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100-HR-1 Operable Unit Focused Feasibility Study Report

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EXECUTIVE SUMMARY

The standard Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Feasibility Study (FS) includes development and screening of alternatives (phases 1 and 2) and the detailed analysis of alternatives (phase 3). This focused feasibility study (FFS) constitutes the phase 3 portion of the FS process for the remedial alternatives initially developed and screened in the *100 Area Feasibility Study Phases 1 and 2* (DOE-RL 1993a).

The FFS process is conducted in two stages, a Process Document (DOE-RL 1994a) and an operable unit-specific FFS document, such as this one. The FFS process is performed by implementing a "plug-in" style approach as defined in great detail in the Process Document. The Process Document is a companion to this document.

The objective of this operable unit-specific FFS is to provide decision makers with sufficient information to allow appropriate and timely selection of interim remedial measures (IRM) for sites associated with the 100-HR-1 Operable Unit. The IRM candidate waste sites are determined in the limited field investigation (DOE-RL 1993d). Site profiles are developed for each of these waste sites. The site profiles are used in the application of the plug-in approach. The waste site either plugs into the analysis of the alternatives for the group, or deviations from the developed group alternatives are described and documented. A summary of the FFS results for the 100-HR-1 IRM candidate waste sites is as follows:

- None of the waste sites require additional alternative development.
- Three of the waste sites directly plug into the waste site group alternative (132-H-1, 132-H-2, and 132-H-3). The site-specific detailed analysis is conducted, referencing the waste site group analysis as appropriate. A waste site detailed analysis summary is presented in Table ES-1.
- A comparative analysis of remedial alternatives is presented for each waste site. A summary of the comparative analysis is presented in Table ES-2.

Table ES-1 Waste Site Remed

Alternatives and Technologies

Alternatives		Technologies Included	Waste Site Group				
			116-H-7	116-H-1	Pipelines	116-H-4	132-H-1 132-H-2 132-H-3
No Action	SS-1 SW-1	None				O	P
Institutional Controls	SS-2 SW-2	Deed Restrictions					
		Groundwater Monitoring					
Containment	SS-3 SW-3	Surface Water Controls			P		
		Modified RCRA Barrier			P		
		Deed Restrictions			P		
		Groundwater Monitoring			P		
Removal, Disposal	SS-4 SW-4	Removal	P	P	P		
		Disposal	P	P	P		
In Situ Treatment	SS-8A	Surface Water Controls	O				
		In Situ Vitrification	O				
		Groundwater monitoring	O				
		Deed restrictions	O				
	SS-8B	Void Grouting			P		
		Modified RCRA Barrier			P		
		Surface Water Controls			P		
		Deed Restrictions			P		
		Groundwater Monitoring			P		
	SW-7	Dynamic Compaction					
		Modified RCRA Barrier					
		Surface Water Controls					
		Groundwater Monitoring					
		Deed Restrictions					
Removal, Treatment, Disposal	SS-10	Removal	P	P			
		Thermal Desorption		P,O			
		Soil Washing	P	P			
		Disposal	P	P			
	SW-9	Removal					
		Thermal Desorption					
		Compaction					
		ERDF Disposal					

Note:

P - Indicates the detailed analysis which is provided in the Process Document
O - Indicates the detailed analysis which is provided in the operable unit-specific report
blank - Technology does not apply to this Waste Site
RCRA - Resource Conservation and Recovery Act
ERDF - Environmental Restoration Disposal Facility

Table ES-2 Comparative Analysis Summary[1]

CERCLA Comparative Evaluation Criteria	Waste Sites (Table Reference)	116-H-7 Retention Basin (Table 6-1)			116-H-1 Process Effuent Trenches (Table 6-2)		100-H Pipelines (Table 6-3)		
	Alternatives[2]	SS-4	SS-8A	SS-10	SS-4	SS-10	SS-3	SS-4	SS-8B
Overall Protection of Human Health and Environment		Better	Good	Best	Better	Best	Good	Best	Better
Compliance with ARAR[3]		Best	Best	Best	Best	Best	Best	Best	Best
Long-Term Effectiveness and Permanence		Best	Better	Best	Best	Best	Good	Best	Better
Reduction of Toxicity, Mobility, and Volume		Fair	Best	Good	Fair	Better	Good	Better	Best
Short-Term Effectiveness		Better	Best	Good	Better	Good	Best	Good	Better
Implementability		Best	Good	Better	Best	Better	Best	Better	Good
Present Worth[4] (millions $)		28.0	98.0	34.2	5.8	7.0	11.9	2.2	0.9

Notes:

1. Comparative Analysis Summary is based on Tables 6-1 through 6-3. Comparisons are made between relevant alternatives for each individual waste site group only.

2. Alternatives are summarized from Table 5-1.
   - SS-3 Containment
   - SS-4 Removal & Disposal
   - SS-8A In Situ Treatment of Soils
   - SS-8B In Situ Treatment of Pipelines
   - SS-10 Removal, Treatment & Disposal of Soil

3. ARAR - applicable or relevant and appropriate requirement

4. Cost is present worth at 5% discount rate.

Key:
- Best
- Better
- Good
- Fair
- Poor

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ACRONYMS

ARAR	applicable, or relevant and appropriate requirements
ARCL	allowable residual contamination levels
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CMS	Corrective Measures Study
COPC	contaminants of potential concern
D&D	decontamination and decommissioning
EPA	U.S. Environmental Protection Agency
FFS	focused feasibility study
FS	feasibility study
HPPS	Hanford Past-Practice Strategy
ICR	incremental cancer risk
IRM	interim remedial measures
LFI	limited field investigation
PRG	preliminary remediation goals
QRA	qualitative risk assessment
RAO	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation

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1.0 INTRODUCTION

This 100-HR-1 Operable Unit-specific focused feasibility study (FFS) is prepared in support of a Resource Conservation and Recovery Act (RCRA) facility investigation (RFI)/Corrective Measures Study (CMS) for the 100-HR-1 Operable Unit. The *100 Area Source Operable Unit FFS* (DOE-RL 1994) otherwise referred to as the Process Document, is a required reference document to this operable unit-specific FFS which together provide a complete detailed analysis of remedial alternative.

The approach for the RFI/CMS activities for the 100 Area has been defined in the *Hanford Past-Practice Strategy* (HPPS) (DOE-RL 1991). The HPPS emphasizes integration of the results of ongoing site characterization activities into the decision making process at the earliest point practicable (observational approach) and expedites the remedial action process by emphasizing the use of interim actions (DOE-RL 1991).

In accordance with the HPPS, FFS are performed for those operable unit waste sites which have been identified as candidates for interim remedial measures (IRM) based on information contained in applicable work plans and limited field investigation (LFI). The FFS constitutes the Phase 3 (detailed analysis) portion of the feasibility study (FS) process for the remedial alternatives initially developed and screened in the *100 Area Feasibility Study Phases 1 and 2* (DOE-RL 1993a).

Figure 1-1 depicts the interrelationships and sequencing of steps and activities associated with the HPPS which must be integrated to bring an operable unit from field investigation through the record of decision. This figure provides a graphical description of the entire process of characterization activities, risk assessments, treatability studies, and FS for the high and low priority sites within an operable unit and for the operable unit as a whole.

1.1 FOCUSED FEASIBILITY STUDY APPROACH

As shown in Figure 1-2, the FFS process is conducted in two stages, a Process Document (DOE-RL 1994a) and operable unit-specific FFS documents, such as this one. The FFS process is performed by implementing a "plug-in" style approach similar to that defined by the U.S. Environmental Protection Agency (EPA) Region IX in the *Operable Unit Feasibility Study, VOCs in Vadose Zone, Indian Bend Wash Superfund Site, South Area, Tempe, Arizona* (EPA 1993). To implement this approach, the waste sites in the 100 Area source operable units were first separated into *waste site groups*, then the detailed analysis phase was implemented for the remedial alternatives (previously developed in the *100 Area Feasibility Study Phases 1 and 2* [DOE-RL 1993a]) based on the characteristics of individual waste site groups. The definition of waste site groups, identification of remedial action objectives (RAO), development of remedial alternatives, and the group-specific detailed and comparative analyses are documented in the *100 Area Source Operable Unit Focused Feasibility Study Report* (Process Document) (DOE-RL 1994a). The results of the group-specific FFS (Process Document) serve as the baseline for the site-specific analyses presented in this document.

