of 20 feet from the surface at an average cost of $85 per foot of drilling to extract a sample. The only units for which the $8,700 per sample cost applies are underground landfills.

Groundwater Monitoring

Groundwater monitoring wells are used to characterize groundwater quality, determine the absence of contamination, and, where necessary, the extent of contamination.

For this characterization strategy, wells are considered to be placed in a configuration that includes one upgradient well and three downgradient wells per site. This is based on the RCRA Groundwater Monitoring Technical Enforcement Guidance Document and the requirements of 40 CFR 264.90, as well as Washington State regulations WAC173-304-490 and 173-160. Well spacing is estimated at 150 feet between wells based on the EPA guidance for RCRA groundwater monitoring. The actual configuration of wells onsite may vary from this general configuration because sites which are adjacent to one another may need to be considered as one larger site for site characterization. Site size (small, large) will also affect the actual spacing.

Groundwater monitoring using minimum well configurations of at least one upgradient and three downgradient wells is recommended only for sites requiring characterization for remediation.

In order to develop costs for characterization, each type of site was be assumed to have a one upgradient and three downgradient wells spaced at 150 feet. Based on this, it is assumed that the numbers of wells should be increased if the longest dimension of the unit is greater than 400 feet. The following formula was used to determine the numbers of downgradient wells for generalized Hanford units with a length or width dimension greater than 400 feet:

$$\frac{\text{length of largest side}}{150\text{ ft}} + 1$$

The number of upgradient wells are calculated as 1/3 the number of downgradient wells. It is also assumed that the direction of groundwater flow is through the shortest dimension of the site (i.e., the longest side is oriented perpendicular to groundwater flow).

In order to determine the costs associated with groundwater monitoring, it was assumed that one groundwater sample was collected from each well at a cost of approximately $7,100 per sample. The monitoring wells were assumed to be installed ten feet into the aquifer resulting in well installation depths of 50 feet (shallow groundwater areas) and 255 feet (deep groundwater areas). The costs for monitoring well installation are presented in Section 2. When adding this cost to the cost of sampling, a total cost (rounded) of $12,200 for shallow areas and $33,200 for deep groundwater areas was obtained and used for calculating the costs of groundwater monitoring.

Exceptions to the above strategy for site characterization occur for several generalized Hanford units. For incinerators and aboveground tanks (site type M and H) which required characterization for remediation, groundwater monitoring was not applied because contamination is expected to remain in the enclosed building housing the tank or in soil and not reach the groundwater. The same strategy was applied to the process sewers (N) and the units categorized as "other" (O, primarily wastewater pumping stations), because these units are expected to consist of pipes in buried

units or trenches which do not have as high potential for liquid waste releases to groundwater as to soil. Additionally, groundwater wells spaced at 150-foot intervals around such a large site would be excessively expensive while providing proportionately little additional data. Soil borings were used to replace soil samples from the monitoring wells for process sewers (N), aboveground tanks (4), and other units (O). For the exceptions listed above, the characterization costs were adjusted accordingly.

Soil Sampling

Soil sampling, where soil borings are collected at least on each of the four sides of the site, is recommended for sites requiring characterization to verify no residual contamination, to verify for no release, or characterize for remediation.

For sites identified for remediation, soil core monitoring or soil sampling during monitoring well installation will be used to determine whether contamination is present in the uppermost soil column onsite, or to determine if contaminants remained onsite or have been released. The constituents to be monitored include the full scan of RCRA 40 CFR 261 Appendix VIII or IX constituents.

Soil samples collected during groundwater monitoring well installation, in the deep groundwater areas, are collected at five-foot intervals to a depth of 255 feet, which is ten feet below the groundwater table. Samples in the shallow groundwater areas are collected at two-foot intervals during monitoring well installation. Soil samples collected from monitoring wells include 28 samples from shallow wells and 56 samples from deep wells. The unit costs of soil sample analysis during groundwater monitoring well construction are $7,000 per sample. These costs are based on the sampling cost data provided in Section 2.

Soil borings in areas where groundwater monitoring wells are not included in site characterization are placed according to the length of the perimeter of the unit, as follows:

- o Up to 500 feet, every 50 feet on each side
- o Greater than 500 feet, every 100 feet on each side.

In the shallow groundwater areas, soil boring samples are collected every two feet to a depth of 30 feet. In the deep groundwater areas where liquid wastes are disposed, samples are collected every two feet to a depth of 100 feet and for dry waste sites every two feet to a depth of 50 feet. The sites which are considered "liquid" sites are those where a substantial amount of liquid was placed over the life of the unit and include: surface impoundments, ditches, and underground dispersion systems. Spills were not included as liquid sites.

In addition to the samples specified above, an increase in the sample numbers by ten percent was applied for all soil samples in order to account for duplicates and spikes for the analysis. Therefore, for soil borings in the shallow area, 17 samples are collected per boring. From soil borings in the deep groundwater area at units which contained liquid waste, 55 samples are collected per boring; in non-liquid units, 28 samples were collected per boring.

The cost of obtaining and analyzing samples from soil borings is approximately $7,100 per sample (refer to Section 2 for development of these costs).

The following exceptions to the above-described monitoring strategy were identified applied:

- o For ditches (F units), the number of borings to be completed to verify for no release and verify for no residual contamination for the generic site was decreased because of the large size of the generalized Hanford (over 2,000 feet). This would require 82 borings under the strategy presented above. The unit is not very wide, so it was determined that half as many borings would provide adequate data. A strategy of alternating sampling locations over

100-foot intervals on either side of the site was chosen for an overall interval of 200-foot spacing between borings. One boring on each end of the ditch was also included.

- For verifying no release in aboveground tanks (H), the soil samples are to be taken at two-foot intervals to a depth of 6 feet in each boring.

- For the "other" category (O), soil sampling was determined to be needed only to a depth of 30 feet in the shallow and deep groundwater areas because the potential for liquid release is low.

- Soil monitoring at the incinerators (M) to verify no release will be replaced by collecting ten wipe samples of the incinerator.

- For characterizing process sewers (N) for remediation, soil sampling was applied to a depth of 30 feet at two-foot intervals instead of using monitoring wells.

- For spills (J), a soil sampling depth of 20 feet was determined to be adequate to characterize for no release and no residual contamination.

For each of the above-listed bullets the characterization cost estimate has been adjusted accordingly.

Other Methods

Other methods of site characterization are applicable to the waste management units on a case-by-case basis, but it is beyond the scope of this project to apply these methods to the generic sites in calculating the costs for characterization in this section. Other potentially applicable site characterization methods include test pit excavation for direct observations of subsurface conditions; piezometer installation and monitoring; soil gas sampling and analysis; grab sampling of air, wastes, surface soils, surface water and/or sediments; remote sensing; aquifer tests; modeling; aerial photography; long-term groundwater monitoring; and infrared imagery for identifying areas of vegetative stress or contamination.

3.2.4. Summary of Characterization Costs

The process for estimating the characterization and remediation cost for the 3004(u) sites consists of the following steps:

(1) For each waste site type, develop a generic waste unit description and dimensions (entitled "generalized Hanford unit).

(2) Identify the number of units associated with each generalized Hanford unit.

(3) Apply the generic characterization strategy methodology to each generalized Hanford unit.

(4) Apply the unit costs to all sites each generalized Hanford unit with each characterization category, and obtain an estimated total cost for all sites.

For each Hanford area, the number of waste units within each type of waste site are counted and the results were listed earlier in Table 3-30. A detailed description of the generalized Hanford units and the numbers of samples required under the characterization strategy are presented in Appendix C.

Tables 3-35 and 3-36 present the estimated costs for characterization of the RCRA 3004(u) sites. Table 3-35 presents the costs for sites located in shallow groundwater areas while Table 3-36 presents the costs for sites located in the deep groundwater areas. The costs are developed based on the type of characterization anticipated (verify no residual contamination, verify no hazardous constituents, verify no release, or remediation). The characterization cost for the shallow groundwater area sites $166 million. The characterization cost for the deep groundwater area sites is $1.07 billion. The total characterization cost for the RCRA 3004(u) sites is $1.24 billion on an individual site basis. Reductions in these costs through site groupings are addressed in Section 4.

TABLE 3-35 CHARACTERIZATION COSTS FOR SHALLOW GROUNDWATER AREAS

SHALLOW AREA CHARACTERIZATION COSTS

UNIT TYPE	VERIFY FOR NO HAZARDOUS CONSTITUENTS						VERIFY FOR NO RELEASE						VERIFY FOR NO RESIDUAL CONTAMINATION						CHARACTERIZE FOR REMEDIATION					
	No. of Sites	Strategy: Planning	Strategy: GW Mon. Well	Strategy: Waste Unit Sampling	Cost Per Site ($)	Total Cost ($)	No. of Sites	Strategy: Planning	Strategy: GW Mon. Well	Strategy: Soil Sampling	Cost Per Site ($)	Total Cost ($)	No. of Sites	Strategy: Planning	Strategy: GW Mon. Well	Strategy: Soil Sampling	Cost Per Site ($)	Total Cost ($)	No. of Sites	Strategy: Planning	Strategy: GW Mon. Well	Strategy: Soil Sampling	Cost Per Site ($)	Total Cost ($)
A. ABOVEGROUND COVERED LANDFILL	0	0	0	0	0	0	1	47,396	0	68	521,356	521,356	0	0	0	0	0	0	0	0	0	0	0	0
B. ABOVEGROUND UNCOVERED LANDFILL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C. BELOWGROUND COVERED LANDFILL	3	2,800	0	3	28,900	86,700	27	100,000	0	340	2,469,800	66,684,600	10	100,000	0	340	2,469,800	24,698,000	1	79,720	4	112	888,120	888,120
D. BELOWGROUND UNCOVERED LANDFILL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E. SURFACE IMPOUNDMENT	1	2,800	0	3	28,900	28,900	1	100,000	0	238	1,758,860	1,758,860	1	100,000	0	238	1,758,860	1,758,860	7	100,000	4	112	908,400	6,358,800
F. DITCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	100,000	20	560	4,142,000	8,284,000
G. UNDERGROUND DISPERSION SYSTEM	21	2,800	0	3	28,900	606,900	0	0	0	0	0	0	25	47,396	0	68	521,356	13,033,900	8	100,000	4	112	908,400	7,267,200
H. ABOVEGROUND TANK	0	0	0	0	0	0	4	11,150	0	16	122,670	490,680	5	11,150	0	16	122,670	613,350	0	0	0	0	0	0
I-1. UNDERGROUND TANK	4	2,100	0	3	23,100	92,400	6	47,396	0	68	521,356	3,128,136	2	47,396	0	68	521,356	1,042,712	8	100,000	4	112	908,400	7,267,200
J. SPILLS	0	0	0	0	0	0	0	0	0	0	0	0	1	47,396	0	68	521,356	521,356	4	100,000	4	112	908,400	3,633,600
K. UNDERGROUND VAULT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	79,720	4	112	888,120	888,120
L. BURNING PIT	0	0	0	0	0	0	1	47,396	0	68	521,356	521,356	6	47,396	0	68	521,356	3,128,136	1	79,720	4	112	888,120	888,120
M. INCINERATOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N. PROCESS SEWER	0	0	0	0	0	0	1	100,000	0	714	5,076,500	5,076,500	0	0	0	0	0	0	0	0	0	0	0	0
O. OTHER	0	0	0	0	0	0	3	47,396	0	68	521,356	1,564,068	1	47,396	0	68	521,356	521,356	0	0	0	0	0	0
TOTAL						814,900						84,485,236						45,317,670						35,475,160
GRAND TOTAL																								166,092,966

TABLE 3-36 CHARACTERIZATION COSTS FOR DEEP GROUNDWATER AREAS

DEEP AREA CHARACTERIZATION COSTS

UNIT TYPE	VERIFY FOR NO HAZARDOUS CONSTITUENTS						VERIFY FOR NO RELEASE						VERIFY FOR NO RESIDUAL CONTAMINATION						CHARACTERIZE FOR REMEDIATION					
		Strategy						Strategy						Strategy						Strategy				
	No. of Sites	Plan-ning	GW Mon. Well	Unit Sampling	Cost Per Site ($)	Total Cost ($)	No. of Sites	Plan-ning	GW Mon. Well	Soil Sampling	Cost Per Site ($)	Total Cost ($)	No. of Sites	Plan-ning	GW Mon. Well	Soil Sampling	Cost Per Site ($)	Total Cost ($)	No. of Sites	Plan-ning	GW Mon. Well	Soil Sampling	Cost Per Site ($)	Total Cost ($)
A. ABOVEGROUND COVERED LANDFILL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. ABOVEGROUND UNCOVERED LANDFILL	0	0	0	0	0	0	1	100,000	0	560	4,076,000	4,076,000	0	0	0	0	0	0	0	0	0	0	0	0
C. BELOWGROUND COVERED LANDFILL	3	2,800	0	3	28,900	86,700	9	100,000	0	560	4,076,000	36,684,000	13	100,000	0	560	4,076,000	52,988,000	6	100,000	4	224	1,800,800	10,804,800
D. BELOWGROUND UNCOVERED LANDFILL	1	2,800	0	3	28,900	28,900	0	0	0	0	0	0	0	0	0	0	0	0	1	100,000	14	844	6,472,800	6,472,800
E. SURFACE IMPOUNDMENT	0	0	0	0	0	0	1	100,000	0	770	5,567,000	5,567,000	60	100,000	0	770	5,567,000	334,020,000	16	100,000	6	336	2,651,200	42,419,200
F. DITCH	0	0	0	0	0	0	0	0	0	0	0	0	2	100,000	0	1,265	9,081,500	18,163,000	6	100,000	20	1,120	8,604,000	51,624,000
G. UNDERGROUND DISPERSION SYSTEM	7	2,800	0	3	28,900	202,300	1	100,000	0	220	1,662,000	1,662,000	42	100,000	0	220	1,662,000	69,804,000	26	100,000	4	224	1,800,800	46,820,800
H. ABOVEGROUND TANK	0	0	0	0	0	0	4	11,400	0	16	125,000	500,000	0	0	0	0	0	0	5	11,400	0	16	125,000	625,000
I-1. UNDERGROUND TANK	3	2,100	0	3	23,100	69,300	42	80,000	0	112	875,200	36,758,400	3	80,000	0	112	875,200	2,625,600	133	100,000	4	224	1,800,800	239,506,400
I-2. UNDERGROUND TANK	0	0	0	0	0	0	2	80,000	0	112	875,200	1,750,400	0	0	0	0	0	0	48	100,000	4	224	1,800,800	86,438,400
J. SPILLS	0	0	0	0	0	0	1	31,200	0	44	343,600	343,600	4	31,200	0	44	343,600	1,374,400	3	100,000	4	224	1,800,800	5,402,400
K. UNDERGROUND VAULT	0	0	0	0	0	0	4	80,000	0	112	875,200	3,500,800	3	80,000	0	112	875,200	2,625,600	1	100,000	4	224	1,800,800	1,800,800
L. BURNING PIT	0	0	0	0	0	0	0	0	0	0	0	0	2	80,000	0	112	875,200	1,750,400	0	0	0	0	0	0
M. INCINERATOR	0	0	0	0	0	0	0	0	0	0	0	0	1	7,100	0	10	78,100	78,100	0	0	0	0	0	0
N. PROCESS SEWER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100,000	0	714	5,098,000	5,098,000
O. OTHER	0	0	0	0	0	0	1	48,300	0	68	531,100	531,100	1	48,300	0	68	531,100	531,100	0	0	0	0	0	0
""TOTAL""						387,200						91,373,300						483,960,200						497,012,600
""GRAND TOTAL""																								1,072,733,300

3.3 REMEDIATION STRATEGY

The process and criteria used to select a remedial alternative for a 3004(u) site is essentially the same as that for a CERCLA site. Under current EPA policy and guidance, a SWMU requiring corrective action will undergo an RI/FS process. The basic difference in the selection process involves the cleanup criteria and cost.

Under SARA, CERCLA site cleanups must comply with ARARs. The RCRA program does not have this requirement. Therefore, RCRA actions at this time must be consistent with the RCRA cleanup standards under the closure standard, groundwater corrective action, and land disposal prohibitions. The closure standard requires that a site be cleaned up to background concentrations or closed in compliance with the closure and post-closure requirements for a RCRA landfill. Groundwater corrective action requires cleanup to background concentrations or generic drinking water standards (such as MCLs) applicable to all facilities. Health-based standards specific to the situation (alternate concentration limits or ACLs) may be proposed for site closure or groundwater corrective action. The land disposal prohibitions require that wastes to be disposed into "land" units (such as a new landfill constructed as part of a remedial action) must meet certain concentration limits or disposal is not allowed.

As the RCRA program currently stands, cleanup to background concentrations is the established requirement with which corrective actions must be consistent. Allowances are made to pursue other standards (MCLs and ACLs, as identified above) as an alternative, but this would be made on a case-by-case basis through submission of data and negotiation with the State of Washington and EPA Region X.

It should be noted that one approach under consideration in promulgating the RCRA corrective action regulations is for EPA to establish health-based cleanup target levels in each medium. The draft regulations are currently being prepared and EPA's commitment to this alternative is not yet established.

Another area of difference between RCRA 3004(u) and CERCLA cleanups is that cost is not a factor in selecting remediation at 3004(u) sites. All

other factors identified in Section 2 regarding the cost-effectiveness evaluation would still apply.

Section 3.3.1 provides an overview of the remediation strategy. Section 3.3.2 discusses the in-place remediation techniques identified for the inactive sites. The technologies selected and the basis for the selection are also identified. Section 3.3.3 discusses the exhumation alternative and the assumptions made regarding the applicability and implementation of the technique to the Hanford sites. Section 3.3.4 presents the unit costs associated with each remediation technique and activity. Section 3.3.5 presents a summary of the potential remediation costs for the RCRA 3004(u) sites.

3.3.1 Overview of the Remediation Strategy

The remediation strategy has been developed based on identification of remediation techniques suitable to the types of sites identified in the characterization effort as potentially requiring remediation. The Statement of Work for this project required that exhumation be considered in all cases and that one applicable in-place remediation technique be selected for each type of unit. Together, these two techniques, on a site-by-site basis, are assumed to provide the range of effort and cost required to address site problems.

Approximately 70 remediation techniques are available to remediate RCRA 3004(u) sites. These are listed in Appendix A. Of these, fifteen were selected as potentially applicable techniques at Hanford for the purposes of developing budgetary estimates. To identify the potential remediation techniques to be applied to the generalized Hanford units, a broad engineering analysis was performed which included review of available remediation techniques by SAIC engineers and geologists. The criteria for selecting potentially applicable remediation techniques included cost, manpower requirements, equipment requirements, and release/dispersal effects in the local hydrogeologic settings. The remedial technique or combination of techniques that will actually be implemented will depend on the results of an engineering feasibility study ultimately conducted for each site.

3.3.2 Selection of In-Place Remediation Techniques

In-place remediation techniques are defined in this report to include remedial actions that generally do not require the removal of the waste and contaminated soil from the unit. Instead, application of these techniques will remove contaminants or immobilize the contaminants within the local area surrounding the unit.

Of the 15 generalized Hanford units, only 11 have been identified as potentially requiring remediation: belowground landfill (covered, uncovered), surface impoundments, ditches, underground dispersion systems, aboveground tanks, belowground tanks, spills, underground vaults, burning pit, and process sewer. A review of the available information concerning remedial techniques for such waste sites indicates that eight techniques are generally applicable to these units:

- Soil flushing
- Soil treatment
- Grout-in-place
- In-situ vitrification
- Cap/cover
- Subsurface barriers
- Groundwater pumping and treatment
- In-place decontamination.

Each of these techniques is explained briefly in Appendix B. It should be noted that on a site-specific basis these techniques may or may not be the preferred remediation technique. In general, the final remediation technique is selected through a feasibility study and often involves multiple technologies. The technologies identified above are anticipated to be appropriate for the type and number of units considered in this analysis.

For the RCRA 3004(u) sites, one in-place remedial technique for each type of generalized Hanford unit identified in Section 3.2 was selected according to the following steps. The first step for each type of waste unit is to review all of the potential in-place remedial actions described above, and generate a preliminary set of techniques that appear to be applicable for the remediation of that unit. The second step is to select

the most appropriate remedial action for the unit from the preliminary set of remediation techniques. The results of this exercise are presented in Table 3-37 and the basis for selecting each remediation technique is described below. The selection process focused on techniques that could permanently resolve contamination problems to be consistent with current RCRA program strategy.

In general, for waste disposal unit types E (surface impoundments), F (ditches), and G (underground dispersion systems) that received liquid waste, groundwater pumping and treatment is selected as the in-place remediation technique for this analysis. This selection is based on the following assumptions: (1) most, if not all, of the wastes disposed of have reached the groundwater, and (2) wastes still in the vadose zone have sufficient liquid present to permit pumping. Other in-place treatment techniques such as soil treatment, capping/covering, etc., may effectively control the migration of any remaining contaminants in at least part of the soil column beneath the unit. However, the contamination to the groundwater still remains untreated. Only soil flushing appears to one of the techniques that may be applicable to contaminants in the soil column. A disadvantage of soil flushing is that effective containment and collection of the elutriate is difficult. In soil flushing, the potential for mobilizing some contaminants and allowing others to remain in place exists.

Based on the above considerations, groundwater pumping and treating is generally considered to be the most appropriate method for removing the contamination from the groundwater for the purposes of this analysis. It is further assumed that any contaminants that remain in the unsaturated region and cannot be pumped out will remain absorbed the soil, and will not migrate to groundwater.

In practice, groundwater recovery and treatment is not generally conducted alone. It is often more appropriate to consider additional in-place techniques such as capping/covering sealing and partial excavation to complete the remedial action for these sites. Also, it should be noted that selection of one remediation technique for a general type of problem

TABLE 3-37 POTENTIAL IN-SITU REMEDIAL ACTIONS FOR WASTE UNITS

Type of Waste Units	POTENTIAL IN-SITU REMEDIAL ACTIONS								Comments
	Soil Flushing	Soil Treatm.	Grout-in-Place	In-situ Vitrif.	Cap/ Cover	Subsurface Barrier	Grd Wtr Recovery & Treatment	In-place Decont.	
C (Belowground Covered Landfill) D (Belowground Un-Covered Landfill)			X	X	X	X			Grout-in-place or encapsulation with grout is chosen to contain and immobilize the waste within the unit.
E (Surface Impoundments) F (Ditches) G (Underground Depression Systems)	X		X	X	X	X	X		Ground Water Recovery and Treatment is chosen as the technique for removing contaminants that have migrated to the groundwater or any materials that can be flushed from the vadose zone (Comment 1).
H (Aboveground Tanks)			X					X	In-place decontamination by draining the tank and rinsing with appropriate solvent. Sludge will be removed using hi-pressure water injection system. In some cases, this technique may not work, thus, grout-in-place should be used.
I-1 (Underground Tanks)	?[1]	X	X				?[1]		Grout-in-place by injecting grout into the tank and the surrounding soil to contain and immobilize contaminants.
I-2 (Underground Diversion Boxes)	?[1]		X			?[1]	?[1]		Grout-in-place or encapsulation of unit using grout to contain waste within unit.

[1]Technical implementation and chemical compatibility concerns must be addressed before these actions can be taken. They are the techniques which were considered to be potentially applicable.

TABLE 3-37 POTENTIAL IN-SITU REMEDIAL ACTIONS FOR WASTE UNITS (continued)

Type of Waste Units	POTENTIAL IN-SITU REMEDIAL ACTIONS								Comments
	Soil Flushing	Soil Treatm.	Grout-in-Place	In-situ Vitrif.	Cap/ Cover	Subsurface Barrier	Grd Wtr Recovery & Treatment	In-place Decont.	
J (Spills)		X	?[1]		?[1]		X		Grout-in-place is recommended to immobilize the contamination in subsurface soil. Ground water recovery and treatment is also suggested if the contamination reaches groundwater table.
K (Underground Vault)			X	X			?[1]	X	Grout-in-place such as encapsulation of unit in grout is recommended for this type of waste unit.
L (Burning Pit)			X	X	X		X		Grout-in-place is selected to immobilize the waste within the unit.
N (Process Sewer)		X	X	X	X		X	X	Grout-in-place is recommended to stabilize the unit.

[1]Technical implementation and chemical compatibility concerns must be addressed before these actions can be taken. They are the techniques which were considered to be potentially applicable.

overlooks site-specific selection of a remediation technique. For example, not all liquid waste disposal units have contaminated groundwater. Some units that are located in a shallow groundwater region and near the bank of the Columbia River may have contaminated the local groundwater at one time in the past; however, the groundwater may have been flushed many times so that only traces of contamination remain. In this case, other in-situ remedial actions or no action may be chosen to deal with potential remobilization of the contaminants that remain bound to the soil beneath the units.

For the generalized Hanford units including burial grounds (C/D), process sewers (N), burning pits (L), and ditches (F), grout-in-place and encapsulation are considered to be the most appropriate alternatives for this analysis. Other applicable treatment techniques include in-situ vitrification, capping/covering, and subsurface barriers. In-situ vitrification is still a developmental technique with many economic and applicability limitations. Capping/covering would limit the potential for exposing the waste; however, it would not prevent migration of contaminants from the unit due to any interactions with active liquid waste disposal units located nearby. Finally, subsurface barriers may not be applicable to control contaminated groundwater for units that are located in deep groundwater areas such as the 200 areas where the water table is more than 200 feet below ground surface or where subsurface migration is found unlikely.

For generalized Hanford units C and D (belowground covered and uncovered landfills), it is recommended that in-situ encapsulation be used as the remediation technique rather than grout-in-place, since the amount of solidifier and cost required for the latter technique can become exorbitant while the benefit is nominally the same as the in-situ encapsulation method. Encapsulation refers to injecting a "liner" or "barrier" of grout below and around the unit, thus creating a containment structure.

It is assumed that most diversion boxes (type I-2), weir boxes (type K). and underground vaults (type K) are empty. If there was any leakage from the units, it would be confined to the surrounding soil. Since the contamination is primarily contained within the unit, it is most appropriate

to consider grout-in-place or encapsulation of the unit for this analysis. The grouted unit can remain buried in the ground with little possibility of releasing contaminants to the soil.

For spills (type J), it is assumed that the released contamination did not spread vertically and laterally to a great extent from the original site. Grouting-in-place was selected to remediate this type of waste site. Groundwater recovery and treatment is applicable, if the contamination reaches the groundwater table. In-situ vitrification is also applicable, however, the technology is still new and the cost could be too high for such a site. Cap/covers and subsurface barriers would have limited impact on the site due to climatic and geological site characteristics.

For underground tanks (type I-1), the most practical choice of the in-place remediation techniques is grout-in-place. For aboveground tanks (type H), in-place decontamination can be used as the in-place remediation technique. It should be noted that in cases where removal of the remaining waste is not possible, grout-in-place should be used as an alternative.

Waste unit types A (aboveground covered landfill), B (aboveground uncovered landfill), M (incinerators), and O (other) are not recommended for remediation, based on their match to the four characterization categories (verify no release, verify no residual contamination, verify no hazardous constituents or characertize for remediation) in Section 3.2. Therefore, no remedial alternative is suggested for these units.

3.3.3 Exhumation

One commonly used option for cleaning up a waste site is to exhume the waste material, treat it, and dispose of it at a permitted RCRA or Dangerous Waste disposal site. Depending on the extent of the contamination at the site and the exhumation effort, application of this technique can lead to virtually complete removal of the contamination from the site. The statement of work for this project required that exhumation be considered along with in-place remediation.

The exhumation technique consists of excavating, removing, treating, and disposing of the waste and the contaminated soil. Prior to excavating

the site, site planning needs to be performed. During this phase, all engineering and survey work is conducted to establish the basis for the actual excavation. During the planning phase, a staff which includes engineers, surveyors, draftpersons, geologists, health and safety officers, and secretaries, will be needed.

Excavation of contaminated soil and structures requires heavy construction or mining equipment. The excavated soil then must be drummed prior to disposal. Containment of the wastes, decontamination of containers prior to disposal, and transport of the waste containers by truck will also be required to control radionuclides. Removal and transportation of the contaminated material from the site will rely on flat-bed trucks. Disposal of the waste is assumed to be onsite, at a permitted and controlled land disposal site. Excavated waste material that does not meet the constituent concentration limitations under the EPA and State regulations ("land disposal ban") cannot be disposed of without pretreatment prior to disposal. A more detailed description of the exhumation technique is presented in Appendix A of this report.

Exhumation can be applied to remediate most of the waste units identified at the Hanford site. However, exhumation alone may not completely remove all of the contamination. Special equipment may be required for deep excavations, but some contamination may be so deep or so hazardous that excavation is neither practical nor feasible. In selecting the actual remedial alternative for a specific site, a combination of excavation and in-place remediation is most likely. Such decisions reflect a case-by-case analysis beyond the scope of this study.

3.3.3.1 Excavation Estimate

The amount of soil to be excavated is dependent on the extent of the contamination in the sub-surface soil. For liquid waste sites, the lateral migration mainly appears to be caused by the occurrence of clay lenses at depths of 30 to 50 feet under many sites. A review of the Waste Management Operations Report, Volume 2 (Rockwell International Energy Systems Group, 1979) indicates that for CERCLA Site 216-S-1&2, the lateral contamination extends on the average to about 115 feet on each side of the site. The

lateral migration of the contaminants from a liquid waste unit can be calculated using the following equation:

$$V = (L + 230ft + D) \times (W + 230ft + D) \times D \qquad \text{(Eq. 1)}$$

where: V = Volume of excavated soil (ft^3)
L = Length of the unit (ft)
W = Width of the unit (ft)
D = Depth of excavation (ft)

The maximum depth of excavation is limited to 60 feet below surface since the excavation costs assume no shoring nor utilization of special deep excavation equipment.

For dry waste sites, it is assumed that the contaminants do not migrate far from the site because there is not enough precipitation to mobilize the contaminants from the waste unit. It is necessary to modify the above formula before it can be applied to these sites. The modification is to use a factor of 1.5 times the dimensions of the site (length and width only) instead of a multiplier of three because the factor of three produced an excavation area for the landfills may be several hundred feet for a one hundred-foot wide unit. This appeared unreasonable given the sandy soil conditions where contaminants are generally transported downward to a greater extent than laterally. Also, it was also determined that reasonable excavation depth would be conservatively limited to 20 feet beneath the bottom of the waste site, even though the contaminants may not have reached that depth. The following equation may be used:

$$V = [(1.5 \times L) + D] \times [(1.5 \times W) + D] \times D \qquad \text{(Eq. 2)}$$

Equation 2 is assumed to be applicable for most units with small to average size, where the length does not exceed two times the width. For units that have an elongated shape such as ditches of more than 1000 feet long but only five to ten feet wide, it is not practical to assume significantly greater migration along the longest dimension. Contamination is anticipated to occur in a more elliptical fashion around such a unit. Thus, to accommodate such a unit structure, equation 2 is modified as follows. With regard to the width of the unit, the lateral extent of the

migration still remains at 1.5 times the width. However, for the length of the unit, this lateral migration is assumed to be also 1.5 times the width as shown in Equation 3:

$$V = [(1.5 \times W) + L + D] \times [(1.5 \times W) + D] \times D \qquad \text{(Eq. 3)}$$

The above formulas were used to develop cost estimates to excavate all sites that were determined to potentially require remediation. However, it should be noted that these equations were developed based on limited data and information on the sites. Cost estimates for actual remediation will draw on a more extensive assessment of the extent of the site contamination.

3.3.3.2 Limitations and Applications

Engineering and health and safety limitations exist that should be considered prior to selecting excavation as a remedial technique. First, it is necessary to establish a working excavation depth for the remediation sites. In some areas of the Hanford site, the water table is located at more than 200 feet from the surface (200 Areas). If all liquid waste disposed of reached groundwater, then the soil column beneath the waste unit is contaminated and requires remediation. In the cases where the sites are located in an area with a deep water table, the depth of the excavation can exceed 200 feet below ground surface. Although it is possible to excavate to this depth, the cost can become exorbitant due to special modification to equipment, additional requirements for support such as shoring, and potential production rate reduction (USEPA, 1985). Thus, to use conventional heavy construction equipment such as backhoes, dozers, and loaders, a maximum optimal excavation depth of 60 feet was chosen as the basis for the exhumation technique (USEPA, 1985).

A review of the location of the potential RCRA 3004(u) sites indicated that the majority of these units are buried or "operated" within 30 feet below ground level. In addition, an examination of the contamination profiles in the soil column beneath sites such as cribs, it appears that the contamination is more or less concentrated within the next 20 feet of the soil column beneath the unit. If this assumption stands for all waste units, then excavation to 60 feet below ground surface would at least exhume the soil region where the contamination is most concentrated. Although site

interaction in the subsurface is known to occur, in order to estimate excavation volumes it was necessary to assume that there is no interaction from other units located in the proximity of the excavated site and therefore any contaminants remaining in the soil below the 60-foot depth from the ground surface may be considered immobilized. In actual selection of remediation strategies it is recommended that additional remediation techniques such as groundwater recovery and treatment be considered in conjunction with exhumation to remove any contaminants that have reached the groundwater or may remain in mobile form in the unsaturated zone.

Second, a one to one slope is assumed to be used for the excavation. For excavation to a depth of 60 feet, such a slope will generally not require shoring.

Third, exhumation of large buried structures such as cement or asphalt-lined, contaminated retention basins requires additional work to break the structures into manageable size for packaging and hauling and to create areas suitable for excavation. In such cases, the cost for excavation is increased by at least 20 percent.

Fourth, it is questionable whether or not exhumation is an appropriate technique for remediation of large underground tanks that still contain highly radioactive residues. Direct exposure to the residues could pose a potentially high threat to the health and safety of the workers. This technique has therefore not been presented as a remediation technique for the tank farms.

Fifth, disposal of excavated soil or the residues from treatment or the soil could become a major issue requiring resolution. Normally, the excavated or treated contaminated soil can be packaged and disposed of offsite in a permitted land disposal site. However, if exhumation is required for the majority of the identified sites at Hanford, offsite disposal may not be feasible due to the amount of contaminated soil to be disposed. Neither offsite nor onsite capacity is sufficient to accommodate the volumes of mixed waste anticipated to be generated from exhumation of the waste sites. As a result, an engineered and approved land disposal site may need to be constructed onsite to accommodate the disposal of all excavated material.

3.3.4 Estimated Remediation Costs

This section discusses the methodology for estimating the costs associated with the exhumation or in-place remediation of each of the generalized Hanford units defined in Section 3.2.

3.3.4.1 Methodology for Cost Evaluation

The process for estimating the remediation costs for the potential 3004(u) sites consists of the following steps:

(1) For each waste site type, develop a generic waste unit description and dimensions (entitled "generalized Hanford unit").

(2) Identify the number of units associated with each generalized Hanford unit designated for remediation.

(3) Apply the generic remediation strategy methodology to each generalized Hanford unit.

(4) Apply the unit remediation costs for each generalized Hanford unit and obtain an estimated total cost for all sites.

Steps 1 through 2 have already been developed and were described in Section 3.2. In Step 3 of the above process, all engineering estimates of the volume of waste to be treated or excavated are calculated for each generalized Hanford unit. The calculations and bases for these estimates are incorporated in the unit descriptions provided in Appendix C of this report. The development of generic remediation cost requires unit costs associated with each of the suggested remedial actions. These unit costs are presented in detail in Appendix A of this report.

3.3.4.2 Remediation Cost Estimates

The process for estimating the remediation costs for the RCRA 3004(u) sites consists of estimating the cost associated with each generalized

Hanford unit as described earlier, and applying that cost to the number of units requiring remediation for that generalized unit.

For each unit that requires remediation, the following three elements are considered in the estimate for the total cost:

- o Feasibility study, engineering, and construction management costs
- o Remedial action (or cleanup) cost
- o Post remedial action cost, or monitoring cost.

Although site characterization is a required activity prior to the actual remedial action, it is not being considered as part of the total cost for the site remediation. Instead, it is being analyzed under the general topic of site characterization. In general, all units that were identified as potential sources of hazardous constituent release to the environment required some sort of site characterization, even for those that were recommended for remediation, to determine the extent of the contamination. The strategies and costs associated with the site characterization were described in Section 3.2.

Feasibility Study, Engineering, and Construction Management Cost

The cost associated with this study phase of the remedial action is comprised of two cost elements: (a) feasibility study cost, and (b) engineering and construction management cost.

For a feasibility study (FS), there is a minimum amount of work that needs to be performed, such as analyzing remedial investigation (RI) data, formulating and selecting remedial action (RA) alternatives, estimating public and environmental risk associated with each RA alternative, etc. Based on SAIC's experience in performing these studies, the estimated cost for an FS ranges from $100,000 to $300,000 for one unit/site, depending on the amound of work that needs to be done and the complexity of the site. Thus, for a small waste unit such as an underground vault, the FS cost is estimated at about $100,000. On the other hand, for complex waste unit such as a crib or a pond where liquid waste was disposed of and more technologies may require evaluation, it is estimated that the FS cost is approximately $300,000 due to greater extent of subsurface contamination, possible

groundwater contamination, potential interaction with other waste units located nearby, etc. For large solid waste units, it is assumed that subsurface contamination is more or less localized. The potential for groundwater contamination would be negligible and fewer RA alternatives would need to be considered. However, because the unit is rather large, the evaluation and analysis of RI data will take more time than a smaller unit. As a result, for these units, it is assumed that the FS cost is approximately $200,000. This cost is also assumed to be the cost incurred for a medium-sized liquid waste unit.

The cost of the engineering, and construction management (Engr, CM) is generally defined as a percentage of the actual remedial action (RA) cost, and typically ranges between ten to 20 percent of the total cost. For example, on the DOE CENTRA project, which involves low-level radioactive and heavy metal wastes, this cost averages about 15% of the total remediation cost. For this study, the Engr, and CM cost element is an average of 15% of the actual remediation cost. Also, this cost element can inversely vary with the unit size and this factor is being considered by site size as follows:

Site Size (Lateral Surface Area)	FS, Engr, CM Cost (% of RA Cost)
Small (<1,000 sq. ft.)	20
Medium (1,000-10,000 sq. ft.)	15
Large (>10,000 sq. ft.)	10

Using the above criteria, the size of each type of unit can be determined. Table 3-38 presents the estimate of the size of each type of waste site based on the generic descriptions presented in Appendix C. Only certain types of sites have been designated for remediation as discussed previously. Site types not requiring remediation [A (aboveground covered landfill), B (aboveground uncovered landfill), M (incinerator), and O (other)] have therefore been omitted from this remediation analysis.

The combination of the FS and Engineering studies is also limited to a maximum cost of $2,000,000 per waste unit.

TABLE 3-38. SIZE CATEGORIZATION BY TYPE OF WASTE SITE

Type of Waste Site		Lateral Surface Area (ft^2)	Relative Size
A	Aboveground Covered Landfill	NA	NA
B	Aboveground Uncovered Landfill	NA	NA
C	Belowground Covered Landfill	56,000	Large
D	Belowground Uncovered Landfill	750,000	Large
E	Surface Impoundment	90,000	Large
F	Ditches	12,200	Large
G	Underground Dispersion Systems	276	Small
H	Aboveground Tank	NA	NA
I	Underground Tank	NA	NA
J	Spills	5,000	Medium
K	Underground Vault	128	Small
L	Burning Pit	11,000	Large
M	Incinerator	NA	NA
N	Process Sewer	24,000	Large
O	Other	NA	NA

NOTE: Waste Site Types A, B, M, and O were not identified as requiring remediation.

Remedial Action Cost

The cost for remedial action is estimated using the unit costs documented in Appendix A and are listed below:

o Excavation and disposal	$365/Cubic Yard (CY)
o Excavation, treatment, and disposal	$689/CY
o Grout-in-place	$ 60/CY
o In-situ decontamination	$1.10/gal or $210/CY
o Groundwater recovery and treatment	$35/1000 gal

In the development of the remediation strategy for the 3004(u) sites the selection of remediation techniques includes exhumation and one potentially applicable in-place treatment method for each generalized Hanford unit. Since the remediation alternatives have already been established, only the costs associated with these techniques will be estimated and presented in this section.

Post-Remedial Action (RA) Monitoring Cost

This cost element is geared towards monitoring groundwater, soil, and vegetation at each site for radioactivity, heavy metals, and other organic and inorganic contaminants after remediation has been completed. As part of the post-RA monitoring strategy, each site is assumed to be monitored semi-annually. As described in Section 2, at least four groundwater samples will be analyzed per site remediated during each monitoring event at the cost of about $7,100 per sample. Therefore, for each waste unit undergoing remediation, the cost associated with the post-RA monitoring activities will be about $60,000/year, given a labor cost of $3,200/year. These costs include monthly inspection of the wells, semi-annual sampling, semi-annual data analysis, and semi-annual maintenance. According the RCRA regulations, post-closure monitoring activities should be conducted for 30 years after closure of the site. As a result, the total post-RA monitoring for each site is estimated at $1,800,000.

The above monitoring cost is based on a semi-annual monitoring strategy. This is applicable for most of the selected in-place treatment processes, except for the in-place decontamination. For the latter

technique, it is assumed that once the unit is cleaned, there is no residual contamination left in the unit, and therefore, post-RA monitoring is not required.

3.3.5 Estimated Remediation Cost Summary

For each Hanford area, the total remediation cost for each generalized Hanford unit identified as requiring remediation was estimated for two scenarios: exhumation for almost all cases, and one applicable in-place remedial action. For each remedial action, costs associated with feasibility study, engineering, actual remedial action, and post-remedial action monitoring are estimated wherever applicable. For each generalized Hanford unit, the various costs are calculated based on the total cost per unit and the number of units requiring remediation within that type.

Table 3-39 presents the exhumation costs. Two costs are identified: Method A and Method B. Method A represents the cost of waste or contaminated material removal and redisposal. Method B represents the cost of waste or contaminated material removal, treatment, and residue disposal. The single shell tank farms and catch tanks were not included in this analysis as the hazard to human health and the environment from attempting to exhume these sites was too extensive to consider this option.

Table 3-40 presents the in-place remediation costs. Tables 3-39 and 3-40 identify the volume of material estimated for the basis of the cost evaluation. Estimation details are presented in Appendix A.

Based on the information presented in Tables 3-39 and 3-40, the cost range for exhumation is $14.8 billion to $27.6 billion for sites designated for potential remediation on a site-by-site basis. The cost of in-place remediation is estimated at $874 million on a site-by-site basis.

It should be noted that these costs are generated based on remediation of individual sites. However, sites can be grouped together and treated as an entity. As a result, it is expected that the remediation cost could be reduced drastically. Examples of these cost reductions are provided in Appendix I.