The following methodology has been developed for the implementation of the plug-in approach (as shown in Figure 1-2):

1) Assemble Waste Site Groups and Associated Group Profiles

Assemble waste sites with similar characteristics (e.g., physical structure, function, and impacted media) into waste site groups as shown on Figure 1-3. These groups are based on the "analogous site" approach to site characterization discussed in the HPPS. Specifically, the following waste site groups have been identified as potential sources in the 100 Area and are evaluated in the Process Document:

- retention basins
- pipelines
- process effluent trenches
- sludge trenches
- fuel storage basin trenches
- decontamination cribs/french drains
- pluto cribs
- seal pit cribs
- burial grounds
- decontamination and decommissioning (D&D) facilities.

Develop a description, or profile, which is representative of the waste sites within each waste site group. Such a description is called the *group profile.* Data used to generate the group profiles for each of the waste site groups were compiled from 100 Area operable unit LFI (i.e., 100-DR-1, 100-BC-1, and 100-HR-1 [DOE-RL 1993b, DOE-RL 1993c, and DOE-RL 1993d]) which are considered representative of the source areas in the 100 Area. Detailed discussion of the waste site groups and development of the associated group profiles are documented in Section 3.0 of the Process Document.

2) Develop Remedial Alternatives

Develop remedial alternatives based on the group profiles. Identify additional alternative components or *enhancements* which may be incorporated into the alternatives on a case-by-case basis in order to maximize the number of waste sites within each waste site group for which the alternatives will be applicable. For each alternative, identify site characteristics or *applicability criteria* that must be met in order to ascertain the applicability of the subject alternative. For example, the institutional controls alternative may be applicable to a waste site if concentrations of all contaminants of potential concern (COPC) are less than corresponding preliminary remediation goals (PRG). Detailed description of the IRM alternatives and specification of associated applicability criteria are presented in Section 4.0 of the Process Document.

3) <u>Perform Detailed and Comparative Analyses</u>

Perform detailed and comparative analyses of the IRM alternatives. The detailed and comparative analyses are presented in Sections 5.0 and 6.0 (respectively) of the Process Document.

4) <u>Develop Individual Site Profiles</u>

Develop a *site profile* which includes the extent of contamination, contaminated media/material, refined COPC/maximum concentrations, and a review against the reduced infiltration concentrations for each waste site within an operable unit. Development of individual site profiles are documented in Section 2.0 of the operable unit-specific FFS.

5) <u>Identify Representative Group</u>

Compare the individual site profile to the group profiles presented in the Process Document to determine the waste site group to which the subject site belongs. Compare the site characteristics to the applicability criteria for the alternatives developed for the waste site group noting any *deviations* which may result in a requirement for alternative enhancement or site-specific evaluation. Identification of the appropriate waste site group, and comparison to the associated alternative applicability criteria for each site are documented in Section 3.0 of the operable unit-specific FFS.

6) <u>"Plug-In" or Perform Site-Specific Analysis</u>

a. If applicability criteria are met based on the comparison conducted in step 5, the waste site plugs into the analysis of the alternative for the group. Site-specific volume and cost estimates are documented in Sections 2.0 and 5.0, respectively, of the operable unit-specific reports.

b. If applicability criteria are not met, the waste site does not plug into the analysis of the alternative for the group. Deviations from the developed group alternative will be documented in Section 4.0 of the operable unit-specific FFS. An evaluation of the alternative based on site-specific conditions is then performed and documented in Sections 5.0 and 6.0 of the operable unit-specific FFS.

Steps 1 through 3 are documented in Sections 3.0 through 6.0 of the Process Document (DOE-RL 1994a). Site-specific evaluation of the alternatives for the 100-HR-1 Operable Unit sites, in accordance with steps 4 through 6, are documented in this report.

1.2 PURPOSE AND SCOPE

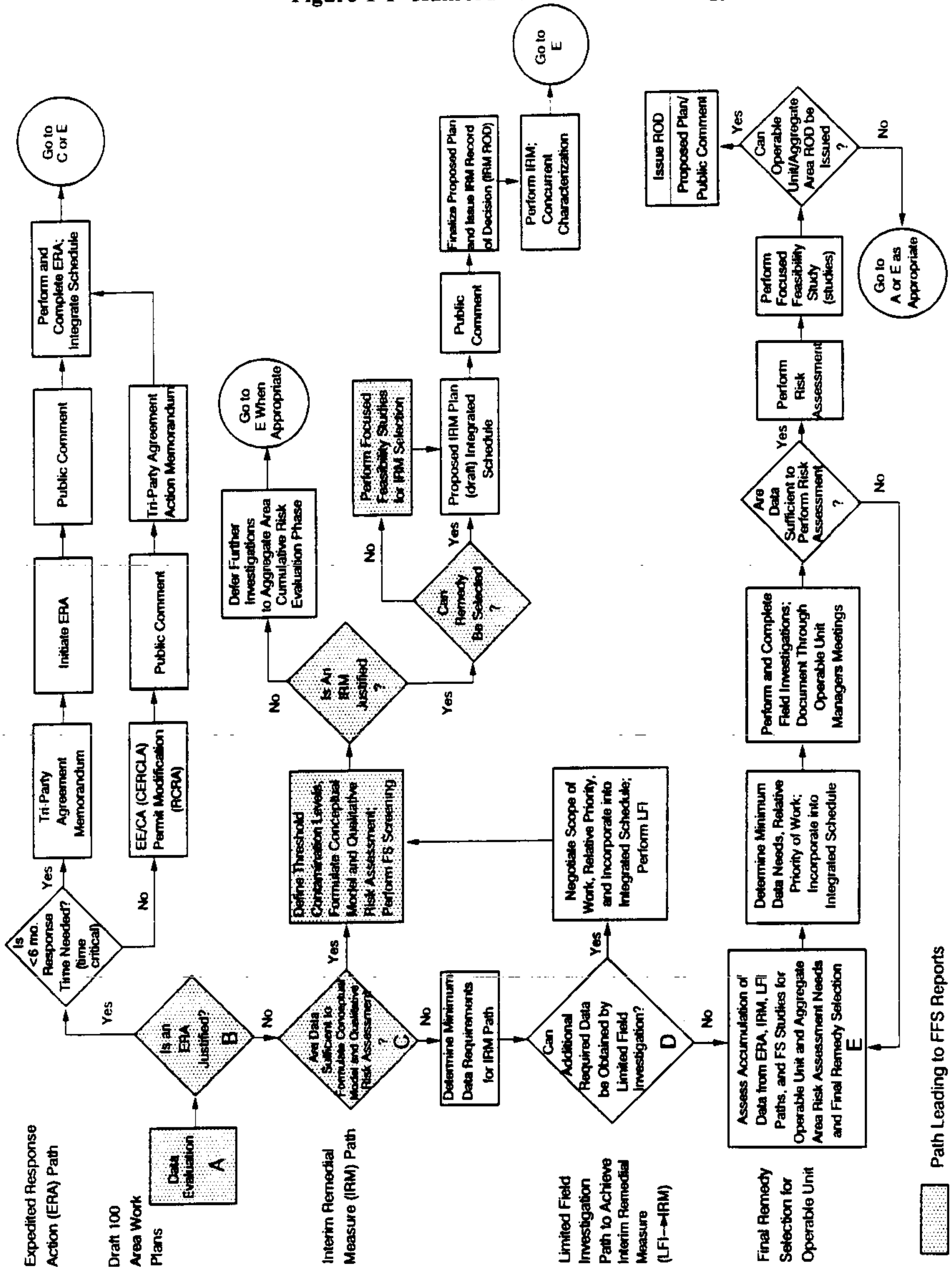
In accordance with steps 4, 5, and 6 listed above, this report presents:

- the 100-HR-1 Operable Unit individual waste site information (Section 2.0)
- the development of individual site profiles (Section 2.0)
- the identification of representative groups for individual waste sites and a comparison against the applicability criteria and identification of appropriate enhancements for the alternatives (Section 3.0)
- a discussion of the deviations and/or enhancements of an alternative and additional alternative development, as needed (Section 4.0).
- the detailed analyses for waste sites which deviate from the representative group alternatives (Section 5.0)
- the comparative analysis for all individual waste sites.

Note that the scope of this document is limited to 100-HR-1 Operable Unit IRM candidate sites as determined in the LFI. Impacted groundwater beneath the 100 H Area shall be addressed in a separate FFS document. In addition, low priority waste sites and potentially impacted river sediments proximate to the 100 Area are not considered candidates for IRM, accordingly, they are being addressed under the RFI/CMS pathway of the HPPS. The decision to limit the scope of the FFS are documented and justified in the applicable work plans, LFI, qualitative risk assessment (QRA), and the 100 Area FS Phase I and II.

The objective of this operable unit-specific FFS is to provide decision makers with sufficient information to allow appropriate and timely selection of IRM for sites associated with the 100-HR-1 Operable Unit.

Figure 1-1 Hanford Past-Practice Strategy



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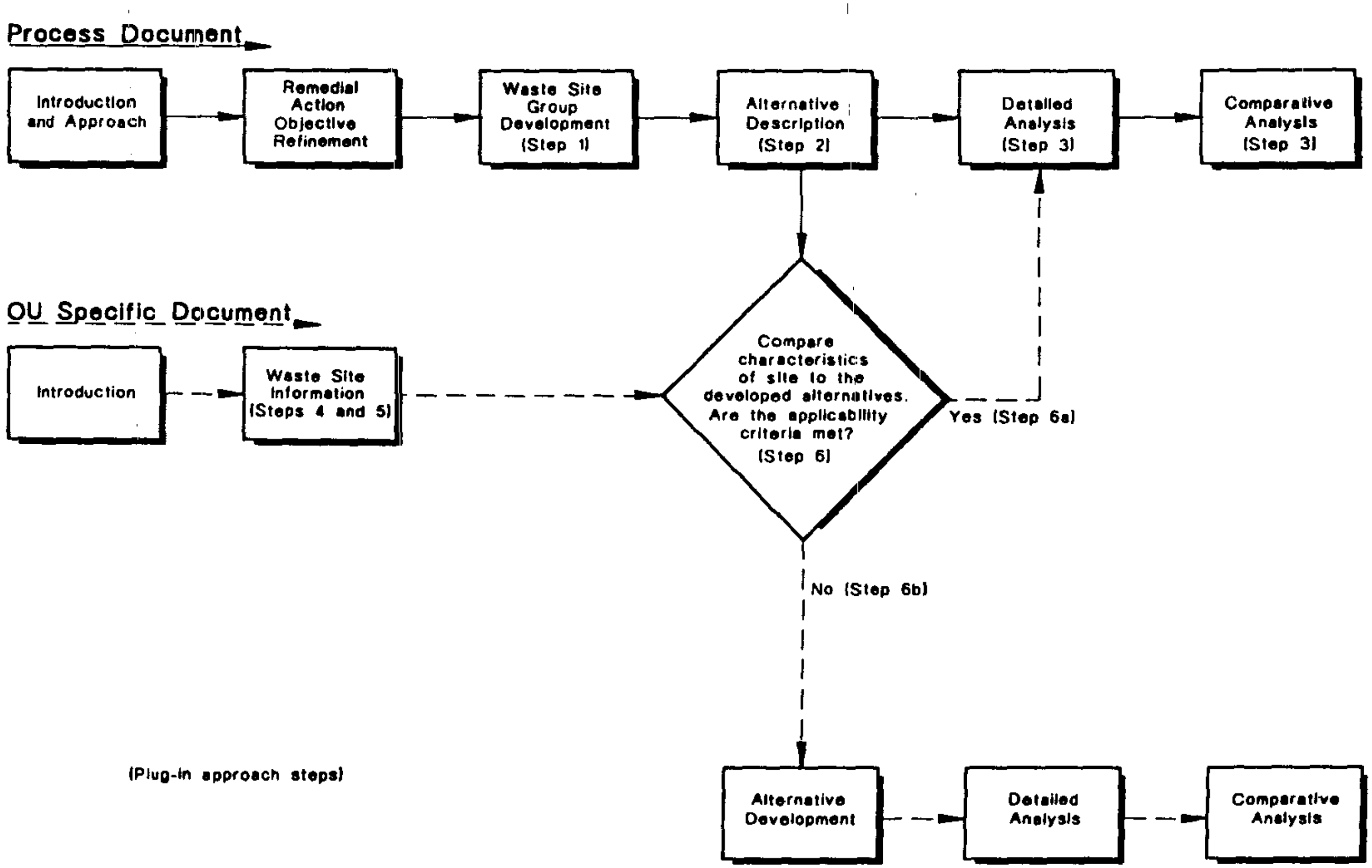

Figure 1-2 100 Area Source Operable Unit FFS Process

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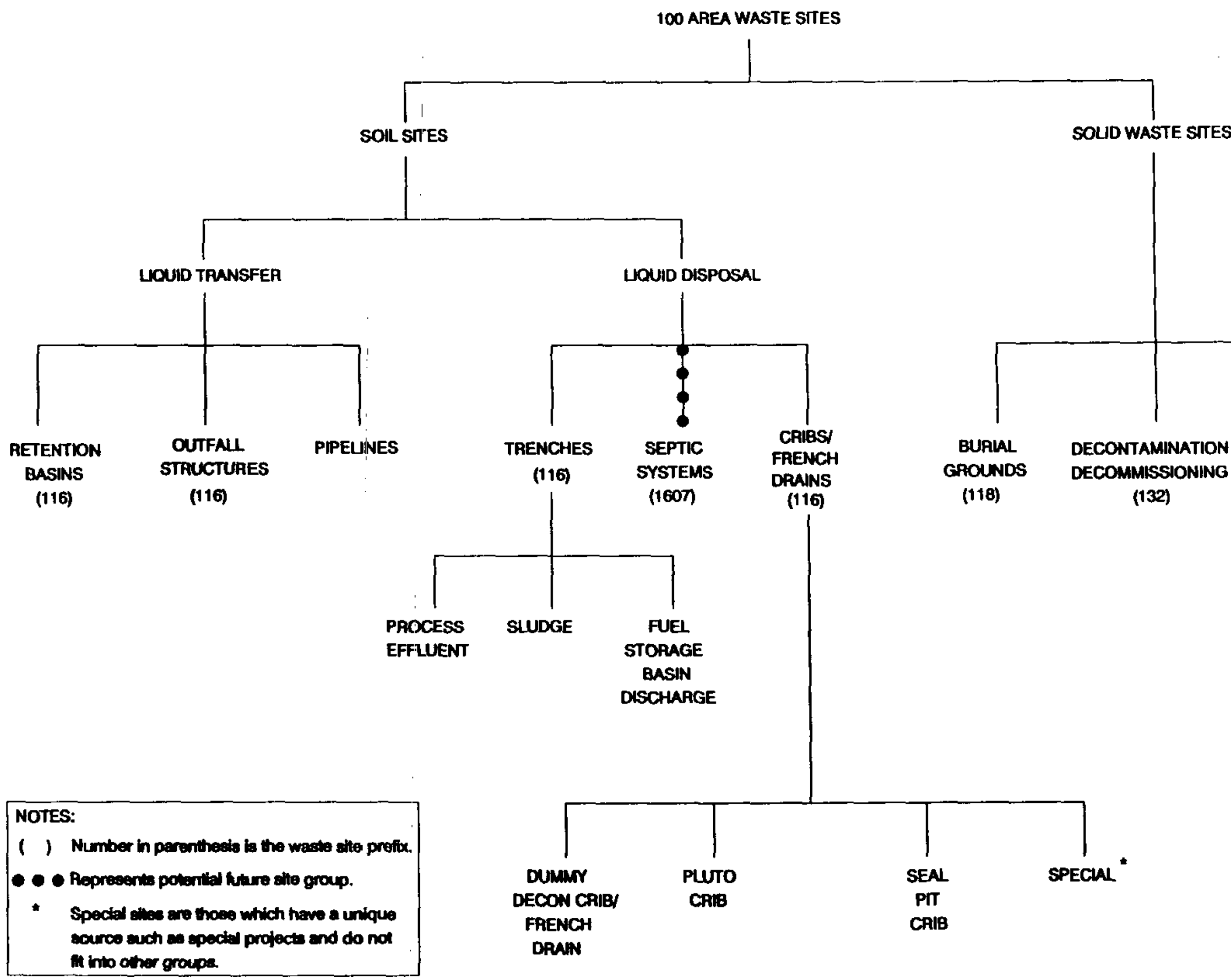


Figure 1-3 Analogous Waste Sites

2.0 WASTE SITE INFORMATION

2.1 OPERABLE UNIT BACKGROUND

The 100-HR-1 Source Operable Unit is located immediately adjacent to the Columbia River in the northeast portion of the 100 H Area. The operable unit lies primarily within the northeast quadrant of Section 18 of Township 14N, Range 27E, and is located between latitude 46° 42′ 30″ and 46° 43′ 30″ north and longitude 119° 29′ 00″ and 119° 28′ 00″ west. Site maps locate it within north/south Hanford Site plant coordinates N94,000 and N99,000 and east/west plant coordinates W37,000 and W41,000 (Figure 2-1).