TABLE 3-39 RCRA 3004(u) Sites Excavation Costs

Type of Waste Site	Number of Unit	Excavation Volume (CY)	FS Cost ($/unit)	EXHUMATION: Method A ENG Cost ($/unit)	Method A RA Cost ($/unit)	Method B ENG Cost ($/unit)	Method B RA Cost ($/unit)	Post-RA Monitoring Cost ($/unit)	Method A Tot. Unit Cost ($/unit)	Method A Total Cost ($)	Method B Tot. Unit Cost ($/unit)	Method B Total Cost ($)
C	7	222,800	200,000	1,800,000	81,322,000	1,800,000	153,509,200	1,800,000	85,122,000	595,854,000	157,309,200	1,101,164,400
D	1	2,680,000	200,000	1,800,000	978,200,000	1,800,000	1,846,520,000	1,800,000	982,000,000	982,000,000	1,850,320,000	1,850,320,000
E	23	668,500	300,000	1,700,000	244,002,500	1,700,000	460,596,500	1,800,000	247,802,500	5,699,457,500	464,396,500	10,681,119,500
F	8	1,530,000	300,000	1,700,000	558,450,000	1,700,000	1,054,170,000	1,800,000	562,250,000	4,498,000,000	1,057,970,000	8,463,760,000
G	34	210,000	300,000	1,700,000	76,650,000	1,700,000	144,690,000	1,800,000	80,450,000	2,735,300,000	148,490,000	5,048,660,000
H	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
I-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
I-2	50	3,600	100,000	262,800	1,314,000	496,080	2,480,400	1,800,000	3,476,800	173,840,000	4,876,480	243,824,000
J	7	28,400	100,000	1,554,900	10,366,000	1,900,000	19,567,600	1,800,000	13,820,900	96,746,300	23,367,600	163,573,200
K	2	550	100,000	40,150	200,750	75,790	378,950	1,800,000	2,140,900	4,281,800	2,354,740	4,709,480
L	1	80,000	200,000	1,800,000	29,200,000	1,800,000	55,120,000	1,800,000	33,000,000	33,000,000	58,920,000	58,920,000
N	1	4,200	100,000	306,600	1,533,000	578,760	2,893,800	1,800,000	3,739,600	3,739,600	5,372,560	5,372,560
SUM										14,822,219,200		27,621,423,140

NOTES: Method A consists of excavation and disposal w/o incineration (@ $365/CY).
Method B consists of excavation and disposal with incineration (@ $689/CY).
NA Not Applicable. Require other remedial techniques.
C Belowground Covered Landfill
D Belowground Uncovered Landfill
E Surface impoundments
F Ditches
G Underground Dispersion Systems
H Aboveground Tank
I-1 Underground Tank
I-2 Diversion Boxes
J Spills
K Underground Vault
L Burning Pit
N Process Sewer

Table 3-40 RCRA 3004(u) Sites In-Place Remediation Costs

			IN-SITU REMEDIAL ACTIONS														
			Grout-in-Place					In-Place Decontamination				Groundwater Recovery Treatment					
Type of Waste Site	Number of Unit	FS Cost ($/unit)	Volume of Soil (CY)	ENG Cost ($/unit)	RA Cost ($/unit)	Mon. ($/unit)	Vol. of Waste Water (gal)	ENG Cost ($/unit)	RA Cost ($/unit)	Mon. ($/unit)	Volume of Water (Mgal)	ENG Cost ($/unit)	RA Cost ($/unit)	Mon. ($/unit)	Tot. Unit Cost ($/unit)	Total Cost ($)
C	7	200,000	40,000	240,000	2,400,000	1,800,000	NA	NA	NA	NA	NA	NA	NA	NA	4,640,000	32,480,000
D	1	200,000	347,000	1,800,000	20,820,000	1,800,000	NA	NA	NA	NA	NA	NA	NA	NA	24,620,000	24,620,000
E	23	300,000	NA	NA	NA	NA	NA	NA	NA	NA	71	248,500	2,485,000	1,800,000	4,833,500	111,170,500
F	8	300,000	NA	NA	NA	NA	NA	NA	NA	NA	165	577,500	5,775,000	1,800,000	8,452,500	67,620,000
G	34	300,000	NA	NA	NA	NA	NA	NA	NA	NA	19	133,000	665,000	1,800,000	2,898,000	98,532,000
H	5	100,000	NA	NA	NA	NA	21,000	4,620	23,100	0	NA	NA	NA	NA	127,720	638,600
I-1	140	100,000	3,000 (a)	93,600	936,000	1,800,000	NA	NA	NA	NA	NA	NA	NA	NA	2,929,800	410,144,000
I-2	50	100,000	9 (a)	281	2,808	1,800,000	NA	NA	NA	NA	NA	NA	NA	NA	1,903,089	95,154,440
J	7	100,000	17,000	102,000	1,020,000	1,800,000	NA	NA	NA	NA	NA	NA	NA	NA	3,022,000	21,154,000
K	2	100,000	75 (a)	2,340	23,400	1,800,000	NA	NA	NA	NA	NA	NA	NA	NA	1,925,740	3,851,480
L	1	200,000	46,000	276,000	2,760,000	1,800,000	NA	NA	NA	NA	NA	NA	NA	NA	5,036,000	5,036,000
N	1	100,000	4,200 (a)	131,040	1,310,400	1,800,000	NA	NA	NA	NA	NA	NA	NA	NA	3,341,440	3,341,440
SUM																873,742,460

NOTES: NA Not Applicable.

(a) Since this technique requires direct injection of grout into the unit, the volume is expressed in terms of volume of grout. Unit cost for this technique is estimated at ($312/CY).

C Belowground Covered Landfill
D Belowground Uncovered Landfill
E Surface Impoundment
F Ditches
G Underground Dispersion Systems
H Aboveground Tank
I-1 Underground Tank
I-2 Diversion Boxes
J Spills
K Underground Vault
L Burning Pit
N Process Sewer

3.4 ESTIMATED MANPOWER AND SCHEDULING

A description of the characterization and remediation tasks necessary at each of the generalized Hanford units, as well as a list of the numbers of sites included under each characterization or remediation effort were provided in Sections 3.2 and 3.3. This section provides a description of the manpower needed to complete site characterization and remedial action on the basis of the RCRA 3004(u) site types. Then, unit schedules for completion of characterization and remediation are provided. This effort was necessary to ultimately produce a master schedule for addressing both RCRA and CERCLA sites as described in Section 4. The methods used to develop estimates of manpower and scheduling recommended for characterization and remediation are also provided in this section.

3.4.1 Characterization Unit Schedules and Manpower Requirements

Characterization activities for the generalized Hanford units vary according to the category of characterization as described in Section 3.2. In order to develop unit schedules, the characterization activities were segregated into three tasks as follows:

- Task C1 - review file data, prepare health and safety plans, prepare safety and analysis plans

- Task C2 - conduct field activities (soil and groundwater monitoring and sampling waste management units)

- Task C3 - sample analysis, evaluation of results, and report preparation.

Each of the above described activities has an associated time requirements that were developed on the basis of engineering field experience and assumptions regarding the average time necessary to perform the various activities.

To develop the time estimates to complete various activities, a factor of $60 per hour was selected as the average cost per hour, fully loaded (overhead, administrative costs, etc.), for a person with the appropriate

skills. The cost represents a person with the level of engineering or scientific skills needed to perform the engineering, planning, and implementation activities to characterize a site.

The total amount of money allotted for planning site characterization and evaluating results (Tasks C1 and C3) is ten percent of the total characterization costs for sampling and analysis. A maximum of $100,000 was selected as the ceiling for these efforts (combined). This value was divided by $60 per hour to determine the maximum number of man-hours available.

Next, the total planning cost for site characterization was allocated between the C1 and C3 tasks. In order to segregate the costs, the costs were sorted into six cost brackets. By using the $60 per hour rate, the total hours to complete the tasks could be calculated. It was assumed that significantly more planning was required for sampling and analysis, health and safety, etc., in the higher cost brackets than the lower cost brackets, so a longer schedule was required to complete the work for the higher cost bracket sites. For each cost bracket and corresponding number of hours to complete the task, the percent of personnel time needed for Tasks C1 and C3 is shown on Table 3-41. The schedule time is also shown on Table 3-41. The schedule time for Task C1 was established based on best judgment and previous experience; different schedule times have been assigned based on the anticipated complexity of the sampling needed. Task C3 schedule times were similarly developed and include six weeks for sample analysis.

For the lower cost brackets (less than $35,000), the budget and time needed to perform Task C1 was significantly greater than the budget and time for Task C3. Since the planning costs were derived on the basis of the total cost for characterization, the lower cost brackets represent the characterizations with the least data to be collected. That is, for the lower cost brackets a much greater proportion of the money will be spent on developing health and safety plans and sampling and analysis plans (C1) than will be spent on evaluating the monitoring data and preparing a report (C3) on a small data base (data may include as little as three samples analyses). On the other hand, for a site to be characterized for remediation, a much

TABLE 3-41. SCHEDULE TO COMPLETE CHARACTERIZATION

Cost Bracket ($)	TASK C1 % of Total Planning Cost	TASK C1 Man-Weeks	TASK C1 Schedule Weeks	TASK C3 % of Total Planning Cost	TASK C3 Man-Weeks	TASK C3 Schedule Weeks
0-6,000	75	0.8	1	25	0.4	7
6,000-15,000	50	2.3	4	50	2.4	10
15,000-35,000	30	3.9	4	70	9.0	10
35,000-50,000	30	5.9	4	70	13.7	12
50,000-85,000	30	10.0	6	70	23.4	14
85,000-100,000	30	12.5	8	70	29.2	16

greater proportion of money will be spent on evaluating the data (C3), which may include tracking contaminant plumes, using computer data analysis for hundreds of samples, etc., than will be spent in preparing for sampling (C1).

Task C2, the field activities necessary to characterize a site, include groundwater monitoring, soil monitoring and waste unit sampling. In order to develop manpower estimates and scheduling, the following was assumed:

- Drilling crews include: one supervisor, one driller, one person to conduct sampling and to address health and safety concerns/monitoring

- Crews work eight-hour shifts, one shift per day. If additional work is necessary, additional drill rigs and crews are added to the site. Alternatively, the numbers of shifts that the crew works can be increased. The target for drilling and well installation time was kept to a maximum of four to eight weeks per site

- Drilling one groundwater monitoring well, collection of soil borings at two-foot intervals to a depth of 50 feet (shallow groundwater areas), purging one well, collecting one groundwater sample, and decontamination of equipment will take three people four days to complete (12 mandays over 0.8 weeks scheduling time)

- Drilling one groundwater monitoring well, collection of soil borings at five-foot intervals to a depth of 255 feet (deep groundwater areas), purging one well, collecting one groundwater sample, and decontamination of equipment will take three people seven days to complete (21 mandays over one [1] week of scheduling time)

- Completing one soil boring and collecting soil samples every two feet to a depth of 30 feet (shallow groundwater areas) and decontamination will take three people three days to complete (nine mandays over 0.6 weeks scheduling time)

- Completing one soil boring and collecting soil samples every two feet to a depth of 50 feet (deep groundwater areas with non-liquid wastes placed in the unit during the active life) and decontamination will take three people three days to complete (nine mandays over 0.6 weeks scheduling time)

- Completing one soil boring and collecting soil samples every two feet to a depth of 100 feet (deep groundwater areas with liquid waste placed in the unit during the active life) and decontamination will take three people four days to complete (12 mandays over 0.8 weeks scheduling time)

- Completing four soil borings and collecting soil samples every two feet to a depth of six feet (aboveground tanks regardless of area located) and decontamination will take three people three days to complete (9 mandays over 0.6 weeks scheduling time).

The total manweeks were calculated by multiplying the number of people by the number of days they were needed and dividing the number of days the crew works by the number of days per workweek (five days per week). The scheduling time was calculated by dividing the number of days to complete a well or boring by the number of days per workweek (five days).

To calculate the schedule to complete each type characterization for each generalized Hanford Unit, worksheets were prepared. The worksheets provided in Appendix E show the schedule for each site type in each characterization category (characterization for verify for no hazardous constituents, verify for no release/no residual contamination in shallow groundwater areas, verify for no release/no residual contamination in deep groundwater areas, characterize for remediation in the shallow groundwater areas, and characterize for remediation in the deep groundwater areas).

On the worksheets, Tasks C1, C2 and C3 correspond to the three tasks described in this Section. The scheduling times for the three tasks were linked end to end for each type of site in each characterization category to obtain unit schedules.

At the end of the characterization tasks, six months are allowed for review of materials prior to beginning remediation.

The numbers of samples necessary for characterizing the various Hanford units in the shallow and deep areas, as well as the rationale for the numbers of groundwater monitoring wells and soil borings, and the numbers of samples collected in both the deep and shallow groundwater areas are described in Section 3.2.3. Appendix C describes the generalized Hanford units.

3.4.2 Remediation Unit Schedules and Manpower Requirements

The scheduling and manpower required to perform remediation and post-remediation monitoring at a given unit are presented in this section. Remedial activities include the following tasks:

R1 - Conduct feasibility study (RIA) and conduct engineering design (RIB)
R2 - Perform remedial action
R3 - Conduct post-remediation monitoring.

Each of the above three tasks has associated time requirements that were calculated on the basis of engineering field experience and assumptions regarding the average time needed to perform the activities. Each task is described below:

- RIA - For units that have been designated for remediation, a feasibility study (FS) will need to be performed to identify and evaluate remedial alternatives. For the purposes of this study, a period of six months was scheduled for completion of the FS, and three more months were added for the review of the FS by EPA. Thus, a total of nine months was scheduled to complete this task. Based on the costs required to perform this activity (as identified in Section 3.3), the total number of manweeks was determined as follows, using an average labor rate of $60/hr:

  Estimated FS cost ($) x $60/hr ÷ 40 hrs/week = Total Manweeks

- RIB - After the FS has been completed, reviewed, and approved by EPA, engineering analysis of the recommended remedial alternatives can be started. It is assumed that a period of one year (52 weeks) is require to conduct the engineering analysis which includes initial engineering design and review, cost estimates, and construction management. Based on the costs required to perform this activity (as identified in Section 3.3), the total manpower requirement can be calculated as follows, using an average labor cost of $60/hr:

  Estimated Eng. Cost ($) x $60/hr ÷ 40 hrs/wk = Total Manweeks

- R2 - A remedial action will be implemented at each site requiring remediation. The scheduling and manpower requirements for each unit are based on the estimated volume of waste/soil/water identified as requiring remediation or treatment at each unit. Labor efficiency rates and production rates have been determined for each proposed remedial action. Unit schedules were determined by applying the production rates to the identified volume needing remediation; manpower requirements (manweeks were determined by applying the labor productivity rates to the identified volume needing remediation

  Worksheets showing calculations for manhours and scheduling are provided in Appendix F

- R3 - After a unit has been remediated, it will be necessary to perform post-remedial action groundwater monitoring. A 30-year groundwater monitoring program is recommended so that the site cleanup program will be consistent with the RCRA post-closure monitoring program. Under the RCRA program, land disposal facilities that have undergone closure are required to perform groundwater sampling at the facility on a semi-annual basis for a period of 30 years. The objective of this program is to verify that the closure actions (remediation) have resulted in either the elimination of hazardous constituents from the environment or the reduction of constituent concentrations to levels below the

applicable regulatory standards. Under this program, semi-annual groundwater sampling for hazardous constituents will be performed at one upgradient and three downgradient wells at each remediated site.

It is assumed that the four wells (one upgradient, three downgradient) to be monitored were installed during the characterization phase and therefore the majority of costs associated with the program will be associated with sample collection and analysis.

The monitoring program consists of three phases as follows: well purging and sampling, offsite laboratory analyses of collected samples, and onsite data analyses, as follows:

- Each of the unit's four wells will be purged and sampled. It is assumed that each well will be pumped the equivalent of three well volumes (purging) prior to sampling. The process is estimated to require four hours to complete each well and only a single well at a unit can be purged at a given time. Sampling of the purged well is expected to require four hours to complete. This time includes the sample labeling, packaging, and paperwork associated with shipping the collected samples offsite for analysis as well as decontamination. Thus, one well would be completed in one day. This phase will require an expenditure of 96 hours (three people, four days, eight hours/day) twice a year per unit (a total of 192 hours a year for 30 years)

- Offsite laboratory analyses of the groundwater samples are expected to require six weeks. Shorter turnaround times are not anticipated for this type of activity. No manpower expenditures are required

- The sample results received from the laboratory will be evaluated and any necessary reports based on the analytical data will be generated. It is expected that one person will require four hours to complete this task per unit for a total of eight hours per year per unit

- It is anticipated that clerical support and well maintenance support will be necessary. Four hours of clerical support will be necessary per year and twelve hours of well and pump maintenance and inspection is expected to be necessary per year for each unit. Appendix F presents worksheets for development of the manpower necessary to conduct post-remediation activities.

3.5 SUPPORT ACTIVITIES

Support activities have been identified for site characterization and site remediation. These activities represent studies, plans, and procedures that need to be developed in order to proceed with site characterization and site remediation. The following activities represent support needs for the inactive RCRA 3004(u) sites:

- Assessment of waste management needs to accommodate the wastes generated from site remediation and development of waste management plans

- Characterization and modeling studies of site areas to account for contributing sources (both active and inactive)

- Treatability studies to support remediation technique selection on a site-specific basis

- Evaluation of the need for requesting that Alternate Concentration Limits (ACLs) be used as the cleanup criteria for the inactive waste sites given site-specific conditions

- Evaluation of the need to modify existing permits

- NEPA documentation to support new facilities development and possible remediation activities.

Each of these support activities are described in more detail below.

Existing waste management capacity both onsite and offsite is insufficient to handle the volumes of mixed waste anticipated to be

generated from site remediation. This will require an evaluation of available offsite capacity and an assessment of onsite new facility needs to determine whether new management units are needed as well as the form required (landfill, wastewater treatment system, etc.). Engineering designs and appropriate permits will be required for new facilities to handle the wastes from remediation. Also, characteristics of the waste and contaminated materials expected to be generated from the remediation activities may need to be evaluated to determine if the materials may be delisted as dangerous wastes thereby allowing disposal as only radioactive waste.

Modeling studies will be needed to fully evaluate site conditions and subsurface transport of radioactive and chemical contaminants on a larger grouping on regional (area based) scale rather than on a site-specific basis. The inactive waste sites at Hanford involve a complex environment through the interaction of waste management units that operated twenty or thirty years ago and waste management units that recently ceased operations or are still operating. In addition, sites may be located directly next to each other that are being addressed under different remediation programs [CERCLA and RCRA 3004(u)] that can create an artificial barrier between the sites and may not take into account the complexity of the site interactions. Finally, subsurface processes in effect at Hanford create complex contaminant distributions. For example, thermal gradients and lenses of high/low permeability in the subsurface contribute to lateral spread of contaminant plumes in situations where a downward or elliptical plume may be expected. These conditions coupled with the hydraulic interaction with the Columbia River; operations variations in the past that affected groundwater movement and possibly contaminant flow; and continued interactions with active discharges create an environment that may be best understood and evaluated through detailed regional site modeling of both the chemical and radioactive materials movement and behavior. Such modeling would support detailed regional site characterization, long-term monitoring strategies, and selection/design of remediation techniques.

The state-of-the-art for site remediation is continuing to evolve. EPA has generally found that site-specific treatability studies are required prior to final remediation technology selection and design in order to ensure that the selected technique will successfully apply to site

conditions and the combinations of waste constituents found. Often, these studies can determine design modifications, alternative equipment or materials of construction selection, or treatment parameters/procedures required. Sometimes these studies can identify the inapplicability of a given technique otherwise thought to be suitable. The need for treatability studies will depend on a site-by-site basis, but is generally recommended for any type of in-situ treatment or waste treatment process.

Current RCRA closure and cleanup requirements establish the cleanup criteria as background concentrations of a given constituent or a health-based standard such as a maximum concentration limit (MCL). In many cases, particularly where no health-based standard exists (such as soil) or where site conditions do not support cleanup to background concentration, alternate concentration limits (ACLs) may be pursued as alternate cleanup standards. The ACL development process requires detailed studies of site conditions, contaminant characteristics and movement in the environment, and contaminant toxicity and other health effects. This involves a fairly detailed assessment process supported by detailed modeling. EPA review and approval will be necessary. The need for and the feasibility of proposing alternate concentration levels for cleanup criteria at Hanford remediation projects should be evaluated once more detailed site characterization information is available.

Hanford has existing waste management units with RCRA (Washington Dangerous Waste) interim status which are seeking operating permits. These facilities may be likely candidates to receive some of the wastes generated from remediation actions. The permit conditions and waste acceptance criteria will require evaluation, prior to facility use for remediation wastes, to determine whether these wastes may be accepted or whether permit modifications are required prior to waste acceptance.

NEPA documentation such as environmental assessments and environmental impact statements may be needed to support remediation decisionmaking and actual remediation activities. The Savannah River Plant is currently completing a final Environmental Impact Statement for Waste Management Activities, which addresses proposed remediation strategies, proposed waste management changes, and proposed strategies for development and construction of new waste management facilities to handle future wastes and wastes

generated from site remediation. The Nevada Test Site is currently in the process of preparing environmental assessment documents to support the expansion of the existing radioactive waste landfill to provide new landfill cells for disposal of mixed wastes. Finally, Rocky Flats has encountered difficulties in completing the trial burn for a RCRA incinerator because the incinerator was not addressed in previous environmental documents. Although there are already a number of environmental documents addressing waste management issues at Hanford, it is anticipated that new documentation may be needed as remediation plans progress.

3.6 STUDY LIMITATIONS

The data and information used to develop a characterization strategy and remediation strategy for the RCRA 3004(u) sites was provided by Westinghouse and included approximately 5000 pages of data on inactive waste disposal sites and areas of environmental contamination at the Hanford Reservation. Approximately 2000 pages of this information related to potential RCRA 3004(u) sites. These data included lists of the waste sites at the Hanford Reservation, codes for the lists which related to the geographic location of the sites at Hanford, and brief narratives (usually one to two pages) for each site. This section describes some of the limitations of the site data and information provided which formed the basis of the site assessments, remediation selection, and cost estimating for the ten tasks and resulting in this project report.

The statement of work for this project limited the data analysis to the information supplied. The analyses presented in this report are based on this information and reflect the programmatic status (RCRA vs. CERCLA) of each site as of June 1987. Site identification and evaluation efforts have continued at Hanford since that time and negotiations have proceeded with the State of Washington and EPA Region X regarding a Memorandum of Agreement to address inactive waste sites and NPL listing of sites at Hanford. As a result of those efforts, additional CERCLA sites have been designated. These sites may appear in this report as RCRA sites.

The focus of this effort was to conduct a preliminary assessment of potential RCRA sites in order to estimate potential budgetary requirements and time requirements to characterize and remediate these sites. As such,

this analysis and the supporting selections of remediation technologies are not intended to be definitive. For example, one in-place remediation technique was required to be selected for each type of site and thus one technique, considered to be the most applicable on a broad basis, was selected for each unit type. The final selection of the remediation alternative to be implemented will ultimately be conducted through a site-specific feasibility study analysis of all technologies that may be appropriate.

The data used in the site characterization and selection of the remediation technologies usually varied in quality from site to site and required that some assumptions be made regarding site conditions, waste constituents, migration pathways, and potential receptors in order to develop a site score. The chemical constituents disposed were generally unknown. In some instances, the radionuclide species disposed were not known. Assumptions were made in all cases and the characterization or remediation need for action was based upon these assumptions regarding potential constituents based on the processes generating the wastes disposed.

In determining the need for action at a particular site, the information available regarding past site remediation activities was considered. Little supporting documentation was present to verify that remediations performed (such as exhumation) removed all the contamination. Several terms were encountered that could have more than one meaning as applied to remediation. For example, the term "stabilized" can refer to physical stabilization (to prevent erosion) or to chemical fixation (to prevent chemical constituent leaching or migration). Chemical fixation would represent an acceptable corrective action whereas erosion control without other measures may not have addressed the problem. This information affected the need for action assessments regarding choices between remediation and verification for no residual contamination.

Overall, the RCRA 3004(u) analysis was conducted on a site-by-site basis. The analysis is a subjective one and may be subject to change through consideration of additional information regarding wastes disposed and past actions taken, as well as monitoring results that can serve as indicators of hazardous constituent release to the environment. Additional

consideration of site groupings is appropriate both to obtain regional characterizations and remediation strategies that will be more practical for implementation (considering the complex waste management unit interactions present) and more cost-effective.

4.0 COST AND SCHEDULE BENEFITS FROM GROUPING OF SITES

The previous analyses of characterization costs apply on a site-by-site basis. In reality, many of the sites are in such close proximity that they are indistinguishable as units in terms of characterization or remediation because any releases in the subsurface may have been transported to adjacent units. In addition, since some of the RCRA sites are located amidst multiple CERCLA units, therefore the designation as a RCRA site or a CERCLA site may be an artificial distinction.

Characterization and remediation can be more realistically costed and scheduled by considering site groupings which result in time and cost reductions. The following sections identify the RCRA site groupings by area (Section 4.1) and then RCRA/CERCLA group (Section 4.2). Section 4.1 groupings do not effect the characterization or remediation costs however, the groupings in Section 4.2 were considered in developing the costs, manpower and scheduling requirements in Section 4.3.

4.1 RCRA SITE GROUPINGS AND INTERACTION

4.1.1 Site Locations and Groupings

Within a given area, site locations were compared with other RCRA 3004(u) site locations and CERCLA site locations to determine if and how sites may be grouped together for characterization and remediation purposes. Evaluation factors considered included: geographic proximity of sites, need for action category, and potential for contamination from other nearby sites (subsurface and surface interactions). Geographic proximity was the major factor in site groupings. Sites within 100 feet of each other were generally grouped together.

The need for action category was frequently readjusted to account for nearby contamination sources. For example, three or four cribs were adjacent to each other. One crib, based on the data evaluated, was to be remediated while the others were used sufficiently long ago that verification of no residual contamination was an appropriate action. Under such circumstances, the need for action was "upgraded" to remediation because of the influence of the nearby site.

It is common for more than one waste management unit type to be grouped together. Timing of characterization efforts was an additional factor in establishing the site groupings. A more extensive site characterization/remediation effort in one area could readily accommodate a limited sampling effort in the same vicinity. The following sections describe the site groupings determined in each area.

4.1.1.1 100B/C Area

In the 100B/C Area, 28 RCRA sites have been identified. Of these 28 sites, 12 may be organized into groups. The remaining 16 sites would be addressed individually.

The 12 sites have been organized into five groups of waste sites to facilitate scheduling and planning of anticipated additional site investigation. In each grouping, waste sites are as follows:

A.	116-B-6(1)	111B Crib
	116-B-6-2	111B Crib
	118-B-7	Burial Ground
	118-B-5	Burial Ground
B.	116-B-10	Dry well, Quench Tank
	118-B-6	Burial Ground
C.	116-B-5	Crib
	116-B-9	French Drain
D.	118-B-3	Burial Ground (Construction)
	118-B-2	Burial Ground (Construction)
E.	107-B	Retention basin
	107-C	Retention basin (tanks)

In the first four groups have been identified as requiring verification that no hazardous constituents or residual contamination remains. Release of contaminants to subsurface soil is projected to have occured at all sites. The individual groupings are based on geographic proximity.

Group E consists of three large retention basins exhibiting residual radioactivity and surrounded by contaminated soil, and a CERCLA site (trench) which received effluent from the retention basins. Although these sites are encompassed by a relatively large area (1000 feet on each side), it is useful to consider these sites as a unit for the purpose of corrective action as they are part of the same processing facility and the zones of contamination for each one may be indistinguishable. Site remediation has been recommended for both RCRA sites 107-B and 107-C.

4.1.1.2 100 D/DR Area

In the 100 D/DR Area, 24 RCRA sites have been identified. Of these 24 sites, ten may be organized into groups. The remaining sites would be addressed individually.

The ten sites have been organized into four groups of waste sites. Sites within each group are sufficiently close in proximity and like in character to be treated as a unit for the purpose of site remediation/corrective action. The groups are as follows:

A.	116-DR-4	Crib
	116-DR-3	Crib
	118-D-5	Burial Ground
	116-DR-8	Crib
B.	116-D-3	French Drain
	116-D-4	French Drain
C.	116-D-6	French Drain
	116-D-2	Crib
D.	107-D	Retention Basin
	107-DR	Retention Basin

In Group A, subsurface soil contamination is likely to be an issue at each site and the sites are located near one another. It has been recommended that these sites be examined for residual contamination. In Groups B and C, French Drains and Cribs are located in close proximity. Again, subsurface soil contamination is anticipated to have occured and each site should be evaluated for residual contamination. Group D consists of two Retention Basins both of which are currently radioactive. Soil contamination has been documented and surface water and ground water contamination is likely to have occured. Remediation has been recommended for both sites in this group.

4.1.1.3 100 F Area

In the 100 F Area, 22 RCRA sites have been identified. Of these 22 sites, eight sites may be organized into groups. The remaining sites would be addressed individually.

The eight sites have been organized into four groups of waste sites to facilitate planning and scheduling of site remediation/corrective action. Waste sites in each of these groups are sufficiently close in proximity or like in character to be considered as a unit. The four groups are as follows:

<u>Group A</u>

118-F-1	Burial Ground
118-F-6	Solid Waste Burial Ground

<u>Group B</u>

116-F-13	Experimental garden
116-F-12	French drain

<u>Group C</u>

116-F-11	French drain
1608-F	Pumping station

Group D

118-F-4	Pit
118-F-3	Burial ground

The release of contaminants to soil is the primary issue at all of these sites. Recommendations have been made to verify that no release has occured, or to verify that no hazardous constituents or residual contamination remains. The geographic proximity of the sites was a major factor in each grouping.

In developing plans for remediation in the 100 F Area, CERCLA site 116-F-3 is quite close to RCRA site 116-F-4 (crib) and these two sites could be addressed together.

4.1.1.4 100 H Area

In the 100 H Area, 15 RCRA sites have been identified. These sites are not sufficiently close enough in proximity, or like in character, to develop RCRA "groupings" for the purposes of site remediation/corrective action.

4.1.1.5 100 KE/KW Area

In the 100 KE/KW Area, 23 RCRA sites have been identified. Of these 23 sites, ten sites may be organized into groups. The remaining sites would be addressed individually.

The ten sites have been organized into three groups of waste sites to facilitate scheduling/planning of site remediation and corrective action. These sites are sufficiently close in proximity and like in character to warrant consideration as a unit or group. The first group (A) is composed of four RCRA sites, but is in the immediate vicinity of two related CERCLA sites, as follows:

Group A

183-KE Sodium dichromate tank
183-KE1 Sulfuric acid tank
183-KE2 Sulfuric acid tank
100KE*3 Filter water facility trench
(100KE*2: CERCLA site)
(100KE*1: CERCLA site)

In Group B, release of contaminants to soil is the primary issue of concern. Recommendations have been made to verify that no residual contamination remains, or that no release has occured.

Group B

116-KE-3	French drain
116-KE-1	Crib
105-KE	Diesel fuel tank.

Group C is composed of three RCRA sites but is in the vicinity of two related CERCLA sites. The RCRA-designated sites, release of contaminants to soil is anticipated to have occured, and recommendations have been made to verify that no residual contamination remains.

Group C

183-KW	Sodium dichromate tank
183-KW1	Sulfuric acid tank
183-KW2	Sulfuric acid tank
(100KW*2	CERCLA site)
(100KW*1	CERCLA site)

4.1.1.6 100 N Area

In the 100 N Area, 11 RCRA sites have been identified. Of these 11 sites, eight sites may be organized into groups. The remaining sites would be addressed individually.

The eight sites have been organized into three groups of waste sites to facilitate scheduling/planning of site remediation and corrective action. Waste sites within each of these groups are sufficiently close in proximity and like in character to be treated as a unit. Group A consists of two French drains which have received sulfuric acid:

Group A

108-N	French drain
120-N-7	Acid unloading facility French drain

Soil contamination is the primary issue of concern at both sites.

Group B consists of four septic tanks. Subsurface soil contamination is anticipated at all of these locations and recommendations have been made to verify that no residual contamination remains.

Group B

124-N-5	Septic tank
124-N-6	Septic tank
124-N-7	Septic tank
124-N-8	Septic tank

Group C consists of two sites at which diesel oil supply line leaks had occured.

UN-116-N-22
UN-116-N-23.

4.1.1.7 200 East Area

In the 200 East Area, 155 sites have been identified. Of these 155 sites, 118 RCRA sites may be organized into groups. The remaining sites would be addressed individually.

The 118 sites have been organized into twenty-six (26) groups of waste units. These units are grouped based on: (1) their proximity, (2) their

commonalities such as type of unit, type of wastes, or type of releases to the environment, and (3) a combination of these two factors.

The grouping of the waste units in the 200 East Area is as follows:

Group A

216-B-47	Crib
(216-B-48	CERCLA)
(216-B-49	CERCLA)
(216-B-50	CERCLA)
(216-B-43	CERCLA
(216-B-44	CERCLA)
(216-B-45	CERCLA)
(216-B-46	CERCLA)

Group B

241-BX	Tank Farm
241-BXR-153	Diversion Box
241-BX-155	Diversion Box
241-BX-153	Diversion Box
241-BXR-152	Diversion Box
241-BX-154	Diversion Box
241-BX-302-A	Catch Tank
241-BX-302-B	Catch Tank
241-BX-302-C	Catch Tank

(Sites are within confines of tank farm boundary.)

Group C

241-BY	Tank Farm
241-BYR-151	Diversion Box
241-BYR-152	Diversion Box
241-BYR-153	Diversion Box
241-BYR-154	Diversion Box

(Sites are within confines of tank farm boundary.)

Group D

241-B	Tank Farm
241-B-151	Diversion Box
241-B-152	Diversion Box
241-B-153	Diversion Box
241-B-154	Diversion Box
241-B-252	Diversion Box
241-BR-152	Diversion Box
242-B	Evaporator
241-B-301-B	Catch Tank
241-B-301-C	Catch Tank
241-B-302-B	Catch Tank

(Sites are within confines of tank farm boundary.)

Group E

216-B-35	Trench
216-B-36	Trench
216-B-37	Trench
216-B-38	Trench
216-B-39	Trench
216-B-40	Trench
216-B-41	Trench
216-B-42	Trench

Group F

218-E-2	Burial Ground
218-E-5	Burial Ground
218-E-9	Burial Vault
218-E-2A	Burial Ground
218-E-4	Burial Ground
218-E-5A	Burial Ground

Group G

216-B-4	Reverse Well
216-B-13	French Drain
218-E-6	Burial Ground
218-E-7	Burial Vaults
UPR-200-E-80	Waste Line

Group H

216-B-10B	Crib
(216-B-10A	CERCLA)

Group I

216-B-2-1	Ditch
(216-B-2-2	CERCLA)

Group J

216-B-3-1	Ditch
216-B-3-2	Ditch

Group K

241-C	Tank Farm
241-C-252	Diversion Box
241-C-151	Diversion Box
241-C-152	Diversion Box
241-C-153	Diversion Box
241-C-154	Diversion Box
241-CR-151	Diversion Box
241-CR-152	Diversion Box
241-CR-153	Diversion Box

(Sites are within confines of tank farm boundary.)

Group L

216-A-18	Trench
216-A-19	Trench
216-A-20	Trench
216-A-34	Ditch

Group M

241-AZ-151	Diverter Station
241-AZ-151	Catch Tank
216-A-39	Crib

Group N

216-A-41	Crib
(216-A-40	CERCLA)

Group O

241-CX-70	Tank
241-CX-72	Tank
241-C-6	Crib
241-C-5	Crib
(216-C-1	CERCLA)

Group P

216-C-4	Crib
216-C-3	Leaching Pit

Group Q

216-A-3	Crib
216-A-22	Crib
(216-A-28	CERCLA)

Group R

216-A-13	French Drain
216-A-35	French Drain

Group S

216-A-12	French Drain
216-A-14	French Drain

Group T

216-A-15	French Drain
(216-A-5	CERCLA)

Group U

216-A-33	French Drain
216-A-2	Crib
216-A-26A	French Drain
(216-A-4	CERCLA)

Group V

241-A	Tank Farm
216-A-16	French Drain
216-A-17	French Drain
216-A-23A	French Drain
216-A-23B	French Drain
241-A-152	Diversion Box
241-A-153	Diversion Box
241-A-302-B	Catch Tank

Group W

241-AY-152	Diversion Box
241-AY-152	Diverter Station

Group X

216-A-1	Crib
(216-A-7	CERCLA)

Group Y

216-B-14	Crib
216-B-15	Crib
(216-B-16	CERCLA)
216-B-17	Crib
216-B-18	Crib
216-B-19	Crib

Group Z

216-B-20	Trench
216-B-21	Trench
216-B-22	Trench
216-B-23	Trench
216-B-24	Trench
216-B-25	Trench
216-B-26	Trench
216-B-27	Trench
216-B-28	Trench
216-B-29	Trench
216-B-30	Trench
216-B-31	Trench
216-B-32	Trench
216-B-33	Trench
216-B-34	Trench
216-B-52	Trench
216-B-53A	Trench
216-B-53B	Trench
216-B-54	Trench
216-B-58	Trench

4.1.1.8 200 West Area

In the 200 West Area, 147 sites have been identified. Of these 147 sites, 79 RCRA sites may be organized into groups. The remaining sites would be addressed individually.

The 79 sites have been organized into eighteen (18) groups of waste units. These units are grouped based on: (1) their proximity, (2) their commonalities such as type of units, type of wastes, or type of releases to the environment, and (3) a combination of these two factors.

The grouping of the waste units in the 200 West area is as follows:

Group A

216-T-14	Trench
216-T-15	Trench
216-T-16	Trench
216-T-17	Trench

Group B

216-T-26	Crib
216-T-27	Crib
(216-T-28	CERCLA)

Group C

216-Z-6	Crib
216-Z-17	Ditch
216-Z-4	Trench
216-Z-5	Crib
(216-Z-10	CERCLA)

Group D

216-T-9	Trench
216-T-10	Trench
216-T-11	Trench

Group E

216-T-21	Trench
216-T-22	Trench
216-T-23	Trench
216-T-24	Trench
216-T-25	Trench

Group F

216-Z-1A	Tile Field
(216-Z-1&2	CERCLA)

Group G

216-S-15	Pond
(216-S-3	CERCLA)

Group H

216-T-4-1	Ditch
216-T-4-2	Ditch
216-T-4	Pond

Group I

216-U-6	Trench
216-U-5	Trench
216-U-7	French Drain

Group J

218-W-4A	Burial Ground
218-W-11	Burial Ground
218-W-1	Burial Ground
218-W-2	Burial Ground
218-W-3	Burial Ground

Group K

216-Z-1	Ditch
216-Z-19	Ditch
216-Z-11	Ditch
216-Z-9	Ditch
216-U-10	Pond

Group L

218-W-7	Vault
218-W-8	Vault

Group M

241-UR-154	Diversion Box
241-UR-153	Diversion Box
241-U-252	Diversion Box
241-U-153	Diversion Box
241-UR-152	Diversion Box
241-U-301	Catch Tank
241-U	Tank Farm
244-UR	Vault

(Sites are within confines of tank unit boundary.)

Group N

240-S-151	Diversion Box
240-S-152	Diversion Box
241-S-152	Diversion Box

240-S-302	Catch Tank
241-S	Tank Farm

(Sites are within confines of tank farm boundary.)

Group O

241-SX-151	Diversion Box
241-SX-152	Diversion Box
241-SX-302	Catch Tank
241-SX	Tank Farm

(Sites are within confines of tank farm boundary.)

Group P

241-TX-153	Diversion Box
241-TXR-152	Diversion Box
241-TXR-153	Diversion Box
241-TXR-244	Diversion Box
241-TXR-151	Diversion Box
241-TXR-155	Diversion Box
241-TX-302-A	Catch Tank
241-TX-302-B	Catch Tank
241-TX	Tank Farm
242	Evaporator

(Sites are within confines of tank farm boundary.)

Group Q

216-T-13	Trench
216-T-36	Crib
216-T-32	Crib
216-T-5	Trench
241-TR-152	Diversion Box
241-T-152	Diversion Box
241-TR-153	Diversion Box
241-T-151	Diversion Box

241-301-B	Catch Tank
241-T	Tank Farm

(Sites are within confines of tank farm boundary.)

Group R

241-TY-153	Diversion Box
241-TY-302-A	Catch Tank
241-TY-302-B	Catch Tank
241-TY	Tank Farm

(Sites are within confines of tank farm boundary.)

4.1.1.9 200 North Area

In the 200 North Area, seven RCRA sites have been identified. Of these seven sites, two sites may be organized into groups. The remaining sites would be addressed individually. The two sites have been organized into a single grouping for characterization, as follows:

Group A

216-N-2	Trench
216-N-3	Trench

Both trenches have been identified for characterization to determine whether residual contamination is present. The primary consideration is their close proximity.

4.1.1.10 300 Area

In the 300 Area, 18 RCRA sites have been identified. Of these 18 sites, six sites may be organized into groups. The remaining sites would be addressed individually.

The six sites have been organized into three groups of waste sites to facilitate scheduling and planning of site remediation/corrective action. Waste sites in these groups are sufficiently close in proximity to be considered as a unit. These three groups are as follows:

Group A

(no number)	Uranium Acid Spill (313 Bldg)
(no number)	Methanol Storage Tank

Group B

UPR-300-31/40	Unplanned releases
(no number)	311 Tank farm

Group C

(no number)	323 Tanks
316-4	Cribs

In addition to the three groups noted above, a group of four 600 Area waste sites which are located at the northern end of the 300 area, have been identified to facilitate the timing of corrective action. The four burial grounds are sites 618-1, 618-2, 618-3, and 618-8. Sites 618-2 and 618-3 form one large continuous unit.

4.1.1.11 400 Area

In the 400 Area, five sites have been identified. Of these five sites, two sites may be organized into one group. The remaining sites would be addressed individually.

The one site grouping consists of "400 Area retired French drains" and the "400 Area retired Sand bottom Trench". Both of these sites require verification that there are no hazardous constituents associated with the sites.

4.1.1.12 600 Area

With the exception of the four burial grounds near the 300 Area (618-1, 618-2, 618-3, and 618-8), none of the 31 waste sites in the 600 Area are in close enough proximity to constitute a group for the purposes of site

remediation/corrective action. The 600 Area sites should therefore be addressed individually. However, in developing a schedule for further site investigation and remediation, the following sites may be considered together:

- 618-9 West Burial Ground
  618-13 Contaminated Soil Burial Ground
  Horn Rapids Disposal

- 618-7 Burial Ground No. 7
  618-4 Burial Ground No. 4
  618-6 Burial Ground No. 6

The grouping of the burial grounds was described in 4.1.1.10.

4.1.1.13 700 Area

Only one site is identified in the 700 Area. This site, an underground tank, is the only "group" for this area.

4.1.1.14 1100 Area

In the 1100 Area, four sites have been identified. None of these sites are in close enough proximity to constitute a group and should therefore be addressed individually within the 1100 Area.

4.2 RCRA/CERCLA GROUPING

Site groupings at the Hanford Reservation were identified for characterization and remediation purposes. Evaluation factors considered included: geographic proximity of sites, need for action category, and potential for contamination from other nearby sites (subsurface and surface interactions). The resulting groups were assessed for each area at Hanford. Many of the groups initially developed did not include CERCLA sites. However, CERCLA sites in the immediate vicinity of a RCRA grouping were identified. This section outlines the methodology used to determine which RCRA groups can be expanded to "zones" which include both RCRA and CERCLA sites.

The assumptions used to evaluate the interaction of RCRA sites with CERCLA sites include the following:

- Geographic proximity is defined for RCRA groupings as sites within 100 feet of each other and for zones the distance is increased to 300 feet. This is the major factor in both groups and zones.

- Need for action category for RCRA group as the collective assessment of the containment provided by the site in the past and timing of characterization efforts. The inclusion of a CERCLA site in a zone was not determined by the need for action category.

- Potential for contamination is defined as the potential exposure hazards, potential media, impacted, and pathway of migration for RCRA groups. The inclusion of a CERCLA site in a zone was not determined by the potential for contamination.

As identified in Section 4.1, there are RCRA units near CERLA units. As a result of such proximity to a site requiring action, the need for action previously suggested for some RCRA units is reconsidered based on the grouping to reflect the integrated process of recommending resolutions to waste units. For example, group E (200 West) consists of five trenches that are located next to each other. A preliminary review indicated that only trench 216-T-21 required remediation, while the remaining trenches (216-T-22, 23, 24, and 25) would only require verification that there is no residual contamination. However, because of the grouping, all trenches in the group are recommended for remediation since the trench requiring remediation is expected to have impacted the nearby trenches and it is difficult to remediate one without disturbing the other units.

The Hanford Reservation's 100, 200, 300, 400, and 600 Areas sites were analyzed based upon the existing groupings. Twenty-eight zones were developed from RCRA groups and individual CERCLA sites. CERCLA sites were identified and initially associated with RCRA groups based upon proximity. Next, the compatability of unit disposal types was considered. However, having common unit types was not the sole basis for inclusion in the zone, since it was not uncommon for more than one waste management unit type to be

grouped together. The type of waste and/or type of release to the environment were assessed before a candidate CERCLA site was rejected or included in a zone.

The twenty-eight zones can be identified by Hanford (i.e., 200 West, Group Q, or Zone 1). The zones are ranked according to the average HRS score of the CERCLA sites within a zone. Each zone is numbered by this ranking system which establishes a hierarchy for group and site remediation schedules. The twenty-eight zones and the sites which comprise them are as follows:

Zones	Description	Ranking
1.	Group Q (200 West)	2
2.	Group A (200 East)	8
3.	Group Y (200 East)	9
4.	Group T (200 East)	11
5.	Group G (200 West)	13
6.	Group H (200 East)	15
7.	Group U (200 East)	15
8.	Group L (200 West)	15
9.	Group A (100 F)	17
10.	Group F (100 B&C)	18
11.	Group X (200 East)	20
12.	Group C (100 F)	21
13.	Group D (100 D&DR)	22
14.	Group F (100 F)	22
15.	Group A (100 H)	22
16.	Group A (100 K)	22
17.	Group E (100 B&C)	23
18.	Group G (100 B&C)	23
19.	Group B (100 D&DR)	23
20.	Group B (200 West)	25
21.	Group C (100 K)	25
22.	Group O (200 East)	26
23.	Group F (200 West)	27
24.	Group N (200 East)	32
25.	Group Q (200 East)	32

26.	Group C (200 West)	32
27.	Group I (200 East)	34
28.	Group A (100 D&DR)	35

The following sections describe the zones determined in each area.

4.2.1 100 B/C Area

In the 100 B/C Area, four CERCLA sites have been identified. All four sites may be included in RCRA groups to form zones.