The 100-HR-1 Operable Unit is one of three operable units associated with the 100 H Area at the Hanford Site. Two of these units, 100-HR-1 and 100-HR-2, are composed of source units. The groundwater/surface water operable unit is designated 100-HR-3 and includes the entire 100 H Area, the 100 D/DR Area, and the area in between. The 100 D/DR Area is located approximately 2 mi (3.5 km) southwest of the 100 H Area. The 100-HR-1 Operable Unit is bordered on the west and south by the 100-HR-2 Source Operable Unit, which is the solid and buried waste operable unit for the 100 H Area. Designated as a reactor effluent waste source, the 100-HR-1 Operable Unit contains most of the sites in the 100 H Area that were involved in plutonium production, including the 100 H Reactor and its cooling system.

Since the preparation of the *100 Area Feasibility Study Phases 1 and 2* (DOE-RL 1993a), additional data has been collected that is relevant to the 100 Area in general and to the 100-HR-1 Operable Unit specifically. A LFI and QRA were performed for the 100-HR-1 Operable Unit. In addition, aggregate area studies were performed to evaluate cultural resources and area ecology.

2.2 100 AREA AGGREGATE STUDIES

The 100 Area aggregate studies and Hanford Site studies, such as the Hanford Site background studies, provide integrated analyses of selected issues on a scale larger than the operable unit. The 100 Area groundwater operable unit work plans (i.e., DOE-RL 1992a) address studies common to the 100 Area covering topics such as river impact, shoreline, ecology, and cultural resources. Each operable unit work plan also provides detail on the physical setting such as topography, geology, hydrogeology, surface water hydrology, meteorology, environmental resources, and human resources (DOE-RL 1992b). These studies provided data for the LFI, and for the selection of final remedies. References that are applicable to the 100 Area source operable unit FFS are summarized below.

- **Hanford Site Background.** Results of the characterization of the natural chemical composition of Hanford Site soil samples are presented in *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* (DOE-RL 1993e). Background values for radionuclides are currently under evaluation but are not published at this time. Proposed background values are presented in the Process Document.

- **Ecological Analysis.** Bird, mammal, and plant surveys were conducted and reported in Sackschewsky and Landeen (1992). Current contamination data has been compiled from other sources, along with ecological pathways and lists of all wildlife and plants at the site, including threatened and endangered species (Weiss and Mitchell 1992). Another report (Cadwell 1994), discusses aquatic species on the Hanford Reach of the Columbia River; spatial distribution of vegetation types at the site and surveys of species of concern; shrub-steppe bird surveys; and mule deer and elk population monitoring. Report conclusions state that intrusive activities, such as remedial actions, that are conducted inside the controlled-area fences will not have significant impact on the wildlife. Intrusive activities outside the controlled-area fences will have minimal impact on wildlife if the recommendations contained in the three documents listed below are followed (Landeen et al. 1993):

    - *Bald Eagle Managements Plan* (Fitzner and Weiss 1992)
    - *Biological Assessment of Threatened and Endangered Species* (Fitzner et al. 1992)
    - *Biological Assessment for State Candidate and Monitor Species* (Stegen 1992).

- **Cultural Resources.** The Hanford Cultural Resources Laboratory conducted an archaeological survey during fiscal year 1991 for the 100 Area Reactor compounds on the Hanford Site (Chatters et al. 1992). A summary of Hanford Site cultural resources can be found in Cushing (1992). The following is an excerpt from Cushing (1992) on the 100 H Area.

    "This area is situated in what is probably the most culturally rich area on the Hanford Site, and, since construction of the dams elsewhere in the Columbia River system, the most archaeological rich area in the western Columbia Plateau. There are 10 recorded archaeological sites within 2 km (1.2 mi) of the area, including 45BN128 through 45BN141, and 45GR302 (a,b, and c) through 45GR305. These include two historic Wanapum cemeteries, six camps (one associated with a cemetery), and three housepit villages."

2.3 LIMITED FIELD INVESTIGATION

The 100-HR-1 LFI (DOE-RL 1993d) is an integral part of the RFI/CMS process and is based on Hanford-specific agreements discussed in the *Hanford Federal Facility Agreement and Consent Order* (Fourth Amendment) (Ecology et al. 1994), the *Hanford Site Baseline Risk Assessment Methodology* (DOE-RL 1993f), the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-HR-1 Operable Unit* (DOE-RL 1992b), and the *Hanford Past-Practice Strategy* (DOE-RL 1991). The HPPS emphasized initiating and completing waste site cleanup through interim actions.

The primary purpose of the LFI is to collect sufficient data in order to recommend those sites that should remain candidates on the IRM pathway and those sites which should not remain candidates for the IRM pathway. Sites that are not recommended as candidates for an IRM will be addressed in the final remedy selection process. The data gathered in the LFI is also used to evaluate remedial alternatives in this FFS.

A QRA is performed as part of the LFI, and determines the principal risk drivers in the operable unit. The purpose of the 100-HR-1 QRA (WHC 1993) is to provide a qualitative evaluation of human health and environmental exposure scenarios in order to provide sufficient information that will allow defensible decisions to be made on the necessity of IRM. The QRA is an evaluation of risk for a predefined set of human and environmental exposure scenarios and is not intended to replace or be a substitute for a baseline risk assessment.

The QRA is streamlined to consider only two human health exposure scenarios (frequent- and occasional-use) with four pathways (soil ingestion, fugitive dust inhalation, inhalations of volatile organics from soil, and external radiation exposure) and a limited environmental evaluation.

Frequent- and occasional-use exposure scenarios were evaluated in the human health QRA to provide bounding estimates of risk consistent with the residential and recreational exposure scenarios presented in the *Hanford Site Baseline Risk Assessment Methodology* (DOE-RL 1993f). Currently there are no such land uses in the 100-HR-1 Operable Unit.

The qualitative risk estimations for carcinogens are grouped into the following categories based on lifetime incremental cancer risk (ICR):

- high - ICR $>1 \times 10^{-2}$
- medium - ICR between 1×10^{-4} and 1×10^{-2}
- low - ICR between 1×10^{-6} and 1×10^{-4}
- very low - ICR $<1 \times 10^{-6}$.

For noncarcinogenic COPC, a hazard quotient >1.0 was considered unacceptable.

The ecological evaluation assesses dose to the Great Basin pocket mouse. The mouse is used as an indicator receptor because its home range is comparable to the size of most waste sites and will receive most of its dose from a waste site. Ecological risks are defined by calculating an environmental hazard quotient. An environmental hazard quotient greater than one (unity) indicates significant environmental risk.

A frequent-use scenario is evaluated in the year 2018 to ascertain potential future risks associated with each waste site after additional radionuclide decay. For the current occasional-use scenario, the effect of radiation shielding by the upper 2 m (6 ft) of soil on the external exposure risk at each waste site is evaluated.

The results of this assessment are used to help determine the need for IRM, to select the IRM alternatives, and to aid in the determination of risk-based cleanup levels for IRM.

If an IRM is not justified, the site is still subject to further investigation and/or remediation under the RFI/CMS process. The LFI for the 100-HR-1 Operable Unit documents the results of the sampling, data evaluation, and risk assessment conclusions for the operable unit and identifies the constituent concentrations at each of the sites (DOE-RL 1993d).

To determine IRM candidacy, the 100-HR-1 high-priority sites were evaluated using the criteria given below.

- a site poses medium or high risk to human health under the occasional-use scenario, or has an environmental hazard quotient >1.0
- a site must have a complete conceptual model as defined in the LFI, otherwise additional data will be gathered and candidacy will be re-evaluated
- a site has contaminants at levels which exceed applicable or relevant and appropriate requirements (ARAR)
- a site has a probable current impact on groundwater

The LFI also assumes that burial grounds are IRM candidate sites regardless of the above criteria. The results of the IRM candidacy evaluation are presented in Table 2-1. Although the outfall structures were originally on the IRM pathway, they have been recently designated for an expedited response action. The *100 Area River Effluent Pipelines Expedited Response Action Proposal* (DOE-RL 1994b) indicates that the 100 Area outfall structures will be addressed concurrently with the river pipelines. The 116-H-5 outfall structure is therefore removed from the IRM pathway and is not addressed further in this FFS.

The conclusions drawn during the LFI assessment are used solely to determine IRM candidacy for high-priority sites and solid waste burial grounds within the 100-HR-1 Operable Unit. While this FFS relies on the data presented in the LFI/QRA, assessments, evaluations, and conclusions drawn by the FFS are based on the methodology described in the Process Document.

2.4 DEVELOPMENT OF WASTE SITE PROFILES

To facilitate the implementation of the plug-in approach described in Section 1.1, waste site profiles must be developed for each IRM candidate site. Development of the individual waste site profile is imperative to the identification of the appropriate group and the development of applicable remedial action alternatives. The waste site profiles are developed based on existing data for the 100-HR-1 Operable Unit IRM candidate sites. Where site-specific data is unavailable, the analogous site approach is implemented.

The analogous site approach allows conditions from a site, or sites with data to be assumed for sites without data as long as the sites are analogous (i.e., within the same group). This minimizes the amount of site-specific investigations required to define waste site characteristics. The group profiles presented in the Process Document serve as a basis for development of site-specific conditions addressed in each operable unit-specific FFS. For the site-specific evaluation, the following methodology is used when assessing data from analogous waste sites:

- Contaminants:

  - assume contaminant types (radionuclides, inorganic, or organics) are the same for all sites within a group unless site-specific data indicates otherwise
  - if a site has no data, use contaminant inventory (specific constituents) from the group profile.

- Extent of contamination:

  - determine extent of contamination based only on site-specific data when available
  - if no data are available, use group profile data to assume extent of contamination.

The development of waste site profiles is accomplished by describing the original waste site, developing refined COPC, and finally by defining the parameters of the waste site profile.

2.4.1 Site Descriptions

To aid in the identification of the appropriate waste site group, the original physical and functional characteristics of each IRM candidate site has been developed. These characteristics include site name, functional use, and original dimensions.

Site Name - The site name is the initial indicator of the appropriate group.

Use - Functional use of the site as an important characteristic in determination of waste site grouping. For example, if it is known that a site was used for transport of liquid wastes, using Figure 1-3, it is possible to eliminate many potential groups.

Physical Description - This element defines the physical characteristics of a site by identifying both size and structure. These characteristics are valuable for evaluating extent of contamination, as well as identifying media/material.

Data Source - Identifies source of data for each waste site.

Descriptions of each IRM candidate site are presented in Table 2-2.

2.4.2 Refined COPC

In a manner similar to the method described in Section 2.6 of the Process Document, refined COPC have been developed for each IRM candidate site. These refined COPC are developed by screening the COPC from the 100-HR-1 QRA against the PRG defined in Appendix A of the Process Document. Tables 2-3 and 2-4 present the evaluation of refined COPC for waste sites with site-specific data. Waste sites which do not have site-specific data use data from the group site profile for COPC, and therefore no site-specific COPC evaluation table is presented.

The PRG are developed under a recreational land use scenario considering risk to human and ecological receptors, compliance with ARAR, protection of groundwater, local background concentrations and levels of detection. Table 2-5 presents the PRG developed in the Process Document. Of these sources of PRG, the most stringent value is used for screening as long as the value is not below local background and is above contractional detection levels. Another important aspect of the PRG is that the appropriate value varies with depth. As stated in Section 2.2.2 of Appendix A of the Process Document, beyond the first meter of soil humans are not considered to be receptors, beyond two meters burrowing animals are not receptors, and most native plant roots will not reach below three meters of soil. Protection of groundwater must be considered throughout the soil column.

The data sources used for the identification of refined-COPC include:

- LFI for the 100-HR-1 Operable Unit (DOE-RL 1993d)
- Radiological Characterization of the Retired 100 Areas (Dorian and Richards, 1978).

These data sources are the same as what was used to perform the QRA, and constitute the basic data set for the 100 Area source operable units. The study by Dorian and Richards was fairly comprehensive with respect to the number of sites investigated, however only radiological data were taken, and sampling and analysis protocol was not equivalent to the current standards. The LFI data looked at a small number of sites, but collected data for radionuclides, inorganics and organics. Sampling and analysis protocols for the LFI data are based on standards presented in the associated work plan (DOE-RL 1992b).

The following steps were followed for the assemblage of data for the identification of the refined-COPC:

- The vadose zone was broken down into ranges consistent with the zones accessible by receptors as presented in the Process Document (i.e., 0-3 ft, 3-6 ft, 6-10 ft, and below 10 ft in 5 ft intervals)
- Maximum concentrations from the LFI and Dorian and Richards (historical data) (1978) for each interval were identified, and the historical data was decayed to 1992 for consistency with the LFI data.

- The highest concentration between the LFI and historical data was recorded for each interval.

- The maximum concentrations were screened against the PRG presented in Table 2-5.

- All constituents which exceed PRG are identified, and those which exceed a PRG in any of the intervals are considered refined-COPC for the waste site.

When reviewing the data used for the identification of refined-COPC, the following should be considered:

- The tables report only maximum concentrations, therefore it should be noted that the entire data sets as well as the appropriate qualifiers and sampling and analysis protocols are discussed in the data source reports mentioned above.

- Data reported at an interval break, such as 15 ft was reported in the previous range, i.e. 10-15 ft.

- Data reported which overlaps ranges is recorded in both ranges. (i.e., data from 14.5-16 ft is recorded in the 10-15 ft and 15-20 ft ranges)

- Nickel-63 reported in Dorian and Richards may have been analyzed using a surrogate, therefore the concentrations reported may not be an accurate representation of the actual concentration at the waste site.

- Total-Uranium reported in Dorian and Richards has been recorded as uranium-238 since uranium-238 is the major risk contributor of the uranium isotopes in the QRA.

The screening process results in the identification of all refined COPC which must be addressed by any remedial action at the given IRM candidate site. Tables 2-3 and 2-4 present the PRG screening for those sites which have analytical data.

2.4.3 Waste Site Profiles

Based on the data from the 100-HR-1 Operable Unit LFI (DOE-RL 1993d), and the refined COPC discussed in Section 2.4.2, a profile for each IRM candidate site is developed. The site profiles consist of waste site characteristics such as extent of contamination, contaminated media/material, maximum concentrations of the refined COPC, and a determination of exceedance of allowable soil concentrations under a reduced infiltration scenario. The profiles perform two functions: first, they contain the information for comparison to the group profiles and alternative criteria defined in the Process Document; second, they aid in the development of a data base used for determining costs and durations of remedial activities (i.e., contaminated volume impacts cost of disposal and duration of excavation). The profile parameters are defined below, site-specific profiles are detailed in Table 2-6.

- Extent of Contamination - Extent of contamination consists of impacted volume, length, width, area, and thickness. The values for these parameters are based on volume estimates performed for each site (presented in Appendix A of this document). Volume, length, width, and area do not necessarily impact the determination of appropriate remedial alternatives, however they are important considerations for developing costs and durations of remedial actions. Thickness of the contaminated lens impacts the implementability of in situ actions such as vitrification which has a limited vertical extent of influence.

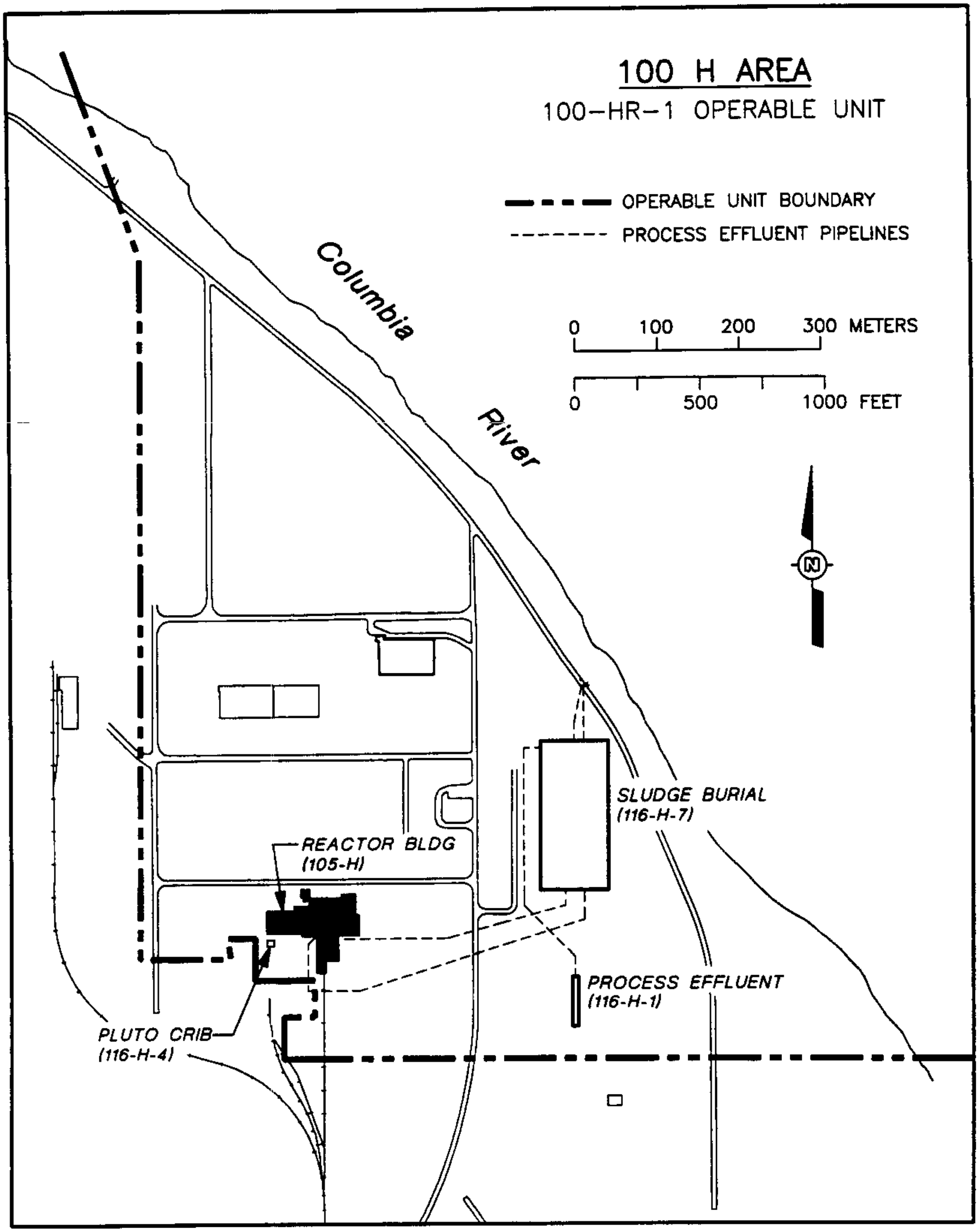
- Contaminated Media/Material - Contaminated media and material located at the site are determined and described. Structural materials such as steel, concrete, and wooden timbers influence the applicability of remedial alternatives, as well as equipment needed for actions such as removal. Presence of soils and sludges are necessary for implementation of treatment options such as soil washing. Presence of solid waste media impacts material handling considerations and may require remedial alternatives which vary from sites with contaminated soil.