The four sites have been included in three RCRA groups to form three zones to facilitate scheduling and planning. In each zone the waste sites are as follows:

Zone 17 (Group E)

107-B	(RCRA)
107-C	(RCRA)
116-B-1	
116-C-1	

Zone 10 (Group F)

116-B-3	(RCRA)
116-B-4	

Zone 18 (Group G)

118-C-1	(RCRA)
118-C-2-2	(RCRA)
116-C-2	

4.2.2 100 D/DR Area

In the 100 D/DR Area, five CERCLA sites have been identified. Three of the sites may be included in RCRA groups to form zones. One of the sites is

grouped with an individual RCRA site (116-D-1A) forming a fourth zone. The remaining site would be addressed individually. In each zone the waste sites are as follows:

Zone 13 (Group D)

107-D	(RCRA)
107-DR	(RCRA)
116-DR-1	
116-DR-2	

Zone 19 (Group B)

116-D-1A	(Individual RCRA site)
116-D-1B	

Zone 28 (Group A)

116-DR-4	(RCRA)
116-DR-3	(RCRA)
118-D-5	(RCRA)
116-DR-8	(RCRA)
116-DR-7	

4.2.3 100 F Area

In the 100 F Area, six CERCLA sites have been identified. All sites may be grouped with individual RCRA sites forming three zones. In each zone the waste sites are as follows:

Zone 17 (Group E)

118-F-2	(Individual RCRA site)
116-F-1	

Zone 23 (Group F)

107-F (Individual RCRA site)
116-F-9
116-F-2

Zone 18 (Group G)

116-F-4 (RCRA)
116-F-3
116-F-6
116-F-10

4.2.4 100 H Area

In the 100 H Area, three CERCLA sites have been identified. Two sites may be grouped with an individual (118-H-5) RCRA site forming a zone. RCRA site 118-H-5 is near the 116-H-2 and 116-H-3 CERCLA sites and may be influencing each other (i.e., subsurface interactions). The remaining site would be addressed individually. The waste site in the zone are as follows:

Zone 15 (Group A)

118-H-5
116-H-2
116-H-3

4.2.5 100 KE/KW Area

In the 100 K, Area four CERCLA sites have been identified. All four sites may be included in RCRA group to form zones.

The four sites have been included in two RCRA groups to form two zones. In each zone the waste sites are as follows:

Zone 16 (Group A)

183-KE
183-KE1
183-KE2
100 KE*2
100 KE*2
100 KE*1

Zone 21 (Group C)

183-KW
183-KW1
183 KW2
100 KW*2
100 KW*1

4.2.6 200 Area CERCLA Sites

In the 200 Area, 52 sites have been identified. Of these 52 sites, 38 sites may be organized into groups or zones.

In the 200 West area 14 CERCLA sites have been organized into four groups of CERCLA-only waste units. These units are grouped based on: (1) their proximity, (2) their commonalities such as type of unit, type of waste, or type of releases to the environment, and (3) a combination of these factors, with proximity being the major factor.

The grouping of the CERCLA waste units in the 200 West Area is as follows:

Group I

216-S-15	Crib
216-S-6	Crib
216-S-17	Pond
216-S-16P	Pond
216-S-16D	Ditch

Group II

216-S-1&2	Crib (2)
216-S-7	Crib
216-S-3	French Drain
216-S-9	Crib

Group IV

216-S-4	French Drain
216-S-21	Crib

Group IV

216-U-4	Reverse Well
216-U-4A	French Drain
216-U-4B	French Drain

4.2.7 200 East Area

In the 200 East Area, 26 sites have been identified. Of these 26 sites, 18 of the sites may be included in RCRA groups to form zones. Fourteen CERCLA sites may be included in RCRA groups to form zones. Four of the sites are grouped with individual RCRA sites to form zones. The remaining eight sites would be addressed individually.

The 15 CERCLA sites have been included in six RCRA groups to form six zones. Four CERCLA sites have been grouped with individual RCRA groups forming four zones. In each zone the waste sites are as follows:

Zone 2 (Group A)

216-B-47	(RCRA)
216-B-48	
216-B-49	
216-B-50	
216-B-43	

216-B-44
216-B-45
216-B-46

Zone 6 (Group H)

216-B-10B	(RCRA)
216-B-10A	
216-B-6	

Zone 27 (Group I)

216-B-2-1	(Individual RCRA Site)
216-B-2-2	

Zone 24 (Group N)

216-A-41	(Individual RCRA site)
216-A-40	

Zone 22 (Group O)

241-CX-70	(RCRA)
241-CS-72	(RCRA)
216-C-6	(RCRA)
216-C-5	(RCRA)
216-C-1	
216-C-10	

Zone 25 (Group Q)

216-A-3	(RCRA)
216-A-22	(RCRA)
216-A-28	

Zone 4 (Group T)

216-A-15	(Individual RCRA Site)
216-A-5	

Zone 7 (Group U)

216-A-33	(RCRA)
216-A-2	(RCRA)
216-A-26A	(RCRA)
216-A-4	

Zone 11 (Group X)

216-A-1	(Individual RCRA site)
216-A-7	

Zone 3 (Group Y)

216-B-14	(RCRA)
216-B-15	(RCRA)
216-B-16	
216-B-17	(RCRA)
216-B-18	(RCRA)
216-B-19	(RCRA)

4.2.8 200 West Area

In the 200 West Area, 20 CERCLA sites have been identified. Of the 20 sites, 12 may be included in the RCRA groups to form zones. Two of the sites are grouped with individual RCRA sites to form zones. The remaining six sites would be addressed individually.

The 12 CERCLA sites have been included in four RCRA groups to form four zones. Two CERCLA sites have been grouped with individual RCRA sites to form tow zones. In each zone the waste sites are as follows:

Zone 20 (Group B)

216-T-26	(RCRA)
216-T-27	(RCRA)
216-T-28	

Zone 26 (Group C)

216-Z-6	(RCRA)
216-Z-17	(RCRA)
216-Z-4	(RCRA)
216-Z-5	(RCRA)
216-Z-10	

Zone 23 (Group F)

216-Z-1A	(Individual RCRA site)
216-Z-1&2	

Zone 5 (Group G)

216-S-15	(Individual RCRA site)
216-S-3	

Zone 8 (Group L)

218-W-7	(RCRA)
218-W-8	(RCRA)
216-T-8	

Zone 1 (Group Q)

241-TR-152	(RCRA)
241-T-152	(RCRA)
241-TR-153	(RCRA)
241-T-151	(RCRA)
241-301-B	(RCRA)
241-T	(RCRA)

216-T-7
216-T-13 (RCRA)
216-T-36 (RCRA)
216-T-32 (RCRA)
216-T-5 (RCRA)

4.3 COST REDUCTIONS FOR RCRA/CERCLA GROUPINGS

As has been suggested previously, addressing waste management units on an individual versus group basis has resulted in high characterization and remediation cost estimates. These costs can be lowered substantially if similar type units in close proximity to one another can be addressed as one larger unit. Cost savings result for a number of reasons related to economies of scale including decreased planning costs, reduction in the number of required groundwater and/or soil samples, elimination of double counting related to excavation areas and sampling, etc. The reductions in characterization and remediation costs that can be realized by grouping units, where possible and/or practical, are illustrated in the examples that follow and are summarized in Table 4-1. Table 4-1 presents the number of individual RCRA units that comprise a given RCRA group, the estimated cost for characterizing each individual unit independent of the group, the estimated characterization cost for characterizing the group itself, and the estimated (RCRA) cost savings, if any, related to addressing the units as a group. Cost savings for RCRA/CERCLA groupings are also noted. Appendix I presents example calculations of cost reductions.

For the 56 site groups considered in Table 4-1, characterizing 342 RCRA units individually would cost $966,254,200. By grouping the sites together, characterization costs are an estimated $183,745,500 for a reduction of $782,508,700 or 81 percent for the sites. Thus, the characterization costs for RCRA sites, as estimated in Section 3.2 to be a total of $1,240,000,000 can be reduced significantly through groupings of RCRA sites or units and groupings of RCRA sites with CERCLA sites.

Additional reductions may be achieved in remediating sites in groups or regions.

TABLE 4-1. COST REDUCTIONS THROUGH GROUPING RCRA SITES AND RCRA/CERCLA SITES FOR CHARACTERIZATION

Area	# of Units in Group	Characterization Costs as Individual Units	Characterization Costs as a Group	Estimate of Cost Savings
100 North Area				
Group B	4	115,600	115,600	None expected
100 K Area				
Group B	3	2,363,300	1,415,600	947,700
Group A (R/C)	4	4,639,000	438,000	4,201,000
Group C (R/C)	3	375,000	250,000	125,000
100 F Area				
Group A	2	5,028,000	2,393,300	2,634,700
Group B	2	560,000	560,000	None Expected
Group C	2	1,062,200	929,400	132,800
Group D	2	5,028,000	1,307,000	3,721,000
Group A (R/C)	1	No change	No change	No change
Group B (R/C)	1	916,100	0(1)	916,100
Group C (R/C)	1	531,100	0(1)	531,100
100 BC Area				
Group A	4	6,090,200	1,427,700	4,662,500
Group B	2	3,045,100	1,427,700	1,617,400
Group C	2	1,062,200	1,062,200	None Expected
Group D	2	57,800	57,800	None Expected
Group A (R/C)	2	1,832,200	1,689,000	143,200
Group B (R/C)	1	531,100	0(1)	531,100
Group C (R/C)	2	3,045,100	2,514,000	531,100

R/C = RCRA/CERCLA Grouping.
(1) Costs are included in CERCLA Characterization.

TABLE 4-1. COST REDUCTIONS THROUGH GROUPING RCRA SITES AND RCRA/CERCLA SITES FOR CHARACTERIZATION (continued)

Area	# of Units in Group	Characterization Costs as Individual Units	Characterization Costs as a Group	Estimate of Cost Savings
100 D and 100 DR Area				
Group B	2	1,062,200	1,062,200	None Expected
Group C	2	1,062,200	1,062,200	None Expected
Group A (R/C)	2	1,832,200	0[1]	1,832,200
Group B (R/C)	1	No change	No change	No change
Group C (R/C)	4	5,366,000	1,790,000	3,576,000
200 East				
Groups B, C, D,	58	56,318,600	6,053,000	50,265,600
Group E	8	44,536,000	9,081,500	35,454,500
Group F	6	28,710,200	7,256,800	21,453,400
Group G	5	9,150,400	4,076,000	5,074,400
Group K	20	36,016,000	3,076,400	32,939,600
Group R	2	3,324,000	2,443,000	881,000
Group S	2	3,324,000	2,443,000	881,000
Group V	13	22,855,200	3,501,600	19,353,600
Group Z	20	$111,340,000	$19,625,000	$91,715,000
Group A (R/C)	1	1,800,800	0(1)	1,800,800
Group I (R/C)	1	2,651,200	2,512,000	139,200
Group Q (R/C)	2	3,324,000	1,662,000	1,662,000
Group Y (R/C)	5	9,004,000	4,352,000	4,652,000
Group X (R/C)	1	1,800,800	0(1)	1,800,800

R/C = RCRA/CERCLA Grouping.
(1) Costs are included in CERCLA Characterization.

TABLE 4-1. COST REDUCTIONS THROUGH GROUPING RCRA SITES AND RCRA/CERCLA SITES FOR CHARACTERIZATION (continued)

Area	# of Units in Group	Characterization Costs as Individual Units	Characterization Costs as a Group	Estimate of Cost Savings
200 West				
Group A	4	10,604,800	1,800,800	8,804,000
Group D	3	16,701,000	2,443,000	14,258,000
Group E	5	13,256,000	2,844,000	10,412,000
Group H	3	23,730,000	17,494,400	6,235,600
Group I	2	11,134,000	11,134,000	None Expected
Group K	5	45,671,200	28,588,400	17,082,800
Group M	17	40,492,800	4,352,000	36,140,800
Group N	16	288,130,000	4,352,000	283,778,000
Group O	18	32,414,400	4,352,000	28,062,400
Group P	27	46,945,800	5,202,400	41,743,400
Group Q	26	56,318,600	6,478,000	49,840,600
Group R	9	16,207,200	3,927,000	12,280,200
Group B (R/C)	2	3,601,600	935,000	2,666,600
Group C (R/C)	4	14,856,800	2,651,000	12,205,800
Group F (R/C)	2	3,462,800	1,800,800	1,662,000
200 North Area				
Group A	2	11,134,000	4,076,000	7,058,000
300 Area				
Group D	2	8,152,000	2,208,700	5,943,300

R/C = RCRA/CERCLA Grouping.
(1) Costs are included in CERCLA Characterization.

4.4 MASTER SCHEDULE FOR RCRA/CERCLA GROUPINGS

Figure 4-1 presents a master schedule covering ten years of site characterization and remediation. The schedule has been constructed in a time line fashion to denote, with a dashed line, those time periods relating to site characterization and to denote, with asterisks, those time periods relating to site remediation activities. The dark solid line visually separates the two time periods. A six month gap has been allowed between site characterization and the beginning of site remediation to accommodate review periods by regulatory agencies anticipated for the remedial investigation reports.

Three lines of cost data are provided at the top of Figure 4-1. The top line presents the yearly expenditures for site characterization. The middle line presents quarterly totals for site characterization. The third line presents the yearly expenditure for site remediation.

The master schedule was constructed using the following assumptions and considerations:

- Unit schedules identified in Sections 2 and 3 were the basis for constructing a master schedule on a site-by-site basis.

- A yearly budget of $50 million for site characterization and $100 million for site remediation was assumed. The first few years of the program were assumed to be a phase-in period for which the yearly budgets were less than full funding. The funding amounts selected were based on budgets that could reasonably be anticipated as compared to budgets anticipated at other DOE facilities.

- CERCLA site characterization costs and schedules involved greater than one year to complete, however, the majority of the funds were anticipated to be expended in the first year for each CERCLA site or grouping. Each RCRA site was considered to have expended the budget for that site within three-fourths to one year.

- Remediation schedules were geared towards completion within a ten to 15 year time frame. This time frame is based on current EPA policy regarding site cleanups: cleanups generally must be completed within 15 years after start.

In constructing the example master schedule shown in Figure 4-1, sites were selected for scheduling on a priority basis. CERCLA sites were considered first. Sites with the hazard ranking of ten or less (HRS score greater than 51) were scheduled first based on the hazard ranking regardless of site location. Then, CERCLA sites in the 200 West Area were scheduled because of the concerns regarding existing multiple contamination plumes. RCRA sites grouped with CERCLA sites were kept in the listing in conjunction with the appropriate CERCLA sites. Sites of major concern that were in the "RCRA" section of this study were also pulled up into the listing to follow those CERCLA sites being characterized nearby. One example is the tank farms in the 200 West area that are pulled up into the listing.

Although the example schedule proceeds through only ten years, the site scheduling effort found that characterization of the CERCLA sites will involve more than ten years of time to complete. Characterization of the RCRA sites is estimated to continue to year 25. Remediation of the sites cannot begin until characterization is complete; and the scheduling analysis indicated that by year 25, remediation may have begun on up to two-thirds of the CERCLA sites given the yearly budget identified above. Less problematic sites, such as RCRA sites requiring only sampling documentation of no contamination problems, may need to be moved up in the schedule so that site characterization for sites known to need remediation is not performed so far in advance of the remediation activities that a site will need to be recharacterized before beginning remediation.

Several limiting factors were used in this analysis. First, the number of drilling rigs available will have a significant impact in some years on the level of activities. The master schedule shown in Figure 4-1 is based on having no more than 25 drilling rigs in operation at any given time. This number was selected as being the number of the type of rigs that could reasonably be expected to be available at one time to support the efforts at the Hanford Reservation. It is very likely that there will be some years in which the full $50 million characterization budget cannot be exercised

FIGURE 4-1. EXAMPLE MASTER SCHEDULE FOR CHARACTERIZATION AND REMEDIATIONS FOR A TEN-YEAR PERIOD.

	Year 1				Year 2				Year 3				Year 4				Year 5			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Annual Characterization Cost				$11,024,464				$12,461,134				$14,649,752				$34,383,744				$150,236,996
Quarterly Characterization Cost	$2,819,021	$2,819,021	$2,819,021	$2,567,401	$3,204,654	$6,362,654	$1,481,913	$1,411,913	$3,328,748	$4,328,748	$4,179,128	$2,813,128	$5,946,196	$9,188,196	$11,838,676	$7,410,676	$33,565,424	$40,157,324	$40,598,124	$35,916,124
Annual Remediation Cost												$800,000				$10,075,000				$101,032,100

Area	Zone	Group	Source	CERCLA	RCRA	Haz Rank
300	-	-	316 - 1	X		1
			316 - 2	X		1
			316 - 3	X		1
200 WEST	1	Q	216-T -7	X		2
			241-TR -152		X	
			241-T -152		X	
			241-TR -153		X	
			241-T -151		X	
			241-301-B		X	
			241-T		X	
			216-T -13		X	
			216-T -36		X	
			216-T -32		X	
			216-T -5		X	
200 EAST	-	-	216-B -7A&B	X		2
	-	-	216-B -5	X		3
200 WEST	-	-	216-T -3	X		4
200 EAST	-	-	216-A -27	X		6
	-	-	216-A -21	X		7
	-	B	241-BX		X	
			241-BXR-153		X	
			241-BX -155		X	
			241-BX -153		X	
			241-BXR-152		X	
			241-BX -154		X	
			241-BX -302-A		X	
			241-BX -302-B		X	
			241-BX -302-C		X	
	-	C	241-BY		X	
			241-BYR-151		X	
			241-BYR-152		X	
			241-BYR-153		X	
			241-BYR-154		X	
	-	D	241-B		X	
			241-B -151		X	
			241-B -152		X	
			241-B -153		X	
			241-B -154		X	
			241-B -252		X	
			241-BR -152		X	
			242-B		X	
			241-B -301-B		X	
			241-B -301-C		X	
			241-B -302-B		X	
	2	A	216-B -48	X		8
			216-B -49	X		
			216-B -50	X		
			216-B -43	X		
			216-B -44	X		
			216-B -45	X		
			216-B -46	X		
			216-B -47		X	
	3	Y	216-B -16	X		9
			216-B -14		X	
			216-B -15		X	
			216-B -17		X	
			216-B -18		X	
			216-B -19		X	
100	-	-	116-K -2	X		10
	-	-	116-K -1	X		
	-	-	107KE		X	
	-	-	107KW		X	
200 WEST	-	-	216-U -1&2	X		13
	7	L	216-T -2	X		15
			216-T -8	X		
			218-W -7		X	
			218-W -8		X	
	-	-	216-T -19	X		16
	-	-	216-S -20	X		19

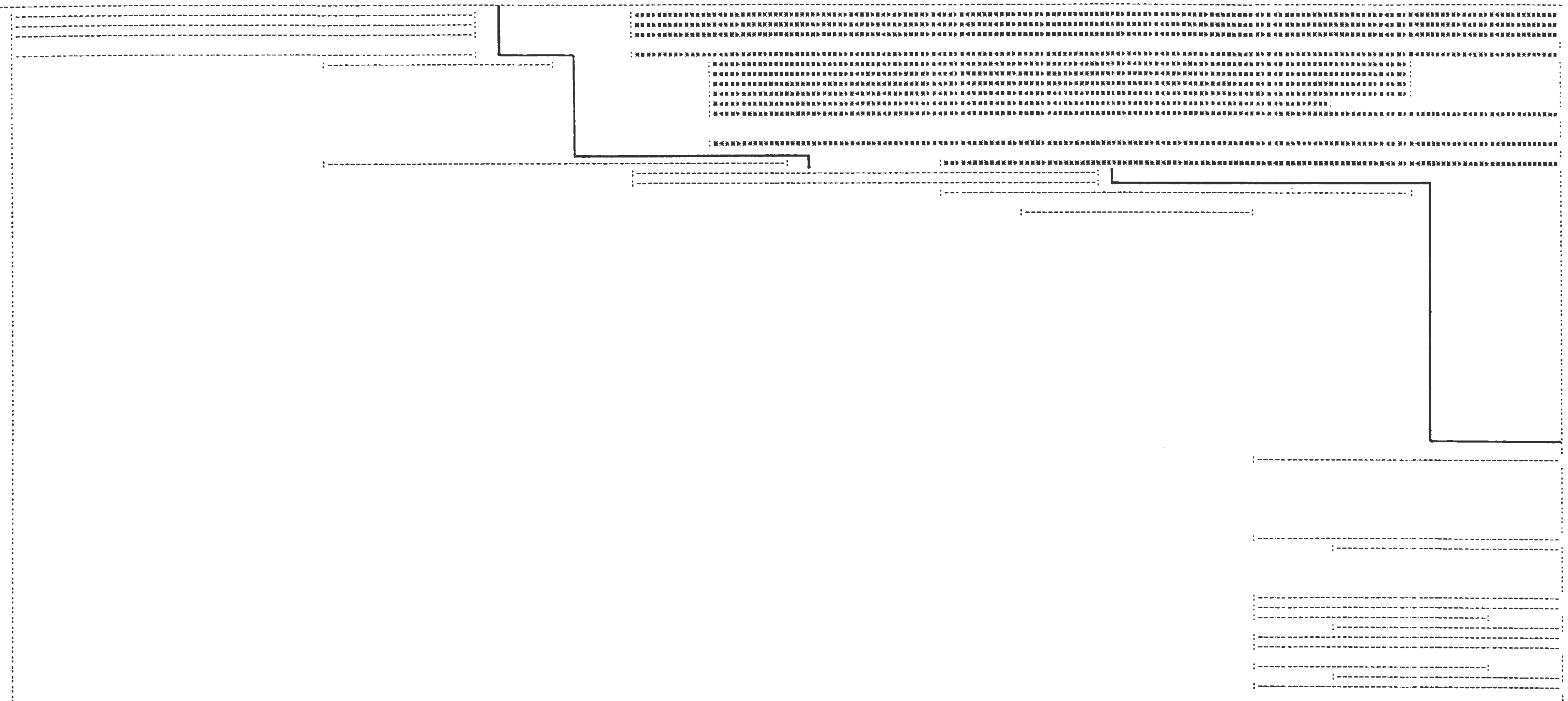

FIGURE 4-1. EXAMPLE MASTER SCHEDULE FOR CHARACTERIZATION AND REMEDIATIONS FOR A TEN-YEAR PERIOD (Continued).

	Year 6				Year 7				Year 8				Year 9				Year 10			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Annual Characterization Cost				$ 49,750,274				$ 50,335,932				$ 49,181,033				$ 49,412,597				$ 50,103,113
Quarterly Characterization Cost	$ 12,336,404	$ 15,955,404	$ 12,642,233	$ 8,816,233	$ 10,081,511	$ 12,794,511	$ 11,188,455	$ 16,281,455	$ 12,267,830	$ 12,849,275	$ 12,031,964	$ 12,031,964	$10,636,746	$ 14,588,801	$ 11,157,660	$ 13,029,390	$ 12,520,398	$ 15,775,208	$ 9,231,298	$ 12,576,209
Annual Remediation Cost				$ 100,224,200				$ 100,345,200				$ 94,312,800				$ 89,653,080				$101,199,000

Area	Group	Source	CERCLA	RCRA
300	-	316 - 1	X	
		316 - 2	X	
		316 - 3	X	
200 WEST	B	216-T -7	X	
		241-TR -152		X
		241-T -152		X
		241-TR -153		X
		241-T -151		X
		241-301-B		X
		241-T		X
		216-T -13		X
		216-T -36		X
		216-T -32		X
		216-T -5		X
200 EAST	-	216-B -7A&B	X	
	-	216-B -5	X	
200 WEST	-	216-T -3	X	
200 EAST	-	216-A -27	X	
	-	216-A -21	X	
	B	241-BX		X
		241-BXR-153		X
		241-BX -155		X
		241-BX -153		X
		241-BXR-152		X
		241-BX -154		X
		241-BX -302-A		X
		241-BX -302-B		X
		241-BX -302-C		X
	C	241-BY		X
		241-BYR-151		X
		241-BYR-152		X
		241-BYR-153		X
		241-BYR-154		X
	D	241-B		X
		241-B -151		X
		241-B -152		X
		241-B -153		X
		241-B -154		X
		241-B -252		X
		241-BR -152		X
		242-B		X
		241-B -301-B		X
		241-B -301-C		X
		241-B -302-B		X
	A	216-B -48	X	
		216-B -49	X	
		216-B -50	X	
		216-B -43	X	
		216-B -44	X	
		216-B -45	X	
		216-B -46	X	
		216-B -47		X
	Y	216-B -16	X	
		216-B -14		X
		216-B -15		X
		216-B -17		X
		216-B -18		X
		216-B -19		X
100	-	116-K -2	X	
	-	116-K -1	X	
	-	107KE		X
	-	107KW		X
200 WEST	-	216-U -1&2	X	
	L	216-T -2	X	
		216-T -8	X	
		218-W -7		X
		218-W -8		X
	-	216-T -19	X	
	-	216-S -20	X	

because the number of available drilling rigs is insufficient. It should be noted that the cost of a particular remedial action could impact the ability to startup new remediations. One or two relatively expensive actions enacted at one time could significantly tie up available funds for several years, thus delaying the startup of new efforts. As described above, the planning process needs to consider such delays in setting up the characterization schedules. Additional limiting factors to ultimately be considered in scheduling remedial actions are the limitations in available manpower and equipment necessary to complete the action.

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INACTIVE WASTE SITE
STUDY REPORT
APPENDICES

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008889
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APPENDIX A

DESCRIPTION OF ENGINEERING ALTERNATIVES (INCLUDING REMEDIAL ACTION TECHNOLOGIES)

A.1 CAP/COVER

A.1.1 General Description

The cap and cover technique provides a horizontal barrier to isolate contaminants within an underlying waste zone and reduce their potential for migration out of this zone. A cap is usually designed as a low permeability barrier to reduce or prevent the movement of surface precipitation down into the contaminated zone. In arid regions, where evapotranspiration regularly exceeds precipitation, a cap can reduce the movement upward to the surface of contaminated water. Other forms of upward contaminant migration that may be reduced by a cap include the withdrawal of contaminated soil moisture by deep rooted plants penetrating into the contaminated zone and the transport of contaminants to the surface by burrowing animals.

The applicability of a cap at Hanford is governed by its prevailing arid climate. Although consideration must be given to an abnormally high precipitation event such as the 100-year storm, the migration of wastes upwards due to the "wicking" of soil moisture and the action of deep rooted plants (Dabrowski, 1973) and burrowing animals (O'Farrell and Gilbert, 1975) are the primary concerns. Because the sites considered for cap/cover deal with low-level radioactive concentrations, the potential for radioactive decay particles penetrating through the 10 to 30 feet of cover soil is expected to be minimal. Site field sampling surveys will determine this later, as described in Section 2, Characterization Plan for CERCLA Sites.

For those sites that contain near the surface a large concentration of radioactive or chemically hazardous materials that cannot be completely or feasibly removed by other technologies, capping can be employed as a barrier above the waste site.

Capping techniques applicable to the Hanford Reservation include:

- Synthetic liners
- Asphalts and asphalt cement

- Reinforced Portland cement
- Low permeability clay bentonite
- Gravel-cobble
- Chemical toxins (herbicides).

An applicable barrier cap may consist of one or a combination of these techniques. For instance, synthetic liners coupled with a soil-bentonite layer are commonly used.

In choosing a technique appropriate to the Hanford Reservation, several concerns must be evaluated. The expected or field-proven life of the cap must be adequate until the wastes within the site are no longer hazardous for contaminant pathways in question. Capital and operation and maintenance costs must also be considered. For sites that are to be capped, consideration must be given to any adjacent active sites that may cause lateral migration of fluids beneath the cap and into the contaminant zone. Subsidence may occur, destroying the cap as the supporting soil beneath it collapses. Many of the waste units considered in this report are cribs, French drains, ditches and trenches. Cribs particularly have a history of subsidence, and if excavation and disposal are used to extract the contaminants concentrated near the surface before a cap is installed, some subsidence is likely.

Long-term monitoring of the cap and site after completion are important. The waste site must be monitored to determine whether contaminants are escaping either to the surface or down towards the ground water. The integrity of the cap must be monitored and periodic maintenance may be needed, such as sealing of asphalt liners that have developed cracks or removal of deep rooted plants and burrowing animals that could disrupt a clay or synthetic liner.

An evaluation of the possible capping technologies indicates that a gravel-cobble barrier or a reinforced concrete cap are the best choices. Synthetic liners and asphalts have too short a life span; it would be necessary to excavate and reinstall a synthetic liner every 20 years. Asphalts, chemical toxins, clays, reinforced concrete, and to some extent

gravel-cobble are susceptible to subsidence. Bentonite must be kept moist to be effective. In the arid climate at Hanford, drying and cracking of a bentonite liner is likely. Chemical toxins are still experimental.

Both reinforced concrete and gravel-cobble can be expensive to install. Reinforced concrete is the more expensive of the two, is susceptible to cracking, and requires periodic repairs to maintain cap integrity. The life span of concrete is also expected to be shorter than that of gravel-cobble. Both, however, are effective against burrowing animals. A gravel-cobble liner offers better long-term protection against surface water infiltration if it is covered with a less permeable layer such as the natural soil found at the Hanford Reservation.

A layer of cobbles (1.49 - 2.99 in. diameter) will create a zone of large void spaces lacking nutrients and water. If this zone is deep enough, plant roots will be prevented from penetrating it. The mass of the cobbles prevents burrowing mammals from tunneling beyond the barrier zone. A gravel layer (.118 - .236 in. diameter) above the cobbles prevents finer sediments within the soil column from passing into and filling the cobble voids. The gravel layer is covered with a soil of lower permeability than the gravel to contain any surface water infiltration and to sustain plant life in order to maintain the evapotranspiration levels normal for the area. Should a large storm event saturate the soil layer, capillary action would draw all or most of the water away from the site, due to its lower permeability, without penetrating into the gravel-cobble layer or into the contaminated zone.

A.1.2 Design and Construction

The barrier zone is the cobble layer. It must be of sufficient mass to deter burrowing mammals and of sufficient void space and depth to inhibit plant roots. The area above the site will be excavated to a depth adequate to contain the cobble layer and the supporting layers placed above. The cobble layer will be at most 2.5 feet deep. To protect the cobble layer from filling with smaller particles over time, a gradation of material sizes, decreasing towards the surface, is used to trap these finer particles as they migrate downward. A gravel layer above the cobbles, approximately

ten inches deep, will serve this function. Approximately 2.5 feet of sandy soil will be placed above this.

An area above and to some prespecified distance laterally beyond the contaminated zone will be excavated. A layer of cobbles will be placed at the bottom of the excavated pit with its upper surface kept level. The gravel layer will be placed and compacted above the cobbles, and backfill will be placed and compacted in six-inch lifts over the site up to the original grade. The remaining backfill will be placed and compacted over the site with the final surface grade designed to withstand wind erosion and to promote surface water runoff. The depth of excavation of each site may be more or less than the five feet assumed in this Appendix. The controlling criteria will be excavate enough soil so that backfilling of all excavated soil will produce a surface grade adequate to withstand the elements. The compacted soil layer must be able to retain the designed-for storm intensity (like the 100-year storm) and prevent surface water from penetrating into the gravel-cobble layers. After installation, a monitoring plan will be implemented to ensure that the cap is effectively deterring deep rooted plants and burrowing mammals and that the integrity of the cap has not been impacted by subsidence, filling of the cobble voids, or by any unforeseen factors that may be detected during periodic monitoring.

Excavation will require a bulldozer or backhoe, depending on the size of the site. Placement of the cobble, gravel and soil layers will be accomplished by a combination of backhoe and hand or bulldozer. Hand-held vibrating tampers will be used to compact the gravel and soil. The gravel and cobble will be imported by truck and the excess excavated soil will be exported by truck.

In selecting a capping technique, the important factors to be considered include 1) the health and safety of the workers (excavation above a crib could result in sudden collapse of the crib itself; the excavated material may be contaminated and require specific health and safety gear), 2) the environmental impact of excavating (wind may disperse excavated contaminated soil), 3) possible inundation by water (such as flooding of the sites near the Columbia River), 4) design of the site to

handle a large storm event (like the 100-year storm), and 5) the expectation that the waste will remain in place and degrade to acceptable radioactive levels or chemical concentrations within a reasonable time. Costs are also of concern; the gravel and cobble must be economically available.

A.1.3 Advantages and Disadvantages

Advantages of the gravel-cobble cap are that it is effective against plant root penetration and burrowing animals, it is not subject to rapid deterioration, and it does not appear to alter water balance relationships when installed correctly (Hakonson et al, 1982). Since it does not deteriorate quickly, operation and maintenance costs should be low over the life of the cap. Disadvantages are that contaminants are still onsite and must be monitored and that subsidence may disrupt the cap.

A.1.4 Remedial Action Schedule

It is assumed that site reconnaissance and surveying have been performed during the earlier characterization phase. It is also assumed that a list of contractors cleared to work at Hanford is available, and that the contractor chosen to implement this remedial action will already be at Hanford and will be able to transfer equipment and personnel from a nearby site.

The remedial action schedules are largely derived from the average daily output values given by construction cost guides (Means, 1985 and Dodge, 1987). Some information has been taken from technical journals when it was more specific than the construction cost guides.

Mobilization of equipment to the generic site and site setup take a day. Excavation to a depth of five feet using two backhoes will take 24 days, installation of the gravel-cobble layers 19 days, and backfilling and compacting the site 53 days. Demobilization and decontamination of equipment will require two days. A total of 19.8 weeks will be required for remedial action implementation. Post remedial action monitoring will

continue for 30 years following the remedial action implementation.

A summary of the remedial action schedule for cap/cover is as follows:

o Mobilization/Setup	0.2 weeks
o Prepare and excavate site	4.8 weeks
o Install gravel-cobble layers	3.8 weeks
o Backfill and compact site	10.6 weeks
o Demobilize and decontaminate site	0.4 weeks
Total	19.8 weeks

A.1.5 Resource Requirements

Excavation and backfilling of the site will require two backhoes, both of which will be used to excavate for several days. Four dump trucks will be required to remove excavated materials. So that large portions of the site are not exposed to the elements (wind or precipitation) for an extended period of time, the backhoes will be used to install the gravel-cobble layers and to perform backfilling operations on the fourth day. Ten dump trucks will be required during backfilling operations, along with four vibrating compactors (with operators) and eight laborers. The excavation and the gravel-cobble layer and backfilling operations will continue in tandem until completion of the gravel-cobble layers and the covering soil layer.

The resource requirements are summarized as follows:

Excavation (53-day duration)

Manpower

4 Teamsters (dump truck operators)
2 Operating Engineers-Hoisting (backhoe operators)
2 Oilers (backhoe support)
2 Laborers (backhoe support)
Equipment

2 Backhoes
4 Dump trucks

Laying gravel-cobble and backfilling (72-day duration)

Manpower

10 Teamsters (dump truck operators)
6 Operating Engineers-Hoisting (2 backhoe operators and 4 vibrating compacter operators)
2 Oilers (backhoe support)
8 Laborers (backhoe support and soil compaction)

Equipment

10 Dump trucks
2 Backhoes
4 Vibrating compacters

Materials

7580 yd^3 Cobble
2530 yd^3 Gravel

A.1.6 Costs

The depth of excavation for placement of the cobble layer is five feet. The cap is designed to extend 20 feet in all directions beyond the area of contamination. Side slopes of the excavated site will be 1:1. These criteria have been used to compute the areal extent of contamination for all sites that considered cap/cover as a remedial action. The average of the two median sites gave a cross-sectioned area of 9100 yd^2 to be capped. This generic site was used for costing.
It is assumed that eight hours are worked per day and that holidays are

ignored. All costs, except the cost of applying the cobble and gravel layers, have been taken from Dodge, 1987. Table A.1.1 summarizes costs for the cap/cover technology.

A.1.7 References

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O'Farrel, T.P. and R.O. Gilbert. 1975. Transport of Radioactive Materials by Jackrabbits on the Hanford Reservation, Health Phys. 29:9-15.

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TABLE A.1.1 CAP/COVER COSTS

	Hourly Rate ($/hr)	Total Cost ($/yr)
Labor[1]:		
1 Site Superintendent	58	$120,640/yr
1 Health & Safety Supervisor	48	99,840/yr
2 Radiation Safety Technicians (40% of time) (Additional labor cost for equipment operators included in equipment costs)	28	46,600/yr
	Subtotal	$267,080/yr
Equipment		
2 Backhoes w/operators and support ($2.49/yd^3)[2]		$ 39,100
10 Dump Trucks w/drivers 1/4 mile round trip ($1.22/yd^3)		19,200
4 Vibrating Compacters w/operators and support ($9.25/yd^3)		145,000
	Subtotal	$203,000
Materials & Safety		
Cobble, 2.5 ft thick ($7.19/yd^2 installed)[3]		$ 65,400
Gravel, 10 in thick ($3.60/yd^2 installed and compacted)[4]		32,800
Health and Safety (5 men including backhoe operator @ $25/day/man during excavation and laying of cobble only = 11 wks)		9,000
	Subtotal	$107,200

Total Cost = Equip + Materials & Safety + Labor for 11 weeks

= $203,000 + 107,200 + (19.8/52) (267,000) = $412,000/unit site

Unit Cost = $412,000/9,100 yd^2
= $45/yd^2

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(1) Kaiser Labor Rates
(2) Means 1987
(3) Hakonson et al. 1982 (adjusted)
(4) Dodge 1987

A.2 GROUT-IN-PLACE

A.2.1 General Description

Grouting is a process whereby one of a variety of suspensions or fluids is injected into an earth formation where it is allowed to set in place. The purpose of this process may be to impart additional strength to the formation, reduce the permeability of the formation, or, in theory, to stabilize and solidify a body of waste or soil in situ. It should be noted that waste stabilization/solidification using grouting techniques is not an established remedial technology and would require further development before it could be used with confidence.

Grout injection may be accomplished by a variety of techniques including curtain grouting, jet grouting, and area grouting. Curtain grouting involves creating an underground barrier wall by injecting columns of grout that overlap vertically and horizontally. Jet grouting employs a high-pressure nozzle to cut a kerf in soil or soft rock where grout is allowed to set. Area or blanket grouting is a low-pressure technique for injecting and stabilizing shallow soils for reduced infiltration or increased strength.

The three general classes of grout utilized today are as follows:

- Suspension grouts
- Chemical grouts
- Bituminous grouts (Tiedemann and Graver, 1982; Bowen, 1981)

Suspension grouts are the most common type of grout and include coarse grouts that contain particles in suspension. Cement, clay, and cement-clay grouts are in this category. These materials are usually the more viscous of the available grouting materials and have the largest particle size. These grouts are restricted to use in the grouting of fractured rock or coarse grained material.

Chemical grouts rely on polymerization reactions to form hardened gels. They have initially low viscosities and thus can be used in finer grained, cohesionless soils as well as a secondary treatment for grouting of coarse soils and rock fissures. Some chemical grouts such as urethane can be suspensions that undergo polymerization to form a gel. This class of grout is comprised of two subclasses: silicates and organic polymer grouts.

Bituminous grouts can be either emulsions of bitumen in water or asphalts. These grouts can be used to seal soils, fill rock cavities, or construct thin cutoff walls.

A.2.2 Design and Construction

The nature of the earth materials at a site will greatly influence the type of grout to be used. If soil materials are to be grouted, the characteristics that must be determined include:

- Permeability
- Porosity
- Particle size distribution

Permeability will influence the selection of grout type (particulate or chemical) to be used, the allowable viscosity, and the required injection pressures (Bowen, 1981). The porosity, or voids ratio, will give an indication of the amount of grout a unit volume of soil will "take," and how rapidly grout may be injected (Herndon and Lenahan, 1976a). The particle size distribution indicates, among other things, the presence of large particles that could interfere with grout injection.

After a detailed site and waste characterization is completed, a grout capable of being injected into the treatment area and immobilizing the wastes must be formulated. For this discussion, it is assumed that a chemical grout is suitable for the alluvial deposits found at Hanford and is also capable of solidifying the waste deposits and immobilizing their hazardous constituents. In actual practice, bench and pilot scale testing

would be required on a site-specific level to determine if these assumptions are valid.

Based on background and exploratory data, the location for a pattern of primary injection holes is chosen and injection at one or more zones is identified. Based on field experience in similar soil types, it was estimated that the primary holes would be on 20-foot centers. The first few primary holes are then drilled and slotted grout pipes installed (Millet and Engelhardt, 1982). Background and exploratory data are also used to identify each vertical zone or stage to be grouted. The grout pipe, usually small diameter PVC pipe, is then slotted to allow grout penetration into the formation. Starting at the bottom, successive stages are sealed off using a pneumatic packer and then pressure grouted. Each hole is then pressure tested, often using a nonsetting fluid of the same viscosity as the grout. These tests are used to determine the initial grout mixture and are often conducted using the grout plant and other equipment to be used for the actual grouting (Millet and Engelhardt, 1982 and Karol, 1982a).

Each zone within each primary hole is then injected with the grout mixture until a predetermined amount is pumped (grout take) or a predetermined flow rate at maximum allowable pressure is reached. Maximum allowable pressure is typically around 1 pound per square inch (psi) per foot of overburden (Millet and Engelhardt, 1982). Data from the drilling and injection of the first primary holes is analyzed and, if necessary, the grout mixture or injection pressure modified before completing the remaining primary holes. Following completion of the primary hole grouting, the program is again analyzed, necessary changes made, and a pattern of more closely spaced secondary holes drilled and injected.

The analysis and evaluation of the completed grouting becomes, in essence, another pressure test. Close quality control during drilling and grouting identifies areas that require tertiary hole grouting to complete sealing. Such areas are identified by faster than expected drilling rates and higher than expected grout takes (Millet and Engelhardt, 1982). For a successful grouting program, each hole series (i.e., primary, secondary) will have lower grout takes than the previous one. Many projects will

require that proof holes be drilled and injected. A very low grout take on tertiary or proof holes indicates that most voids are grout filled and the grouting program was successful.

A.2.3 Advantages and Disadvantages

The greatest advantage of grout injection, if it can successfully be accomplished, would be the in-situ immobilization of hazardous constituents until they can decay or be recovered for treatment. Other advantages include minimization of human contact with the wastes and the absence of operation and maintenance costs for the completed remedy.

The major disadvantage of this technique lies in its unproven nature. Any application of it has to be custom tailored to both the geohydrologic conditions of the site and to the characteristics of the wastes present. The state-of-the-art of grouting for hazardous material control is such that each proposed waste/grout combination must be thoroughly tested to predict effectiveness of immobilization. Also, because each application of this technique is experimental, long term effectiveness is not known.

A.2.4 Remedial Action Schedule

The following estimated schedule is based on pressure injecting phenolic resin grout into the soils of a site measuring 370 feet square, to a depth of 160 feet. The soils are presumed to be relatively uniform sands with a porosity of 20 percent. Grout injection holes will be located on 20 foot centers, and 400 primary and 361 secondary holes, each 160 feet deep will be required. It is assumed that one rig can drill grout holes at a rate of 3 per week.

Each grout plant will be manifolded to six grout pipes and can pump four cubic yards (yd^3) of grout through each pipe per day. Twelve grout plants will be used. Working a five-day week, total grouting capacity will be 1,440 yd^3/ week, or 374,400 yd^3 per year with a soil porosity of 0.20. Based on these estimated quantities, the following represents the estimated remedial action schedule.

o Mobilization and Site Preparation	
Drill Rig	0.5 weeks
Grout Plants (12)	6.0 weeks
o Drilling 761 holes, three holes/rig/week, three rigs	84.5 weeks
o Grouting (162,250 yd^3)	
Primary Holes 126,555 yd^3, 1,440 yd^3/week	87.9 weeks
Secondary Holes 35,695 yd^3, 1,440 yd^3/week	24.8 weeks
Total	119.5 weeks = 2.3 years

A.2.5 Resource Requirements

The labor requirements for grout-in-place can be divided into three categories: supervisory personnel, drilling crews, and grouting crews. The supervisory personnel would include one site supervisor overseeing all onsite operations, three labor foremen overseeing drilling and grouting efforts, and one radiation protection technician observing only the drilling effort. Each drill rig would be manned by a lead driller and a driller's helper. Each grout plant would be manned by a crew of four who would mix, test, and inject the grout.

Equipment for grout hole drilling would be limited to a truck and a track or skid-mounted drill rig, outfitted with a minimum of 170 feet of small diameter hollow stem auger. Miscellaneous small tools are standard rig equipment. Each grout plant would consist of a grout mixer, an agitator, a grout pump, a pressure transducer with recorder, a manifold, piping, and a sleeve grout pipe.

The principal materials needed for this effort would be reusable grout pipe of sufficient length to reach the bottom of a grout hold and extend to the grout plant manifold and the grout formulation itself. A typical phenolic resin grout would consist of a polyphenolic polymer power that is

soluble in water, a catalyst such as a formaldehyde solution, and an activator, usually a metal salt such as ferric chloride.