- Refined COPC/Maximum Concentrations - Refined COPC for a site are determined as discussed in Section 2.4.2. The associated maximum concentration for each constituent is the highest concentration detected in any of the IRM candidate site data. Refined COPC may influence the applicability of remedial alternatives. For instance, presence of radioactive contaminants may allow natural decay to be a consideration in determining appropriate remedial actions, while the presence of organic contaminants may require that enhancements, such as thermal desorption, be added to a treatment system. The presence of cesium-137 influences the effectiveness of treatment alternatives such as soil washing.

- Reduced Infiltration Concentration - The reduced infiltration concentration is a level which is considered protective of groundwater under a scenario where hydraulic infiltration is limited by the application of a surface barrier. The derivation of this concentration is documented in Appendix A of the Process Document. The maximum concentration detected is compared to the allowable reduced infiltration concentration. Exceedance of the reduced infiltration concentrations indicates that impact to groundwater will not be mitigated by containment alternatives such as a barrier.

The profiles for each IRM candidate site in the 100-HR-1 Operable Unit are presented in Table 2-6.

Figure 2-1 100-HR-1 Operable Unit Map



SOURCE: DOE/RL 94-63

ITH:JJA:P711B-A3

9413292.0087

Table 2-1 IRM Recommendations from the 100-HR-1 LFI

Waste Site	Qualitative Risk Estimation		Conceptual Model	Exceeds ARAR	Probable Current Impact on Groundwater	Potential for Natural Attenuation by 2018	IRM Candidate yes/no
	Low-frequency scenario	EHQ >1					
116-H-1 Process Effluent Disposal Trench	Medium	Yes	Adequate	Yes	Yes	No	Yes
116-H-2 Effluent Disposal Trench	Low	Yes	Incomplete(a)	No	No	No	Yes(b)
116-H-3 Dummy Decontamination French Drain	Low	No	Adequate	No	No	Yes	No
116-H-7 Process Effluent Retention Basin	High	Yes	Adequate	Yes	Yes	No	Yes
116-H-9 Confinement Seal Pit Drainage Crib	Low	No	Adequate	No	No	Yes	No
116-H-5 Process Effluent Outfall Structure	Medium	--	Adequate	No	No	No	Yes
Process Effluent Pipelines (Soil)	Very Low	No	Adequate	No	Yes	No	Yes
Process Effluent Pipelines (Sludge)	High	No	Adequate	No	Yes	No	Yes
116-H-7 Sludge Burial Trench	Very Low	--	Adequate	No	No	No	No
132-H-3 Effluent Pumping Station	Low	--	Adequate	Unknown	Unknown	Unknown	Yes
132-H-2 Exhaust Air Filter Building	Low	--	Adequate	Unknown	No	Unknown	Yes
132-H-1 Reactor Exhaust Stack	Low	--	Adequate	Unknown	No	Unknown	Yes
116-H-4 Pluto Crib	Low	--	Adequate	Unknown	No	Unknown	Yes

EHQ = Environmental Hazard Quotient (calculated by the qualitative ecological risk assessment (WHC, 1993, *Qualitative Risk Assessment of the 100-DR-1 Source Operable Unit*, WHC-SD-EN-RA-005, Rev. 0, Westinghouse Hanford Company, Richland, Washington).

-- = not rated by the qualitative ecological risk assessment.

(a) = conceptual model is considered incomplete due to discrepancies between the limited field investigation (LFI) data and historical data. The LFI data indicates little or no contamination which contradicts with the historical data. Additional investigation may be necessary.

(b) = data needed concerning nature and vertical extent of contamination, site remains an interim remedial measure (IRM) candidate until data are available, therefore not addressed in this focused feasibility study.

ARAR = applicable or relevant and appropriated requirements, specifically the Washington State Model Toxics Control Act Method B concentration values for soils (DOE-RL, 1992a, *RCRA Facility Investigation/Corrective Measures Srudy Work Plan for the 100-HR-3 Operable Unit*, DOE/RL-88-36, Rev. 0, U.S. Department of Energy, Richland, Washington).

Table 2-2 100-HR-1 Site Description

Site #/Name (Alias)	Use	Physical Description	Data Source
116-H-7 (107-H Retention Basin)	Held cooling water effluent from H Reactor for cooling/decay before release to Columbia River.	Retention Basin Reinforced concrete, single containment. 192.6 m x 84.1 m x 6.1 m deep	LFI, historical
116-H-1 Process Effluent Disposal Trench (107-H Liquid Waste Disposal Trench)	Received high activity effluent produced by ruptured fuel elements. Received sludge from 116-H-7 retention basin when 100 H Area was deactivated. Also received 90 kg of sodium dichromate.	Trench Unlined 58.8 m x 33.5 m x 4.6 m deep	LFI, historical
116-H-4 Pluto Crib (105-H Pluto Crib)	Received cooling water discharge contaminated by failed fuel elements. Received 1,000 kg of sodium dichromate. Crib was excavated and material buried in 118-H-5 burial ground. 132-H-2 exhaust air filter building was later built on the same site.	Crib/French Drain Unlined pluto crib. 3.1 m x 3.1 m x 3.1 m deep	Analogous
Pipelines	Transported reactor cooling water from reactors to retention basins, outfall structures, and 116-H-1 trench; leaked effluent to soil; contains contaminated sludge and scale.	Process Effluent Pipelines Total length ≈1228 m; pipe diameter varies; depth below surface varies.	historical
132-H-1 (116-H Reactor Exhaust Stack)	Contaminated stack demolished in place, buried, and covered with 1 m fill.	D&D Facility Demolished reinforced concrete exhaust stack. 67.1 m high x 7.6 m x 4.6 m deep	D&D
132-H-2 (117-H Exhaust Air Filter Building)	Contaminated building demolished in place, buried, and covered with 5 m fill. Building was built on site of demolished and removed 116-H-4 pluto crib.	D&D Facility Demolished reinforced concrete building. 22.6 m x 12.5 m x 12.5 m x 8.8 m deep	D&D
132-H-3 (1608-H Effluent Pumping Station)	Collected and pumped water from H Reactor drains, including irradiated fuel storage drains, into 116-H-7 process effluent retention basin. Water and sludge in sumps was removed before station was demolished in place and covered with 5 m of fill.	D&D Facility Four concrete sumps. Capacity of ≈300,000 liters 11 m x 10.4 m x 9.7 m deep	D&D

D&D = decontamination and decommissioning
LFI = limited field investigation

Table 2-3 116-H-7 Refined Contaminants of Potential Conce

116-H-7	Zone 1		Zone 2		Zone 3		Zone 4										Refined COPC Summary
	0 - 3 ft		3 - 6 ft		6 - 10 ft		10 - 15 ft		15 - 20 ft		20 - 25 ft		25 - 30 ft		30 - 35 ft		
	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	
RADIONUCLIDES (pCi/g)																	
Am-241		NO a b c d e		NO b c d e	7.20E-01	NO c d e	7.20E-01	NO d e		NO d e		NO d e		NO d e		NO d e	
C-14		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Cs-134	5.52E+00	NO a b c d	4.10E-01	NO b c d	3.68E-04	NO c d e	6.44E-04	NO d e		NO d e		NO d e		NO d e		NO d e	
Cs-137	4.29E+01	YES d	2.01E+03	YES	4.64E+01	YES d	4.29E+01	NO d	5.67E+01	NO d	1.52E+01	NO d	1.80E+01	NO d	3.53E-01	NO d	YES
Co-60	3.42E+01	YES d	2.20E+03	YES	3.60E+01	YES d	3.60E+01	NO d	2.93E+01	NO d	3.66E+01	NO d	2.81E+00	NO d		NO d e	YES
Eu-152	4.86E+02	YES d	1.72E+04	YES d	2.60E+02	YES d	2.60E+02	NO d	2.08E+02	NO d	1.41E+02	NO d	7.07E+00	NO d	7.07E-02	NO d e	YES
Eu-154	9.37E+01	YES d	5.68E+03	YES d	3.70E+01	YES d	3.70E+01	NO d	3.69E+01	NO d	3.12E+01	NO d	1.25E+00	NO d		NO d e	YES
Eu-155	8.88E+00	NO a b c d	6.63E+02	NO b c d	8.13E-01	NO c d	1.18E+00	NO d	2.57E+00	NO d	2.03E+00	NO d	1.28E-01	NO d		NO d e	
H-3	7.70E+00	NO a b c d e	1.50E+02	NO b c d e	6.89E+00	NO c d e	1.78E-01	NO d e	1.74E+01	NO d e		NO d e		NO d e		NO d e	
K-40		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Na-22		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Ni-63	1.07E+03	NO a b c d	1.79E+04	NO b c d		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Pu-238	4.49E-01	NO a b c d e	6.78E+00	YES b c	2.38E-02	NO c d e	6.96E-02	NO d e	2.64E-01	NO d e		NO d e		NO d e		NO d e	YES
Pu-239/240	1.40E+01	YES a b c	2.00E+02	YES	1.30E+00	NO c d	1.90E+00	NO d	3.20E+00	NO d	5.00E-02	NO d e		NO d e		NO d e	YES
Ra-226	2.90E-01	YES a b c		NO b c d e		NO c d e	6.50E-01	YES	6.50E-01	YES	4.40E-01	YES		NO d e		NO d e	YES f
Sr-90	9.51E+01	NO a b c d	2.38E+02	YES b c	3.20E+00	NO c d	1.22E+01	NO d	1.15E+02	NO d	8.15E-01	NO d e	1.36E+00	NO d	7.47E-01	NO d e	YES
Tc-99		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Th-228	4.10E-01	NO a b c e		NO b c d e		NO c d e	8.10E-01	NO e	8.10E-01	NO e	4.60E-01	NO e		NO d e		NO d e	
Th-232	4.10E-01	NO a b c e		NO b c d e		NO c d e		NO d e	4.40E-01	NO e	4.40E-01	NO e		NO d e		NO d e	
U-233/234		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
U-235		NO a b c d e		NO b c d e	3.80E-01	NO c d e	3.80E-01	NO d e		NO d e		NO d e		NO d e		NO d e	
U-238	8.30E-01	NO a b c d e	4.70E+00	NO b c d	6.80E-01	NO c d e	6.80E-01	NO d e	5.30E-01	NO d e	5.30E-01	NO d e		NO d e		NO d e	
INORGANICS (mg/kg)																	
Antimony		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Arsenic	4.70E+01	YES a b c		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	YES
Barium		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Cadmium		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Chromium VI		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Lead	5.40E+02	YES		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	YES
Manganese		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Mercury		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Zinc		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
ORGANICS (mg/kg)																	
Aroclor 1260 (PCB)		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Benzo(a)pyrene		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Chrysene		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Pentachlorophenol		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	

* Maximum concentrations are screened against the PRG.
The COPC are refined based on the soil concentration and the PRG.
The elimination of a COPC is described by the letters which follow (i.e., a, b, c, d, e, f).
a) Soil concentration < or = human health concentration
b) Soil concentration < or = animal concentration (human health as substitute)
c) Soil concentration < or = plant concentration (human health as substitute)
d) Soil concentration < or = protectiveness of ground water concentration
e) Soil concentration < or = CRQL/CRDL
f) Ra-226 is eliminated as a COPC because non-waste site samples presented in Table 3-1 of the 100-BC-2 Operable Unit LFI Report (DOE-RL 1994d) show Radium-226 at a concentration of approximately 1 pCi/g (i.e., average + 2 standard deviations).

PRG = Preliminary Remediation Goals
COPC = contaminants of potential concern
PCB = polychlorinated biphenyls
CRQL = contract required quantitation limit
CRDL = contract required detection limit
LFI = limited field investigation
Max = Blank: No information is available, or not detected
Sreening = YES: Exceeds PRG
Screening = NO: Eliminated as COPC

Sources:

DOE-RL, 1993d, Tables 3-8, 10

Dorian, J.J., and V.R. Richards, 1978, Tables 2.7-74, 75, 77, 78, 79

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Table 2-4 116-H-1 Refined Contaminants of Potential Conce

116-H-1	Zone 1		Zone 2		Zone 3		Zone 4										Refined COPC Summary
	0 - 3 ft		3 - 6 ft		6 - 10 ft		10 - 15 ft		15 - 20 ft		20 - 25 ft		25 - 30 ft		30 - 35 ft		
	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	Max	Screening*	
RADIONUCLIDES (pCi/g)																	
Am-241		NO a b c d e		NO b c d e		NO c d e	2.00E-01	NO d e	1.60E-01	NO d e		NO d e		NO d e		NO d e	
C-14		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Cs-134		NO a b c d e	1.75E-04	NO b c d e		NO c d e	1.56E-04	NO d e		NO d e	1.84E-04	NO d e		NO d e		NO d e	
Cs-137	4.01E+02	YES d	9.00E-01	NO b c d	2.21E+01	YES d	3.20E+01	NO d	3.60E+02	NO d	3.88E+01	NO d		NO d e		NO d e	YES
Co-60	3.42E+01	YES d	8.30E-02	NO b c d	9.64E-01	NO c d	2.50E+00	NO d	5.37E+01	NO d	7.44E+00	NO d		NO d e		NO d e	YES
Eu-152	5.30E+02	YES d	1.28E+00	NO b c d	2.03E+00	NO c d	5.40E+01	NO d	9.28E+02	NO d	1.11E+02	NO d		NO d e		NO d e	YES
Eu-154	8.80E+01	YES d	1.42E-01	NO b c d	4.83E-01	NO c d	5.40E+00	NO d	7.10E+02	NO d	1.85E+01	NO d		NO d e		NO d e	YES
Eu-155	4.49E+00	NO a b c d	5.03E-02	NO b c d e	2.35E-02	NO c d e	7.17E-02	NO d e	9.95E+00	NO d	8.56E-01	NO d		NO d e		NO d e	
H-3		NO a b c d e		NO b c d e		NO c d e	3.93E-01	NO d e	2.55E-01	NO d e		NO d e		NO d e		NO d e	
K-40		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Na-22		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Ni-63		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Pu-238	2.82E-01	NO a b c d e		NO b c d e		NO c d e		NO d e	3.08E-01	NO d e		NO d e		NO d e		NO d e	
Pu-239/240	6.60E+00	YES a b c		NO b c d e		NO c d e	7.40E-01	NO d e	1.10E+01	YES	1.80E+00	NO d		NO d e		NO d e	YES
Ra-226		NO a b c d e		NO b c d e		NO c d e		NO d e	8.50E-01	YES	5.50E-01	YES		NO d e		NO d e	YES f
Sr-90	3.53E+01	NO a b c d		NO b c d e		NO c d e	1.22E+00	NO d	5.57E+01	NO d	1.09E+01	NO d		NO d e		NO d e	
Tc-99		NO a b c d e		NO b c d e		NO c d e		NO d e	6.70E-01	NO d e		NO d e		NO d e		NO d e	
Th-228		NO a b c d e		NO b c d e		NO c d e	9.50E-01	NO e	7.50E-01	NO e	7.50E-01	NO e		NO d e		NO d e	
Th-232		NO a b c d e		NO b c d e		NO c d e		NO d e	8.90E-01	NO e	6.40E-01	NO e		NO d e		NO d e	
U-233/234		NO a b c d e		NO b c d e		NO c d e	5.30E-01	NO d e	6.20E-01	NO d e		NO d e		NO d e		NO d e	
U-235		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
U-238		NO a b c d e		NO b c d e		NO c d e	6.10E-01	NO d e	3.91E-01	NO d e	5.80E-01	NO d e		NO d e		NO d e	
INORGANICS (mg/kg)																	
Antimony		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Arsenic		NO a b c d e		NO b c d e		NO c d e	3.79E+01	YES	2.76E+01	YES		NO d e		NO d e		NO d e	YES
Barium		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Cadmium		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Chromium VI		NO a b c d e		NO b c d e		NO c d e		NO d e	2.96E+01	YES		NO d e		NO d e		NO d e	YES
Lead		NO a b c d e		NO b c d e		NO c d e	1.87E+02	YES	1.45E+02	YES		NO d e		NO d e		NO d e	YES
Manganese		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Mercury		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Zinc		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
ORGANICS (mg/kg)																	
Aroclor 1260 (PCB)		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	
Benzo(a)pyrene		NO a b c d e		NO b c d e		NO c d e		NO d e	8.10E-01	NO d		NO d e		NO d e		NO d e	
Chrysene		NO a b c d e		NO b c d e		NO c d e		NO d e	9.20E-01	YES		NO d e		NO d e		NO d e	YES
Pentachlorophenol		NO a b c d e		NO b c d e		NO c d e		NO d e		NO d e		NO d e		NO d e		NO d e	