A.2.6 Costs

The equipment involved in injecting grout includes a drill rig for drilling injection holes and a grout plant for mixing and injecting the grout. The drill rig would employ at least two operators and the grout plant at least three. The following costs are based on grouting an area sufficiently large for the crew to work in the same area for a full year. It is assumed that a phenolic resin grout would be used.

Table A.2.1 summarizes the grout injection costs, which are based on Means, 1985, updated using the ENR Construction Cost Index for 1987 (June).

A.2.7 References

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TABLE A.2.1 GROUT INJECTION COSTS

	Hourly Rate ($/hr)	Annual Cost ($/yr)
Labor		
1 Site Supervisor	58[1]	120,640
3 Labor Foremen	44[1]	274,560
48 Laborers (12 4-man Grout Crews)	20[4]	1,996,800
1 Radiation Protection Technician	28[1]	58,240
	Subtotal	$ 2,450,240
Equipment		
Drilling Cost ($100/ft) (3 rigs x 3 hole/wk x 160 ft/hole)		7,488,000
12 Grout Plants ($282/day)[3]		1,235,000
	Subtotal	$ 8,723,000
Materials and Safety		
Phenolic Grout ($150/yd^3)[3]		11,232,000
Health and Safety ($25/day/man x 7 men) (Drilling crew only)		45,500
	Subtotal	$11,277,500
	Total Cost	$22,450,000

Volume of Soil Grouted:

$$\frac{4\,yd^3/hole/day \times 6\ holes/plant \times 12\ plants/site \times 260\ days}{20\%\ Soil\ Porosity} = \frac{374{,}400\ yd^3}{year\ \ yr.}$$

$$\text{Unit Cost} = \frac{\$22{,}450{,}000/yr.}{374{,}400\ yd/yr.} = \$60/yd^3 \text{ of soil}$$

Sources:

(1) Kaiser Labor Data
(2) SAIC Field Experience
(3) Means (1985 x 1.07)
(4) Dodge

A-3 IN-SITU VITRIFICATION

A.3.1 General Description

Vitrification involves the mixing of waste with molten glass at a temperature greater than 1,300°C. At this temperature all of the combustibles are completely burned away, including the various organic chemicals. Vitrification offers the greatest degree of containment, since the resultant solids formed generally have very low leach rates. The process is being employed on radioactive and highly toxic waste.

In-situ vitrification involves encapsulating previously burned wastes in a glass matrix without first exhuming the waste and is limited in its application to shallow depths and soils with low moisture content. Electrodes embedded in the ground are used to facilitate classification of the soil. The process is extremely energy intensive; therefore, costs can be very high.

A.3.2 Design and Construction

The vitrification process is most effective at level grades. For those sites that are on slopes, excavation and grading may have to be performed. The excavated soil (a maximum of ten feet), is assumed to be uncontaminated and will provide backfill after the vitrification process.

Upon completion of vitrification activities at a site, the area and equipment are decontaminated. Contaminated equipment with further useful life can be kept in the "hot" area when not in use. Contaminated electrodes with no useful service life would be decontaminated then disposed of. Other transportable equipment is taken to the decontamination trailer for washing. Standby parts and equipment are decontaminated on a scheduled basis. During the disassembly and repair, direct contact and exposure to personnel should be minimized.

The equipment and materials required to conduct in-situ vitrification include:

1. Electrodes: 2-inch diameter, 6-foot long molybdenum rods with threaded connection, covered by a 1-inch thick graphite sleeve (reusable component; decontamination required). Flaked graphite and glass frit.

2. Off-gas hood: 16-gauge stainless steel panels, bolted and gasketed and supported by trusses and beams. Backfilling around the lower edge (skirt) to minimize leakage; system pressure at six inches of water.

3. Control trailer: power system for vitrification. Pilot design at Hanford Reservation utilized a Scott-Tee transformer connection for conversion of 3-phase input into a balanced 2-phase output configuration; site management and health physicist offices.

4. Off-gas trailer: scrubber system for inorganic fumes and radioactive particulates entrained in the off-gas from the vitrified mass. Process equipment includes indirect cooling, direct quench, two-stage, high pressure venturi scrubber, and wastewater collection tank.

5. Support trailer: electrical system hardware including glycol cooling unit.

6. Excavation equipment: bulldozer, earth mover, front end loader, and truck.

7. Crane: supports, and diesel generator.

8. Drilling equipment.

9. Decontamination trailer: wash tanks, high-pressure water, detention tanks, pumps, filtration system, and drip pans.

10. Power line.

A.3.3 Advantages and Disadvantages

The advantages of using in-situ vitrification at Hanford Reservation are as follows:

1. The technology has been demonstrated at the Hanford site.

2. The remaining chemical and radioactive contaminants are immobilized in a glass matrix with low leachability, thus minimizing future environmental contamination.

3. Safety and health of workers is minimized because the waste is left safely in place, thus reducing dust (radioactive) and landfilling (contact with worker) problems.

The disadvantages of using in-situ vitrification at Hanford Reservation are as follows:

1. In-situ vitrification only immobilizes the contaminants in the upper 50 feet or so of soil and has no effect on contaminants that have already migrated below this elevation.

2. Cost can become very high because of the large energy consumption.

A.3.4 Remedial Action Schedule

Mobilization of equipment, setup of equipment, site preparation for the first run, drilling of the electrode holes, and placement of the electrodes will take approximately two to three weeks. Preparation of the next area can be performed concurrent with other activities and does not impact the

schedule. Changeover of the hood between runs takes 20 hours with a 300 hour run time, 320 hours per 1,360yd^3, or 24 hours per hundred cubic yards.

For a 100 feet by 100 feet site the total time work is being performed onsite will be two weeks for mobilization and setup and 21 weeks for vitrification. Backfilling is based on spreading and compaction at a rate of 315 yd^3/day. This will require four six yd^3 dump trucks each moving 85 yd^3 of soil per day two miles to the site. At these rates the backfilling will take three weeks.

A.3.5 Resource Requirements

Typical large earth-moving equipment including front end loaders, dump trucks, and graders will be required for excavation and backfilling. During vitrification, a front end loader, a truck, drilling equipment, and a crane capable of moving 25 tons will be required. All items will be leased; however, the crane will be rented and two operators will be employed as needed.

The site work and vitrification support costs includes equipment, labor, and supervision (a site manager and site engineer). The vitrification support crew would be staffed in three shifts, seven days a week, requiring four two-man crews. See A.3.2 for a list of equipment and materials.

A.3.6 Costs

The costs are based on a large scale in-situ vitrification study conducted at Hanford. The capital costs have been estimated in 1987 dollars. The vitrification costs are based on a process time of 320 hours (vitrification - 300 hours; demobilization, including decontamination - 20 hours). The vitrification is conducted on a trench 35 feet by 35 feet by 30 feet deep (1,360 yd^3). Soil initially excavated from the vitrification area is stockpiled and later used to backfill the excavated contaminated areas. (Contaminated soil excavated during site preparation would be landfilled and replaced with clean soil.)

The basic cost associated with in-situ vitrification is given as $389/yd^3$ (Batley-1987), but does not include heath and safety costs associated with working on radiological sites or the cost of backfilling the depression. This depression consists of the ten feet of excavated soil plus an additional 20 percent compaction of the vitrified zone, for a total of 18 feet. Table A.3.1 summarizes the costs for in-situ vitrification.

A.3.7 References

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TABLE A.3.1 IN-SITU VITRIFICATION COSTS

Basic Vitrification:	$386/yd^3
(includes: labor, vitrification system, electricity, site preparation and closure, electrodes, support operations maintenance, supplies, and waste disposal)	
Health and Safety (H&S):	
$25/day/man, 10-man crew for 21 weeks (four 2-man crews, site managers, site engineer) = $36,750	
H&S cost increment = ($36,750)/(14,800 yd^3) =	$3/yd^3
TOTAL COST	$389/yd^3

Source: Batley, 1987

A.4 GROUNDWATER RECOVERY/TREATMENT

A.4.1 Soil Flushing

A.4.1.1 General Description

Soil flushing historically has been a technique used for uranium extraction and production at mining operations. Soil flushing involves selective leaching of radioactive material from contaminated soil by use of chemical solutions injected into the soil column.

Soil flushing of radioactively contaminated soil columns has the advantage of reducing quantities of strontium-90 and cesium-137 typically contained within the Hanford Reservation vadose zone. The applicable geological environment for soil flushing is determined by a site-specific assessment of the amount of radioactive material in the soil column.

A.4.1.2 Design and Construction

There are two major components associated with a soil flushing operation: a surface plant to process injected solutions and treat contaminated fluids, and a well system comprised of injection and production wells equipped with pumps to inject and produce fluids. In addition, chemicals are used to enhance the extraction of contaminants from the groundwater and soil.

During site preparation, the design and performance of soil flushing activities are affected by many factors. Among these are well spacing, soil and groundwater contaminant types and levels, degree of water saturation and fluid conductivity of the soil, chemical activity of the soil with respect to the groundwater and its constituents, and areal extent and depth of contamination.

A surface plant is required for recovery and treatment of contaminated liquid pumped from the soil column. This facility will be a mobile wastewater treatment unit capable of precipitating heavy metals and

radionuclides out of solution. The precipitate will be encapsulated and disposed at a landfill. The surface plant will treat groundwater pumped from each site prior to reinjection of groundwater and/or solvents into the soil column. This circulation pattern will be repeated for a number of cycles.

A.4.1.3 Advantages and Disadvantages

The greatest advantage of soil flushing is that it does not involve excavation and transport of large volumes of contaminated soil. The major disadvantage of soil flushing is that the technique is unproved for decontamination of radioactive and chemically contaminated soil columns. Application would require site-specific analysis of the geology. Furthermore, this technology may not result in the desired level of site decontamination.

A.4.1.4 Remedial Action Schedule

The construction schedule for the well system involves the following activities:

1. Site preparation and drilling of wells.

2. Mobilization of contractors and equipment and setup of equipment.

3. Circulation of treatment fluids through the contaminated soil column.

4. Decontamination and demobilization of equipment.

Based on a treatment volume of 25 feet by 25 feet by 250 feet, circulation of 80 gpm, and two wells for this treatment volume, the respective time periods for the above activities are as follows:

o Mobilization/setup (Assumes delivery of modular and portable treatment facility)	2 weeks

o	Site preparation/drilling	2 weeks
o	Treatment of soil (Assumes 10 pore volume flushes of soil pores at 20% porosity)	12 weeks
o	Decontamination/Demobilization	1 week
	Total	17 weeks

A.4.1.5 Resource Requirements

Manpower requirements for installation and operation of a soil flushing operation consist of the following:

1. Overall project management and supervision of wells and surface processing facilities. Experience in geotechnical well drilling and chemical process engineering. A total staff of three to six, depending on the size and technology used.

2. Operation and maintenance of the well and surface facilities. This requires operator experience with mechanical and chemical process equipment, and equipment used for radioactive decontamination. A total staff of four to eight, depending on the size and technology used.

3. Support of health and safety engineer.

Equipment required for soil flushing includes: drilling rigs; well tubing and casing; down hole well pumps; injection pumps; pumps for circulation fluids through chemical processing equipment; chemical processing equipment for decontamination of radioactive solutions, ion-exchange columns, mixer/settlers, filtration slurries, and storage tanks; and safety equipment for hazardous and radioactive materials.

Materials required for soil flushing include: acids and bases; lime; solvents; ion-exchange resins; and filter media.

A.4.1.6 Costs

The cost for soil flushing does not include a surface recovery concentration facility. The groundwater pump and treatment technology, which operates in tandem with soil flushing, has projected costs for a surface treatment facility and the associated solid waste disposal cost. Table A.4.1 summarizes the costs associated with solution mining techniques.

The following assumptions are used to develop a unitized cost for site remediation at the Hanford Reservation using soil flushing:

- Two wells are required to treat an area 25 feet by 25 feet by 250 feet
- Well costs of $200 per foot of depth
- The wells would treat 156,250 ft^3 of nominal soil volume, with 20 percent porosity (2900 yd^3 of soil per well)
- Soil treatment cost are $1.60/ton at 100 ppm solution
- Pumping rate of 80 gpm (40 gpm per well).

A.4.2 Groundwater Treatment

A.4.2.1 General Description

Treatment of the water removed by the groundwater pumping system will be performed in two stages. The first stage involves the removal of contaminants by chemical addition and sedimentation in a clarifier and filtration through a dual media sand filter and an activated carbon bed. The second stage involves selective ion-exchange for the removal of

TABLE A.4.1 SOIL FLUSHING COSTS

	Hourly Rate ($/hr)	Annual Cost ($/yr)
Labor(1)		
1 Foreman	44	21,120
0.7 Laborers	25	84,000
	Subtotal	$105,120
Equipment		
Drilling $100/ft (250 ft, 2 wells)		50,000
Pumping (pumps, pipes, mix tanks) 80 gpm plant, assembled onsite		18,500
	Subtotal	$68,500
Materials and Safety		
Chemicals $160/ton (19.5 x 10^6 gal of water at 10,000 gpm)		15,600
Health and Safety (8 men @ $25/day/man, 15 weeks)		15,000
	Subtotal	$30,600
	Total	$204,220

Volume of Soil Flushed, 5,800 yd^3

Unit Cost = $\frac{\$204,000}{5,800\ yd^3}$ = $\$35/yd^3$

Capital Cost $80,000, 1/yr recovery.

Sources: (1) Kaiser
Other data obtained through SAIC internal data

strontium and cesium, followed by a mixed bed polishing demineralizer unit. Process flow rates up to 100 gallons per minute can be realized for systems of these types in mobile units that could be moved from site to site.

A.4.2.2 Design and Construction

Although the CERCLA sites are not identical, the general approach to treatment of groundwater pumped from the sites will be similar. Differences will obviously exist between sites that contain NH_3 wastes vs. CN wastes, but these differences do not weigh heavily in the overall site cleanup costs and are not addressed in detail here. These details must be identified when the individual site characterizations are performed.

The wastewater treatment trailer will consist of a chemical feed system for pH control and precipitation of the heavy metals such as chromium and lead in the clarifier along with uranium and plutonium. Fine particulate matter will then be removed in the dual media sand filter. The water then passes through an activated carbon bed for removal of volatile organic carbon (VOC). While the available data on these 81 CERCLA sites mentions disposal of organic wastes for some but not all of the sites, the activated carbon bed is considered part of the system for radionuclide removal, particularly cobalt-60.

Second stage treatment involves the use of ion-exchange resins specifically selected for removal of cesium and strontium. These units are also trailer mounted and can include additional mixed bed units should they be required for additional chemical or radionuclide removal.

The clean water will be acceptable for unrestricted release, although it is expected that it will be reused as part of the groundwater flushing process. Finally, it is assumed that the generated solids (i.e., sludges), consisting of spent carbon and depleted resins, will be solidified prior to disposal.

A.4.2.3 Advantages and Disadvantages

The advantages of this technique are that it is highly flexible in operation and design, suitable for treatment of a wide range of organics and heavy metals, tolerant of some fluctuations in concentration and flow, and relatively inexpensive. The disadvantages are that it is intolerant of high suspended solid levels; unsuitable for removal of low molecular weight organics and highly soluble, highly ionized organics; limited in practice to wastes with less than 10,000 ppm organics; and requires pretreatment for oil and grease removal where concentrations are greater than ten ppm. Spent resin has the potential for containing high concentrations of contaminants and therefore requires costly pretreatment prior to disposal.

A.4.2.4 Remedial Action Schedule

The remedial action schedule, which consists of setting up and operating a groundwater pumping and treatment system, is the same as that for soil flushing. Thus, 18 days will be required for every two million gallons of groundwater treated, based on an estimated treatment throughput of 80 gallons per minute (gpm), 24 hours per day.

A.4.2.5 Resource Requirements

It is estimated that four crews of two persons each, including a crew supervisor and seven skilled laborers, are required to operate the two mobile wastewater treatment units. The skilled laborers include health and safety technicians.

Equipment includes one chemical treatment trailer and another trailer for radionuclide treatment. Materials include chemicals, activated carbon, and sand filter for the chemical wastewater treatment unit and resins for the radionuclide treatment unit. Additionally, safety equipment is required for all workers assigned to the unit.

A.4.2.6 Costs

Waste Water System

The capital costs of the first stage trailer is $500,000 and has been assumed to be spread over five years. Chemical costs are estimated at $120/day. Safety equipment costs $25/day/man for protective clothing such as gloves and may run higher during hot weather, as high as $100/day/man if respirators are needed. The 28,000 pound carbon bed is replaced twice each year at a current cost of $0.90/pound.

It is expected that the equipment will be operated around the clock using four crews of two men each for a total of eight men. One of these will be a supervisor. It is expected that this crew would also operate the radionuclide removal system.

Radionuclide Removal System

The capital cost of this equipment, trailer mounted, is estimated at $100,000, also with a five year design life. The only other costs associated with this operation are for the resins and the processing of these resins into a form suitable for disposal. For the purpose of this analysis it is assumed that these waste products will be solidified.

The resins will be nuclear grade cation resins specifically designed for selectively removing only cesium and strontium at a cost of approximately $1,000/ft^3. Current commercial solidification systems for mobile processing cost between $50 and $70/ft^3. This analysis uses a value of $50/ft^3.

The analysis of resin usage is based on the removal of 21,000 curies of strontium and cesium from a column of water roughly equal to the quantity of liquid disposed of in these sites. It is further assumed that the maximum cesium loading on the resin will be 0.5 uCi/cc which will result in a maximum contact dose rate on the demineralizer of 200 mR/hour.

Cost Summary

As shown in Table A.4.2, the combined cost of the chemical treatment system and the radionuclide removal system, results in a total cost of $29/1,000 gallons or $12/cubic yard of soil flushed.

A.4.3 References

Annamalai, V., et al. 1980. Operating Experience in the Recovery of Uranium at the Pawnee and Zamzou Sites. SPE paper 9507, Dallas, Texas.

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TABLE A.4.2 WASTEWATER TREATMENT COSTS

	Hourly Rate ($/hr)	Annual Cost ($/yr)
Labor(1)		
1 Supervisor	44	91,520
7 Skilled Laborers	25	364,000
	Subtotal	$ 455,520
Equipment		
1 Chemical Treatment Trailer, $500,000 over 5 years		100,000
1 Radionuclide Treatment Trailer, $100,000 over 5 years		20,000
	Subtotal	$ 120,000
Materials and Safety		
Chemicals (for Chemical Treatment Trailer) ($120/day)		44,000
Carbon replacement ($28,000 lb @ $.90/lb, twice/yr)		50,000
Sand replacement ($1,000/bed, once/yr)		1,000
Resin (150 ft^3/yr x $1,000/$ft^3$)		150,000
Polishing Resins (600 ft^3/yr x $100/$ft^3$)		60,000
Health and Safety ($25/day/man, 8 men)		73,000
	Subtotal	$ 378,000
Waste Treatment & Disposal		
Sludge from clarifer (3,650 ft^3/yr)		
Sand (100 ft^3/yr)		
Carbon (400 ft^3/yr)		
Resins (750 ft^3/yr)		
Processing Cost (4,900 ft^3/yr @ $50/$ft^3$)		245,000
Disposal (4,900 ft^3/yr @ $8/$ft^3$)		39,200
	Subtotal	$ 284,200
	Total Cost	$1,238,000

System Throughput @ 80 gpm = 4.2×10^7 gal/yr
Unit Cost = $29/1000 gal, or $12/$yd^3$

Sources: (1) Kaiser
Other data obtained through SAIC internal data

A.5 EXCAVATION, TREATMENT, AND DISPOSAL OF CONTAMINATED SOIL

A.5.1 General Description

One of the recommended remediation techniques for hazardous waste sites is excavation of waste materials, which includes removal of the contaminated soil, waste containers, and waste; treatment to immobilize the hazardous components of the waste, and disposal of the treated waste in an approved disposal site. Excavation, removal, and hauling of the waste to the disposal site is usually accomplished with conventional heavy construction equipment.

A.5.2 Design and Construction

This section describes conventional equipment and methods for the excavation, removal, treatment, and disposal of contaminated soil, sludge, and other solid waste material.

Because of the nature of this action, in which contaminated soil is to be exposed to the elements, it has been determined that an enclosure will be required for the excavation area. The scenario developed for this remediation technology is based on a prefabricated steel building on a concrete foundation. The building is equipped with an "airlock" type entrance large enough for construction equipment to enter. The building is not necessarily airtight, but will be under negative pressure at all times to prevent leakage of contamination. This negative pressure is maintained by an air ventilation system that exhausts through a filter system, typically a particulate filter and activated carbon filter. The air would be continuously monitored for radioactivity. A separate "clean-room" or other small structure would be located inside the cover structure to provide for office space, a change area, lunch room, and rest room facilities.

There is a wide range of heavy construction equipment that can be used for digging and loading. This includes a trencher, dragline, belt loader, wheel bucket excavator, backhoe, dozer and loader, and crane. However, not all of this equipment is applicable for excavation at a hazardous waste site (USEPA, 1985). While conventional equipment may not be appropriate in these cases, conventional equipment costs and capacities were used in this

analysis. The error introduced in the unit cost is minimal since equipment costs are a small fraction of the total cost.

Excavation was assumed to be performed by a backhoe with a boom or dipper stick, with a hoe dipper attached to the outer end. The unit is usually a crawler-mounted, hydraulically operated vehicle. The maximum reach of the boom ranges from 35 to 70 feet. Theoretical production rate for a backhoe is from 360 cubic yard (yd^3)/day for a 1 yd^3 bucket to 1200 yd^3/day for a 3.5 yd^3 bucket (Godfrey, 1984).

Dozers and loaders are usually fitted with a hydraulic controlled blade and bucket lift, and can be either crawler-mounted or equipped with rubber tires. Crawler dozers equipped with blades have tremendous earth-moving power and are excellent graders. The dozers are usually used in combination with other excavators such as backhoes. Front-end loaders are tractors equipped with buckets for digging, lifting, hauling, and dumping materials. They can carry materials as far as 300 feet from the digging area (USEPA, 1985). Depending on the type of bucket capacity, crawler loaders can theoretically produce from about 500 to more than 1200 yd^3/day (Godfrey, 1984).

Due to the inherently hazardous nature of the material, manual handling is not desirable. For this reason is has been assumed that excavated waste material will be loaded into a hopper arrangement and meter-fed into standard 55 gallon drums. These drums will be capped, checked for external contamination, and transferred by roller conveyor to the truck loading station located outside the cover structure. Excavated and drummed waste materials must be transported either to an onsite treatment facility or directly to the approved disposal site.

In either case the filled drums will be loaded onto flatbed tractor trailers using standard forklifts equipped with four-drum grapples. Each truck will be capable of carrying approximately 60 drums weighing approximately 25 tons. Payloads greater than this would require an extensive road construction program which is not considered warranted.

Contaminated soil excavated from the site can be disposed of directly at an engineered and permitted disposal site if the contamination level is

within the disposal limitation currently promulgated under RCRA regulation. However, if the waste concentration does not meet the RCRA requirement, the excavated contaminated soil should be treated prior to final disposal. Treatment techniques for contaminated soil include thermal destruction, solidification, and chemical treatment. Among these treatment techniques, thermal destruction is probably the most costly process for removing contaminants from the soil.

Thermal destruction is a treatment technique that uses high temperature oxidation under controlled conditions to break down the waste into basic constituents such as CO_2, H_2O vapor, SO_2, NO_x, HCl, gases, and ash. Waste products such as noxious gases generated by this technology should be controlled using air pollution equipment to prevent the release of undesirable chemicals into the environment (Kaiser Engineers, 1987). At present, there are more than 20 different thermal destruction technologies that appear suitable for hazardous waste treatment. However, only rotary kilns and hearth incinerators are proven technologies that have been commercially and industrially used to treat hazardous and toxic wastes (SAIC, 1987).

Solidification of contaminated soil can be achieved by direct mixing of the soil with a solidification agent such as cement, silicates, or thermoplastics to form a monolithic block of waste with high structural integrity. The contaminants may not interact chemically with the solidifier but are mechanically locked within the solidified matrix. The effectiveness of this method is rather short-term, since the waste could be leached out of the matrix over a long period of time due to the porous nature of cement and grout.

Vitrification is also considered as a solidification technology. In this case, the waste is combined with molten glass at a temperature of 1,350^{o}C or higher. With this technique, the waste is either stable or totally destroyed during the processing. An in-situ vitrification technique is discussed in Appendix A.3.

Chemical treatment of contaminated soil consists of applying chemicals to the soil to mobilize the contaminants for extraction. Soil flushing with

surfactants, dilute acids and bases, and water are used to mobilize the contaminants for extraction. This technique is discussed in Section A.4.

Excavated contaminated soil meeting the disposal limitation under RCRA regulation, and treated soil are assumed to be disposed of onsite, since it is envisioned that the amount of excavated waste materials would be too enormous to be disposed of offsite. Therefore, it is assumed that an onsite RCRA-permitted, engineered disposal site will be established to handle the disposal of the excavated soil.

A.5.3 Advantages and Disadvantages

Excavation, packaging, removal, treatment and disposal of contaminated soil are functions performed extensively in hazardous waste site remediation. There are no definite limitations on the types of waste that can be remediated by this technique. However, worker health and safety needs to be considered during the selection of this technique for removing explosive, reactive, highly toxic and radioactive waste materials.

Excavation is applicable for all types of waste sites and conditions, although it may become cost-prohibitive at great depths or in complex geologic formations. Also, due to the potentially great health and safety risks faced by workers, this technique may not be applicable for highly reactive waste sites such as underground tank farms that may still contain highly radioactive residues. In this case, other alternatives such as in-situ treatment technologies should be considered for remediation.

A.5.4 Remedial Action Schedule

Site activities begin with site clearing and laying of the cover building foundation footings. The length of time required for these activities is dependent on the size of the site, but is assumed to require 30 days, with an additional 30 days of curing before erection of the building can start. The erection of the building is also based on building size and is estimated to take one working day per 1000 ft^2 area. For most of the sites, this will require from several weeks to a few months.

During this period, all of the drum handling equipment and other support services can be installed. Once the building is erected, the excavation will proceed at a rate of 630 yd^3/day. Once excavation of the site is completed, backfilling, using uncontaminated native soils, will begin. Initially, approximately five feet of soil will be backfilled over the base of the excavation pit to cover any contaminated soils that were not excavated. Once this is done, the cover structure will be decontaminated and disassembled. Backfilling will continue until the site has been filled to the original grade.

A.5.5 Resource Requirements

Erection of the cover structure will require conventional excavation equipment, but not to depths which could result in exhumation of the disposed waste, i.e., two to three feet for foundation footers. With the building finished, a single backhoe (or front end loader) will be used to dig soil and transfer it to the drum loading equipment. Powered drum conveyors transport the filled, clean drums outside to a loading dock where as many as seven forklifts move the drums onto flatbed trailers. Seven forklifts are needed based on a production rate of 630 cubic yards of soil per day. Each drum can hold seven cubic feet. Therefore, 2430 drums are needed daily, or approximately five drums per minute must be loaded onto a trailer. Each forklift can be equipped to pick up four drums at a time. If each forklift takes five to six minutes to pick up, move, and set down four drums and return to the pickup point, approximately six to seven forklifts are needed.

At the drum loading rates identified above, it will take approximately 30 minutes to load a truck and 30 minutes to unload it. If the travel time to the disposal site is also 30 minutes, a complete round trip will take two hours. In this event, each truck can transport 240 drums per day, for a total of ten trucks required per site. Backfilling of the excavated pit will proceed at 630 yd^3/day.

A.5.6 Costs

The costs associated with the excavation of a site have been broken down into five categories: labor, equipment (leased or rented), materials

and safety, capital equipment, and disposal. A sixth cost associated with the thermal destruction via rotary kiln incinerator is also listed.

Labor costs include a site superintendent; one labor foreman; six laborers associated with the drum filling, loading and decontamination; and a clerk to keep records on the progress of work, time sheets, and drum marking. A radiation site manager is also required, as are three radiation safety technicians, one working at the excavation area providing continuous monitoring, and two working on the drum decontamination and marking/labeling efforts. Hourly labor rates are shown in Table A.5.1.

Rental rates for a backhoe, seven forklifts, and ten tractor trailers (including operators), in addition to a detailed breakdown of the various equipment that must be purchased to perform the excavation work are provided in Table A.5.1. The total cost of the building, utilities, and ancillary equipment is only four percent of the total cost. Therefore, while some costs are based on field experience with similar equipment, the error associated with any single cost element is small.

The only regularly consumed material will be drums at a cost of $21/drum. Health and safety, including such items as gloves, and protective clothing, respirators for workers exposed to dust, will cost $100 per day per man.

Disposal costs are based on a drum capacity of seven cubic feet, but a burial cost based on 7.5 ft^3 of volume. The cost of thermal destruction is based on currently available information. For rotary kiln incinerators this cost is approximately $200/ton. Using a soil density of 120 $\#/ft^3$, this cost becomes $324/$yd^3$.

A.5.7 References

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TABLE A.5.1 EXCAVATION & DISPOSAL COSTS

	Hourly Rate ($/hr)	Annual Cost ($/yr)
Labor[1]		
1 Site Superintendent	58	$ 121,000
1 Shift Foreman	44	91,520
6 Laborers (drum loading, filling)[2]	20	249,600
3 Radiation Safety Technicians	28	174,720
1 Clerical/Records Manager	26	54,080
1 Radiation Site Manager (labor associated with equipment operation is included with equipment costs)	48	99,840
	Subtotal	$ 790,760
Equipment		
1 Backhoe w/operator ($249/yd^3)[2] 630 yd^3/day x 260 days/yr.		407,862
10 Tractor Trailers-Flatbed w/driver ($350/day)[3] 60 drums/trip, 4 trips/day		1,277,500
7 Forklifts w/operators ($185/day/each)[4]		472,675
8 Dump trucks w/operators ($490/yd^3)		803,000
2 Dozers w/operators and compacters ($2.75/yd^3)		450,500
	Subtotal	$ 3,412,000
Capital Equipment		
Cover Structure (400 x 400)[4] (+ 20% for utilities)		1,872,000
Cover Structure Foundation		19,200
Soil Dumping & Drum Filling Equipment[3]		100,000
Drum Conveyors[3]		50,000
Positive Ventilation System with Filters and Monitoring System 4 required @ 3000 cfm		180,000
Local Air Sampling System		5,000
Structure Air Lock (Personnel & Equipment) not airtight		20,000
Clean Room (lunch/change/HP)[2]		77,000
Cover Structure Decontamination and Disassembly		1,800,000
	Subtotal	4,123,000

TABLE A.5.1 EXCAVATION & DISPOSAL COSTS (CONTINUED)

	Hourly Rate ($/hr)	Annual Cost ($/yr)
Materials and Safety		
Drums - 632,000/yr (Steel 55 gal DOT 17-H)(3)		13,267,800
Health & Safety (12 people x $100/day x 260 d/yr) (forklift operator and truck driver not included)		312,000
	Subtotal	$13,580,000
Other Support Activities		
Disposal		
632,000 drums/yr x 7.5 ft^3/drum x $8/$ft^3$		37,920,000
Treatment		
$200/ton x $\frac{1\text{ ton}}{2000\text{ lb}} \times \frac{120\text{ lb}}{ft^3} \times \frac{27\text{ ft}^3}{yd^3} = \$324/cy^3$ (by incineration)		
	Total Cost	$56,772,000

Summary

630 yd^3/day x 260 day/yr = 163,800 yd^3/yr

	$/yr	$/$yd^3$	w/o Treatment	w/ Treatment
Labor	1,111,000	7	2%	1%
Equipment	3,412,000	13	4%	2%
Materials & Safety	13,580,000	83	24%	12%
Capital Equipment	4,123,000	12	3%	2%
Disposal	37,920,000	231	67%	35%
Treatment (if required)		324	—	48%
Total w/o Treatment		365	100%	
Total w/Treatment		689		100%

(1) Kaiser Labor Rates (except as noted)
(2) Dodge 1987
(3) Field Experience
(4) Means 1985

A.6 IN-PLACE DECONTAMINATION

A.6.1 General Description

This technique refers to the decontamination of structures containing waste material such as above-ground tanks, vaults, and waste containers. In-place decontamination consists of removing residues from the structure, rinsing it with an appropriate solution, and, if necessary, filling it with inert material such as sand, clean soil, or cement.

A.6.2 Design and Construction

This technique does not require complex or state-of-the-art equipment; the requirement is to remove residual contamination and rinse the structure with an appropriate cleaning solution so as to remove all hazardous constituents.

Typically, the residue remaining in the structure will be in the form of a sludge or layer of crystallized salts. In either case, it will be necessary to liquefy the residues prior to removing them, as a liquid is easier to remove than a solid. The removal process consists of pumping the liquefied material out of the container; if it is equipped with a bottom outlet, gravity discharge can be used instead.

After the residue has been removed, a rinsing solution is injected into the unit for cleanup purposes. According to RCRA regulations, it is recommended that three rinsings be used for this type of decontamination technique. Selection of the rinsing solution depends on the chemical characteristics of the waste residues. For example, if the tank is known to contain oil heel, it is suggested that a petroleum-based solvent first be used to liquefy the sludge, followed by a detergent solution for rinsing.

Once the liquefied residue is removed from the unit, proper treatment and disposal of the waste is required. In most cases, the waste will either be chemically neutralized or stabilized in some sort of waste-solidifier matrix. The cost for these treatment techniques is presented in USEPA, 1985. The rinsing solution also requires treatment and proper disposal. In

addition, it will be necessary to sample the third (final) rinsing solution to ensure that no hazardous contaminants remain.

Following cleanup of the structure, it can either be left as is, refilled with inert material such as sand or cement, or used for another purpose. Since it is assumed that this technique ensures decontamination, no further action is required.

A.6.3 Advantages and Disadvantages

The advantages of this technique are that it is easy to perform and relatively inexpensive, does not require special equipment and material, and the decontaminated structure can be reused for other purposes.

Disadvantages include requirements for treatment and disposal of the residual waste and rinsing solution. Also, it is not applicable for structures that have leaks or residues that cannot be readily dissolved and removed from the unit. Additionally, if the waste is highly reactive and/or radioactive, a potential occupational health hazard could be a limiting factor. In these cases, other remediation techniques such as in-situ vitrification are more appropriate.

A.6.4 Remedial Action Schedule

For the purpose of estimating the manpower requirements and work schedule for this technique, it is assumed that a 50,000 gallon tank, 15 feet high by 24 feet in diameter, containing about 500 gallons of diesel oil heel is recommended for cleanup. It is also assumed that the tank is equipped with a six-inch diameter bottom outlet capable of discharging approximately 250 gallons per minute.

First, it is assumed that 1,000 gallons of solvent will be mixed with the oil heel in order to liquefy it. The liquefaction phase requires about two days for a complete reaction. During this time, the detergent solution is also prepared for the rinsing phase. When it is determined that the contents of the unit are ready for removal, the bottom outlet is hooked up to a waste storage unit. It is estimated that the discharge of 1,500 gallons of waste will take about six minutes. With a pump capable of

delivering 250 gallons per minute, each rinsing will require approximately 200 minutes. It is assumed that the solution will remain in the tank for one hour prior to discharge. The full tank discharge will require an average of about 200 minutes. Thus, for each rinsing, it is estimated that a total of 460 minutes, or approximately eight hours, is required. Assuming that other activities such as refilling tank trucks and setting up equipment will take an additional two hours per rinsing, a sum total of ten hours is estimated for each rinsing of the tank. Thus, an estimated six days will be required to complete the cleanup of the tank.

Second, it is assumed that the tank is left as is after it has been cleaned up, and that treatment of the waste residue and rinsing solution takes place afterward. Using a mobile wastewater treatment facility with a throughput of 80 gallons per minute (gpm), the wastewater treatment requires about 31 hours. Treatment of waste residue is estimated at three hours, or ten percent of the time required for wastewater treatment. Therefore, the total amount of time required for treatment of waste residue and rinsing water is estimated at about four days.

At the third rinsing of the waste unit, three samples of discharge will be collected and analyzed for cleanup confirmation. The sampling and analysis will take about six weeks, with one additional day for an evaluation of the results. Thus, the total amount of time required to clean up the above tank is estimated at eight weeks.

A.6.5 Resource Requirements

The manpower requirement is estimated for different phases of the cleanup operation. For the waste liquefaction phase, it is estimated that about four hours will be required to perform the operation requiring a tank truck operator, a health safety officer, and a field engineer. During the rinsing phase, it is estimated that the operation will take approximately four days, with a crew of two tank truck operators, a health safety officer, and a field engineer. For the waste residue and wastewater treatment phase, it is estimated that a crew of two operators and one health safety technician will be able to perform the operation in four days. For the confirmation sampling phase, it is estimated that one engineer will require

one day to evaluate the sampling analysis results. Table A.6.1 shows a summary of the manpower requirement estimated for this remediation technique. Based on the total waste unit volume of 50,000 gallons or 250 cubic yards (yd^3), the estimated unit manpower is calculated at 4.9 man-hours/1,000 gallons or about 1.0 man-hours/yd^3.

A.6.6 Costs

A summary of the costs to clean up the above unit is described in Table A.6.1. The unit cost is approximately $1.10/gallon or $210/$yd^3$ of waste unit volume.

A.7.7 References

ENR Market Trends. 1987. Engineering News-Record.

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TABLE A.6.1 IN-PLACE DECONTAMINATION COSTS

	Hourly Rate ($/hr)	Annual Cost ($/yr)
Labor		
Waste Liquefaction Phase		
1 Tank Truck Operator	25(1)	100
1 Health Safety Officer	48(2)	192
1 Field Engineer	44(2)	176
Waste Unit Rinsing Phase		
2 Tank Truck Operators	25(1)	1,600
1 Health Safety Officer	48(2)	1,536
1 Field Engineer	44(2)	1,408
Waste Treatment Phase		
2 Operators*		
1 Health Safety Technician*		
Confirmation Sampling Phase		
1 Engineer	58(2)	464
	Subtotal	$5,476
Equipment		
Waste Liquefaction Phase		
1 Tank Truck ($360/day)(1)		360
Waste Unit Rinsing Phase		
2 Tank Trucks ($360/day)(1)		2,880
	Subtotal	$3,240
Materials and Safety		
Waste Liquefaction Phase		
Solvent (1,000 gal, $1/gal)		1,000
Waste Unit Rinsing Phase		
Mixed Detergent Solution (150,000 gal, $0.05/gal)		7,500
	Subtotal	$8,500

TABLE A.6.1 IN-PLACE DECONTAMINATION COSTS (continued)

	Hourly Rate ($/hr)	Annual Cost ($/yr)
Other Support Activities		
Waste Treatment**		
Wastewater Treatment (150,000 gal, $29/1,000 gal)		4,350
Waste Residue Treatment (Drum and Disposal) (1,500 gal or 7.5 yd^3, $1,350/$yd^3$)		10,125
Configuration Sampling Phase		
Sampling Cost (3 samples, $7,000/sample)		21,000
	Subtotal	$35,475
	Total	$52,700

Estimated Volume of Waste Unit	50,000 gal. or ≃ 250 yd^3
Unit Cost	$1.10/gal. or $210/$yd^3$
Estimated Unit Manpower	4.9 man-hours/1,000 gal. or 1.0 man-hours/yd^3

(1) Godfrey, updated using ENR Market Trends
(2) Kaiser
* Labor cost included in unit cost for Waste Treatment/Other
** Unit cost includes labor, equipment, and material

APPENDIX A (CONTINUED)

REMEDIAL ACTION TECHNOLOGIES CONSIDERED

A. Air Pollution Controls

- Capping

  - synthetic membranes
  - clay
  - asphalt
  - multimedia cap
  - concrete
  - chemical sealants/stabilizers

- Dust Control Measures

  - polymers
  - water

Surface Water Controls

- Capping (See A.)

- Grading

  - scarification
  - tracking
  - contour furrowing

- Revegetation

  - grasses
  - legumes
  - shrubs
  - trees, conifers
  - trees, hardwoods

- Diversion and Collection Systems

  - dikes and berms
  - ditches, trenches, diversions
  - terraces and benches
  - chutes and downpipes
  - seepage basins
  - sedimentation basins/ponds
  - levees
  - floodwalls

C. Leachate and Groundwater Controls

- Capping (See A.)

- Containment Barriers

  Function Options (Vertical Barriers)

  - upgradient placement
  - downgradient placement
  - circumferential placement

  Materials/Construction Options (Vertical Barriers)

  - soil-bentonite slurry wall
  - cement-bentonite slurry wall
  - vibrating beam/asphalt wall
  - grout curtains
  - steel sheet piling
  - Envirowall cut-off

  Horizontal Barrier (Bottom Sealing)

  - block displacement
  - grout injection

- Groundwater Pumping

  Function Options

  - extraction alone
  - extraction/injection
  - injection wells

  Equipment/Material Options

  - well points
  - deep wells
  - suction wells
  - ejector wells

- Subsurface Collection Drains

  - French drains
  - tile drain
  - pipe drain (dual media drain)

D. Gas Migration Controls

- Capping (gas barriers) (See A.)
- Gas Collection and/or Recovery
  - passive pipe vents
  - passive trench vents
  - active gas collection systems

E. Waste and Soil Excavation and Removal

- Excavation/Removal
  - backhoe
  - cranes and attachments
  - front end loaders
  - scrapers
  - pumps
  - industrial vacuums
  - drum grapplers
  - forklifts and attachments
- Grading (See B.)
- Capping (See A.)
- Revegetation (See B.)

F. Contaminated Sediments Removal and Containment

- Sediment Removal

  Mechanical Dredging

  - clamshell
  - dragline
  - backhoe

  Hydraulic Dredging

  - plain suction
  - cutterhead
  - dustpan

  Pneumatic Dredging

  - airlift
  - pneuma
  - oozer

- Sediment Turbidity Controls and Containment

  - curtain barriers
  - cofferdams
  - pneumatic barriers
  - capping

G. <u>In-Situ Treatment Methods</u>

  - hydrolysis
  - oxidation
  - reduction
  - soil aeration
  - solvent flushing
  - neutralization
  - polymerization
  - sulfide precipitation
  - bioreclamation
  - permeable treatment beds
  - chemical dechlorination

H. <u>Direct Waste Treatment</u>

- Incineration

  - rotary kiln
  - fluidized bed
  - multiple hearth
  - liquid injection
  - molten salt
  - high temperature fluid wall
  - plasma arc pyrolysis
  - cement kiln
  - pyrolysis/starved combustion
  - wet air oxidation

- Gaseous Waste Treatment

  - activated carbon
  - flares
  - afterburners

- Treatment of Aqueous and Liquid Waste Streams

  Biological Treatment Techniques

  - activated sludge
  - trickling filters
  - aerated lagoons
  - waste stabilization ponds
  - rotating biological discs
  - fluidized bed bioreactors

TABLE 3-1 REMEDIAL TECHNOLOGIES (Continued)

Chemical Treatment Techniques

- neutralization
- precipitation
- oxidation
- hydrolysis
- reduction
- chemical dechlorination
- UV/ozonation

Physical Treatment Techniques

- flow equalization
- flocculation
- sedimentation
- activated carbon
- Kleensorb
- ion exchange
- reverse osmosis
- liquid/liquid extraction
- oil water separator
- steam distillation
- air stripping
- steam stripping
- filtration
- dissolved air flotation

Discharge to POTW

- Solids Handling and Treatment

Dewatering

- screens, hydraulic classifiers, scalpers
- centrifuges
- gravity thickening
- flocculation, sedimentation
- belt filter press
- filter press
- drying or dewatering beds
- vacuum assisted drying beds

Treatment

- neutralization
- solvent
- oxidation
- reduction
- composting

- Solidification/Stabilization/Fixation

  - cement based
  - lime based
  - thermoplastic
  - organic polymer
  - self-cementing techniques
  - surface encapsulation
  - glassification
  - solidification materials (i.e., flyash, polymers, sawdust)

I. Land Disposal Storage

  - landfills
  - surface impoundments
  - land application
  - waste piles
  - deep well injection
  - temporary storage

J. Contaminated Water Supplies and Sewer Lines

- In-Situ Cleaning

- Removal and Replacement

- Alternate Drinking Water Supply

  - bottled water
  - cisterns/tanks
  - deeper or upgradient wells
  - municipal water system
  - relocation of intake

- Individual Treatment Units

APPENDIX B

DESCRIPTION OF THE RCRA REMEDIATION TECHNIQUES

APPENDIX B

The following descriptions are provided for the eight in-place remediation techniques identified as potentially applicable to the 3004(u) sites for the purposes of this analysis.

Soil Flushing

Soil flushing is a technique where an appropriate chemical solution is applied to a waste site to remobilize waste constituents that are bound to the soil, and the leachate is collected with a series of shallow well points. Solutions of sulfuric, hydrochloric, nitric, phosphoric, or carbonic acid may be used to dissolve basic metal salts (hydroxides, oxides, and carbonates).

This technique represents a low cost alternative to excavation and treatment of the waste, especially when there is a high safety and health hazard associated with the excavation. However, there are some disadvantages which include: (1) uncertainties with regard to the adequate contact with the wastes, (2) the technique is not applicable for containerized waste, and (3) there are concerns about the ability to effectively recollect the leachate elutriate, or the soil flushing solvent from the site. If the elutriate is not completely removed from the soil, it can become a pollutant itself.

Soil Treatment

As in the soil flushing technique, this process involves application or injection of a substance into the contaminated soil to immobilize or destroy the pollutants. However, instead of creating elutriate or leachate that needs to be collected and treated, this technique does not generally mobilize hazardous constituents from the waste site to the environment. As a result, this technique is limited to waste that can be degraded, has non-toxic breakdown products, and/or can be converted to insoluble chemical products.

Soil treatment techniques include soil neutralization/detoxification and microbial degradation processes. The ability to use soil neutralization

or detoxification is highly waste dependent. Many heavy metals may be precipitated as insoluble salts by injecting alkalis or sulfides. While microbial degradation is highly applicable for removing organic contamination such as oil or solvents, it is not a likely treatment for removing heavy metal contaminants from the soil. Some of the disadvantages of this technique include the potential of generating leachate that can not be contained when the treatment is unsuccessful, and it is also difficult to determine the degree of effectiveness of the technique.

Grout-in-Place

In-situ grouting is a technique that involves injection of grout or cement directly into the waste site to create a solid matrix and restrict the movement of contaminants. The application of this technique includes: (1) direct mixing of the waste inside the unit to form a solid matrix, (2) injecting solidifier around a buried waste unit as a form of encapsulation, or (3) a combination of both of the above methods.

If correctly applied, this technique would be a feasible remedial method for waste sites with short-term effectiveness. However, because the solidifier (grout) is a porous solid, the contaminants could be leached out of the solid matrix over a long period of time.

Cap/Cover

Surface sealing or capping is a process used to cover the waste site to prevent the waste materials from coming in contact with land surface and to minimize the migration of waste to groundwater. Surface sealing comes with two basic designs: multi-layered and single-layered caps.

In humid climate areas such as the East Coast of the U.S. where the infiltration rate is high, this technique is one of many favored in-place remediation technologies. However, current RCRA program policy is to use techniques that provide final destruction or final immobilization of contaminants. Capping is considered a temporary rather than a final action. On a case-by-case basis, capping may be an appropriate technique to control erosion and resuspension of contaminated soil as well as preventing vegetation growth over contaminated soil.

Subsurface Barrier

Subsurface barriers are used for imbedding a low permeability cut-off wall or diversion structure in the proximity of the waste site to contain, capture, or redirect the groundwater flow near the site. These subsurface barriers include soil-bentonite slurry walls, cement-bentonite slurry walls, diaphram walls, grout curtains, and sheet piling.

This technique is readily applicable for sites with shallow groundwater tables and low permeability confining layers such as competent bedrock. However, for sites with deep groundwater, the technique may not be economically nor practically feasible to control groundwater due to depth limitations of excavation equipment. Such a decision requires case-by-case analyses. Subsurface barriers may not be able to withstand the attacks from highly corrosive materials, and may not withstand certain organic compounds. Depending on the construction technique, gaps within the structure are not uncommon that would lead to groundwater seepage from the contaminated area.

The subsurface barrier is often used in conjunction with groundwater pumping. Groundwater pumping is discussed along with groundwater treatment in a subsequent section.

In-Place Decontamination

This technique refers to the decontamination of structures containing waste materials such as aboveground tanks, vaults, and waste containers. In-place decontamination of these structures consists of removing waste from the structure, rinsing the structure with an appropriate solution, and, if necessary, filling the emptied structure with unreactive materials such as sand, clean soil, or cement. In some cases, the emptied and cleaned structure could also be reused for other purposes. The removed waste materials would need to be treated and disposed of appropriately. The cost associated with this technique is minimal when compared to other in-place remedial actions. However, this technique is not applicable to contamination in the environment (e.g., soils).

In-Situ Vitrification

In-situ vitrification is a thermal process that converts contaminated soil into a chemically inert and stable glass and crystalline product that has about the same durability properties as granite. The resultant solids formed have a very low leach rate. This technique has been tested on a pilot-scale basis at the Hanford Reservation, and the results indicate that such a process may be feasible for decontamination/stabilization of the contaminated soil at the site.

Groundwater Recovery and Treatment

Groundwater recovery and treatment is very similar to soil flushing, except that instead of applying chemicals to the waste and collecting the elutriate, this technique only requires removal of contaminated groundwater by pumping then treating the contaminated water. In some cases, it would also be appropriate to perform soil flushing (with water) before pumping and treating groundwater. After the contaminated water is treated, it can be discharged directly to nearby surface water, or reinjected into another uncontaminated aquifer. Appropriate permits would be required.

Contaminated water treatment includes filtration, ion-exchange, solvent absorption and separation, evaporation, and/or solidification, depending on the constituent concentrations in and characteristics of the contaminated water.

APPENDIX C

SUMMARY DESCRIPTIONS OF GENERALIZED HANFORD UNIT RCRA 3004(u) SITES

APPENDIX C

SUMMARY DESCRIPTIONS OF GENERALIZED HANFORD UNIT RCRA 3004(u) SITES

This Appendix describes the characteristics of the Generalized Hanford Unit, including the dimensions of the unit structures, methods of emplacement, average service lives, etc., which were developed on the basis of the individual units within each type of site (e.g., tank, surface impoundment, etc.). For example, the dimensions of the Generalized Hanford Unit crib are calculated as an average of the dimensions of the cribs listed under Type "G" waste units for each type of site.

Also included in this appendix are the details of the characterization techniques applied to each Generalized Hanford Unit site, if different from the general strategy described in Section 3.2.4, and estimates for the volume of contaminated soil to be treated either by exhumation or by in-situ remediation techniques as described in Section 3.3 of this report. These form the basis of calculating characterization and remediation costs. Unit costs for Generalized Hanford Unit site types are also provided in Section 3.2.4 of the Task 9 report. Section 3.2.4 of the Task 9 report provides the strategy for applying characterization techniques to the 15 Generalized Hanford Unit site types.

A - Aboveground Covered Landfill

The Generalized Hanford Unit aboveground covered landfill was a mound of non-liquid waste, 125 feet long, 50 feet wide and 50 feet high. The base was unlined. No chemical inventory is available, however the zone is posted as a radiation zone. The landfill was covered with two feet of clean soil. Only one facility was included in this site type so the dimensions of this landfill were used for the Generalized Hanford Unit aboveground landfill description. Site used for this analysis is Site 618-13.

Since no aboveground covered landfills are to be characterized for remediation, no groundwater monitoring wells are needed. Because the unit

is small (less than 100 feet per side length), one boring will be placed on each side of the Generalized Hanford Unit site to verify for no release and verify for no residual contamination.

As mentioned above, there is no aboveground, covered landfill that requires remediation and, therefore, no remedial action and costs are developed for this type of waste unit.

B - Aboveground Uncovered Landfill

The Generalized Hanford Unit aboveground uncovered landfill was a mound of retired and stabilized, non-liquid waste that covers an area of 620,000 square meters. It was approximately 427 feet long, 100 feet wide and five feet deep. The area was used to dispose radioactive wastes. No chemical inventory is available. Only one site was included in this site type so the dimensions of this landfill were used to develop the Generalized Hanford Unit aboveground uncovered landfill. The site used for the analysis was 216-E-9.

For this Generalized Hanford Unit site twenty soil borings are placed around the perimeter to a depth of 30 feet in shallow groundwater areas and 50 feet in deep groundwater areas for sites to the categories to verify no release and verify no residual contamination.

Because no sites fitting this Generalized Hanford Unit description are in the category to characterize for remediation, no groundwater monitoring wells are needed at these sites. Since no aboveground, uncovered landfills are characterized for remediation, no remedial action and costs are developed for this type of waste unit.

C - Belowground Covered Landfill

The Generalized Hanford Unit belowground landfill consisted of a series of unlined, excavated trenches. The landfill was approximately 350 feet long, 160 feet wide, and 15 feet deep. The waste was generally non-liquid, solid waste but may have included drums of liquid waste materials. The

site averaged 17 years of operations and was last used in 1962. The landfill is covered with four feet of soil at grade.

Samples to verify for no residual contamination and verify for no release are collected every two feet to a depth of 30 feet in the shallow areas and 50 feet in the deep groundwater areas. Twenty soil borings are placed around the perimeter as per the description in Section 3.2.4. For sites where it was necessary to characterize for remediation, four groundwater monitoring wells will be placed upgradient (one) and downgradient (three) at the sites. To verify for no hazardous constituents, a total of three borings per unit will be collected.

The Generalized Hanford Unit belowground covered landfill was developed by calculating average dimensions and site ages for ten percent of the sites included in this site type. The eleven sites used in the analysis were chosen randomly from all of the Hanford Reservation areas.

Since this type of waste unit is considered to receive solid waste, and the length is more than twice the width of the site, Equation 3 is used to estimate the amount of contaminated soil to be excavated. The depth of the site is 15 feet below ground, and it is assumed the contamination is located 20 feet beneath the site. Therefore, the excavation depth is estimated at 35 feet. The estimated excavation volume is as follows:

$$\begin{aligned} V_{exc} &= [(1.5 \times 160') + 350' + 35] \times [(1.5 \times 160') + 35] \times 35' \\ &= 625' \times 275' \times 35' \\ &= 6{,}015{,}625 \text{ ft.}^3 \simeq 222{,}800 \text{ cubic yards (yd}^3\text{)}. \end{aligned}$$

For in-situ treatment, it is suggested that in-situ encapsulation be used to stabilize the waste unit. It is assumed that a five-foot thick grout wall will be built around and underneath the unit at a distance of 20 feet from the site. A cap will be formed by injecting grout into the site to a depth of five feet, covering the entire unit, with the edge located at the grout wall surrounding the site. The volume of soil proposed to be grouted can be calculated as follows:

- Generalized Hanford Unit waste unit dimensions: 350′ x 160′ x 15′

- Inside dimension of the encapsulation wall:
  (350′ + 40′) x (160′ + 40′) x (15′ + 20′)
  V_{ins} = 390′ x 200′ x 35′ = 2,730,000 ft.^{3}
  $\simeq$ 101,000 yd^3

- Outside dimension of the encapsulation wall:
  (350′ + 50′) x (160′ + 50′) x (15′ + 25′)
  V_{out} = 400′ x 210′ x 40′ = 3,360,000 ft.^{3}
  $\simeq$ 124,450 yd^3

- Volume of encapsulation wall:
  $V_{wall} = V_{out} - V_{ins}$ = 124,450 - 101,000 = 23,450 yd^3

- Volume of soil calculated for the cap:
  V_{cap} = 400′ x 210′ x 5′ = 420,000 ft.^{3}
  $\simeq$ 16,000 yd^3

- Total volume of soil to be grouted for the in-situ encapsulation process:

  $V_{total} = V_{wall} + V_{cap}$ = 23,450 + 16,000 = 39,450 yd^3
  or 40,000 yd^3.

Sites used for the analysis included 118-C-1, 118-B-5, 118-D-5, 118-F-6, 118-H-2, 218-E-1, 218-E-12A, 218-W-02A, 618-9, USBR-2,4-D, and East White Bluffs Landfill.

D - Belowground Uncovered Landfill

The Generalized Hanford Unit belowground uncovered landfill is a pit, approximately 1,500 feet long, 500 feet wide and 20 feet deep. The pit was intended for disposal of non-radioactive construction debris, however contamination from leaks and non-deliberate disposal of contaminated construction materials may have occurred. No chemical inventory is

available, however no chemicals have been disposed onsite and only soil wastes are disposed.

Due to the large size of this site, soil borings will be taken (as per Section 3.2.4) at 50 locations along the perimeter of the sites to verify no release or verify for no residual contamination. (However, no sites are included in these categories at this time.) Groundwater monitoring wells will be placed in a configuration including three upgradient wells and 11 downgradient wells. To verify for no hazardous constituents, a total of three borings per site will be collected.

This Generalized Hanford Unit landfill was developed by combining information from the two sites within this site type, and determining a Generalized Hanford Unit site with average dimensions from the two sites. Sites used for the analysis include 200 Area Construction Waste and UPR-200-E-124.

This type of waste unit is considered to be similar to that of Type C described previously and, thus, all related assumptions and remediation techniques are applicable for both types. As a result, to estimate the volume of contaminated soil required to be excavated, the same formula is used as follows:

- Waste unit dimensions: 1,500′ x 500′ x 20′

- Excavation dimensions:
  [(1.5 x 500′) + 1,500′ + 40′] x [(1.5 x 500′) + 40′] x 40′
  V_{exc} = 2,290′ x 790′ x 40′ = 72,364,000 $ft.^3$
  $\simeq$ 2,680,000 yd^3.

The volume of soil to be grouted for in-situ encapsulation can also be calculated as follows:

- Inside dimension of the encapsulation wall:
  (1,500′ + 40′) x (500′ + 40′) x (40′)
  V_{ins} = 1,540′ x 540′ x 40′ = 3.33×10^7 ft.^{3}
  $\simeq$ 1,232,000 yd^3

- Outside dimension of the encapsulation wall:
  (1,500′ + 50′) x (500′ + 50′) x (45′)
  V_{out} = 1,550′ x 550′ x 45′ = 3.84×10^7 ft.^{3}
  $\simeq$ 1,421,000 yd^3

- Volume of encapsulation wall:
  $V_{wall} = V_{out} - V_{ins}$ = 1,421,000 - 1,232,000 = 189,000 yd^3

- Volume of cap:
  V_{cap} = 1,550′ x 550′ x 5′ = 4,262,500 ft.^{3} = 158,000 yd^3

- Total volume of soil to be grouted for this technique:
  $V_{total} = V_{wall} + V_{cap}$ = 189,000 + 158,000 = 347,000 yd^3.

E - Surface Impoundments

The Generalized Hanford Unit surface impoundment was 600 feet long, 48 feet wide and 13 feet deep. It had a sideslope of two to one, and has accepted 64,641,000 gallons of liquid waste over the life of the unit. When the unit became inactive, it was backfilled with three feet of clean soil. The unit accepted a variety of chemical and radioactive wastes.

Because of the site dimensions, groundwater monitoring wells (used when characterizing for remediation) will be placed in a configuration of one upgradient and five downgradient wells. Soil borings to verify no release and verify no residual contamination will be collected on each side of the site for a total of four borings. To verify no hazardous constituents three samples will be collected from the waste management unit.

The Generalized Hanford Unit surface impoundment was developed by calculating average dimensions for ten percent of the sites included in this

site type. The ten sites used in the analysis were chosen randomly from all of the Hanford Reservation areas.

Since this waste unit type is considered as a liquid waste disposal site, Equation 1 described in Section 3.3 is used to calculate the amount of contaminated soil to be excavated. It is also assumed that the majority of the contamination is located up to 60 feet below ground surface, although the average depth of the Generalized Hanford Unit is approximately 13 feet below ground. Therefore, an excavation depth of 60 feet is estimated.

- Dimensions of waste unit: 600′ x 48′ x 13′

- $V_{exc} = [230' + 600' + 60'] \times [230' + 48' + 60'] \times 60'$
  $= 890' \times 338' \times 60' = 18{,}049{,}000 \text{ ft.}^3$
  $\simeq 668{,}500 \text{ yd}^3.$

Groundwater recovery and treatment has been considered as an in-situ remedial action appropriate to Unit Type E surface impoundments. A methodology was developed to estimate the costs of applying this remedial technology to the Generalized Hanford Unit surface impoundment unit. The methodology is used to estimate the volume of contaminated groundwater required to be pumped and treated at a cost of $35 per 1000 gallons.

The first step in calculating the volume of water needed to be pumped and treated is to determine the surface area of the lateral waste migration associated with the Generalized Hanford Unit. This area has been estimated above. The surface area (square feet) is then multiplied by the aquifer thickness in the area to determine the total volume of the aquifer needing pumping. An average aquifer thickness of 35 ft. was determined in the deep groundwater areas of Hanford (200, 400) and 60 ft. in the shallow groundwater areas (100, 300, 700, 1100).

The calculation of the aquifer depth results in the volume of the contaminated area needing pumping. It was assumed for the purposes of this study that the pore space occupied by the water in this zone is thirty percent of the total volume. Based on RCRA guidance this volume would need

to be pumped three times to adequately reduce the levels of contamination. Therefore as a conservative estimate the total volume of the contaminated area determined previously was used. This value (cubic feet) was converted to gallons by using the following multiplier, 7.48 gallons/ft^3. To account for the differences in aquifer thicknesses encountered at Hanford, a weighted average of the gallons of water needing treatment was used. A three/one deep to shallow groundwater site average ratio was used based on the number of units found in each area. This volume of water is then multiplied by the pump and treatment unit cost to determine the total cost of the operation in present dollars. For waste unit type E, the volume of groundwater pumped and treated is estimated at 71,000,000 gallons based on an average surface area of 230,740 ft^2.

Sites used for the analysis include 184-8 Powerhouse Ash Pit, 216-S-12 trench, 216-U-13 241-UR Steam Cleaning pit, 216-B-53A trench, UPR-1100-1 Sand Pit, 400 Area Retired Sanitary Ponds, 216-Z-19 Ditch or Trench, 107-B, 216-N-1, and 216-S-15.

F - Ditch

The Generalized Hanford Unit waste management ditch was 2,035 feet long, six feet wide and four feet deep. The ditch was unlined and typically received the following wastewaters: steam condensate, process cooling water and vacuum pump seal water. When the trench became inactive the wastes remain in place, and the ditch was backfilled with clean soil.

Because of the large dimensions of this site, 20 groundwater monitoring wells will be used at each site requiring characterization for remediation. Soil borings, when necessary, will be placed on alternating sides of the site at an interval of 100 feet, as described in Section 3.2.4, for a total of 42 soil borings to verify no release and verify no residual contamination.

Nine sites were used in this analysis. For eight sites, information was available on the unit's dimensions. The average of these dimensions was calculated and used to develop the Generalized Hanford Unit ditch.

This waste unit type is similar to that of type E and thus, all assumptions and remediation techniques are applicable for both types.

The excavated volume is estimated as follows:

- o Waste unit dimensions: 2,035′ x 6′ x 4′
- o Excavation depth is assumed at 60 feet.

$$V_{exc} = [230' + 2{,}035' + 60'] \times [230' + 6' + 60'] \times 60'$$
$$= 2{,}325' \times 296' \times 60' = 41{,}292{,}000 \text{ ft.}^3$$
$$\simeq 1{,}530{,}000 \text{ yd}^3.$$

Groundwater recovery and treatment has been considered as an in-situ remedial action appropriate to Unit Type F ditch. A methodology was developed to estimate the costs of applying this remedial technology to the Generalized Hanford Unit Type F (ditch). The methodology is used to estimate the volume of contaminated groundwater required to be pumped and treated at a cost of $35 per 1000 gallons.

Using the same bases outlined for waste unit type E, the volume of pumped and treated groundwater is estimated at 165,000,000 gallons for type F, assuming that the generic site surface area of 534,540 ft^2.

Sites used for the analysis include 100-KE3, 216-T-4-2, UPR-200-W-139, 216-Z-19, 216-U-9, 216-Z-11, 216-Z-1 (D), 216-T-4-1(D), and 216-Z-17.

G - Underground Dispersion Systems

Underground dispersion systems include french drains, tile fields, cribs, dry wells, reverse wells, etc. The Generalized Hanford Unit underground dispersion systems were developed by calculating average dimensions for all of the 130 sites in this site type.

This Generalized Hanford Unit is a five-sided wooden box with open bottom, situated on a five-foot bed of three-inch gravel. It is 23 feet long, 12 feet wide, and seven feet high. The bottom of the unit is located at about 18 feet below surface, and the excavated area is backfilled with clean soil. The average excavated area for emplacement of the unit is 110 feet long, 60 feet wide, and 18 feet deep. The unit was operated for seven years, and was last used in 1973.

Because of the small dimensions of these sites, groundwater wells, when necessary to characterize for remediation, will be placed in a configuration including one upgradient and three downgradient wells. To verify for no release and verify for no residual contamination one soil boring will be collected on each side of the Generalized Hanford Unit sites. To verify for no release, three samples are collected and analyzed from the waste management unit.

This waste unit type is the same as types E and F. Therefore, all assumptions and remediation techniques developed for these waste unit types are applicable.

The excavated volume is estimated as follows:

- Waste unit dimensions: 23′ x 12′ x 7′
- Excavation depth is assumed at 60 feet.

$$V_{exc} = (230' + 23' + 60') \times (230' + 12' + 60') \times 60'$$
$$= 313' \times 302' \times 60' = 5{,}671{,}500 \text{ ft.}^3$$
$$\simeq 210{,}000 \text{ yd}^3.$$

Groundwater recovery and treatment has been considered as an in-situ remedial action appropriate to Unit Type G (underground dispersion systems). A methodology was developed to estimate the costs of applying this remedial technology to the Generalized Hanford Unit underground dispersion systems. The methodology is used to estimate the volume of contaminated groundwater required to be pumped and treated at a cost of $35 per 1000 gallons.

Based on the same assumptions described for waste unit type E, the estimated volume of contaminated groundwater that requires to be pumped and treated is calculated at 19,000,000 gallons based on an average surface area of 61,226 ft^2.

Sites Used in the Analysis:

216-S-13	216-T-29	216-U-8	216-B-14	216-B-47
216-S-22	216-T-32	216-Z-5	216-B-19	216-B-8
216-S-23	216-T-33	216-Z-9	216-B-17	216-B-15
216-T-6	216-T-34	216-Z-12	216-B-18	216-B-12
216-T-26	216-T-35	216-Z-16	216-A-1	216-B-9
216-T-27	216-T-36	216-Z-18	216-A-2	216-B-10B
216-T-31	216-A-26A	216-A-17	216-U-7	216-A-35
216-A-16	216-Z-8	216-A-33	116-KW-2	116-B-9
116-D-4	116-F-11	116-B-10	116-D-4	116-F-12
116-D-3	116-F-7	116-KE-3		
116-B-5	117-D	116-F-5	116-KW-1	
116-B-6-1	116-D-2	116-H-4	316-4	
116-B-6-2	116-DR-4	117-H		
116-B-3	116-F-4	116-KE-1		

H - Aboveground Storage Tank

The Generalized Hanford Unit aboveground storage tank was constructed of stainless steel and had a capacity of 21,000 gallons. The average service life of this unit was 19 years. After the tank was removed from service, some waste and/or contamination typically remained in the tank and associated piping. Leaks and spills have occurred during filling and transfer operations associated with this unit and remediation has not been performed. Wastes managed by this unit include mixed wastes.

Because of the aboveground location of these sites, groundwater monitoring is assumed to be unnecessary for characterizing for remediation. Instead, soil borings to a depth of six feet (2-foot intervals) will be used

to characterize these sites. One soil boring will be collected on each side of the site where necessary to verify for no release and verify for no residual contamination categories as well as to characterize for remediation.

Since the tank is located above ground, and it is assumed there is no leak from the tank, exhumation is not recommended as a remediation technique. In-place decontamination is suggested for this type of waste unit.

Fourteen sites were used in this analysis. For nine sites information was available on dates of service and five sites had information concerning tank capacities. One of the five sites for which tank capacity data were available (276-S) had multiple tanks with varying capacities. Each of these tanks were considered separately in the analysis.

Sites Used for the Analysis:

183-KE	183-KW	242-B	334	241-SX-401
183-KE*	183-KW1	242-T	224-B	241-SX-402
183-KE1	183-KW2	276-S	205-A	

I - Underground Tanks

This site type includes underground tanks, catch tanks, diversion boxes, receiving vaults, enclosed compartments septic tanks, and weir boxes. Due to the physical and size differences between these types of tanks, two Generalized Hanford Units were developed for this group: (1) underground tanks; (2) catch tanks and diversion boxes.

The Generalized Hanford Unit underground tank was developed by reviewing all of the data on underground tanks and calculating average dimensions for these tanks. Only 63 tanks from 35 sites of the total 115 tank sites has data for use in the development of Generalized Hanford Unit tank dimensions.

Because of the small dimensions of these sites, groundwater wells, when necessary to characterize for remediation, will be placed in a configuration including one upgradient and three downgradient wells. One soil boring will be collected on each side of the site where necessary to characterize sites verifying for no release and verifying for no residual contamination categories. Section 3.2.4 describes the numbers of soil sample.

The Generalized Hanford Unit tank was a 600,000-gallon belowground tank made of six-inch reinforced, prestressed concrete. The top of the tank was six feet below grade. The tank was a single shell tank that was last used in 1976 for storage of cladding wastes, mixed chemical decontamination/ decommissioning wastes including acids. The radiological hazard associated with the tank was high in comparison with other 200 area facilities.

The diversion box is a generally small unit used to change the direction of waste water flowing in a line to a tank or discharge. The Generalized Hanford Unit diversion box was 8 feet long, 6 feet wide, 5 feet tall. The box is assumed to have a bottom depth of 10 feet below ground surface.

As discussed in Section 3.3 of this report, exhumation of these underground tanks is not considered a viable solution due to potential occupational health hazards. In this case, it is assumed that grout-in-place is used to remediate the waste unit.

The total volume of grout required for this in-place treatment technique is assumed to be equal to the volume of the Generalized Hanford Unit waste unit or 600,000 gallons (or approximately 3,000 yd^3.

For the diversion boxes, it is assumed that little contamination to the surrounding subsurface soil has occurred and, therefore, it is recommended that only 20 feet of soil be collected instead of the additional 230 feet suggested in Equation 1. Using the modified Equation 1, the excavated volume can be calculated as follows:

- Dimension of the waste unit: 8′ x 6′ x 5′, buried 10 feet below the surface

- Excavation depth is assumed at: 10′ + 20′ = 30′

- Excavation volume:

$$V_{exc} = (20' + 8' + 30') \times (20' + 6' + 30') \times 30'$$
$$= 58' \times 56' \times 30' = 97{,}440 \text{ ft.}^3$$
$$\simeq 3{,}600 \text{ yd}^3.$$

For in-place remediation, grout-in-place is suggested. The amount of grout needed is equal to the volume of the waste unit or:

$$V = 8' \times 6' \times 5' = 240 \text{ ft.}^3$$
$$\simeq 9 \text{ yd}^3$$

Sites Used for the Analysis:

183-KE	241-U-361	UPR-200-W-137
105-KE	241-SX	1607-F-1
166-KE	241-TX	2904-S-171
105-KW	241-U	2904-S-170
241-S	276-S-141	216-S-172
241-T	241-TY	309-TW
216-A-524	241-T-361	6652-G
270-E	241-Z-361	6652-C
241-CX-72	241-SX-302	323 Tanks
241-B-361	241-A	
241-CX-70	241-BX	
241-AX	241-B	
276-S-142	241-C	

J - Spills

The Generalized Hanford Unit spill consisted of a zone 50 feet by 100 feet which was contaminated by chemical and radioactive waste to a depth of 15 feet. Approximately 1,500 gallons of waste was spilled as a result of failed or leaking transfer pipelines. Waste lines were repaired and the site was covered with two feet of gravel.

Because spills have occurred intermittently and because the volume of liquid associated with spills is small compared to the volume of liquid continuously applied to a site such as a surface impoundment ditch or dispersion system, this Generalized Hanford Unit site is considered to be a non-liquid waste site, so groundwater monitoring in deep groundwater areas only extends to 50 feet instead of 100 feet. Soil borings are taken on each side of the spill area for a total of four borings to verify for no release and verify for no residual contamination. A soil boring depth of 20 feet at 2-foot intervals was determined to be adequate to verify no release and verify no residual contamination. Groundwater monitoring wells are placed in a configuration of one upgradient and three downgradient as per discussion in Section 3.2.4.

The Generalized Hanford Unit spill was developed by evaluating all information provided on the 15 spills. The spill volumes, waste types and situations which caused the spill (e.g., leaking pip, etc.) were evaluated to determine an average or Generalized Hanford Unit spill for the purposes of developing remediation costs.

To calculate the amount of contaminated soil, it is assumed that the subsurface contamination extends to about 20 feet from the site. Thus, it is proposed that the excavation be extended an additional 20 feet from the original site. As a result, the excavated volume can be estimated as follows:

- Excavation depth is assumed to be: 15′ + 20′ = 35′

- Excavated volume:

$$V_{exc} = (50' + 40' + 35') \times (100' + 40' + 35') \times 35'$$
$$= 125' \times 175' \times 35' = 765{,}600 \text{ ft.}^3$$
$$\simeq 28{,}400 \text{ yd}^3.$$

For in-situ treatment, in-place grouting is recommended. The volume of soil requiring grouting can be estimated with the following assumptions:

- The in-place grouting will be performed on an area covering an additional 20 feet on all sides of the spill area

- The grouting depth is assumed to reach 35 feet (15 feet plus 20 feet) below ground:

$$V = (50' + 40') \times (100 + 40') \times (15' + 20')$$
$$= 90' \times 140' \times 35' = 441{,}000 \text{ ft.}^3$$
$$\simeq 17{,}000 \text{ yd}^3.$$

Sites Used for the Analysis:

UN-216-E-69	UPR-200-E-44/103/123
UPR-200-E-80/1	UPR-200-E-7
UPR-200-W-69	UPR-200-W-102
UPR-200-W-113	UPR-200-W-2
UN-116-N-22	UN-116-N-23
Uranium Acid Spill (Bldg. 313)	UPR-300-1
UPR-300-31/40	UPR-1100-2
UPR-200-W-117	

K - Underground Vault

The Generalized Hanford Unit underground vault was constructed of concrete. It was 17 feet long, ten feet wide and 12 feet deep and typically rested on a one-foot thick concrete floor. The underground vault was usually used for the disposal of radioactive solid waste.

Because of the small dimensions of these sites, groundwater wells, when necessary to characterize for remediation, will be placed in a configuration including one upgradient and three downgradient wells. One soil boring will be collected on each side of the site where necessary to characterize sites fitting the verify for no release and verify for no residual contamination categories. Section 3.2.4 describes the numbers of soil samples in the deep and shallow groundwater areas.

Eight sites were used in this analysis. For 7 sites information was available on the unit's dimensions. Two of the 8 sites had multiple vaults and these vaults were considered separately in the analysis. One site (241-WR) had a large vault that was composed of nine individual compartments. The average size of one of these compartments (all of equal size) was determined and subsequently used in the analysis.

For this type of waste unit, it is assumed that there is negligible subsurface soil contamination that remains close to the unit. To excavate this unit, it is assumed that an additional three feet around the unit be added to facilitate the removal of the unit from the ground. Therefore, the excavated volume can be calculated as follows:

- Waste unit dimensions: 17′ x 10′ x 12′

- Excavation depth: 12′ + 3′ = 15′

$$V_{exc} = (17' + 3' + 15') \times (10' + 3 + 15') \times 15'$$
$$= 35' \times 28' \times 15' = 14{,}700 \text{ ft.}^3$$
$$\simeq 550 \text{ yd}^3.$$

For in-place remediation, grout-in-place is suggested for this type of waste unit. The volume of grout required is equal to the volume of the waste unit, or:

$$V = 17' \times 10' \times 12' = 2{,}040 \text{ ft.}^3$$
$$\simeq 75 \text{ yd}^3.$$

Sites used for the analysis include 118-F-7, 218-E-7, 241-CX-72, 2904-S-160, 205-S, 218-W-7, 218-W-8, and 241-WR.

L - Burning Pit

The Generalized Hanford Unit burning pit was 100 feet long, 110 feet wide and 30 feet deep. It was used for disposal and burning of non-radioactive materials such as paint waste, office waste and chemical solvents.

Because of the small dimensions of this Generalized Hanford Unit site, groundwater wells, when necessary to characterize for remediation, will be placed in a configuration including one upgradient and three downgradient wells. One soil boring will be collected on each side of the site where necessary to characterize sites fitting the verify for no release and verify for no residual contamination categories. Section 3.2.4 describes the numbers of soil samples to be taken.

The Generalized Hanford Unit burning pit was developed by calculating average dimensions from data for the ten sites in this site type.

To estimate the volume of contaminated soil removed from this type of unit, it is assumed that the pit is backfilled to grade level, and the contamination still remains 20 feet beneath the unit. Since it is assumed that this unit contains solid waste, Equation 2 of Section 3.3. is used to estimate the volume of the excavation.

- Waste unit dimensions: 110′ x 100′ x 30′

- Excavation depth: 30′ + 20′ = 50′

$$V_{exc} = [(1.5 \times 110') + 50'] \times [(1.5 \times 100') + 50'] \times 50'$$
$$= 215' \times 200' \times 50' = 2{,}150{,}000 \text{ ft.}^3$$
$$\simeq 80{,}000 \text{ yd}^3.$$

For in-situ remediation, grout-in-place is recommended for this type of waste unit. It is assumed the contaminants have moved to about 1.5 times the lateral dimension of the unit, and remained 20 feet beneath the unit. Therefore, the volume of soil to be grouted can be estimated as follows:

$$V = (1.5 \times 40') \times (1.5 \times 100') \times 50'$$
$$= 165' \times 150' \times 50' = 1{,}238{,}000 \text{ ft.}^3$$
$$\simeq 46{,}000 \text{ yd}^3.$$

Sites used for the analysis include 200 West Burning Pit, 100B/C Burning Pit, 100-K Burning Pit, 128-N-1 100-N Burning Pit, 100-H Burning Pit, 100-D/DR Burning Pit, 100-F Burning Pits #2, 618-5 Burial Ground #5, 200 East Burning Pit, and Z Plant Burning Pit.

M - Incinerator

The Generalized Hanford Unit incinerator was a two-story concrete block building that was 37 feet long and 57 feet wide. The lower part housed a storage room and electrical room, a process room containing waste handling equipment, a chemical mixing room and a change room. This part was 15 feet tall. The second story was 19 feet tall and contained the building's heating and ventilation system. The chemical inventory onsite is unknown and the radiological inventory is relatively low compared to other 200 area sites.

In order to characterize for remediation groundwater monitoring is normally required under this project, however, because the incinerator is located in a building, groundwater monitoring is unnecessary for site characterization. For the incinerator site that needs to be verified for no residual contamination, ten wipe samples will be used instead of soil monitoring. Since there is no unit of this type being recommended for remediation, no remedial action is developed for costing purposes. The Generalized Hanford Unit description is based on only one site because within this site type, only one incinerator exists. The site used was 232-Z.

N - Process Sewers

The Generalized Hanford Unit process sewer was about 4,000 feet long and an assumed six feet in diameter. It consisted of stainless steel pipes buried 10 feet below grade and backfilled with soil. Radioactive liquids have been drained from the pipes.

Because process sewers have a low potential for contaminating groundwater due to their small size, monitoring wells will be replaced with soil borings to a depth of 30 feet, at two-foot intervals to characterize for remediation. Based on an engineering numerical cost analysis, and due to the great length of this unit, and the low potential for large releases of liquid wastes, a configuration of alternating soil sample location on each side of the sewer, at 200-foot intervals was used to cover the cost of characterization.

For analysis purposes, it is assumed that there is no release from the process sewer pipe. Therefore, it is assumed that the exhumation of this Generalized Hanford Unit waste unit will consist of removing the pipe from the ground and disposing of it in an approved landfill. The total amount of excavation and disposal is assumed to be the same as the volume of the waste unit or:

$$V_{exc} = 4{,}000' \times \frac{(3.14159)(6')^2}{4} = 113{,}100 \text{ ft.}^3$$

$$\simeq 4{,}200 \text{ yd}^3.$$

For in-place remediation, grout-in-place is recommended for this unit. Again, the total volume of grout needed is equal to the volume of the pipe or 4,200 yd^3.

This Generalized Hanford Unit description was developed by using average dimensions from two sites: REDOX Chemical Sewer of 203-S, and sewer pipe for retired liquid waste.

O - Other

The sites in this site type were grouped on the basis of similarities with respect to remediation costs. They include three wastewater pumping stations, a cask storage pad and a sandfilter monitor.

When necessary to characterize for remediation, groundwater monitoring wells were replaced with soil borings (see Section 3.2.4). One soil boring will be placed on each side of the site to a depth of 30 feet at all sites (samples collected at 2-foot intervals) where necessary to verify for no release and verify for no residual contamination. Since there is no unit of this type being recommended for remediation, no remedial action is developed for costing purposes.

The Generalized Hanford Unit "other" site refers to an inactive radioactive wastewater transfer pumping station which was used to pump low level radiological and decontamination chemicals from a reactor building, which flowed to combine with other wastewaters prior to discharge to the Columbia River. The site was decommissioned under the 100 area decommissioning program for final disposal.

Sites used for the analysis include 1608-H, 16-8-DR, 1608-F, 100D, Land 2718-S.

APPENDIX D

SUMMARY OF RCRA 3004(u) SITES

APPENDIX D-1

LIST OF SITES IDENTIFIED AS POTENTIAL RCRA 3004(u) SITES

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987)

RCRA 3004(u) SITE	AREA
105-B Battery Acid Sump	100 B/C
184-B Powerhouse Ash Pit	100 B/C
1607-B1 Septic Tank	100 B/C
1607-B3 Septic Tank	100 B/C
1607-B7 Septic Tank	100 B/C
1607-B8 Septic Tank	100 B/C
1608-D Waste Water Pumping Station	100-D/DR
100-D Cask Storage Pad	100-D/DR
1706-D Gasoline Storage Tank	100 D/DR
1608-DR Waste Water Pumping Station	100 D/DR
1607-D1 Septic Tank	100 D/DR
1607-D4 Septic Tank	100 D/DR
1608-F Waste Water Pumping Station	100-F
184-F Powerhouse Ash Pit	100-F
1607-F1 Septic Tank	100-F
1607-F3 Septic Tank	100-F
1607-F4 Septic Tank	100-F
1607-F5 Septic Tank	100 F
1607-F6 Septic Tank	100 F
1608-H Waste Water Pumping Station	100 H
184-H Powerhouse Ash Pit	100 H
100-H2 Burning Pit	100 H
1607-H2 Septic Tank	100 H
1607-H3 Septic Tank	100 H
1607-H4 Septic Tank	100 H
105-KE Emergency Diesel Fuel Tank	100 KE/KW
166-KE Oil Storage Tank	100 KE/KW
183-KE1 Sulfuric Acid Storage Tank	100 KE/KW
183-KE2 Sulfuric Acid Storage Tank	100 KE/KW
183-KE Liquid Alum Storage Tank No. 2	100 KE/KW
183-KE Sodium Dichromate Storage Tank	100 KE/KW

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

RCRA 3004(u) SITE	AREA
105-KW Emergency Diesel Fuel Tank	100 KE/KW
166 KW Oil Storage Tank	100 KE/KW
183-KW1 Sulfuric Acid Storage Tank	100 KE/KW
183-KW2 Sulfuric Acid Storage Tank	100 KE/KW
183-KW Sodium Dichromate Storage Tank	100 KE/KW
1717-K Gasoline Storage Tank	100 KE/KW
1717-K Waste Oil Storage Tank	100 KE/KW
182-K Emergency Cooling Flow-Diesel Pump Oil Supply	100 KE/KW
100-N Burning Pit (128-N-1)	100 N
124-N-4 Septic Tank	100 N
124-N-5 Septic Tank	100 N
124-N-6 Septic Tank	100 N
124-N-7 Septic Tank	100 N
124-N-8 Septic Tank	100 N
Acid Unloading Facility French Drains (120-N-7)	100 N
108-N Acid Tank Vent French Drains (120-N-6)	100 N
163-N Neutralization Pit and French Drain (120-N-3)	100 N
Sanitary Waste Drain Field	200 East
207-S Retention Basin	200 West
242-T Evaporator incl. UPR-200-W-12	200 West
242-B Evaporator	200 East
Diversion Boxes, Catch Tanks, and Receiving Vaults	200 East

25 diversion boxes - include UN-216-E-68, UPR-200-E-4, 6, 45, 73, 74, 75, 77
2 receiving vaults
2 diverter stations
1 unidentified unit
10 catch tanks

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

RCRA 3004(u) SITE	AREA
Diversion Boxes, Catch Tanks, and Receiving Vaults	200 West
22 boxes includes UPR-200-W-7,20, 51, 52, 80, 81, 99, 114, 126	
8 catch tanks (incl. 240-S-302)	
Tanks 276-S-141 and 276-S-142	200 West
241-A Tank Farm (single shell) (6 tanks) includes UPR-200-E-125, 48, 126, 47	200 East
241-AX Tank Farm (single shell) (4 tanks) UPR-200-E-115, 119	200 East
241-B Tank Farm (single shell) (16 tanks) includes UPR-200-E-127, 128, 129, 130, 108, 109	200 East
241-BX Tank Farm (single shell) (12 tanks) includes UPR-200-E-131, 132, 133, 3, 5, 78, 89	200 East
241-BY Tank Farm (single shell) (12 tanks) includes UPR-200-E-134, 135, 110	200 East
241-C Tank Farm (single shell) (12 tanks) includes UN-216-E-91, UPR-200-E-136, 137, 16, 50, 91	200 East
241-S Tank Farm (single shell) (12 tanks) includes upr-200-W-80, 81	200 West
241-SX Tank Farm (single shell) (15 tanks) includes UPR-200-W-49, 50, 114, 80, 81	200 West
241-T Tank Farm (single shell) (16 tanks) includes UPR-200-W-148	200 West
241-TX Tank Farm (single shell) (18 tanks) includes UPR-200-W-149, 100	200 West
241-TY Tank Farm (single shell) (6 tanks) includes UPR-200-W-150, 153, 151, 152	200 West

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

RCRA 3004(u) SITE	AREA
241-U Tank Farm (single shell) (16 tanks) includes UPR-200-W-154, 155, 156, 157	200 West
241-B-361 Settling Tank	200 East
270-E Condensate Neutralization Tank	200 East
241-T-361 Settling Tank	200 West
241-U-361 Settling Tank	200 West
241-Z-361 Settling Tank	200 West
241-CX-70 Tank	200 East
241-CX-72 Vault and Tank	200 East
216-A-524 Control Structure	200 East
2904-S-160 Control Structure	200 West
2904-S-170 Weir Box	200 West
2904-S-171 Weir Box	200 West
216-S-172 Weir Box and Control Structure	200 West
244-UR Vault includes UPR-200-W-24	200 West
241-WR Vault	200 West
224-B Concentration Facility	200 East
2718-S Sand Filter Monitor	200 West
276-U Solvent Handling Facility	200 West
241-SX-401 Condenser Shielding Building tanks, dry well (+ equip)	200 West
241-SX-402 Condenser Shielding Building tanks, dry well (+ equip)	200 West
232-Z Waste Incineration Facility (building & equip)	200 West
203-S, 205-S Uranium Nitrate Hexahydrate Processing Facility - 203-S basin, 204-S basin, 205-S Vault, sewer	200 West
218-W-02A Burial Ground	200 West
216-S-19 Pond	200 West
216-A-3 Crib	200 East

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

RCRA 3004(u) SITE	AREA
UPR-200-W-34	200 West
216-U-10 Pond includes 200-W-107	200 West
216-Z-19 Ditch	200 West
216-A-10 Crib	200 East
216-U-10 Crib	200 West
216-B-59 Trench	200 East
R-3 Waste Line (UPR-200-E-80) includes UPR 200-E-1	200 East
UPR-200-W-2 (failed waste line)	200 West
UPR-200-W-110 (trench)	200 West
UPR-200-W-111 (sludge trench)	200 West
UPR-200-W-112 (sludge trench)	200 West
UPR-200-W-113 (failed waste line)	200 West
221-U Railroad Cut (UPR-200-W-117)	200 West
UPR-200-W-139 (ditch)	200 West
205-A Silica Gel Facility	200 East
276-S Solvent Handling Facility	200 West
UPR-200-W-30 (pit)	200 West
331 Life Sciences Laboratory Drainfield	300
311 Tank Farm Underground Methanol Storage Tanks	300
313 Building Underground Methanol Storage Tank	300
331 Life Sciences Laboratory Sanitary Waste Trench (1966-1969)	300
331 Life Sciences Laboratory Waste Trench (1964-1974)	300
323 Tanks (4)	300
309 TW Tanks	300
Retired Radioactive Liquid Waste Sewer System	300
Retired 315 Sanitary Drain Field	300
Retired 335/336 Sanitary Drain Field	300
300 Area Retired Filter Backwash Pond	300

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

RCRA 3004(u) SITE	AREA
Solvent Evaporator	300
334 Tank Farm Waste Acid Storage Tank	300
In Situ Vitrification Test Site	300
300 Area Interim Filter Backwash Disposal Pit	300
400 Area Retired Sanitary Pond	400
400 Area Retired French Drains	400
Retired Septic Tanks	400
French Drain (South of 4722-C)	400
400 Area Retired Sand Bottom Trench	400
6652-G ALE Field Storage Building Septic Tank	600
6652-C Space Science Laboratory Septic Tank	600
Army Bunkers Septic Tank (3)	600
Army Munitions Burial Site	600
Underground Waste Solvent Tank	700
184-N Diesel Oil Supply Line Leak (UN-116-N-22)	100N
184-N Diesel Oil Supply Line Leak (UN-116-N-23)	100N
Railroad Car Flush Water Spill (UN-216-E-69)	200 East
Radioactive Contamination from Uncovered Buried Waste (UN-216-E-72)	200 East
Battery Acid Sand Pit (UPR-1100-1)	1100 Area
Paint Disposal Area (UPR-1100-2)	1100 Area
Antifreeze/Degreaser Sand Pit (UPR-1100-3)	1100 Area
Antifreeze Tank (UPR-1100-4)	1100 Area
Uranium-Bearing Acid Waste Tech Acid Spill (313 bldg.)	300
UPR-200-E-7	200 East
UPR-200-E-44 (BCS crib line, R-17 change house) and UPR-200-E-103, -123	200 East
UPR-200-E-124 (R-13 pit) and UPR-200-E-85	200 East
UPR-200-W-69	200 West
UPR-200-W-102 (process tanks vent lines)	200 West

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

UPR-200-W-135 (cave-in and runoff path)	200 West
UPR-200-W-137 (location)	200 West
UPR-300-1 (transfer line leak)	300
UPR-300-31 (pipe trench system 311 tank farm) and UPR-300-40	300
100 B/C Burning Pit	100 B/C
118-D-1 (100-D) Burial Ground No. 1	100 D/DR
118-D-2 (100-D) Burial Ground No. 2	100 D/DR
118-D-3 (100-D) Burial Ground No. 3	100 D/DR
100-D/DR Burning Pit	100 D/DR
100-F Burning Pits-2	100 F
118-F-7 (100-F) Miscellaneous Hardware Storage Vault	100 F
118-H-1 (100-H) Burial Ground No. 1	100 H
100-H Burning Pit	100 H
107-H (100-H) Retention Basin	100 H
118 K (100-K) Burial Ground	100 K
100-K Burning Pit	100 K
116-B-9 (104-B-2) French Drain	100 B/C
118-B-1 (105-B) Burial Ground	100 B/C
116-B-3 (105-B) Pluto Crib	100 B/C
118-B-4 (105-B) Spacer Burial Ground	100 B/C
116-B-2 (105-B) Storage Basin Trench	100 B/C
118-C-2 (105-C) Ball Storage Tank	100 B/C
118-C-1 (105-C) Burial Ground	100 B/C
116-C-2-2 (105-C) Pluto Crib Sandfiller	100 B/C
116-D-6 (105-D) Cushion Corridor French Drain	100 D/DR
116-D-2 (105-D) Pluto Crib	100 D/DR
116-D-1A (105-D) Storage Basin Trench No. 1	100 D/DR
118-DR-1 (105-DR) Gas Loop Burial Ground	100 D/DR
116-DR-4 (105-DR) Pluto Crib	100 D/DR
116-DR-3 (105-DR) Storage Basin Trench	100 D/DR
116-F-11 (105-F) Cushion Corridor French Drain	100 F

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

116-F-4 (105-F) Pluto Crib	100 F
116-H-4 (105-H) Pluto Crib	100 H
118-H-5 (105-H) Thimble Pit	100 H
116-KE-3 (105-KE) Storage Basin French Drain	100 KE/KW
116-KW-2 (105-KW) Storage Basin French Drain	100 KE/KW
107-B Retention Basin	100 B/C
107-C Retention Basin	100 B/C
107-D Retention Basin	100 D/DR
107-DR Retention Basin	100 D/DR
107-F Retention Basin	100 F
107-KE Retention Basin	100 KE/KW
107-KW Retention Basin (3)	100 KE/KW
116-B-5 (108-B) Crib	100 B/C
116-B-10 (108-B) Dry Well	100 B/C
118-B-6 (108-B) Solid Waste Burial Ground	100 B/C
116-D-3 (108-D) Crib No. 1	100 D/DR
116-D-4 (108-D) Crib No. 2	100 D/DR
116-B-6-1 (111-B) Crib No. 1	100 B/C
116-B-6-2 (111-B) Crib No. 2	100 B/C
118-B-7 (111-B) Solid Waste Burial Site	100 B/C
118-F-4 (115-F) Pit	100 F
116-KE-1 (115-KE) Condensate Crib	100 KE/KW
116-KW-1 (115-KW) Condensate Crib	100 KE/KW
P-11 Crib	600
117-B Crib	100 B/C
117-C Crib	100 B/C
117-D Crib	100 D/DR
116-DR-8 (117-DR) Crib	100 D/DR
116-F-7 (117-F) French Drain	100 F
117-H Crib	100 H
116-F-12 (148-F) French Drain	100 F
216-T-20 (155-TX) Trench (216-T-20)	200 West

RCRA 3004(u) SITES

(identified from Hanford Waste Management Units Report, May 1987) (continued)

116-F-13 (1705-F) Experimental Garden French Drain	100 F
100-KE*3 (183-KE) Filter Water Facility KE*3	100 KE/KW
200 Area Construction Waste Site	200 East
200 East Burning Pit	200 East
218-E-8 200 East Construction Burial Ground	200 East
218-E-1 200 East Dry Waste Burial Ground	200 East
218-E-12A 200 East Dry Waste No. 12A; Burial Ground	200 East
218-E-2 200 East Industrial Waste No. 2; Burial Ground	200 East
218-E-5A 200 East Industrial Waste No. 5A; Burial Ground	200 East
218-E-9 200 East Regulated Equipment Storage Site No.9	200 East
218-E-4 200 East/Minor Construction No. 4; Burial Ground	200 East
218-E-7 200 East/22-B Vaults; Burial Vaults (3)	200 East
200 West Burning Pit	200 West
216-C-3 (201-C) Leaching Pit	200 East
216-S-11 (202-S) Chemical Sump No. 2; Pond (2)	200 West
216-A-1 Crib	200 East
216-A-11 French Drain	200 East
216-A-12 French Drain	200 East
216-A-13 French Drain	200 East
216-A-14 French Drain	200 East
216-A-15 French Drain	200 East
216-A-16 French Drain	200 East
216-A-17 French Drain	200 East
216-A-18 Trench	200 East
216-A-19 Trench	200 East
216-A-2 Crib	200 East
216-A-20 Trench	200 East
216-A-22 Crib	200 East

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

216-A-23A French Drain	200 East
216-A-23B French Drain	200 East
216-A-26A French Drain	200 East
216-A-31 Crib	200 East
216-A-32 Crib	200 East
216-A-33 French Drain	200 East
216-A-34 Crib	200 East
216-A-35 French Drain	200 East
216-A-39 Crib	200 East
216-A-41 Crib	200 East
216-B-3-2 Ditch	200 East
216-B-10B Crib	200 East
216-B-11A and B Reverse Well	200 East
216-B-2-1 Ditch	200 East
216-B-3-1 Ditch	200 East
216-B-22 Trench	200 East
216-B-23 Trench	200 East
216-B-24 Trench	200 East
216-B-25 Trench	200 East
216-B-26 Trench	200 East
216-B-27 Trench	200 East
216-B-28 Trench	200 East
216-B-30 Trench	200 East
216-B-31 Trench	200 East
216-B-32 Trench	200 East
216-B-33 Trench	200 East
216-B-9 Crib	200 East
216-B-4 Reverse Well	200 East
216-B-52 Trench	200 East
216-B-53B Trench	200 East
216-B-53A Trench	200 East
216-B-54 Trench	200 East
216-B-57 Crib	200 East

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

216-B-58 Trench	200 East
216-B-60 Crib	200 East
216-B-13 French Drain	200 East
216-B-14 Crib	200 East
216-B-29 Trench	200 East
216-B-15 Crib	200 East
216-B-34 Trench	200 East
216-B-17 Crib	200 East
216-B-18 Crib	200 East
216-B-19 Crib	200 East
216-B-20 Trench	200 East
216-B-21 Trench	200 East
216-B-35 Trench	200 East
216-B-36 Trench	200 East
216-B-37 Trench	200 East
216-B-38 Trench	200 East
216-B-39 Trench	200 East
216-B-40 Trench	200 East
216-B-41 Trench	200 East
216-B-42 Trench	200 East
216-B-47 Crib	200 East
216-B-51 Crib	200 East
216-C-4 Crib	200 East
216-C-5 Crib	200 East
216-C-8 Crib	200 East
216-B-12 Crib	200 East
216-N-1 Covered Pond	200 North
216-N-3 Trench	200 North
216-N-2 Trench	200 North
216-N-4 Pond	200 North
216-N-5 Trench	200 North
216-N-6 Pond	200 North
216-N-7 Trench	200 North

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

216-S-22 Crib	200 West
216-S-23 Crib	200 West
216-S-26 Crib	200 West
Z-Plant Burn Pit	200 West
216-S-13 Crib	200 West
216-T-12 Trench	200 West
216-T-13 Trench	200 West
216-T-5 Trench	200 West
216-T-14 Trench	200 West
216-T-15 Trench	200 West
216-T-16 Trench	200 West
216-T-17 Trench	200 West
216-T-18 Crib	200 West
216-T-31 French Drain	200 West
216-T-33 Crib	200 West
216-T-34 Crib	200 West
216-T-35 Crib	200 West
216-T-36 Crib	200 West
216-T-4-1 Ditch	200 West
216-T-4A Pond	200 West
216-T-4-2 Ditch	200 West
216-T-6 (216-T-5) Crib (2)	200 West
216-T-32 (216-T-6) Crib	200 West
216-T-26 (216-TX-1) Crib	200 West
216-T-27 (216-TX-2) Crib	200 West
216-T-22 (216-TX-2) Trench	200 West
216-T-21 (216-TX-3) Trench	200 West
216-T-24 (216-TX-4) Trench	200 West
216-T-23 (216-TX-5) Trench	200 West
216-U-6 Cold Trench No.1	200 West
216-U-13 Trench (2)	200 West
216-U-5 (216-U-4) Trench	200 West
216-U-9 (216-U-6) Ditch	200 West

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

216-Z-6 (216-W-4) Crib	200 West
216-U-8 (216-WR-1) Crib	200 West
216-Z-11 Ditch	200 West
216-Z-9 (216-Z-10) Ditch	200 West
216-Z-1D (216-Z-11) Ditch	200 West
216-Z-16 Crib	200 West
216-Z-17 Trench	200 West
216-Z-18 Crib (5)	200 West
216-Z-3 Crib	200 West
216-Z-1A (216-Z-7) Tile Field	200 West
216-Z-8 French Drain	200 West
218-E-3 Burial Ground	200 East
218-E-5 Burial Ground	200 East
218-E-6 Burial Ground	200 East
216-U-7 (221-U) Vessel Blower Pit French Drain	200 West
218-W-7 (222-S) Vault	200 West
218-W-8 (222-T) Vault	200 West
216-Z-5 (231-W) Sumps	200 West
216-Z-4 (231-W-3) Trench	200 West
216-B-8 (241-B-3) Crib	200 East
216-C-6 (241-CX-4) Crib	200 East
216-S-18 (241-SX) Steam Cleaning Pit	200 West
216-T-25 (241-TX-5) Trench	200 West
216-Z-12 Crib	200 West
216-U-15 (388-U) Tank Dumping Trench	200 West
216-S-12 (288-U) Stack Wash Sump; Trench	200 West
216-T-29 (291-T Sand Filter Sewer; Crib	200 West
316-4 300 North Crib	300
618-10 300 North Solid Waste Burial Ground and UPR-600-1, 2, 3	600
618-9 300 West Burial Ground	600
618-11 300 Wye Burial Ground and UPR-600-4, 5, 6, 7, 8, 9, 10	600

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

618-13 303 Area Contaminated Soil Burial Site	600
118-B-5 Ball 3X Burial Ground	100 B/C
118-D-5 Ball 3X Burial Ground	100 D/DR
118-H-4 Ball 3X Burial Ground	100 H
116-F-5 Ball Washer Crib	100 F
118-F-1 Burial Ground No. 1	100 F
118-F-2 Burial Ground No. 2	100 F
118-F-3 Burial Ground No. 3	100 F
618-3 Burial Ground No. 3	600
618-4 Burial Ground No. 4	600
618-5 Burial Ground No. 5	600
618-6 Burial Ground No. 6	600
618-7 Burial Ground No. 7	600
City of Hanford Landfill	600
216-S-8 Cold Aqueous Trench	200 West
216-S-14 Cold Organic Trench	200 West
118-D-4 Construction Burial Ground	100 D/DR
118-H-3 Construction Burial Ground	100 H
118-B-2 Construction Burial Ground No. 1	100 B/C
118-B-3 Construction Burial Ground No. 2	100 B/C
216-T-10 Decontamination Trenches	200 West
216-T-9 Decontamination Trenches	200 West
218-W-2 Dry Waste Burial Ground No. 2	200 West
218-W-3 Dry Waste Burial Ground No. 3	200 West
218-W-4A Dry Waste Burial Ground No. 4A; includes UPR-200-W-72	200 West
218-W-9 Dry Waste Burial Ground No. 9	200 West
218-W-1 Dry Waste No. 1; Burial Ground	200 West
618-8 Early Waste Burial Ground	600
East White Bluffs City Landfill	600
216-T-11 Equipment Decontamination Trenches	200 West
213 J and K Gable Mountain Plutonium Cribs	600

RCRA 3004(u) SITES
(identified from Hanford Waste Management
Units Report, May 1987) (continued)

218-W-1A Industrial Burial Ground No.1	
118-H-2 H-1 Loop Burial Area, 100-H Burial Ground No. 2	100 H
Hanford Trailer Camp	600
Horn Rapids Landfill	600
218-W-1A Industrial Waste Burial Ground No. 1	200 West
J.A. Jones No. 1; Construction Pit	600
J.A. Jones No. 2; Burial Ground	600
Midway Landfill No. 1	600
Midway Landfill No. 2	600
Nonradioactive Burial Ground	200 West
618-12 North Process Pond Scraping Disposal Area	600
Original Central Landfill	600
Pickling Acid Crib	600
118-F-5 PNL Sawdust Repository	100 F
118-F-6 PNL Solid Waste Burial Ground	100 F
218-E-14 Purex Tunnel No. 1; Burial Tunnel	200 East
218-E-2A Regulated Equipment Storage Site No. 2A; Trench	200 East
Sodium Dichromate Barrell Disposal; Landfill	600
218-W-11 Solid Waste Burial and Regulated Storage	200 West
618-1 Solid Waste Burial Ground No. 1	600
618-2 Solid Waste Burial Ground No. 2	600
218-E 13 Burial Ground	200 East
White Bluffs City Landfill	600
USBR-2, 4-D Burial Ground	600

OTHER INACTIVE WASTE SITES

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
building	100 B/C		105-B Reactor Building	building, fuel storage basin; not in scope per SOW
storage unit	100 B/C		104-B2 Storage	
building	100 B/C		105-C Reactor Building	reactor, basin; not in scope per SOW
building	105-D		105-D Reactor Building	reactor; not in scope per SOW
building	100-D/DR		105-DR Reactor Building	reactor; not in scope per SOW
building	100-F		105-F Reactor Building	reactor; not in scope per SOW
building	100-H		105-H Reactor Building	reactor; not in scope per SOW
building	105-KE/KW		105-KE Horizontal Control Rod Storage Cave	
building	105-KE/KW		105-KE Reactor Building	reactor; not in scope per SOW
station	107-KE Basin		105-KE Recovery Station	
building	105-KE/KW		105-KW Reactor Building	reactor; not in scope per SOW
station	107-KE Basin		105-KW Heat Recovery Station	
tank	100-KE/KW		1607-K3 Septic Tank	
storage unit	100 H		183-H Solar Evaporation Basins	seeking RCRA closure permit; permit will address cleanup.
storage	200 North		212-N Building	
building/tanks	200 west		233-S Plutonium Concentration Facility	
stack	200 West		296-S-7 Stacks	
building/tanks	200 East		201-C Process Building	
building/equip	200 East		215-C Gas Preparation Building	
building	200 West		202-S REDOX	contains solid rad waste

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
building	200 west		292-S Jet Pit House	contam surfaces
storage unit	100 B/C		105-C Horizontal Control Rod Storage Cave	active?
storage unit	100 KE/KW		105-KW Horizontal Control Rod Storage Cave	active?
building	200 west		293-S Offgas Treatment Facility	rad contam struct/equip
stack	200 west		296-S-1 Stack	
stack	200 west		296-S-2 Stack	
stack	200 west		296-S-4 Stack	
stack	200 west		296-S-6 stack	
building	200 west		2904-SA Sample Building	
stack	200 west		296-U-10 Stack	
building/equip	200 East		241-A-431 tank farm vent bldg	
building	200 west		2711-S stack monitoring bldg	
building	200 East		241-C-801 Cesium Loadout Facility	
building/equip	200 West		221-U Canyon Bldg	
soill	100 North	UN-116-N-19	184-N Day Tank Fuel Oil Soill	
soill	100 North	UN-116-N-20	166-N North Diesel Oil Return Line Leak	
soill	100 North	UN-116-N-21	184-N Diesel Oil Day Tank Overflow	
soill	100 North	UN-116-N-15	108-N Neutralization Sump Soill	
soill	100 North	UN-116-N-33	108-N Acid Transfer Soill	
soill	200 East	UN-216-E-61	Radioactive Contamination From Railroad Burial Cars	
soill	200 East	UN-216-E-60	Radioactively Contaminated	

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
			Dirt Spill	
spill	200 East	UN-216-E-62	Radioactive Liquid Spill	
spill	200 East	UN-216-E-63	Radioactively Contaminated Tumbleweeds	
spill	200 East	UN-216-E-64	Radioactive Contamination From 270-E-1 Acid Neutralization Tank	
spill	100 N	UN-116-N-6	Chemical Decontamination Drain Line Leak	
spill	100 N	UN-116-N-7	Ten-Inch Radioactive Drain Return Line Leak	
spill	200 East	UN-216-E-67	Radioactively Contaminated Pipe Encasement	
spill	200 West	UN-216-W-82	Radioactive Spill Near 204-S Radiation Zone	
spill	200 East	UN-216-E-70	Radioactive Contamination From Jumper Removal	
spill	200 East	UN-216-E-88	Radioactive Contamination at TC-4 Railroad Spur	
spill	200 East	UN-216-E-90	Radioactive Spill Near 221-B Building	
spill	200 West	UN-216-W-85	Radioactive Spill from Multi-Purpose Transfer Box	
spill	200 West	UN-216-W-86	Radioactively Contaminated Pigeon Feces	
spill	200 West	UN-216-W-87	Radioactive Spill From Filter Housing	
spill	200 West	UN-216-W-88	Radioactive Spill From UNH Trailer	
spill	200 West	UN-216-W-89	Radioactive Contamination Southwest of 236-Z Building	
spill	200 West	UN-216-W-90	Radioactive Contamination South of 236-Z Building	

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
soill	200 west	UN-216-w-91	Radioactive Contamination Near 234-5Z Building	
soill	200 East		Anhydrous Ammonia Release to Air at B Plant	
soill	200 west		Caustic Soill at Plutonium Finishing Plant	
soill	200 East		Oil Soill at 211-B Bulk Storage Area	
soill	200 East		Uranyl Nitrate Soill to Ground Near 2718-E Building	
soill	200		Diesel Fuel Soill - 202-A	
soill	300		Phosphoric Acid Soill	
soill	300		Fuel Oil Soill	
soill	300		Solvent Refined Coal Soill	
soill	300		Uranium-Bearing Acid Soill - 303 F Building	
soill	400		Coolant Soill	
soill	600		Gasoline Soill at Patrol Boat Refueling Area	
soill	600		Tank Truck Gasoline Soill	
soill	100-F	UPR-100-F-1	Sewer lines	
soill	100-N	UPR-100-N-1	Line Leak near 1304-N Emergency Dump Tank	
soill	100-N	UPR-100-N-2	Line Leak from FLV858 Valve	
soill	100-N	UPR-100-N-3	Line Leak from 100-N Fuel Storage Basin	
soill	100-N	UPR-100-N-5	Radioactive Chemical Waste Handling Facility	excluded; part of active unit
soill	100-N	UPR-100-N-8 & UPR-100-N-4	1322-A Sump	two UPRs

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
spill	100-N	UPR-100-N-9	Drain line rupture	
spill	100-N	UPR-100-N-10	105-N Building Lift Station	
spill	100-N	UPR-100-N-11	Contaminated Valve Bonnet	
spill	100-N	UPR-100-N-13	1314-N Loading Station Railroad Waste Tank	
spill	100-N	UPR-100-N-14	1.3-N Drain System	
spill	100-N	UPR-100-N-17	166-N Diesel Oil Supply Line	
spill	100-N	UPR-100-N-18	166-N Tank Farm and 184-N Diesel Oil Day Tank	
spill	100-N	UPR-100-N-25	1310-N Tank	
spill	100-N	UPR-100-N-26	1314-N Radioactive Liquid Waste Load Out Facility	
spill	100-N	UPR-100-N-29	1304-N Emergency Dump Tank	
spill	100-N	UPR-100-N-30	1304-N Emergency Dump Tank	
spill	100-N	UPR-100-N-31	1301-N Liquid Waste Disposal Facility	
spill	100-N	UPR-100-N-32	Emergency Dump Tank Bypass Line	
chute	100 KE/KW	UPR-100-K-1	105-KE pickup chute/fuel basin	
spill	100-N	UPR-100-N-34	WPPSS Trestle Vicinity Line	
contam	200-E	UPR-200-E-2	Contamination near B and T Plant Stacks	
spill	100-N	UPR-100-N-12	Spacer transport line leak	
spill	200-E	UPR-200-E-9	216-BY-5 flush tank	
spill	200-E	UPR-200-E-10	PUREX Tube Bundles	
spill	200-E	UPR-200-E-11	PUREX Tunnel Railroad Tracks	
spill	200-E	UPR-200-E-12	Burial Box	
spill	200-E	UPR-200-E-18	A-8 Proportional Sampler Pit	

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
			vent Pipe Bonnet	
soil	200-E	UPR-200-E-19	A-6 Proportional Sampler Pit vent Pipe Bonnet	
soil	200-E	UPR-200-E-20	PUREX Tube Bundles	
contam	200-E	UPR-200-E-22	Ground Contamination from 291-A Stack	
soil	200-E	UPR-200-E-27	244-CR Vault	
coil	200-E	UPR-200-E-28	Process Vessel Steam Coil	
soil	200-E	UPR-200-E-33	Leaking Box	
soil	200-E	UPR-200-E-34	F-15 PUREX tank	excluded; active unit; not in scope
pump	200-E	UPR-200-E-35	218-E-13	
soil	200-E	UPR-200-E-36 & UPR-200-E-37	Semiworks Pumps	two UPRs
soil	200-E	UPR-200-E-39 & UPR-200-E-40	216-A-36B Crib Sampling Shack	two UPRs
bldg soil	200-E	UPR-200-E-41	271-B Building Waste Line	
soil	200-E	UPR-200-E-42	244-AR Diverter Tank	
soil	200-E	UPR-200-E-43	102-BY Pump	
soil	200-E	UPR-200-E-49	241-AY Tank Farm	see also 102-BY pump
soil	200-E	UPR-200-E-52	E-5-2 Strontium Concentrator	
soil	200-E	UPR-200-E-54	225-B Building	
soil	200-E	UPR-200-E-55	212-B Building	
soil	200-E	UPR-200-E-56	241-AN Tanks	
contam	200-E	UPR-200-E-58	roadway to 218-E-1 dry waste burial ground	
soil	200-E	UPR-200-E-59	244-AX Vault (nest)	
soil	200-E	UPR-200-E-76	9-2 Tank Transfer Line 216-E-4	

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
soill	200-E	UPR-200-E-82	B Plant Transfer Line 216-E-10	group with 241-C-152 diversion box (RCRA)
trench	200-E	UPR-200-E-83	feces	
soill	200-E	UPR-200-E-81	transfer line from PUREX	group with 241-CR-151 diversion box (RCRA)
soill	200-E	UPR-200-E-86	No. 812 Transfer Line 216-E-14	
soill	200-E	UPR-200-E-87	Plutonium Contamination near 224-B Building 216-E-15	
soill	200-E	UPR-200-E-92	contam thistles near 200 East Area Burial Ground 216-E-20	
soill	200-E	UPR-200-E-93	200 East Area Burial Ground 216-E-21 (contam thistles)	
discharge	200-E	UPR-200-E-94	241-C Tank Farm Gravel Pit 216-E-22	
soill	200-E	UPR-200-E-95	B-Plant Railroad Cars 216-E-23	
contam	200-E	UPR-200-E-96	area between 291-A stack and diversion box 216-E-24	
soill	200-E	UPR-200-E-97	ground contamination 216-E-25	
contam	200-E	UPR-200-E-98	area near 291-C Stack 216-E-26	
soill	200-E	UPR-200-E-99	244-CR Vault (near 241-C) 216-E-27	
soill	200-E	UPR-200-E-105	107-BY Tank Farm	??????
soill	200-E	UPR-200-E-106	Burning Ground	??????
soill	200-E	UPR-200-E-107	100-CR Tank	??????
soill	200-E	UPR-200-E-112	Cesium Ion Exchange Column	

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
pit	200-E	UPR-200-E-114	202-A Building Valve Pit	
spill	200-E	UPR-200-E-116	112-BY Pump	
spill	200-E	UPR-200-E-117	200 East/PUREX Area	
tank	200-E	UPR-200-E-118	107-C Effluent Tank	
spill	200-E	UPR-200-E-120 & UPR-200-W-57	Plutonium Extraction Column Fire	two UPRs
spill	200-E	UPR-200-E-121	Plutonium Extraction Column Release	
spill	200-W	UPR-200-W-3	T Plant Railroad	
spill	200-W	UPR-200-W-4	Burial Box	
diversion box	200-W	UPR-200-W-5	241-TX-155 Diversion Box	???????
leak	200-W	UPR-200-W-13	REDOX H-4 Oxidizer Coil	
leak	200-W	UPR-200-W-15	REDOX D-12 Waste Concentrator Steam Coil	
trench	200-W	UPR-200-W-16	Dry Waste Burial Ground	???????
spill	200-W	UPR-200-W-17	pump transfer leak	
leak	200-W	UPR-200-W-14	waste line from 242-T bldg	
leak	200-W	UPR-200-W-19	leak at 216-UR crib	
spill	200-W	UPR-200-W-22	UNH Solution	
spill	200-W	UPR-200-W-23	Waste Box	
spill	200-W	UPR-200-W-27	T-Plant First-Cycle Waste Line	
diversion box	200-W	UPR-200-W-28	241-TX-155 Diversion Box	??????
diversion box	200-W	UPR-200-W-29	line leak	group with 241-TX-153 diversion box
coil	200-W	UPR-200-W-31	202-S Building Coil Leaks	
spill	200-W	UPR-200-W-32	REDOX UNH Transfer Line	
spill	200-W	UPR-200-W-33	C-5 Condensate Line	

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
soill	200-W	UPR-200-W-38	process line near 241-TX-154 Diversion Box	
soill	200-W	UPR-200-W-39	224-U Building	
diversion box	200-W	UPR-200-W-40	224-U Building	?????
soill	200-W	UPR-200-W-41	S-Plant Burial Box	
soill	200-W	UPR-200-W-42	S-Plant Railroad Shack	
soill	200-W	UPR-200-W-43	S-Plant	
soill	200-W	UPR-200-W-45	200 West Area Burial Ground	?????
soill	200-W	UPR-200-W-46	REDOX W-2 Centrifuge	
soill	200-W	UPR-200-W-47	REDOX Pond	??????
soill	200-W	UPR-200-W-48	221-U Railroad Crossing	
soill	200-W	UPR-200-W-53	200 West Area Burial Ground	??????
soill	200-W	UPR-200-W-55	224-U Loading Ramp	
soill	200-W	UPR-200-W-56	202-S Column Carrier Trench	
soill	200-W	UPR-200-W-58	221-T Canyon Cell Blocks	
soill	200-W	UPR-200-W-59	202-S F-1 Process Vessel Coil	
soill	200-W	UPR-200-W-60	221-U Railroad Cut	
soill	200-W	UPR-200-W-61	241-SX Transfer Line	
soill	200-W	UPR-200-W-62	23rd St and Camden Ave	
contam	200-W	UPR-200-W-63	area near 241-TX-153 Diversion Box	
soill	200-W	UPR-200-W-64	23rd St and Camden Ave	
soill	200-W	UPR-200-W-65	T Plant Railroad Cut	
soill	200-W	UPR-200-W-67	2706-T Building	
soill	200-W	UPR-200-W-68	13th St and Dayton Ave	
trench	200-W	UPR-200-W-70	200 West Area Burning Ground	????????

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
soill	200-W	UPR-200-W-71	102-U Tank	
soill	200-W	UPR-200-W-66	line leak	group with 216-B-3 (RCRA) and 216-B-2-2 (CERCLA)
soill	200-W	UPR-200-W-73	221-T Tunnel Railroad Right-of-way	
soill	200-W	UPR-200-W-74	241-Z Effluent Header D-3	
soill	200-W	UPR-200-W-75	241-Z D-7 Sample Cabinet	
soill	200-W	UPR-200-W-76	241-TX Diversion Box	
soill	200-W	UPR-200-W-77	200 West Area	
soill	200-W	UPR-200-W-78	JC3 Storage Area	
soill	200-W	UPR-200-W-97	failed waste line	
soill	200-W	UPR-200-W-79	241-Z sump	
soill	200-W	UPR-200-W-82	process line leak 302-S Catch Tank	group with 241-S-151 (RCRA) and 302-S catch tank (RCRA)
soill	200-W	UPR-200-W-84	200 West Area Burial Ground	??? which one????
soill	200-W	UPR-200-W-86	200 West Area	
soill	200-W	UPR-200-W-95	202-S Building Coil Leaks 216-W-2	
soill	200-W	UPR-200-W-96	233-S Filter House Drain Line 216-W-4	
soill	200-W	UPR-200-W-98	R-19, 222-7 Building Transfer Line 216-W-6	
soill	200-W	UPR-200-W-130	waste line at 231-Z bldg	
soill	200-W	UPR-200-W-101	221-U Building 216-W-9	
soill	200-W	UPR-200-W-116	204-S Waste Storage Tank 216-W-26	
	200-W	UPR-200-W-123	204-S Unloading Facility Area	

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
soill	200-W	UPR-200-W-124	REDOX Pond	
soill	200-W	UPR-200-W-125	transfer line 288-U tank	
soill	200-W	UPR-200-W-127	242-S Building	
soill	200-W	UPR-200-W-128	U-103 Tank	
soill	200-W	UPR-200-W-129	Pump Pit at TX-113 Tank	
leak	200-W	UPR-200-W-130	leaking waste line flange	
soill	200-W	UPR-200-W-131	155-TX Diversion Box	???????
soill	200-W	UPR-200-W-132	241-UR-151 Diversion Box	??????
soill	200-W	UPR-200-W-133	vacuum pump	
soill	200-W	UPR-200-W-138	221-U Building Vessel Vent Blower Pit	
soill	300	UPR-300-4	REDOX and Purex Equipment	
soill	300	UPR-300-5	309 Storage Basin Fill Line	?????????
soill	300	UPR-300-7	384 Building	
soill	300	UPR-300-8	311 Tank Farm Caustic Storage Tank	
soill	300	UPR-300-9	306-N Building	
soill	300	UPR-300-2	Decontamination waste near 340 building	
soill	300	UPR-300-11	Radioactive Liquid Waste Line	
soill	300	UPR-300-12	325 Building	
soill	300	UPR-300-13	tank leak	
soill	300	UPR-300-14	Fill Tank No. 32	
soill	300	UPR-300-15	Acid Storage Tanks Nos. 3 and 4	
fire	300	UPR-300-17	Burial Box	
soill	300	UPR-300-18	Drain Hole	

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
spill	300	UPR-300-19	313 Building - Chemical Storage Area	
spill	300	UPR-300-20	313 Building - Uranium Recovery Area	
spill	300	UPR-300-21	333 Building - Chemical Bay Area	
spill	300	UPR-300-22	333 Building - Chemical Bay Area	
spill	300	UPR-300-23	333 Building - Trench Piping System	
spill	300	UPR-300-24	333 Building - Waste Acid System	
spill	300	UPR-300-25	333 Building - Uranium Mill Tank	
spill	300	UPR-300-26	311 Tank Farm - Caustic Storage Tank	
spill	300	UPR-300-27	333 Building - Uranium Bearing Acid Storage Tank	
spill	300	UPR-300-28	334A Building - Soent Waste Acid Storage Tanks	
spill	300	UPR-300-29	333 Building- Waste Acid System	
spill	300	UPR-300-30	333 Building- Waste Acid System	
spill	300	UPR-300-32	333 Building - Uranium Bearing Acid System	
spill	300	UPR-300-33	333 Building- Waste Acid System	
spill	300	UPR-300-34	333 Building- Waste Acid System	
spill	300	UPR-300-35	333 Building - Uranium Bearing Acid Facility	
spill	300	UPR-300-35	333 Building - Uranium Bearing	
spill	300	UPR-300-36	333 Building- Waste Acid System	
spill	300	UPR-300-37	333 Building- Waste Acid System	

OTHER INACTIVE WASTE SITES

Site Type	Area	Official Number	Site Name/ Description	Comments
soill	300	UPR-300-38	313 Building - Uranium Recovery Area	
soill	300	UPR-300-39	311 Tank Farm Caustic Storage Tank	
soill	300	UPR-300-41	311 Tank Farm Pipe Trench	
contam	600	UPR-600-11	berm material	
soil.	600	UPR-600-12	200 East Hill	
soill	600	UPR-600-14	Propane Gas Tank	
dump	600	UPR-600-15	618-4 Burial Ground	???????
fire	600	UPR-600-16	120 Building (P-11 Facility)	
soill	1100	UPR-1100-5	1171 Building	
soill	3000	UPR-3000-1	Richland City Sewer System	
leak	200-W	UPR-200-W-35	DNH line leak	
leak	200-W	UPR-200-W-118	leakage from 211-U tank farm	
disposal	200-W	UPR-200-W-134	improperly disposed drum	
soill	200-W	UPR-200-W-34	ditch overflow to chem sewer	
contamination	200-E	UPR-200-E-111	soil contamination in pit	
contamination	200-E	UN-216-E-90	unknown contamination	
leak	100-N	UPR-100-N-12	spacer transport line leak	

SITES EXCLUDED FROM INACTIVE WASTE DISPOSAL SITE STUDY

SITES EXCLUDED FROM INACTIVE WASTE DISPOSAL SITE STUDY

Site	Basis for Exclusion
2727-S Nonradioactive Dangerous Waste Storage Facility	included in Part B permit application
241-A-151 Diversion Box Radioactive Contamination (UN-216-E-65) and UPR-200-E-25, -26, and -31	spill associated with active waste management unit
216-A-42 Diversion Box	spill associated with active waste management unit
1607-K3 Septic Tank	active unit
166-N Fuel Oil Leak (UN-116-N-24)	active unit
100-N Fuel Basin Leak (UN-116-N-35)	active unit
UPR-200-E-14	part of 216-B-3 pond which is an active unit
UPR-200-E-13	associated with CERCLA site
UPR-200-E-15	associated with CERCLA site
UPR-200-E-21	associated with CERCLA site
UPR-200-E-29	associated with CERCLA site
UPR-200-E-34	associated with active waste management unit
UPR-200-E-51	associated with active waste management unit
UPR-200-E-79	associated with active waste management unit
UPR-200-E-84	associated with active waste management unit
UPR-200-W-6	associated with active waste management unit

UPR-200-W-21	associated with active waste management unit
UPR-200-W-36	associated with CERCLA site
UPR-200-W-66	associated with CERCLA site

NOTES ON SPILLS ASSOCIATED WITH UNITS

UPR-600-1 UPR-600-2 UPR-600-3	GOES WITH	618-10
UPR-600-4 UPR-600-5 UPR-600-6 UPR-600-7 UPR-600-8 UPR-600-9 UPR-600-10	GOES WITH	618-11
UPR-200-W-8 UPR-200-W-37	GOES WITH	200 West Burning Ground

?? is this the same as the burning pit ??

UPR-200-W-66	GOES WITH	216-B-3 pond (active) and 216-B-2-2 (CERCLA)
UPR-200-W-72	GOES WITH	218-W-4A (Dry Waste Burial Ground 4A)
UPR-200-W-8 (coord: N42500/W73350)	GOES WITH	200 West Burn Pit (p. 612 missing - which burn pit - check coord)

?? which burn pit ??

UPR-200-W-11 (coord: N40160/W77009)	GOES WITH	200 West burial ground

?? which one ??

UPR-200-W-18	GOES WITH	216-U-9 ditch
UPR-200-W-16 (coord: N42700/W77600)	GOES WITH	dry waste burial ground

?? which one ??

APPENDIX D-2

LIST OF SITES
SORTED BY NEED FOR ACTION AND LOCATION

100 B/C AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1ER	107-B*	107-B Retention Basin	Retention Basin
1IR	107-C*	107-C Retention Basin	Sump Tanks
2CM	118-C-1	105-C Burial Ground 118-C-1	Burial Ground
2CM	118-B-1	105-B Burial Ground 118-B-1	Burial Ground
2EQ	105-B*	105-B Battery Acid Sump (3)	Sump
2LQ	100B/C*	100 B/C Burning Pit	Burning Pit
3CM	118-B-2	Construction Burial Ground #1	Burial Ground
3CM	118-B-3	Construction Burial Ground #2	Burial Ground
3IQ	1607-B1*	1607-B1 Septic Tank (3)	Tank/Tile Field
3IQ	1607-B3*	1607-B3 Septic Tank (3)	Tank/Tile Field
3IQ	1607-B7*	1607-B7 Septic Tank (3)	Tank/Tile Field
3IQ	1607-B8*	1607-B8 Septic Tank (3)	Tank/Tile Field
4CM	118-B-7	111-B Soild Waste Burial Site	Burial Ground
4CR	118-B-6	108-B Soild Waste Burial Groun	Burial Ground
4CR	118-B-5	Ball 3X Burial Ground 118-B-5	Burial Ground
4CR	116-B-2	105-B Storage Basin Trench	Trench
4GM	116-C-2-2	105-C Pluto Crib Sandfilter	Crib Sandfilter
4GM	116-B-6-2	111-B Crib #2 116-B-6-2	Crib
4GM	117-C*	117-C Crib	Crib
4GM	116-B-9	104-B-2 French Drain	French Drain
4GM	116-B-5	108-B Crib 116-B-5 (3)	Crib
4GM	117-B*	117-B Crib	Crib
4GM	116-B-3	105-B Pluto Crib 116-B-3	Crib
4GM	116-B-10	108-B Dry Well, Quench Tank	Dry Well
4GM	116-B-6-1	111-B Crib #1 116-B-6-1	Crib
5CR	118-B-4	105-B Spacer Burial Ground	Burial Ground
5EQ	184-B*	184-B Powerhouse Ash Pit (3)	Pit
5IR	118-C-2	105-C Ball Storage Tank	Tank

100 D/DR AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1EM	107-DR*	107-DR Retention Basin	Retention Basin
1EM	107-D*	107-D Retention Basin	Retention Basin
2CM	118-D-4	Construction Burial Ground	Burial Ground
2CM	118-D-3	100 D Burial Ground #3 118-D-3	Burial Ground
2CM	118-D-1	100 D Burial Ground #1 118-D-1	Burial Ground
2CM	118-DR-1	105-DR Gas Loop Burial Ground	Burial Ground
2CM	118-D-2	100 D Burial Ground #2 118-D-2	Burial Ground
2CR	118-D-5	Ball 3X Burial Ground 118-D-5	Burial Ground
2IQ	1706-D*	1706-D Gas Storage Tank (3)	Tank
2DM	1608-DR*	1606-DR Waste Water Pumping	Pumping Station
3GG	1607-D4*	1607-D4 Septic Tank	Tank/Tile Field
3GQ	1607-D1*	1607-D1 Septic Tank	Tank/Tile Field
4CR	116-D-1A	105-D Storage Basin Trench #1	Basin Trench
4ER	116-DR-3	105-DR Storage Basin Trench	Basin Trench
4GM	116-D-2	105-D Pluto Crib 116-D-2	Crib
4GM	116-D-3	108-D Crib #1 116-D-3	French Drain
4GM	116-DR-4	105-DR Pluto Crib 116-DR-4	Crib
4GM	116-D-4	108-D Crib #2 116-D-4	French Drain
4GM	116-DR-8	117-DR Crib	Crib
4GM	116-D-6	105-D Cushion Corridor French	French Drain
4GS	117-D*	117-D Crib	Crib
4LQ	100-D/DR*	100 D/DR Burning Pit	Burning Pit
4DM	100-D*	100-D Cask Storage Pad (3)	Storage Pad
5DM	1608-D*	1608-D Waste Water Pumping	Pumping Station

100 F AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1ER	107-F*	107-F Retention Basin	Retention Basin
1KR	118-F-7	100F Miscellaneous Hardware	Burial Vault
2CM	118-F-1	Burial Ground #1 118-F-1	Burial Ground
2CM	118-F-3	Burial Ground #2 118-F-3	Burial Ground
2CM	118-F-6	PNL Solid Waste Burial Ground	Burial Ground
2CM	118-F-2	Burial Ground #2 118-F-2	Burial Ground
2DM	1608-F*	1608-F Wastewater Pumping	Pumping Station
3GM	116-F-13	1705-F Experimental Garden	French Drain
3GQ	1607-F5*	1607-F5 Septic Tank	Tank/Tile Field
3GQ	1607-F4*	1607-F4 Septic Tank	Tank/Tile Field
3GQ	1607-F3*	1607-F3 Septic Tank	Tank/Tile Field
3GQ	1607-F6*	1607-F6 Septic Tank	Tank/Tile Field
3GQ	1607-F1*	1607-F1 Septic Tank	Tank/Tile Field
4CM	118-F-4	115-F Pit 118-F-4	Burial Ground
4GM	116-F-5	Ball Washer Crib 116-F-5	Crib
4GM	116-F-11	105-F Cushion Corridor French	French Drain
4GM	116-F-4	105-F Pluto Crib 116-F-4 (9)	Crib
4GR	116-F-12	148-F French Drain 116-F-12	French Drain
4GR	116-F-7	117-F Crib 116-F-7	French Drain
4LQ	100-F*	100-F Burning Pits #2	Burning Pit
5CR	118-F-5	PNL Sawdust Repository 118-F-5	Burial Ground
5EQ	184-F*	184-F Powerhouse Ash Pit (3)	Pit

100 H AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1ER	107-H*	100-H Retention Basin 107-H	Retention Basin
2CM	118-H-5	105-H Thimble Pit 118-H-5	Pit
2CM	118-H-2	H-1 Loop Burial Area, 100-H	Burial Ground
2CM	118-H-3	Construction Burial Ground	Burial Ground
2CM	118-H-1	100 H Burial Ground #1 118-H-1	Burial Ground
2CM	118-H-4	Ball 3X Burial Ground 118-H-4	Burial Ground
2DM	1608-H*	1608-H Waste Water Pumping	Pumping Station
3EQ	184-H*	184-H Powerhouse Ash Pit (3)	Pit
3GQ	1607-H-2*	1607-H2 Septic Tank	Tank/Tile Field
3GQ	1607-H-4*	1607-H4 Septic Tank	Tank/Tile Field
3GQ	1607-H-3*	1607-H3 Septic Tank	Tank/Tile Field
4GM	117-H*	Crib 117-H	Crib
4GM	116-H-4	105-H Pluto Crib 116-H-4 (9)	Crib
4LQ	100-H2*	100-H2 Burning Pit for Residue	Burning Pit
4LQ	100-H*	100 H Burning Pit	Burning Pit

100 KE/KW AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1FQ	100-KE*3	183-KE Filter Water Facility	Trench
1GR	116-KE-1	115-KE Condensate Crib	Crib
1GR	116-KW-1	115-KW Condensate Crib	Crib
1GS	116-KE-3	105-KE Storage Basin Fr Drain	French Drain
1GS	116-KW-2	105-KW Storage Basin Fr Drain	French Drain
1IQ	166-KW*	166-KW Oil Storage Tank	Tank
1IQ	1717-K*	1717-K Waste Oil Storage Tank	Tank
1IQ	166-KE*	166-KE Oil Storage Tank	Tank
1IS	107-KW*	107-KW Retention Basin	Retention Basin
1IS	107-KE*	107-KE Retention Basin	Retention Basin
2CR	118-K	100-K Burial Ground 118 K	Burial Ground
2HQ	183-KE2*	183-KE2 Sulfuric Acid Storage	Tank
2HQ	183-KE*	183-KE Liquid Alum Storage	Tank
2IQ	105-KW*	105-KW Emergency Diesel Fuel	Tank
2IQ	1717-K*	1717-K Gas Storage Tank (3)	Tank
2IQ	105-KE*	105-KE Emergency Diesel Fuel	Tank
2IQ	182-K*	182-K Emergency Cooling Flow	Tank
4HQ	183-KW2*	183-KW2 Sulfuric Acid Storage	Tank
4HQ	183-KW*	183-KW Sodium Dichromate Tank	Tank
4HQ	183-KW1*	183-KW1 Sulfuric Acid Storage	Tank
4HQ	183-KE1*	183-KE1 Sulfuric Acid Storage	Tank
4HQ	183-KE*	183-KE Sodium Dichromate Tank	Tank
4LQ	100-K*	100-K Burning Pit	Burning Pit

100 NORTH AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1GQ	120-N-3	163-N Neutralization Pit/Drain	Pit
1GQ	120-N-7	Acid Unloading Facility	French Drain
1GQ	120-N-6	108-N Acid Tank Vent French	French Drain
1JQ	UN-116-N-22	184-N Diesel Oil Supply Line	Line Leak
1JQ	UN-116-N-23	184-N Diesel Oil Supply Line	Line Leak
1LQ	128-N-1	100-N Burning Pit (128-N-1)	Burning Pit
3GQ	124-N-8	124-N-8 Septic Tank	Tank/Drain Field
3GQ	124-N-4	124-N-4 Septic Tank	Tank/Drain Field
3GQ	124-N-6	124-N-6 Septic Tank	Tank/Drain Field
3GQ	124-N-7	124-N-7 Septic Tank	Tank/Drain Field
3GQ	124-N-5	124-N-5 Septic Tank	Tank/Drain Field

200 NORTH AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1ER	216-N-4	212-P Swamp, 216-N-2, 216-N-4	Pond
1ER	216-N-6	212-R Swamp, 216-N-6 Swamp (9)	Pond
4ER	216-N-3	212-N-2 trench, 212-N-3	Trench
4ER	216-N-5	212-P trench, 216-N-5 trench	Trench
4ER	216-N-2	216-N-1 Trench, 216-N-2	Trench
4ER	216-N-7	212-R trench, 212-N-7 trench	Trench
4ER	216-N-1	212-N Swamp, 216-N-1 Swamp,	Pond

200 EAST AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1C	UN-216-E-72	UN-216-E-72 (UNCOVERED WASTE)	soill site
1D	UPR-200-E-85/124	UPR-200-E-85/124, R-13 Pit	pit
1E	216-B-2-1	216-B-2, B DITCH	ditch
1G	216-B-47	216-BY-5 CAVERN/CRIB	crib
1G	216-B-18	216-BC-5 Crib	crib
1G	216-A-26A	216-A-26 French Drain	french drain
1G	216-B-8	241-B-3 CRIB	crib
1G	216-B-15	216-BC-2 Crib	crib
1G	216-A-1	216-A-1 Cavern	crib
1G	216-B-14	216-B-14	crib
1G	216-B-19	216-BC-6 Crib	crib
1G	216-B-17	216-BC-4 Crib	crib
1G	216-B-12	216-ER-1, 2, 3 cribs, 216-ER	cribs - 3
1G	216-A-2	216-A-2 Cavern	crib
1G	216-B-9	216-B-361, 241-B-361	crib/tile field
1GM	216-A-10	216-A-10 crib	crib
1GM	216-B-10B	216-B-10B	crib
1H	205-A	205-A SILICA GEL FACILITY	tanks
1H	270-E*	270-E Condensate neutral.	tank
1HM	224-B*	224-B CONC. FACILITY	tank
1HM	242-B*	242-B Evaporator	evaporator
1I	216-A-524	216-A-524 Control Structure	box
1I	241-CX-72	241-CX-72 Tank	tank
1I	241-CX-70	241-CX-70 tank	tank
1I	241-B-361	241-B-361 settling tank	tank
1IM	241-B-301-C	catch tank 241-B-301-C	tank
1IM	241-BX-302-A	catch tank 241-BX-302-A	tank
1IM	241-C-152	241-C-152 diversion box	diversion box
1IM	241-BX-302-B	catch tank 241-BX-302-B	tank
1IM	241-B-153	241-B-153 diversion box	diversion box
1IM	244-CR*	catch tank 244-CR	tank
1IM	241-BX-302-C	catch tank 241-BX-302-C	tank
1IM	241-AZ-151	catch tank 241-AZ-151	tank
1IM	241-C*	241-C tank farm	tanks
1IM	244-BXR*	catch tank 244-BXR	tank
1IM	241-B-301-B	catch tank 241-B-301-B	tank
1IM	241-AX*	241-AX tank farm	tanks
1IM	241-B*	241-B tank farm	tanks
1IM	241-A-302-B	catch tank 241-A-302-B	tank
1IM	241-BX*	241-BX tank farm	tanks
1IM	241-B-302-B	catch tank 241-B-302-B	tank
1IM	241-BY*	241-BY tank farm	tanks
1IM	241-BYR-153	241-BYR-153 diversion box	diversion box
1IM	241-A*	241-A tank farm	tanks
1J	UN-216-E-69	UN-216-E-69 Railroad Car Flush	soill site
2B	216-E-9	216-E-9, 200 East Regulated	burial vault
2I	244-CR*	244-CR receiving vault	receiving vault
2I	244-BXR*	244-BXR receiving vault	receiving vault
2IM	241-BYR-151	241-BYR-151 diversion box	diversion box
2IM	241-AZ-151	241-AZ-151 diverter station	diverter station

200 EAST AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
2IM	241-BX-155	241-BX-155 diversion box	diversion box
2IM	241-AY-152	241-AY-152 diverter station	diverter station
2IM	241-B-252	241-B-252 diversion box	diversion box
2IM	241-A-153	241-A-153 diversion box (?)	diversion box
2IM	241-BXR-153	241-BXR-153 diversion box	diversion box
2IM	241-BYR-154	241-BYR-154 diversion box	diversion box
2IM	241-CR-152	241-CR-152 diversion box	diversion box
2IM	241-C-154	241-C-154 diversion box	diversion box
2IM	241-C-153	241-C-153 diversion box	diversion box
2IM	241-BX-153	241-BX-153 diversion box	diversion box
2IM	241-BR-152	241-BR-152 diversion box	diversion box
2IM	241-AY-152	241-AY-152 diversion box	diversion box
2IM	241-C-252	241-C-252 diversion box	diversion box
2IM	241-CR-151	241-CR-151 diversion box	diversion box
2IM	241-A-152	241-A-152 diversion box	diversion box
2IM	241-BX-154	241-BX-154 diversion box	diversion box
2IM	241-BYR-152	241-BYR-152 diversion box	diversion box
2IM	241-CR-153	241-CR-153 diversion box	diversion box
2IM	241-C-151	241-C-151 diversion box	diversion box
2IM	241-BXR-152	241-BXR-152 diversion box	diversion box
2J	UPR-200-E-44/103	UPR-200-E-44/103/123 BCS LINE	spill site
2D	218-E-14	218-E-14 PUREX TUNNEL NO. 1	burial tunnel
3D		200 Area Construction Waste	pit
3G		sanitary waste drain field	drain field
4C	218-E-2	218-E-2, 200 East Industrial	burial ground
4C	218-E-3	218-E-3 Burial Ground	burial ground
4C	218-E-13	UN-218-E-13 Burial Ground	burial ground
4C	218-E-1	218-E-1, 200 East Dry Waste	burial ground
4C	218-E-5	218-E-5 Burial Ground	burial ground
4C	218-E-2A	Reg. Equipment Storage	trench
4C	218-E-4	218-E-4, 200 East/Minor No. 2	burial ground
4C	218-E-8	218-E-8, 200 East Construction	burial ground
4C	218-E-6	218-E-6 Burial Ground	burial ground
4C	218-E-5A	200 East Industrial Waste #5A	burial ground
4CM	218-E-12A	218-E-12A, 200 East Dry Waste	burial ground
4E	216-B-52	216-B-52 Trench	trench
4E	216-B-3-1	216-B-2, B SWAMP DITCH	ditch and pond
4E	216-B-20	216-BC-7 Trench	trench
4E	216-B-31	216-BC-18 TRENCH	trench
4E	216-B-3-2	216-B-2-2E, B SWAMP DITCH	ditch
4E	216-B-22	216-BC-9	trench
4E	216-B-27	216-BC-14 TRENCH	trench
4E	216-A-19	216-A-19 Grave/Sump/Test hole	trench
4E	216-A-34	216-A-34 Crib	ditch
4E	216-B-42	241-BX-8 Grave,216-BX-8 Trench	Trench
4E	216-B-58	216-B-58 TRENCH, 216-B-59 CRIB	crib/trench
4E	216-B-54	216-B-54 Trench	trench
4E	216-B-53A	216-B-53A Trench	trench
4E	216-A-18	216-A-18 Excavation	trench
4E	216-B-29	216-BC-16 Trench	trench

200 EAST AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
4E	216-B-40	241-BX-6 Grave/Trench	Trench
4E	216-B-36	216-BX-2 Trench/Grave	trench
4E	216-B-34	216-BC-21 Trench	trench
4E	216-B-25	216-BC-12, 216-B-24	trench
4E	216-B-41	241-BX-7 Grave,216-BX-7 Trench	Trench
4E	216-B-35	216-BX-1 Trench	trench
4E	216-B-53B	216-B-53 TRENCH	trench
4E	216-A-20	216-A-20 Grave/Sump/Test hole	trench
4E	216-B-28	216-BC-14 TRENCH	trench
4E	216-B-23	216-BC-10 TRENCH	trench
4E	216-B-32	216-BC-19	trench
4E	216-B-30	216-BC-17 TRENCH	trench
4E	216-B-24	216-BC-11	trench
4E	216-B-21	216-BC-8 Trench	trench
4E	216-B-33	216-BC-20 TRENCH	trench
4E	216-B-38	216-BX-4 Trench	trench
4E	216-B-39	241-BX-5 GRAVE,216-BX-5 TRENCH	Trench
4E	216-B-26	216-BC-13 TRENCH	trench
4E	216-B-37	216-BX-3 Trench	trench
4EM	216-C-3	216-C-3, 201-C Leaching Pit	leaching pit
4G	216-C-4	216-C-4 crib	crib
4G	216-B-57	216-B-57 Crib	crib
4G	216-A-35	216-A-35 Dry Well	french drain
4G	216-A-32	216-A-32	crib
4G	216-A-14	216-A-14 French Drain	french drain
4G	216-A-22	216-A-22 French Drain	crib
4G	216-B-11-A/B	216-B-11 CRIB, 242-B-1 CRIB	reverse well
4G	216-A-31	216-A-32 Crib	crib
4G	216-A-39	216-A-40 CRIB/TRENCH	crib
4G	216-A-11	216-A-11 French Drain	french drain
4G	216-A-16	216-A-16 Dry Well	french drain
4G	216-A-13	216-A-13 French Drain	french drain
4G	216-A-23A	216-A-23A French Drain	french drain
4G	216-A-33	216-A-33 Dry Well	french drain
4G	216-A-17	216-A-17 Dry Well	french drain
4G	216-B-13	216-B-13	french drain
4G	216-B-51	216-BY-9 CRIB	crib
4G	216-C-8	271-CR crib, 216-C-8 crib	French Drain
4G	216-A-3	216-A-3 CAVERN	crib
4G	216-A-12	216-A-12 French Drain	french drain
4G	216-A-41	216-A-41 Crib	crib
4G	216-A-15	216-A-15 French Drain	french drain
4G	216-B-60	216-B-60 Crib	crib
4G	216-A-23B	216-A-23B French Drain	french drain
4GM	216-C-5	216-C-5 crib	crib
4GM	216-C-6	216-C-6	crib
4GM	216-B-4	216-B-4	reverse well
4IM	241-B-151	241-B-151 diversion box	diversion box
4IM	241-B-152	241-B-152 diversion box	diversion box
4IM	241-B-154	241-B-154 diversion box	diversion box

200 EAST AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
4J	UPR-200-E-80/1	R-3 waste line	waste line
4J	UPR-200-E-7	Waste Line	waste line
4K	218-E-7	218-E-7, 200 East/222-B	burial vaults (3)
4K	241-CX-72	241-CX-72 Vault & Tank	vault
4LQ		200 East Burning Pit	burning pit

200 WEST AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1C	218-W-3	218-W-3	Burial Ground
1CM	218-W-4A	218-W-4A, UPR-200-W-72	Burial Ground
1CR	218-W-1	218-W-1	Burial Ground
1CR	218-W-2	218-W-2	Burial Ground
1CR	218-W-11	Solid waste burial and regul-	Burial Ground
1E	216-S-19	216-S-19 pond	pond
1EM	216-T-16	216-T-16	trench
1EM	216-U-10	216-U-10 pond	pond
1EM	216-T-15	216-T-15	Trench
1EM	216-Z-4	216-Z-4, 231-W-3	Trench
1EM	216-T-24	241-TX-4 Trench, 216-TX-4 Grav	Trench
1EM	216-T-21	241-TX-1 trench, 216-TX-1 grav	Trench
1EM	216-T-23	241-TX-3 Trench, 216-TX-3 Grav	Trench
1EM	216-Z-9	216-Z-9 Cavern, 234-5 Recuplex	Trench
1EM	216-T-25	216-T-25	Trench
1EM	216-T-17	216-T-17	Trench
1EM	216-T-14	216-T-14	Trench
1EM	216-T-22	241-TX-2 Trench, 216-TX-2 Grav	Trench
1FM	216-U-9	216-U-6 U-Swamp 5	Ditch
1FM	216-Z-1 (D)	Drain Ditch to U-Swamp, Z	Ditch.
1FM	216-Z-19	216-Z-19 ditch	Ditch
1FM	216-Z-17	216-Z-17 Ditch or Trench	Ditch
1FM	216-Z-11	216-Z-1 ditch, Z plant ditch	Ditch
1FM	216-T-4-1 (D)	216-T-4-1 (D)	Ditch
1G	UPR-200-W-135	UPR-200-W-135	ground contam.
1GM	216-Z-18	cribs - 5 parallel	Cribs -5
1GM	216-U-10	216-U-10 crib	Crib
1GM	216-Z-6	231-W-4 Crib, 216-W-4,	Crib
1GM	216-T-27	216-T-27	Crib
1GM	216-T-33	216-T-33	Crib
1GM	216-T-32	216-T-32	Crib
1GM	216-U-8	216-WR-1, 2, 3 Cribs, 216-U-9;	Cribs - 3
1GM	216-Z-1A	234-5 tile field, 216-Z-7;	Tile Field
1GM	216-Z-5	216-Z-5, 231-W-1-2 cribs	crib
1GM	216-S-13	216-S-13 crib	crib
1GM	216-T-26	216-T-26	crib
1HM	276-S*	tanks in 276-S Solvent Facilit	tanks
1I	2904-S-171	2904-S-171 weir box	weir box
1I	2904-S-170	2904-S-170 weir box	weir box
1I	241-SX-302	catch tank 241-SX-302 at	tank
1I	216-S-172	216-S-172 weir box	weir box
1IM	241-T-151	241-T-151 (waste transfer)	diversion box
1IM	241-U*	241-U tank farm	tank
1IM	241-T*	241-T tank farm	tank
1IM	241-SX-151	241-SX-152 (waste transfer)	diversion box
1IM	241-TY-302-A	catch tank 241-TY-302-A at	tank
1IM	241-T-152	241-T-152 (waste transfer)	diversion box
1IM	241-SX	241-SX tank farm	tank
1IM	241-TY*	241-TY tank farm	tank

200 WEST AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1IM	241-TY-302-B	catch tank 241-TY-302-B at	tank
1IM	240-S-152	240-S-152 (waste transfer)	diversion box
1IM	241-TX-302-A	catch tank 241-TX-302-A at	tank
1IM	241-S-152	241-S-152 (waste transfer)	diversion box
1IM	241-TX-302-B	catch tank 241-TX-302-B at	tank
1IM	241-TX-153	241-TX-153 incl. UPR	diversion box
1IM	241-U-301	catch tank 241-U-301 at	tank
1IM	240-S-151	240-S-151 (waste transfer)	diversion box
1IM	241-301-B	catch tank 241-301-B at tank	tank
1IM	241-TR-153	241-TR-153 (waste transfer)	diversion box
1IM	240-S-302	catch tank 240-S-302 at	tank
1IM	241-SX-152	241-SX-151 (waste transfer)	diversion box
1IM	241-S*	241-S tank farm	tank
1IM	241-TR-152	241-TR-152 (waste transfer)	diversion box
1IM	241-TX*	241-TX tank farm	tank
1J	UPR-200-W-69	UPR-200-W-69	ground spill
1JM	UPR-200-W-102	UPR-200-W-102	proc. tnk vent lines
1K	2904-S-160	2904-S-160 Control Structure	box
1NM		REDOX chemical sewer at 203-S,	sewer
2CM	218-W-9	218-W-9	burial ground
2CM	UPR-200-W-111	UPR-200-W-111	trench
2CM	218-W-02A	218-W-02A burial ground	burial ground
2CR	218-W-1A	Industrial Waste Burial Ground	Burial Ground
2CR	UPR-200-W-110	UPR-200-W-110	trench
2EM	UPR-200-W-112	UPR-200-W-112	trench
2GM	216-Z-8	216-Z-8 Crib, 234-5 Recuplex	French Drain
2H	232-Z*	232-Z waste incineration	incinerator
2HM	276-U*	276-U solvent handling	tank
2HM	241-SX-402	241-SX-402 condenser shield-	tank
2HM	241-SX-401	241-SX-401 condenser shield-	tank
2HM	242-T*	242-T Evaporator (batch then	tank(s)
2IM	241-TXR-153	241-TXR-153 (waste transfer)	diversion box
2IM	241-U-252	241-U-252 (waste transfer)	diversion box
2IM	241-TY-153	241-TY-153 (waste transfer)	diversion box
2IM	241-UR-153	241-UR-153 (waste transfer)	diversion box
2IM	241-Z-361	241-Z-361 settling tank	tank
2IM	241-T-361	241-T-361 Settling Tank	tank
2IM	241-TY-151	241-TY-151 (waste transfer)	diversion box
2IM	241-U-153	241-U-153 (waste transfer)	diversion box
2IM	241-TXR-244	241-TXR-244 (waste transfer)	diversion box
2IM	241-UR-154	241-UR-154 (waste transfer)	diversion box
2IM	241-TXR-155	241-TXR-155 (waste transfer)	diversion box
2IM	241-UR-152	241-UR-152 (waste transfer)	diversion box
2IM	276-S-142	underground tank 276-S-142	tank
2IM	UPR-200-W-137	UPR-200-W-137	compartment
2IM	241-TXR-151	241-TXR-151 (waste transfer)	diversion box
2IM	241-TXR-152	241-TXR-152 (waste transfer)	diversion box
2IM	276-S-141	underground tank 276-S-141	tank
2IM	241-U-361	241-U-361 settling tank	tank

200 WEST AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
2K	205-S*	205-S vault at the uranium	vault
2KM	218-W-7	218-W-7	vault
2KM	218-W-8	218-W-8	vault
2KM	241-WR*	241-WR vault	vault
3C	204-S*	204-S basin at the uranium	basin
3C	203-S*	203-S basin at 203-S uranium	basin
3CQ		Non Rad Burial Ground	Burial Ground
3G	241-SX-401	dry well at 241-SX-401	dry well
3G	241-SX-402	dry well at 241-SX-402	dry well
4CR	218-W-1A	Industrial Burial Ground No. 1	Burial Ground
4E	216-T-10	216-T-10	trench
4E	216-T-9	216-T-9	trench
4E	216-T-11	Equipment Decontamination	Trench
4E	216-T-13	216-T-13	trench
4E	216-S-18	216-S-18	trench
4EM	216-S-15	216-S-15	pond
4EM	216-T-4A	216-T-4A	pond
4EM	216-U-13	241-UR Steam Cleaning Pit,	Trenches
4EM	216-S-11	216-S-11 pond	pond
4EM	216-U-6	216-U Cold U Trench #1	Trench
4EM	UPR-200-W-30	UPR-200-W-30 covered pit	pit
4EM	216-T-12	216-T-12	trench
4EM	216-T-20	disposal trench/pit	pit
4EM	216-S-8	216-S-8	trench
4EM	216-S-14	216-S-14	trench
4EM	216-S-12	216-S-12	trench
4EM	216-U-5	221-U Cold U Trench #2	Trench
4EM	216-U-15	216-U-15, 388-U dumping	pit
4EM	216-T-5	216-T-5	trench
4EM	207-S*	207-S retention basin (3)	surface impoundment
4FM	216-T-4-2 (D)	216-T-4-2 (D)	ditch
4FM	UPR-200-W-139	UPR-200-W-139	ditch
4G	216-T-31	216-T-31	french drain
4GM	216-U-7	216-U-7	french drain
4GM	216-T-32	216-T-32	Crib
4GM	216-Z-3	216-Z-3 culvert, 234-5 #3 and	Crib
4GM	216-T-6	216-T-6 crib	Crib
4GM	216-T-18	216-T-17 Crib	Crib
4GM	216-Z-12	216-Z-12	Crib
4GM	216-T-29	216-T-29	Crib
4GM	216-S-23	216-S-23 crib	Crib
4GM	216-T-35	216-T-35	Crib
4GM	216-S-22	216-S-22 crib	Crib
4GM	216-T-36	216-T-36	Crib
4GM	216-T-34	216-T-34	Crib
4GR	216-Z-16	crib: 216-Z-16	Crib
4JM	UPR-200-W-113	UPR-200-W-113	waste line
4JM	UPR-200-W-2	UPR-200-W-2	waste line
4KM	244-UR*	244-UR vault	vault

200 WEST AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
4LQ		200 West burning pit	pit
4D	2718-S*	2718-S sand filter monitor	filter monitor
5J	UPR-200-W-117	UPR-200-W-117	ground spill

300 AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1GM	316-4	300 North Crib	crib
1IQ		Methanol Storage (313 bldg)	underground tanks
1IQ		Methanol Stor. (311 Tank Farm)	underground tanks
1JM		Uranium/Acid Waste (Bldg. 313)	acid spill
1JM	UPR-300-31/40	Pipe Trench System, 311	pipe trench system
2HM		334 Tank Farm Waste Acid Tank	tank
2HM		323 Tanks (4)	tanks
2IM		309 TW Tanks (3)	underground tanks
2NM		Retired Liq. Waste Sewer	sewer pipe
3GQ		331 Life Sci Lab (1966-1969)	trench
3GQ		Retired 335/336 Sanitary	drain field
3GQ		331 Life Sci Lab (1964-1974)	trench
3GQ		331 Life Sciences Laboratory	drain field
3GQ		Retired 315 Sanitary Drain	drain field
4JR	UPR-300-1	Transfer Line Leak	transfer line
5EQ		Retired Filter Backwash Pond	pond
5EQ		300 Area Interim Filter	gravel pit
5DR		In Situ Vitrification Test	testing unit

400 AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
3GQ		Retired Septic Tanks (3)	tank
3GQ		400 Area Retired Sanitary	ponds
3GQ		400 Retired French Drains	french drains
3GQ		400 Area Retired Sand Trench	trench
5GQ		French Drain South of 4722-C	french drains

600 AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1CM	618-9*	300 West Burial Ground	trench
2AR	618-13	303 Area Contaminated Soil	waste pile
2CM		Original Central Landfill (9)	trench
2CM	618-4	Burial Ground No. 4	pits
2CM	618-8	Early Waste Burial Ground	trench
2CM	618-7	Burial Ground No. 7	trench
2CM	618-1	SW Burial Ground No. 1	trench and pits
2CQ		Horn Rapids Disposal	landfill
2CQ		Midway Landfill No. 2 (9)	landfill
2CQ	USBR-2, 4-D	USBR-2, 4-D burial ground	burial ground
2CG	618-10	300 North SW Burial Ground	burial ground
2CR	618-11	300 Wye Burial Ground	burial ground
2CR	618-3*	Burial Ground No. 3	trench
2CR	618-2	SW Burial Ground No. 2	trench
2CS	618-12	North Process Pond Scraping	pond
3CQ		J.A. Jones No. 1 (9)	landfill
3IQ	6652-G*	6652-G ALE Field Storage	tank
3IQ		Army Bunkers Septic Tank (3)	tank
3IQ	6652-C*	6652-C Space Science Lab.	tank
4CQ		White Bluffs City Landfill	landfill
4CQ		East White Bluffs City	landfill
4CQ		Midway Landfill No. 1 (9)	landfill
4CQ		Sodium Dichromate Barrel	landfill
4CQ		City of Hanford Landfill	landfill
4GM	P-11	116-F-6 Crib	crib
4GM	213-J and K	Gable Mountain Cribs	crib
4GQ		Pickling Acid Crib (9)	crib
4LQ	618-5	Burial Ground No. 5	burning pit
5CM		J.A. Jones No. 2 (9)	burial ground
5CQ		Hanford Trailer Camp (9)	landfill
5CG		Army Munitions Burial Site	burial ground
5DS	618-6*	Burial Ground No. 6	trench

700 AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
4IQ		Underground Waste Solvent Tank (3)	tank

1100 AREA SITE CODE MATRIX

Site Code	Official Number	Site Name/ Description	Unit Type
1EQ	UPR-1100-2	disposal on railroad tracks	ground disposal
1EQ	UPR-1100-1	sand pit	pit
1FQ	UPR-1100-3	sand pit	pit
4IQ	UPR-1100-4	underground disposal tank	tank

APPENDIX D-3

600 AREA LIST BY HYDROGEOLOGIC SETTING

APPENDIX - 600 AREA SITES CODED BY HYDROLOGIC SETTING

Site Code	Official Number	Site Name/ Description	Unit Type
S	618-9*	300 West Burial Ground	trench
S	618-13	303 Area Contaminated Soil	waste pile
D		Original Central Landfill (9)	trench
S	618-4	Burial Ground No. 4	pits
S	618-8	Early Waste Burial Ground	trench
S	618-7	Burial Ground No. 7	trench
S	618-1	SW Burial Ground No. 1	trench and pits
S		Horn Rapids Disposal	landfill
S		Midway Landfill No. 2 (9)	landfill
S	USBR-2, 4-D	USBR-2, 4-D burial ground	burial ground
D	618-10	300 North SW Burial Ground	burial ground
D	618-11	300 Wye Burial Ground	burial ground
S	618-3*	Burial Ground No. 3	trench
S	618-2	SW Burial Ground No. 2	trench
D	618-12	North Process Pond Scraping	pond
S		J.A. Jones No. 1 (9)	landfill
D	6652-G*	6652-G ALE Field Storage	tank
D		Army Bunkers Septic Tank (3)	tank
D	6652-C*	6652-C Space Science Lab.	tank
S		White Bluffs City Landfill	landfill
S		East White Bluffs City	landfill
S		Midway Landfill No. 1 (9)	landfill
S		Sodium Dichromate Barrel	landfill
D		City of Hanford Landfill	landfill
S	P-11	116-F-6 Crib	crib
D	213-J and K	Gable Mountain Cribs	crib
S		Pickling Acid Crib (9)	crib
S	618-5	Burial Ground No. 5	burning pit
S		J.A. Jones No. 2 (9)	burial ground
D		Hanford Trailer Camp (9)	landfill
D		Army Munitions Burial Site	burial ground
S	618-6*	Burial Ground No. 6	trench

D = Deep groundwater area (depth to groundwater = 245 feet)
S = Shallow groundwater area (depth to groundwater = 40 feet)

APPENDIX E

MANPOWER AND SCHEDULING WORKSHEETS FOR GENERALIZED HANFORD UNITS

APPENDIX E

This Appendix presents the worksheets used to develop the master schedule, manpower, and budget requirements for each type of generalized Hanford unit within each RCRA 3004(u) characterization or remediation category. These estimates have been based on the estimation techniques presented in Section 3.4.

The following codes are used to identify specific characterization and remediation tasks:

Characterization Tasks

- o C1 - sampling planning
- o C2 - field sampling
- o C3 - characterization report

Remediation Tasks

- o R1A - feasibility study
- o R1B - engineering design
- o R2 - site remediation
- o R3 - post-remedial action monitoring

The following codes have been used for sites involving exhumation:

- o E/A = exhumation method A (waste excavation and disposal)
- o E/B = exhumation method B (waste excavation, treatment, and disposal).

CHARACTERIZE AND REMEDIATE IN-PLACE (DEEP SITES)

Need for Action Code = 1

A - ABOVEGROUND COVERED LANDFILL

No sites in this category.

B - ABOVEGROUND UNCOVERED LANDFILL

No sites in this category.

C - BELOWGROUND COVERED LANDFILL

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	35 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	84	100	2002	162

Total Time = 1,740 wks
Total Cost/Site = $1,801,000 + 4,640,000 = $6,441,000
Total Manweeks = 2,399 wks
No. of Sites = 6

D - BELOWGROUND UNCOVERED LANDFILL

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	6 wks	16 wks	26 wks	39 wks	52 wks	247 wks	1560 wks
Manweeks:	12.5	33.6	29.2	0	84	750	14,589	162

Total Time = 1,954
Total Cost/Site = $6,473,000 + 24,620,000 = $31,093,000
Total Manweeks = 99,576
No. of Sites = 1
C2 assumes 2 drilling rigs working one 8 hour shift.

E - SURFACE IMPOUNDMENTS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	5 wks	16 wks	26 wks	39 wks	52 wks	90 wks	1560 wks
Manweeks:	12.5	14.4	29.2	0	125	104	110	162

Total Time = 1,796 wks
Total Cost/Site = $2,651,000 + 4,833,500 = $7,484,500
Total Manweeks = 557 wks
No. of Sites = 16

F - DITCH

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	5 wks	16 wks	26 wks	39 wks	52 wks	206 wks	1560 wks
Manweeks:	12.5	48	29.2	0	125	241	255	162

Total Time = 1,913 wks
Total Cost/Site = $8,604,000 + 8,452,500 = $17,056,500
Total Manweeks = 873
No. of Sites = 6
C2 assumes 3 drilling rigs on one 8 hour shift.

G - UNDERGROUND DISPERSION SYSTEMS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	5 wks	16 wks	26 wks	39 wks	52 wks	26 wks	1,560 wks
Manweeks:	12.5	9.6	29.2	0	125	56	29	162

Total Time = 1,733
Total Cost/Site = $1,801,000 + 2,898,000 = $4,699,000
Total Manweeks = 423
No. of Sites = 26

H - ABOVEGROUND STORAGE TANK

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	4 wks	1 wk	10 wks	26 wks	39 wks	52 wks	7 wks	NA
Manweeks:	2.3	1.8	2.4	0	42	2	3	

Total Time = 199
Total Cost/Site = $125,000 + 128,000 = $253,000
Total Manweeks = 53.5
No. of Sites = 5

I - UNDERGROUND TANKS

	C1	C2	C3	Review	R1A	R1B*	R2*	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	6 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	42	39	30	162

Total Time = 1,685 wks (I-1) or 1,679 wks (I-2)
Total Cost/Site = $1,801,000 + 2,929,600 = $4,730,600 (I-1)
= $1,801,000 + 1,903,100 = $3,704,100 (I-2)
Total Manweeks = 282 wks (I-1) or 214 wks (I-2)
No. of Sites = I-1 = 133 (tanks, tank farm)
I-2 = 48 (diversion boxes)

*For I-2 sites, R1B = 1 manweeks; R2 = 1 weeks, 0.1 manweek.

J - SPILLS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	19 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	42	43	1,059	162

Total Time = 1724 wks
Total Cost/Site = $1,801,000 + 3,022,000 = $4,823,000
Total Manweeks = 1,357
No. of Sites = 3

K - UNDERGROUND VAULT

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	0.2 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	42	1	0.8	162

Total Time = 1,705 wks
Total Cost/Site = $1,801,000 + 1,925,700 = $3,726,700
Total Manweeks = 257 wks
No. of Sites = 1

L - BURNING PIT

No sites in this category.

M - INCINERATOR

No sites in this category.

N - PROCESS SEWERS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	9 wks	1560 wks
Manweeks:	12.5	75.6	29.2	0	42	55	42	162

Total Time = 1,717 wks
Total Cost/Site = $5,098,000 + 3,341,400 = $8,439,400
Total Manweeks = 418 wks
No. of Sites = 1
C2 assumes 4 drilling rigs operating on one 8 hour shift.

O - OTHER

No Sites

CHARACTERIZATION AND EXHUMATION (DEEP SITES)

Need for Action Code = 1

A - ABOVEGROUND COVERED LANDFILL

No sites in this category.

B - ABOVEGROUND UNCOVERED LANDFILL

No sites in this category.

C - BELOWGROUND COVERED LANDFILL

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	215 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	84	750	3473	162

Total Time = 1,920 wks
Total Cost/Site = $1,801,000 + 85,122,000 = $86,923,000 (E/A)
= $1,801,000 + 157,309,000 = $159,110,000 (E/B)
Total Manweeks = 4,520 wks
No. of Sites = 6

D - BELOWGROUND UNCOVERED LANDFILL

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	6 wks	16 wks	26 wks	39 wks	52 wks	2270 wks	1560 wks
Manweeks:	12.5	33.6	29.2	0	84	750	39,435	162

Total Time = 3,977 wks
Total Cost/Site = $6,473,000 + 982,000,000 = $988,473,000 (E/A)
$6,473,000 + 1,850,320,000 = $1,856,793,000 (E/B)
Total Manweeks = 40,506
No. of Sites = 1
C2 assumes 2 drilling rigs working one 8 hour shift.

E - SURFACE IMPOUNDMENTS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	5 wks	16 wks	26 wks	39 wks	52 wks	586 wks	1560 wks
Manweeks:	12.5	14.4	29.2	0	125	708	9,983	162

Total Time = 2,292 wks
Total Cost/Site = $2,651,000 + 247,802,500 = $250,453,500 (E/A)
= $2,651,000 + 464,396,500 = $467,047,500 (E/B)
Total Manweeks = 11,034 wks
No. of Sites = 16

F - DITCH

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	5 wks	16 wks	26 wks	39 wks	52 wks	1,322wks	1560 wks
Manweeks:	12.5	48	29.2	0	125	708	22,712	162

Total Time = 3,029 wks
Total Cost/Site = $8,604,000 + 562,250,000 = $570,854,000 (E/A)
= $8,604,000 + 1,057,970,000 = $1,066,574,000 (E/B)
Total Manweeks = 23,797
No. of Sites = 6
C2 assumes 3 drilling rigs on one 8 hour shift.

G - UNDERGROUND DISPERSION SYSTEMS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	5 wks	16 wks	26 wks	39 wks	52 wks	198 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	125	708	3,233	162

Total Time = 1,905 wks
Total Cost/Site = $1,801,000 + 80,450,000 = $82,251,000 (E/A)
= $1,801,000 + 148,490,000 = $150,291,000 (E/B)
Total Manweeks = 4,279
No. of Sites = 26

H - ABOVEGROUND STORAGE TANK

No sites in this category

I-2 - UNDERGROUND TANKS

No sites in this category

J - SPILLS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	42 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	42	648	546	162

Total Time = 1747 wks
Total Cost/Site = $1,801,000 + 13,821,000 = $15,622,000 (E/A)
= $1,801,000 + 23,368,000 = $25,169,000 (E/B)
Total Manweeks = 1,449
No. of Sites = 3

K - UNDERGROUND VAULT

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	14 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	42	17	98	162

Total Time = 1,719 wks
Total Cost/Site = $1,801,000 + 2,141,000 = $3,942,000 (E/A)
= $1,801,000 + 2,355,500 = $4,156,000 (E/B)
Total Manweeks = 370 wks
No. of Sites = 1

L - BURNING PIT

No sites in this category.

M - INCINERATOR

No sites in this category.

N - PROCESS SEWERS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	9 wks	1560 wks
Manweeks:	12.5	75.6	29.2	0	42	128	52	162

Total Time = 1,717 wks

Total Cost/Site = $5,098,000 + 3,740,000 = $8,838,000 (E/A)

= $5,098,000 + 5,372,500 = $10,470,500 (E/B)

Total Manweeks = 501 wks

No. of Sites = 1

C2 assumes 4 drilling rigs operating on one 8 hour shift.

O - OTHER

No sites in this category.

CHARACTERIZE AND REMEDIATE (SHALLOW SITES)

Need for Action Code = 1

A - ABOVEGROUND COVERED LANDFILL

No sites in this category.

B - ABOVEGROUND UNCOVERED LANDFILL

No sites in this category.

C - BELOWGROUND COVERED LANDFILL

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	14 wks	26 wks	39 wks	52 wks	35 wks	1560 wks
Manweeks:	10	9.6	23.4	0	84	100	2002	162

Total Time = 1,740
Total Cost/Site = $916,000 + 4,640,000 = $5,556,000
Total Manweeks = 2,399
No. of Sites = 1

D - BELOWGROUND UNCOVERED LANDFILL

No sites in this category.

E - SURFACE IMPOUNDMENTS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	90 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	125	104	110	162

Total Time = 1,796 wks
Total Cost/Site = $916,000 + 4,833,500 = $5,749,500
Total Manweeks = 557
No. of Sites = 7

F - DITCH

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	8 wks	16 wks	26 wks	39 wks	52 wks	206 wks	1560 wks
Manweeks:	12.5	48	29.2	0	125	241	255	162

Total Time = 1913 wks
Total Cost/Site = $4,264,000 + 8,452,000 = $12,716,500
Total Manweeks = 873
No. of Sites = 2
C2 assumes 2 drilling rigs on one 8 hour shift.

G - UNDERGROUND DISPERSION SYSTEMS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	26 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	125	56	29	162

Total Time = 1,733 wks
Total Cost/Site = $916,000 + 2,898,000 = $3,814,000
Total Manweeks = 423
No. of Sites = 8

H - ABOVEGROUND STORAGE TANK

No sites in this category.

I - UNDERGROUND TANKS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	6 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	42	39	30	162

Total Time = 1,685 wks
Total Cost/Site = $916,000 + 2,929,600 = $3,845,600
Total Manweeks = 282
No. of Sites = 1

J - SPILLS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	19 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	42	43	1,059	162

Total Time = 1,724
Total Cost/Site = $916,000 + 3,022,000 = $3,938,000
Total Manweeks = 1,357
No. of Sites = 4

K - UNDERGROUND VAULT

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	6 wks	4 wks	14 wks	26 wks	39 wks	52 wks	0.2 wks	1560 wks
Manweeks:	12.5	9.6	23.4	0	42	1	0.8	162

Total Time = 1,705
Total Cost/Site = $916,000 + 1,925,700 = $2,841,700
Total Manweeks = 257
No. of Sites = 1

L - BURNING PIT

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	6 wks	4 wks	14 wks	26 wks	39 wks	52 wks	82 wks	1560 wks
Manweeks:	10	9.6	23.4	0	84	115	2,247	162

Total Time = 3,169
Total Cost/Site = $916,000 + 5,036,000 = $5,952,000
Total Manweeks = 2,651
No. of Sites = 1

M - INCINERATOR

No sites in this category.

N - PROCESS SEWERS

No sites in this category.

O - OTHER

No sites in this category.

CHARACTERIZE AND EXHUMATION (SHALLOW SITES)

Need for Action Code = 1

A - ABOVEGROUND COVERED LANDFILL

No sites in this category.

B - ABOVEGROUND UNCOVERED LANDFILL

No sites in this category.

C - BELOWGROUND COVERED LANDFILL

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	14 wks	26 wks	39 wks	52 wks	215 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	84	750	3,473	162

Total Time = 1,918 wks
Total Cost/Site = $916,000 + 85,122,000 = $86,038,000 (E/A)
= $916,000 + 157,309,000 = $158,225,000 (E/B)
Total Manweeks = 4,512 wks
No. of Sites = 1

D - BELOWGROUND UNCOVERED LANDFILL

No sites in this category

E - SURFACE IMPOUNDMENTS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	586 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	125	708	9,983	162

Total Time = 2,314 wks
Total Cost/Site = $916,000 + 247,802,500 = $248,718,500 (E/A)
= $916,000 + 464,396,500 = $465,312,500 (E/B)
Total Manweeks = 11,029 wks
No. of Sites = 7

F - DITCH

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	8 wks	16 wks	26 wks	39 wks	52 wks	1,322 wk	1560 wks
Manweeks:	12.5	48	29.2	0	125	708	22,712	162

Total Time = 3,031 wks
Total Cost/Site = $4,264,000 + 462,250,000 = $566,514,000 (E/A)
= $4,264,000 + 1,057,970,000 = $1,062,234,000 (E/B)
Total Manweeks = 23,797
No. of Sites = 2
C2 assumes 3 drilling rigs on one 8 hour shift.

G - UNDERGROUND DISPERSION SYSTEMS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	198 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	125	708	3,233	162

Total Time = 1,903
Total Cost/Site = $916,000 + 80,450,000 = $81,366,000 (E/A)
= $916,000 + 148,490,000 = $149,406,000 (E/B)
Total Manweeks = 4,279 wks
No. of Sites = 8

H - ABOVEGROUND STORAGE TANK

No sites in this category.

I-2 - UNDERGROUND TANKS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	18 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	42	110	151	162

Total Time = 1,723 wks
Total Cost/Site = $916,000 + 3,477,000 = $4,393,000 (E/A)
$916,000 + 4,876,500 = $5,792,500 (E/B)
Total Manweeks = 516 wks
No. of Sites = 1

J - SPILLS

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	8 wks	4 wks	16 wks	26 wks	39 wks	52 wks	42 wks	1560 wks
Manweeks:	12.5	9.6	29.2	0	42	648	546	162

Total Time = 1,747 wks
Total Cost/Site = $916,000 + 13,821,000 = $14,737,000 (E/A)
$916,000 + 23,368,000 = $24,284,000 (E/B)
Total Manweeks = 1,449 wks
No. of Sites = 4

K - UNDERGROUND VAULT

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	6 wks	4 wks	14 wks	26 wks	39 wks	52 wks	14 wks	1560 wks
Manweeks:	10	9.6	23.4	0	42	17	98	162

Total Time = 1,715 wks
Total Cost/Site = $916,000 + 2,141,000 = $3,057,000 (E/A)
$916,000 + 2,355,000 = $3,271,000 (E/B)
Total Manweeks = 362 wks
No. of Sites = 1

L - BURNING PIT

	C1	C2	C3	Review	R1A	R1B	R2	R3
Time:	6 wks	4 wks	14 wks	26 wks	39 wks	52 wks	87 wks	1560 wks
Manweeks:	10	9.6	23.4	0	84	750	1,314	162

Total Time = 1,788 wks
Total Cost/Site = $916,000 + 33,000,000 = $33,916,000 (E/A)
$916,000 + 58,920,000 = $59,836,000 (E/B)
Total Manweeks = 2,353 wks
No. of Sites = 1

M - INCINERATOR

No sites in this category.

N - PROCESS SEWERS

No sites in this category.

O - OTHER

No sites in this category.

CHARACTERIZE FOR NO RELEASE OR NO RESIDUAL CONTAMINATION (DEEP SITES)

Need for Action Code = 2 or 4

A - ABOVEGROUND COVERED LANDFILL

No sites in this category

B - ABOVEGROUND UNCOVERED LANDFILL

	C1	C2	C3
Time:	8 wks	6 wks	16 wks
Manweeks:	12.5	48	29.2

Total Time = 30 weeks
Total Cost/Site = $4,076,000
Total Manweeks = 89.7
No. of Sites = 1
C2 assumes 2 drilling rigs on one 8 hour shift.

C - BELOWGROUND COVERED LANDFILL

	C1	C2	C3
Time:	8 wks	6 wks	16 wks
Manweeks:	12.5	48	29.2

Total Time = 30 weeks
Total Cost/Site = $4,076,000
Total Manweeks = 89.7
No. of Sites = 22
C2 assumes 2 drilling rigs on one 8 hour shift.

D - BELOWGROUND UNCOVERED LANDFILL

No sites in this category.

E - SURFACE IMPOUNDMENTS

	C1	C2	C3
Time:	8 wks	6 wks	16 wks
Manweeks:	12.5	33.6	29.2

Total Time = 30 weeks
Total Cost/Site = $5,567,000
Total Manweeks = 75.3
No. of Sites = 61
C2 assumes 2 drilling rigs on one 8 hour shift.

F - DITCH

	C1	C2	C3
Time:	8 wks	7 wks	16 wks
Manweeks:	12.5	55.2	29.2

Total Time = 31 weeks
Total Cost/Site = $9,082,000
Total Manweeks = 96.9
No. of Sites = 2
C2 assumes 3 drilling rigs on one 8 hour shift.

G - UNDERGROUND DISPERSION SYSTEMS

	C1	C2	C3
Time:	8 wks	4 wks	16 wks
Manweeks:	12.5	9.6	29.2

Total Time = 28 weeks
Total Cost/Site = $1,662,000
Total Manweeks = 51.3
No. of Sites = 43

H - ABOVEGROUND STORAGE TANK

	C1	C2	C3
Time:	4 wks	1 wk	10 wks
Manweeks:	2.3	0.6	2.4

Total Time = 15 weeks
Total Cost/Site = $125,000
Total Manweeks = 5.3
No. of Sites = 4

I - UNDERGROUND TANKS

	C1	C2	C3
Time:	6 wks	3 wks	14 wks
Manweeks:	10	7.2	23.4

Total Time = 23 weeks
Total Cost/Site = $875,000
Total Manweeks = 40.6
No. of Sites = 45

J - SPILLS

	C1	C2	C3
Time:	4 wks	3 wks	10 wks
Manweeks:	3.9	7.2	9

Total Time = 17 weeks
Total Cost/Site = $34,400
Total Manweeks = 20.1
No. of Sites = 5

K - UNDERGROUND VAULT

	C1	C2	C3
Time:	6 wks	3 wks	14 wks
Manweeks:	10	7.2	23.4

Total Time = 23 weeks
Total Cost/Site = $875,000
Total Manweeks = 40.6
No. of Sites = 7

L - BURNING PIT

	C1	C2	C3
Time:	6 wks	3 wks	14 wks
Manweeks:	10	7.2	23.4

Total Time = 23 weeks
Total Cost/Site = $875,000
Total Manweeks = 40.6
No. of Sites = 2

M - INCINERATOR

	C1	C2	C3
Time:	2 wks	1 wk	8 wks
Manweeks:	2	0.6	1

Total Time = 11 weeks
Total Cost/Site = $78,000
Total Manweeks = 3.6
No. of Sites = 1

N - PROCESS SEWERS

No sites in this category.

O - OTHER

	C1	C2	C3
Time:	4 wks	3 wks	12 wks
Manweeks:	5.9	7.2	13.7

Total Time = 19 weeks

Total Cost/Site = $531,000

Total Manweeks = 26.8

No. of Sites = 2

CHARACTERIZE FOR NO RELEASE OR NO RESIDUAL CONTAMINATION (SHALLOW SITES)

Need for Action Code = 2 or 4

A - ABOVEGROUND COVERED LANDFILL

	C1	C2	C3
Time:	4 wks	3 wks	12 wks
Manweeks:	5.9	7.2	13.7

Total Time = 19 weeks
Total Cost/Site = $531,000
Total Manweeks = 26.8
No. of Sites = 1

B - ABOVEGROUND UNCOVERED LANDFILL

No sites in this category.

C - BELOWGROUND COVERED LANDFILL

	C1	C2	C3
Time:	8 wks	4 wks	16 wks
Manweeks:	12.5	7.2	13.7

Total Time = 28 weeks
Total Cost/Site = $2,514,000
Total Manweeks = 77.7
No. of Sites = 37
C2 assumes 3 drilling rigs operating concurrently over one 8 hour shift.

D - BELOWGROUND UNCOVERED LANDFILL

No sites in this category.

E - SURFACE IMPOUNDMENTS

	C1	C2	C3
Time:	8 wks	9 wks	16 wks
Manweeks:	12.5	25.2	29.2

Total Time = 33 weeks
Total Cost/Site = $1,789,000
Total Manweeks = 66.9
No. of Sites = 2
C2 assumes 2 drilling rigs operating concurrently on one 8 hour shift.

F - DITCH

No sites in this category.

G - UNDERGROUND DISPERSION SYSTEMS

	C1	C2	C3
Time:	4 wks	3 wks	12 wks
Manweeks:	5.9	7.2	13.7

Total Time = 19 weeks
Total Cost/Site = $531,000
Total Manweeks = 26.8
No. of Sites = 25

H - ABOVEGROUND STORAGE TANK

	C1	C2	C3
Time:	4 wks	1 wk	10 wks
Manweeks:	2.3	1.8	2.4

Total Time = 15 weeks
Total Cost/Site = $125,000
Total Manweeks = 6.5
No. of Sites = 9

I - UNDERGROUND TANKS

	C1	C2	C3
Time:	4 wks	3 wks	12 wks
Manweeks:	5.9	7.2	13.7

Total Time = 19 weeks
Total Cost/Site = $531,000
Total Manweeks = 26.8
No. of Sites = 8

J - SPILLS

	C1	C2	C3
Time:	4 wks	3 wks	12 wks
Manweeks:	5.9	7.2	13.7

Total Time = 19 weeks
Total Cost/Site = $531,000
Total Manweeks = 26.8
No. of Sites = 1

K - UNDERGROUND VAULT

No sites in this category.

L - BURNING PIT

	C1	C2	C3
Time:	4 wks	3 wks	12 wks
Manweeks:	5.9	7.2	13.7

Total Time = 19 weeks
Total Cost/Site = $531,000
Total Manweeks = 26.8
No. of Sites = 7

M - INCINERATOR

No sites in this category.

N - PROCESS SEWERS

	C1	C2	C3
Time:	8 wks	7 wks	16 wks
Manweeks:	12.5	75.6	

Total Time = 31 weeks
Total Cost/Site = $5,169,000
Total Manweeks = 104.1
No. of Sites = 1
C2 assumes 4 drilling rigs on a one 8 hour shift.

O - OTHER

	C1	C2	C3
Time:	4 wks	3 wks	12 wks
Manweeks:	5.9	7.2	13.7

Total Time = 19 weeks
Total Cost/Site = $531,000
Total Manweeks = 26.8
No. of Sites = 4

CHARACTERIZE FOR NO HAZARDOUS CONSTITUENTS

Need for Action Code = 3

A - ABOVEGROUND COVERED LANDFILL

No sites in this category.

B - ABOVEGROUND UNCOVERED LANDFILL

No sites in this category.

C - BELOWGROUND COVERED LANDFILL

	C1	C2	C3
Time:	1 wks	1 wks	7 wks
Manweeks:	0.7	2	0.3

Total Time = 9 weeks
Total Cost/Site = $28,900
Manweeks = 3
No. of Sites = 6

D - BELOWGROUND UNCOVERED LANDFILL

	C1	C2	C3
Time:	1 wks	1 wks	7 wks
Manweeks:	0.7	2	0.3

Total Time = 9 weeks
Total Cost/Site = $28,900
Manweeks = 3
No. of Sites = 1

E - SURFACE IMPOUNDMENTS

	C1	C2	C3
Time:	1 wks	1 wks	7 wks
Manweeks:	0.7	2	0.3

Total Time = 9 weeks
Total Cost/Site = $28,900
Manweeks = 3
No. of Sites = 1

F - DITCH

No sites in this category.

G - UNDERGROUND DISPERSION SYSTEMS

	C1	C2	C3
Time:	1 wks	1 wks	7 wks
Manweeks:	0.7	2	0.3

Total Time = 9 weeks
Total Cost/Site = $28,900
Manweeks = 3
No. of Sites = 28

H - ABOVEGROUND STORAGE TANK

No sites in this category.

I - UNDERGROUND TANKS

	C1	C2	C3
Time:	1 wk	1 wk	7 wks
Manweeks:	0.7	0.5	0.3

Total Time = 9 weeks
Total Cost/Site = $23,100
Manweeks = 1.5
No. of Sites = 7

J - SPILLS

No sites in this category.

K - UNDERGROUND VAULT

No sites in this category.

L - BURNING PIT

No sites in this category.

M - INCINERATOR

No sites in this category.

N - PROCESS SEWERS

No sites in this category.

O - OTHER

No sites in this category.

APPENDIX F

SCHEDULING AND MANPOWER REQUIREMENT ESTIMATES FOR THE REMEDIATION OF RCRA 3004(u) WASTE SITES

APPENDIX F

Scheduling and Manpower Requirement Estimates For the Remediation of RCRA 3004(u) Waste Sites

This Appendix provides the information for estimating the scheduling and manpower requirements for the remediation of 3004(u) waste sites. The bases for these estimates are presented in Appendix A of this report.

For each 3004(u) generalized Hanford waste unit, tentative schedules and manpower requirements are estimated for two types of remediation techniques: exhumation and an appropriate in-place remedial action. The selection and engineering of the remediation techniques was presented in Section 3.3 of this report.

As described in Sections 3.3 and 3.4, the remediation process consists of three different tasks: R1-Feasibility Study and Engineering (FS/Eng), R2-Remedial Action (RA), and R3-post-RA Monitoring. R1 has been subdivided into two areas: R1A is the feasibility study (F) and R1B is the engineering design work. For each of these three tasks, tentative scheduling and staffing requirements are estimated based on unit production rate, and unit manpower requirements provided in Appendix A for each remediation technology.

Assumptions

- For phase R1A, it is assumed that there will be three levels of FS, ranging from $100,000 for a simple and small site to $300,000 for a liquid disposal site which will require the most complex study. It is assumed that $200,000 FS for a solid waste disposal site (or in the case of liquid disposal site, this if for a medium, relatively complex site). For RCRA sites, experience has shown that a maximum of six months were given to perform the FS, and a period of three months for EPA to review the FS. Therefore, a total of nine months is given for the R1A phase.

- For phase R1B, the cost is calculated based on a scaling factor of the RA cost. The factor ranges from ten percent for large site to twenty percent for a small site.

- For both phases R1A and R1B, it is assumed that the sum of the FS cost and the Engineering Cost are limited to a maximum of $200,000 and a minimum of $100,000. These values are based on SAIC's experience in performing FS and average value for an RI/FS/Eng of $1,800,000 given in Federal Regulations (40 CFR Part 300). The manpower requirements for both phases R1A and R1B are estimated from the FS and Eng cost calculated in Task 6 and converted into manhours or manweeks using an average labor cost of $60/manhour.

For all FS/Eng costs, the manpower loading is obtained by converting the cost into manhours or manweeks using the unit cost of $60/manhour. Table F-1 lists the manpower requirements for Task R1 for each of the generalized Hanford waste units for both exhumation and in-place remediation techniques. It should be noted that although there were two different Task R1 costs for exhumation: one for excavation and disposal without treatment, and the other with waste treatment. It is assumed that the work needs to be performed for the FS/Eng phase is the same; therefore, the manpower loading is estimated based on the lower FS/Eng cost estimate.

For Task R2, the schedule and the manpower requirements are obtained based on the RA and labor productivity rate estimated for each suggested remediation technology. These production rates are summarized in Table F-2. These rates are derived from data given in Appendix A for each remediation technology. As previously discussed in Section 3.3 of the report, only a few technologies were selected for remediation of the 3004(u) waste sites. These include exhumation (with and without treatment), grout-in-place, groundwater recovery and treatment, and in-place decontamination. As listed in Table F-2, there are two different rates for the grout-in-place technology. This modification is necessary due to the applicability of the technology to different types of waste units. For generalized unit types C (belowground covered landfill), D (belowground landfill), J (spills), and L (burning pits), the technology is applied as recommended in Appendix A, i.e., grout-in-place the contaminated soil. However, for generalized unit type I-1 (aboveground tanks), I-2 (diversion boxes), K (underground vaults), and N (process sewers), the technique is assumed to be applied with

TABLE F-1. FEASIBILITY STUDY/ENGINEERING SCHEDULE AND MANPOWER REQUIREMENTS FOR 3004(u) GENERALIZED HANFORD WASTE UNITS

Type of Waste Unit	Schedule (weeks)		Manpower Requirements (Manweeks)			
			Exhumation		In-Situ Remediation	
	FS	Eng. Design	FS	Eng. Design	FS	Eng. Design
C	39	52	84	750	84	100
D	39	52	84	750	84	750
E	39	52	125	708	125	104
F	39	52	125	708	125	241
G	39	52	125	708	125	56
H	39	52	N/A	N/A	42	2
I-1	39	52	N/A	N/A	42	39
I-2	39	52	42	110	42	1
J	39	52	42	648	42	43
K	39	52	42	17	42	1
L	39	52	84	750	84	115
N	39	52	42	128	42	55

C = Belowground Covered Landfill
D = Belowground Uncovered Landfill
E = Surface Impoundments
F = Ditches
G = Underground Dispersion Systems
H = Aboveground Tanks
I-1 = Underground Tanks
I-2 = Diversion Boxes
J = Spills
K = Underground Vaults
L = Burning Pits
N = Process Sewers

TABLE F-2. REMEDIAL ACTION (RA) PRODUCTION AND LABOR PRODUCTIVITY RATES

Remediation Technique	RA Production Rate	Labor Productivity Rate
o Groundwater Recovery and Treatment (24 hours/day, 7days/week)	80 gal./min.	0.26 manhour/ 1,000 gal.
o Grout-in-place (8 hours/day, 5 days/week)		
Unit Type I-1, I-2, K, N	100 cu.yd./day	0.4 manhour/cu.yd.
Unit Type C, D, J, L	288 cu.yd./day	1.64 manhour/cu.yd.
o Exhumation (8 hours/day, 5 days/week)		
Containment Building Assembly and Disassembly		0.64 manhour/sq.ft.
Excavation	630 cu.yd./day	0.4 manhour/cu.yd.
Backfill and Compaction	315 cu.yd./day	0.13 manhour/cu.yd.
o In-Place Decontamination (8 hours/day, 5 days/week)	115,000 gal./day	4.9 manhours/ 1000 gal.

Unit Types (C, D, E, etc.) are defined on Table F-1.

a modification that, instead of grouting the soil, the grout be injected directly into the unit to stabilize the residual contain of the unit.

Based on these production rates, the schedule and manpower loadings can be estimated for each of the recommended remedial actions for each type of generalized Hanford waste unit. Tables F-3, F-4, F-5, and F-6 provide a listing of the schedule and manpower requirements for exhumation, grout-in-place, groundwater recovery and treatment, and in-place decontamination respectively.

For Task R3 post-RA monitoring, the schedule and manpower requirements are considered to be constant for all sites. It is assumed that semi-annual groundwater well sampling will be performed for each site and the scheduled time is estimated to be about seven weeks per sampling episode, and the manpower loading is 216 manhours per year or 5.5 manweeks per year. For 30 years after the closure of the site this results in 162 manweeks. Table F-7 summarizes the post-RA monitoring schedule and manpower requirements.

Figures F-1 through F-5 provide specific schedules for each of the remediation activities.

TABLE F-3. SCHEDULE AND MANPOWER REQUIREMENTS FOR EXHUMATION

Type of Waste Unit	X (ft)	Y (ft)	V (yd^3)	Schedule (weeks)	Manpower (manweeks)
C	275	625	222,800	215	3,473
D	790	2,290	2,680,000	2,270	39,435
E	338	890	668,500	586	9,983
F	296	2,325	1,530,000	1,322	22,712
G	302	313	210,000	198	3,233
H	NA				
I-1	NA				
I-2	56	58	3,600	18	151
J	125	175	28,400	42	546
K	28	35	550	14	98
L	200	215	80,000	87	1,314
N	NA		4,200	9	52

Notes:

X = excavated width (ft)
Y = excavated length (ft)
V = excavated volume (yd^3)

Unit types (C, D, E, etc.) are defined on Table F-1.

TABLE F-4. SCHEDULE AND MANPOWER REQUIREMENTS FOR GROUT-IN-PLACE

Type of Waste Unit	Schedule (weeks)	Manpower (manweeks)
C	35	2,002
D	247	14,589
I-1	6	30
I-2	0.02	0.1
J	19	1,059
K	0.15	0.75
L	39	2,247
N	9	42

Unit Types (C, D, etc.) are defined on Table F-1.

TABLE F-5. SCHEDULE AND MANPOWER REQUIREMENTS FOR GROUNDWATER RECOVERY AND TREATMENT

Type of Waste Unit	Schedule (weeks)	Manpower (manweeks)
E	90	110
F	206	255
G	26	29

Unit Types (C, D, etc.) are defined on Table F-1.

TABLE F-6. SCHEDULE AND MANPOWER REQUIREMENTS FOR IN-PLACE DECONTAMINATION

Type of Waste Unit	Schedule (weeks)	Manpower (manweeks)
H	7	3

Unit Types is defined on Table F-1.

TABLE F-7. SCHEDULE AND MANPOWER REQUIREMENTS FOR POST-RA MONITORING

Type of Waste Unit	Schedule (weeks)	Manpower (manweeks)
all units	1,560	162

FIGURE F-1. SCHEDULING ASSOCIATED WITH POST-REMEDIATION ACTIVITIES PER UNIT PER SAMPLING EVENT (R3)

Well purging and sampling	Offsite laboratory analysis	Data Analysis
4 days	6 weeks	0.1 weeks

FIGURE F-2. MANPOWER ASSOCIATED WITH POST-REMEDIATION ACTIVITIES PER YEAR PER SITE

Well purging and sampling	Offsite laboratory analysis	Data Analysis	
192 hours (3 people)		8 hours (1 person)	+ 12 hours maintenance + 4 hours clerical

FIGURE F-3. EXCAVATION

Site Type C	215 weeks	3,473 manweeks
Site Type D	2,270 weeks	39,435 manweeks
Site Type E	586 weeks	9,983 manweeks
Site Type F	1,322 weeks	22,712 manweeks
Site Type G	198 weeks	3,233 manweeks
Site Type I-2	18 weeks	151 manweeks
Site Type J	42 weeks	546 manweeks
Site Type K	14 weeks	98 manweeks
Site Type L	87 weeks	1,314 manweeks
Site Type N	9 weeks	52 manweeks

Site types are defined on Table F-1.

FIGURE F-4. GROUT-IN-PLACE TECHNIQUE

```
                        6.5 wks       28 weeks
Site Type C            |----------|----------------|
                                     2,002 manweeks

                        6.5 wks      241 weeks
Site Type D            |----------|----------------|
                                    14,589 manweeks

                                   6 weeks
Site Type I-1          |-----------------------------|
                                  30 manweeks

                                 0.02 weeks
Site Type I-2          |-----------------------------|
                                 0.1  manweeks

                         6.5 wk       12 weeks
 Site Type J           |----------|----------------|
                                     1,059 manweeks

                               0.15 weeks
Site Type K            |-----------------------------|
                               0.75 manweeks

                        6.5 wks      32 weeks
Site Type L            |--------|------------------|
                                     2,247 manweeks

                                   9 weeks
Site Type N            |-----------------------------|
                                  42 manweeks
```

Site types are defined on Table F-1.

FIGURE F-5. GROUNDWATER RECOVERY AND TREATMENT

```
                        2 wks        88 weeks
Site Type E           |-------|-------------------|
                                   110 manweeks

                        2 wks       204 weeks
Site Type F           |-------|-------------------|
                                   255 manweeks

                        2 wks        24 weeks
Site Type G           |-------|-------------------|
                                    29 manweeks
```

Site types are defined on Table F-1.

TABLE F-8. FS/ENGINEERING SCHEDULE AND MANPOWER REQUIREMENTS

Type of Waste Unit	Schedule	Manpower Requirements (manweek)			
		Exhumation		In-Place Remediation	
		Total	Per Person	Total	Per Person
C	1 year	830	16	70	1.3
D	1 year	830	16	610	12
E	1 year	830	16	100	2
F	1 year	830	16	240	4.5
G	1 year	830	16	55	1
H	1 year	N/A	--	40	0.8
I-1	1 year	N/A	--	40	0.8
I-2	1 year	110	2	40	0.8
J	1 year	650	12.5	45	0.9
K	1 year	40	0.8	40	0.8
L	1 year	830	16	80	1.5
N	1 year	130	2.5	110	2

Unit type is defined on Table F-1.

APPENDIX G

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 1976. 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:

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

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

- 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 heterogeneous) dictate the number, frequency, and distribution of samples required. For example, if a material is known to be truly homogenous, a single sample might suffice to define its quality. However, if a sample is heterogeneous, 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:

- The sampling approach will be well outlined prior to initiation of the sampling effort.

- Sample containers will be cleaned and marked with the designated sample number using a wax pencil or temporary label.

- 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).

- Preservation techniques will be employed in the field as appropriate (Section 4).

- 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:

- 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).

- 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 in 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 include 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)	4 ft	liquids and sludges[a]	cannot be used for caustic liquids
	rigid plastic tubing		caustic liquids	may not be sufficiently rigid
	glass vial attached to a wooden dowell		liquids and sludges	cannot collect multiphase samples
Tanks	teflon/glass tubing with vacuum pump	16 to 20 ft		
	stainless steel well bailer		good depth	
	coliwassa		good for multiphase sampling	
	bacon bomb		good for samples from discrete levels	
	Kemmerer sampler		good for samples from discrete levels	
	weighted bottle			contamination from upper levels
	open drain valves			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)			
Drums (solid)	scoop			
	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	1 ft		
	sampling triers		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.

- Air sampling devices should be located to minimize interference from obstructions and ground dust.

- 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.

- An anemometer and wind direction recorder should be located in the vicinity to collect wind data.

- Barometric pressure, relative humidity, and ambient temperature readings will be recorded in conjunction with the air sampling data.

- Impingers/absorbents/filters will be selected for the specific contaminants of interest according to EPA methods or other approved methods as appropriate.

- 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.	Body-anodized aluminum alloy. Pyrex glass liner sample chamber. Flow restrictor, check valve, rupture disc of stainless steel.	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.
Grab-sampler glass bottle on line	Glass bottle supported by metal frame-Teflon cap.	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.
Grab sampler-glass bottle on pole.	Aluminum pole with glass sample bottle. 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.
Depth-integrating Samplers Sampling.	Bronze (available with epoxy-painted body, nylon nozzles, and silicone rubber gaskets for trace metals sampling.)	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.
	Bronze (available with epoxy-painted body, nylon nozzles, and silicone-rubber gaskets for trace metal 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.
Bag sampler	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	Split spoon and continuous core give excellent samples from precise depths No drilling fluid is used, minimizing contamination problems Formation waters can be sampled during drilling by using a screened lead auger or advancing a well point ahead of the augers Hole caving can be overcome by implacing screen and casing before augers are removed	Cannot be used in all consolidated materials Limited to depths of 100-200 ft; formation samples may not be completely accurate, depending upon how they are taken
Mud rotary	Can be used both in unconsolidated and consolidated formations Core samples can be collected for certain types of analysis Cores excellent for lithological correlation Capable of drilling to any depth Casing not required during drilling Flexibility in well construction	Drilling fluid is required: - 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 No information on location of the water table and only limited information on water-producing zones, is directly available during drilling

TABLE 3. DRILLING METHODS FOR MONITORING WELLS (Continued)

Type	Advantages	Disadvantages
Air rotary	No drilling fluid is used, minimizing contamination problems Cores can be analyzed for certain types of constituents Can be used in both unconsolidated and consolidated formations Capable of drilling to any depth Formation sampling ranges from excellent in hard, dry formations to nothing when circulation is lost in formations with cavities Formation water is blown out of the hole along with cuttings making it possible to determine when the first water-bearing zone is encountered 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	Casing is required to keep the hole open when drilling in soft, caving formation below the water table 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 Cuttings are difficult to control creating dust problems. Health hazards in contaminated areas
Cable tool	Only small amounts of drilling fluid (generally water with no additives) are required	Potential contamination by drilling flui Relatively large diameters are required (minimum 4-in. casing)

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
	Formation samples can be excellent with a skilled driller	Caving of holes requires the casing to be run with the drilling
	When water is encountered, changes in potentiometric levels are observable	Usually a screen must be set before a water smaple can be taken
	Relative permeabilities and rough water quality data from different zones penetrated can be obtained by skilled operators	Open hole gives poor samples for analysis
	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 alkalies, alcohols, aliphatic hydrocarbons, and oils	May absorb some constituents from goundwater
	Good chemical resistance to strong mineral acids, concentrated oxidizing acids, and strong alkalies	May react with and leach some constituents into groundwater if not sampled correctly
Polypropylene	Excellent chemical resistance to mineral acids	May react with and leach some constituents into groundwater
	Good to excellent chemical resistance to alkalies, alcohols, ketones, and esters	
	Good chemical resistance to oils	
	Fair chemical resistance to concentrated oxidizing acids, aliphatic hydrocarbons, and aromatic hydrocarbons	
Teflon (Teflon is a registered trademark of DuPont, Inc.)	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
		Need good equipment to make connections
Stainless steel	Excellent resistance to corrosion and oxidation	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

- Prevent hydraulic connections between different stratigraphic units while drilling

- Seal completely the screened interval from overlying layers

- Manage water pumped or blown from the well during development properly, and

- 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 poly-ethylene/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. Telfon/Viton PVC, silicone	Minimum-slight	Easy
Gear-driven sub-mersible pumps	200 ft	Stainless 304 Teflon, Viton	Minimum-slight	Easy
Helical rotor sub-mersible 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 required excavation of large trench
3) vacuum extractors	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:

- Detect unknown waste deposits, pipes, and cables;
- Determine lateral boundaries of plots and trenches;
- Determine the thickness of overburden material;
- Discriminate between metallic and non-metallic materials;
- Map chemical contaminant migration plumes;
- Locate sinkholes; and
- 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 milliR 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. Field instruments for alpha and beta measurements are only useful for high intensity fields that approach personnel safety limits. Low intensity fields can only 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	$4^{o}C$, hermetically	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	$4^{o}C$, 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	$4^{o}C$, hermetically sealed	Must analyze within 14 days	Sample container should contain no headspace
Acrolein, acrylonirile, acetonitrile	Enough to fill (2) 40 ml vials	Glass vial with Teflon-faced silicon septa and screw cap	$4^{o}C$, hermetically sealed	Must analyze within 14 days	Sample containter should contain no headspace
Phenols	Minimum 100 g	Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing	$4^{o}C$	Must extract within 7 days, and analyze within 30 days	
Phthalate esters	Minimum 100 g	Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing	$4^{o}C$	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	$4^{o}C$	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
				within 30 days	
Nitroaromatics and cycloketones	Minimum 100 g	Grab-borosilicate glass; composite-refrigerated glass; no tygon tubing	$4^{o}C$	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	$4^{o}C$	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	$4^{o}C$	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	$4^{o}C$	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	$4^{o}C$	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	$4^{o}C$/protect from light	Extract and analyze within 14 days	Minimize headspace of sample
Semivolatile (GC/MS)	To fill (2) 40 ml vials	Glass vial with Teflon-faced silicon septa and screw cap	$4^{o}C$	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	$4^{o}C$	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	$4^{o}C$	Analyze ASAP, 24 hours max.	
Chromium VI	100 g	HDPE or glass	$4^{o}C$	Analyze ASAP, 48 hours max.	
EP Toxicity	Minimum 600 g	Borosilicate glass	$4^{o}C$	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]
Inorganic Tests			
Acidity	P,G	Cool, 4° C	14 days
Alkalinity	P,G	do	Do
Ammonia	P,G	Cool, $4^{o}C$, H_2SO_4 to pH<2	28 days
Biochemical oxygen demand	P,G	Cool, $4^{o}C$	48 hours
Bromide	P,G	None required	28 days
Biochemical oxygen demand, carbonaceous	P,G	Cool, $4^{o}C$	48 hours
Chemical oxygen demand	P,G	Cool, $4^{o}C$, H_2SO_4 to pH<2	28 days
Chloride	P,G	None required	Do
Chlorine, total residual	P,G	Dp	Analyze immediately
Color	P,G	Cool, $4^{o}C$	48 hours
Cyanide, total and amendable to chlorination	P,G	Cool, $4^{o}C$, 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_2SO_4 to pH<2	6 months
Hydrogen ion (pH)	P,G	None required	Analyze immediately
Kjeldahl and organic nitrogen	P,G	Cool, $4^{o}C$, H_2SO_4 to pH<2	28 days
Nitrate	P,G	Cool, $4^{o}C$	48 hours
Nitrate-nitrite	P,G	Cool, $4^{o}C$, H_2SO_4 to pH<2	28 days
Nitrite	P,G	Cool, $4^{o}C$	48 hours
Oil and grease	G	Cool, $4^{o}C$, H_2SO_4 to pH<2	28 days
Organic carbon	P,G	Cool, $4^{o}C$, HCl or H_2SO_4 to pH<2	Do
Orthophosphate	P,G	Filter immediately, Cool, $4^{o}C$	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, $4^{o}C$, H_2SO_4 to pH<2	28 days
Phosphorus (elemental)	G	Cook, $4^{o}C$	48 hours
Phosphorus total	P,G	Cool, $4^{o}C$, H_2SO_4 to pH<2	28 days
Residue, total	P,G	Cool, $4^{o}C$	7 days
Residue, filterable	P,G	Cool, $4^{o}C$	48 hours
Residue, nonfilterable (TSS)	P,G	Cool, $4^{o}C$	7 days
Residue, settleable	P,G	Cool, $4^{o}C$	48 hours

TABLE II. 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
Metals[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
Organic Tests[8]			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	14 days
Purgeable aromatic hydrocarbons	G, Teflon-lined septum	Cool, 4°C, 0.0008% $Na_2S_2O_3$[5], HCl to pH 2[9]	Do
Acrolein and acrylonitrile	G, Teflon-lined septum	Cool, 4°C, 0.0008% $Na_2S_2O_3$[5], Adjust pH to 4-5[10]	Do
Phenols[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[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°	7 days until extraction, 40 days after extraction
Nitrosamines[11,14]	G, Teflon-lined cap	Cool, 4°0.008% $Na_2S_2O_3$[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% $Na_2S_2O_3$[5], store in dark	Do
Polynuclear aromatic hydrocarbons[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	Do
Naloethers[11]	G, Teflon-lined cap	Cool, 4°C, 0.008 $NA_2S_2O_3$[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]
TCDD[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	Do
<u>Pesticides</u>			
Pesticides[11]	G, 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

[1]Polyethylene (P) or glass (G).

[2]Sample 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.

[3]When 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 (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); sulfuric acid (H_2SO_4) 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).

[4]Samples 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 $4^{o}C$, 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-dipherryltydrazine 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 (oxident-free) atmosphere.

[14]For the analysis of dipherrylnitrosamine, add 0.008% $Na_2S_2O_3$ 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% $Na_2S_2O_3$.

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 $4^{o}C$, 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:

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

- It is in one's actual possess, or
- It is in one's view, after being in one's physical possession, or
- It is in one's physical possession and then locked up so that no one can tamper with it, or
- 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 1

CHAIN-OF-CUSTODY RECORD

SURVEY				SAMPLERS: (Signature)					
Station Number	Station Location	Date	Time	Sample Type			Seq. No.	No. of Containers	Analysis Required
				Water		Avg.			
				Camp	Grade				

Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Dispatched by: (Signature) Date/Time	Received for Laboratory by: (Signature)	Date/Time
Method of Shipment:		

Distribution:

Orig - Accompany Shipment
1 Copy - Survey Coordinator Field Files

Figure 5.3. Chain-of-Custody Record

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

FIGURE 2. SAMPLE LABEL

OFFICIAL SAMPLE LABEL

Collector _____ Collector's Sample No. _____

Place of Collection _____

_____

Date of Sample _____ Time Sampled _____

Field Information _____

_____

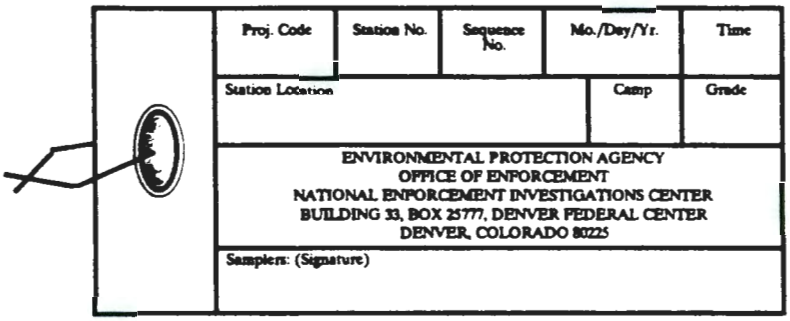
_____

_____

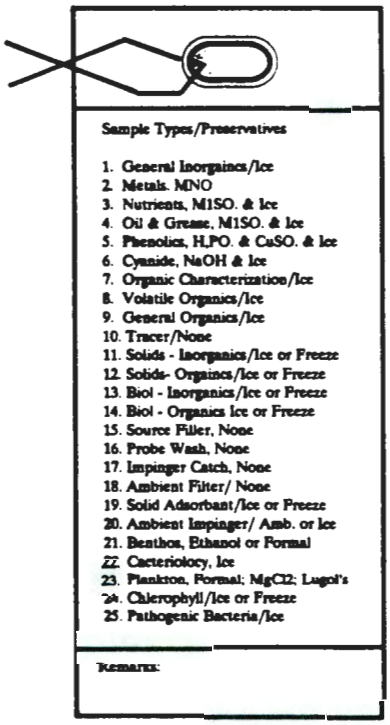
Example of Official Sample Label

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

FIGURE 3. SAMPLE TAGS



Obverse



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 distraction 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.

- 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.

- 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.

- Shipping Papers. No DOT shipping papers are required.

- 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 is 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

Compound	Physical State
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
hydroyanic 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.

- 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 173423) 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).

- 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.

- 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.

- 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.

- 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.

- 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.

- 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.

- 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.

- 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.

- 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.

- 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.

- 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.

Parameters	Matrices
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 regular laboratory waste. Hazardous and radioactive materials, as determined through analysis, will be appropriately contained or disposed of.

TABLE 15. INORGANICS

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

TABLE 15. INORGANICS (Continued)

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

TABLE 15. INORGANICS (Continued)

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

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

TABLE 16. ORGANICS (Continued)

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

TABLE 16. ORGANICS (Continued)

Parameters	Liquids[1] Sample Prep	Liquids[1] Analysis	Solids[2] Sample Prep	Solids[2] 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] Sample Prep	Liquids[1] Analysis	Solids[2] Sample Prep	Solids[2] 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] Sample Prep	Liquids[1] Analysis	Solids[2] Sample Prep	Solids[2] 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 Disolved 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-Dichlorophenoxyacetic acid)		8150		8150
2,4,4-TP (Silvex) (2,4,5-Trichlorophenoxypropionic acid)		8150		8150

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

[2]Solid 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 inlcudes 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 H

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

- 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:

- DOE Order 3790.1A, "Federal Employee Occupational Safety and Health Program for Federal Employees."

- DOE Order 5000.3, "Unusual Occurrence Reporting System."

- DOE Order 5480.1B, "Environmental Protection, Safety, and Health Protection Standards."

- DOE Order 5480.1B, Chapter XII, "Prevention, Control, and Abatement of Environmental Pollution" (including Executive Order 12088 of October 13, 1978)

- 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:

- Monitoring hazards to determine the degree of hazard present;
- 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;
- Monitoring the performance of all personnel to ensure that the required safety and decontamination procedures are followed;
- Notifying emergency authorities as appropriate;
- Ensuring that all CERCLA personnel have been trained for any nonroutine (e.g. emergency) site activities; and
- 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:

- 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.

INSERT TABLE 1 HERE

INSERT TABLE 1 (Continued) HERE

- Hard Hats -- Hard hats may be required for some work operations and may be worn with any level of protective clothing.

- Safety Shoes -- Steeled-toed safety shoes/boots may be required for many field activities. They may be worn with any level of protective clothing.

- 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:

- 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.

- 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.

- 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.

- 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.

- 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.

- 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.

- 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:

- Class A--Ordinary combustible materials (wood,paper, textiles);
- Class B-- Flammable liquids (oils, grease, paints);
- Class C-- Electrical Fires;
- 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:

- 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.

- 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.

- Facial hair that interferes with the mask-to-face seal on respirators is not allowed on personnel entering respiratory protection areas.

- 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.

- 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.

- 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.

- Oxygen Deficiency -- Confined spaces will be monitored for oxygen deficiency. Oxygen deficiency readings should be taken at ground,

waist, and head levels. Any area with an oxygen level of less than 19.5 percent oxygen requires the use of a self-contained breathing apparatus. Under no circumstances should an air purifying respirator be used for confined space or oxygen-deficient atmosphere entry or work. Because explosivity meters will not function properly in oxygen-deficient environments, areas with oxygen-deficient atmospheres should be treated as potentially explosive.

- Chemical Hazards -- When working in an environment with the potential for organic chemical vapors, vapor concentrations shall be monitored using a photoionization or flame ionization detection instrument. No respiratory protection equipment is necessary if the chemical constituents are known and the concentrations do not exceed the Threshold Limit Values (TLVs). Air-purifying respirators may be worn when total vapor concentrations do not exceed 5 ppm for a 5 minute Time Weighted Average (TWA) period. If total vapors exceed 5 ppm, a self-contained breathing apparatus must be worn. If atmospheric concentrations exceed 500 ppm for total vapors, the site will be evacuated and appropriate health and safety personnel contacted to determine additional personnel protective equipment (Level A) or safety precautions required for continued site work. Areas in which high levels of vapors are encountered should be avoided if possible.

- Radiation -- Radioactive monitoring is conducted at most sites located at Hanford. However, additional monitoring will be conducted as required. If radiations levels approach 10.0 mR/hr, a detailed radiological site survey will be conducted. If radiation levels are greater than 10.0 mR/hr, the assistance of a health physicist will be obtained prior to site entry. Radioactivity levels up to 10 mR/hr are acceptable for periods of short duration.

  Because resuspension of radioactively contaminated soil can also result in radiation exposures and inhalation of radioactive particles, air monitoring will conducted during activities involving the disturbance of contaminated soil, and respiratory protection equipment will be used as appropriate.

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.

- 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.

- 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:

- The level of decontamination required will depend on the nature and magnitude of contamination, and the type of protective clothing worn.

- 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 last 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.

- 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.

- 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.

- 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.

- 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.

- A personnel contamination log will be maintained to record contamination levels and decontamination measures taken.

- 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.

- 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:

- Any substantial degradation of a barrier designed to contain radioactive or toxic material or any substantial release of radioactive or toxic material.

- Loss of control of hazardous or radioactive material.

- Accidents involving the transport of radioactive or toxic materials.

- Any fire or explosion which affects the integrity of the site or project.

- 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).

- Any incidence of breach of access control by unauthorized personnel.

- Any acts of vandalism or major theft occurring at a site.

- Any release of contamination outside the controlled area.

- Any injury or contamination to personnel.

In addition to the DOE reporting system, any subcontractors involved in unusual occurrences will be responsible for nay 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:

- 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.

- All injured personnel and other personnel not trained in fire safety shall be evacuated.

- The fire department shall be notified immediately.

- 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.

- All personnel shall be evacuated and the fire department notified if combustible gas meters show combustible gas concentrations approaching the lower explosive limit.

- 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.

- 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:

- 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.

- 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.

- Whenever possible, one individual should remain with the victim while other personnel place necessary emergency phone calls and provide other assistance.

- Minor injuries may be treated onsite by trained personnel. However, all injuries should be checked by qualified medical personnel.

- 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.

- 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.

- 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.

- 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:

- The SSHC shall have the authority to issue orders for emergency response and decontamination.

- 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.

- 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.

- 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.

APPENDIX I

RCRA COST REDUCTION EXAMPLE

APPENDIX I - RCRA SITE COST REDUCTION EXAMPLES

Appendix I presents four example calculations of the cost reductions which result from grouping RCRA/CERCLA sites for characterization and remediation. The examples which follow are organized first according to the site types and numbers of units included in the groups.

The characterization and remediation tasks of monitoring, excavating, etc., were evaluated to determine reductions in the numbers of soil borings, monitoring wells, and samples that can be accomplished by characterizing and remediating the groups of units as opposed to the individual units.

Example A: 200 East BC Crib Area - 20 Trenches

Characterization Costs

As Individual Units:

- The characterization costs to verify no residual contamination associated with a generic trench unit has been determined to be $5,567,000

- Cost for characterizing the 20 trenches on an individual basis would be $111,340,000.

As a Group:

- The characterization costs on a group basis were determined to be $19,625,000

- Addressing these trenches as a group results in a savings of $91,715,000. This is based on the following analysis:

  - The perimeter of site was estimated to be 5,000 feet

  - A total of 50 soil borings at 100 foot intervals, 100 feet deep, would be required

- A total of 2,750 soil samples (2,500 samples plus 250 duplicates, etc.) would be taken from the bore holes (sampled at two foot intervals)

- 2,750 soil samples at $7,100 per sample equals $19,525,000

- Planning costs estimated at $100,000

o Cost savings result from a reduction in soil borings from 280 to 50, samples from 15,400 to 2,750, and characterization planning costs from $2,000,000 to $100,000.

Example B: 300 Area Burial Grounds 618-2 and 618-3 (RCRA)

Characterization Costs

As Individual Units:

o The characterization costs to verify no release associated with a generic burial ground (belowground covered landfill) is $4,076,000

o Cost for characterizing the two burial grounds on an individual basis would be $8,152,000.

As A Group:

o The characterization costs on a group basis were determined to be $2,208,700

o Addressing these burial grounds as a group results in a savings of $5,943,300. This is based on the following analysis:

- The perimeter of the site was estimated to be 1,780 feet

- A total of 18 soil borings at 100 foot intervals, 30 feet deep, would be required

- A total of 297 soil samples (270 samples plus 27 duplicates, etc.) would be taken from the bore holes (sampled at two foot intervals)

- 297 soil samples at $7,100 per sample equals $2,108,700

- Planning costs estimated at $100,000

o Cost savings result from a reduction in soil borings from 33 to 18, samples from 560 to 297, and characterization planning costs from $200,000 to $100,000.

Example C: 200 West Trenches 216-T-14 through 216-T-17 (RCRA)

Characterization Costs

As Individual Units:

o The characterization costs for characterizing for remediation associated with a generic trench (surface impoundment) is $2,691,200

o Cost for characterizing the four trenches on an individual basis would be $10,604,800.

As a Group:

o The characterization costs on a group basis were determined to be $1,800,800

o Addressing these trenches as a group results in a savings of $8,804,000. This is based on the following analysis:

- The perimeter of site was estimated to be 1,200 feet

- A total of four groundwater monitoring wells and samples at $33,200 per well equals $132,800

- A total of 224 soil samples at $7,000 per sample equals $1,568,000

- Planning costs estimated at $100,000

o Cost savings result from a reduction in groundwater wells from 16 to four, soil samples from 896 to 224, and characterization planning costs from $400,000 to $100,000.

Remediation-Excavation Costs

As Individual Units:

Method A (Excavation and Disposal)

o The cost associated with a generic trench is $247,802,500

o Cost for excavating the four trenches on an individual basis would be $991,210,000

o As a group the cost for excavating the four trenches would be $311,782,900, a cost savings of $679,427,300

o Cost savings result from a reduction in total area being excavated (double counting of areas is eliminated), and a reduction in the total costs allocated to engineering and the feasibility study.

Method B (Excavation, Treatment, and Disposal)

o The excavation and treatment costs associated with a generic trench is $464,396,500

o Cost for excavating the four trenches on an individual basis would be $1,857,586,000

o As a group the cost for excavating the four trenches, followed by treatment of the waste, would be $587,478,100, a cost savings of $1,270,107,900

- Cost savings result from a reduction in total area being excavated (double counting of areas is eliminated) and a reduction in the total costs allocated to engineering in the feasibility study.

Groundwater Recovery and Treatment

As Individual Units:

- The groundwater recovery and treatment costs associated with a generic trench (surface impoundment) is $4,533,500

- Cost for recovering and treating the four trenches on an individual basis would be $18,134,000.

As a Group:

- The recovery and treatment costs on a group basis were determined to be $4,708,600, a cost savings of $13,425,400

- Cost savings result from a reduction in the area in the saturated zone requiring recovery (double counting) and a reduction in the total costs allocated to engineering and the feasibility study.

Example D: 200 West Group D Trenches 216-T-9 through 216-T-11

Characterization Costs

As Individual Units:

- The characterization costs associated with a generic trench is $5,567,000

- Cost for characterizing the three trenches on an individual basis would be $16,701,000.

As a Group:

- The characterization costs on a group basis were estimated to be $2,443,000

- Addressing these trenches as a group results in a savings of $14,258,000. This is based on the following analysis:

  - The perimeter of the site was estimated to be 270 feet

  - A total of six soil borings, 30 feet deep, would be required

  - A total of 330 soil samples would be taken (includes duplicates, etc.)

  - 330 soil samples at $7,100 per sample equals $2,343,000

  - Planning costs estimated at $100,000

- Cost savings result from a reduction soil samples from 2,310 to 330, and characterization planning costs from $300,000 to $100,000.

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