* Maximum concentrations are screened against the PRG.
The COPC are refined based on the soil concentration and the PRG.
The elimination of a COPC is described by the letters which follow (i.e., a, b, c, d, e, f).

a) Soil concentration < or = human health concentration
b) Soil concentration < or = animal concentration (human health as substitute)
c) Soil concentration < or = plant concentration (human health as substitute)
d) Soil concentration < or = protectiveness of ground water concentration
e) Soil concentration < or = CRQL/CRDL
f) Ra-226 is eliminated as a COPC because non-waste site samples presented in Table 3-1 of the 100-BC-2 Operable Unit LFI Report (DOE-RL 1994d) show Radium-226 at a concentration of approximately 1 pCi/g (i.e., average + 2 standard deviations).

PRG = Preliminary Remediation Goals
COPC = contaminants of potential concern
PCB = polychlorinated biphenyls
CRQL = contract required quantitation limit
CRDL = contract required detection limit
LFI = limited field investigation
Max = Blank: No information is available, or not detected
Sreening = YES: Exceeds PRG
Screening = NO: Eliminated as COPC

Sources:

DOE-RL, 1993d, Tables 3-2,4, 5

Dorian, J.J., and V.R. Richards, 1978, Tables 2.7-76

Table 2-5 Potential Preliminary Remediation Goals

	HUMAN HEALTH		ECOLOGICAL (a)		Protection of GW (b)	CRQL/ CRDL (c)	ZONE SPECIFIC PRG			
	TR = 1E-06(g)	HQ = 0.1	Mouse	Plant			1 0-3 ft	2 3-6 ft	3 6-10 ft	4 > 10 ft
RADIONUCLIDES (pCi/g)										
Am-241	76.9	N/A	NC	NC	31	1	31	31	31	31
C-14	44200	N/A	NC	NC	18	50	50	50	50	50
Cs-134	3460	N/A	NC	NC	517	0.1 (h)	517	517	517	517
Cs-137	5.68	N/A	NC	NC	775	0.1	5.68	5.68	5.68	775
Co-60	17.5	N/A	NC	NC	1292	0.05	17.5	17.5	17.5	1292
Eu-152	5.96	N/A	NC	NC	20667	0.1	5.96	5.96	5.96	20667
Eu-154	10.6	N/A	NC	NC	20667	0.1	10.6	10.6	10.6	20667
Eu-155	3080	N/A	NC	NC	103333	0.1	3080	3080	3080	103333
H-3	2900000	N/A	NC	NC	517	400	517	517	517	517
K-40	12.1	N/A	NC	NC	145	4 (i)	12.1	12.1	12.1	145
Na-22	545	N/A	NC	NC	207	4 (i)	207	207	207	207
Ni-63	184000	N/A	NC	NC	46500	30	46500	46500	46500	46500
Pu-238	87.9	N/A	NC	NC	5	1	5	5	5	5
Pu-239/240	72.8	N/A	NC	NC	4	1	4	4	4	4
Ra-226	1.1	N/A	NC	NC	0.03	0.1	0.1	0.1	0.1	0.1
Sr-90	1930	N/A	NC	NC	129	1	129	129	129	129
Tc-99	28900	N/A	NC	NC	26	15	26	26	26	26
Th-228	7260	N/A	NC	NC	0.103	1 (d)	1	1	1	1
Th-232	162	N/A	NC	NC	0.013	1	1	1	1	1
U-233/234	165	N/A	NC	NC	5	1	5	5	5	5
U-235	23.6	N/A	NC	NC	6	1	6	6	6	6
U-238 (e)	58.4	N/A	NC	NC	6	1	6	6	6	6
INORGANICS (mg/kg)										
Antimony	N/A	167	NC	NC	0.002	6	6	6	6	6
Arsenic	16.2	125	NC	NC	0.013	1	1	1	1	1
Barium	N/A	29200	NC	NC	258	20	258	258	258	258
Cadmium	1360	417	NC	NC	0.775	0.5	0.775	0.775	0.775	0.775
Chromium VI	204	2086	NC	NC	0.026	1	1	1	1	1
Lead	N/A	N/A	NC	NC	8	0.3	8	8	8	8
Manganese	N/A	2086	NC	NC	13	1.5	13	13	13	13
Mercury	N/A	125	NC	NC	0.31	0.02	0.31	0.31	0.31	0.31
Zinc	N/A	100000 (f)	NC	NC	775	2	775	775	775	775
ORGANICS (mg/kg)										
Aroclor 1260 (PCB)	4.34	N/A	NC	NC	1.37	0.033	1.37	1.37	1.37	1.37
Benzo(a)pyrene	N/A	N/A	NC	NC	5.68	0.33	5.68	5.68	5.68	5.68
Chrysene	N/A	N/A	NC	NC	0.01	0.33	0.33	0.33	0.33	0.33
Pentachlorophenol	N/A	N/A	NC	NC	0.27	0.8	0.8	0.8	0.8	0.8

N/A= NOT APPLICABLE
NC=NOT CALCULATED. Appropriate calculation not established at this time.
TR=Target Risk
HQ=Hazard Quotient
(a)=Human health values used in zones 2 and 3 if Ecological values are not calculated.
(b)=Based on Summer's Model (EPA 1989b)
(c)=Based on 100-BC-5 OU Work Plan QAPjP (DOE-RL 1992)
(d)=Detection limit assumed to be same as Th-232
(e)=Includes total U if no other data exist
(f)=Value calculated exceeds 1,000,000 ppm therefore use 100,000 ppm as default
(g)=Recreational exposure scenario accounting for decay to 2018
(h)=Detection limit assumed to be same as Cs-137
(i)=Based on gross beta analysis

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Table 2-6 100-HR-1 Waste Site Profile
(Page 1 of 2)

Waste Site (group)	Extent of Contamination					Media/ Material	Refined COPC	Maximum Concentration Detected (b)	Are Reduced Infiltration Concentrations Exceeded?
	Volume (m^3)	Length (m)	Width (m)	Area (m^2)	Depth (m)				
116-H-7 (retention basin)	56483.0	201.8	93.3	18828.0	3.0	Soil Concrete	Radionuclides	pCi/g	
							^{60}Co	2.20×10^3	NO
							^{137}Cs	2.01×10^3	NO
							^{152}Eu	1.72×10^4	NO
							^{154}Eu	5.68×10^3	NO
							^{238}Pu	6.78	NO
							$^{239/240}Pu$	2.00×10^2	NO
							^{90}Sr	2.38×10^2	NO
							Inorganics	mg/kg	
							Arsenic	4.7×10^1	YES
							Lead	5.40×10^2	NO
116-H-1 (process effluent trench)	12,015.0	58.8	33.5	1970.0	6.1	Soil	Radionuclides	pCi/g	
							^{60}Co	3.42×10^1	NO
							^{137}Cs	4.01×10^2	NO
							^{152}Eu	5.30×10^2	NO
							^{154}Eu	8.8×10^1	NO
							$^{239/240}Pu$	1.1×10^1	NO
							Inorganics	mg/kg	
							Arsenic	3.79×10^1	YES
							Chromium VI	2.96×10^1	YES
							Lead	1.87×10^2	NO
							Organics	ppb	
							Chrysene	9.20×10^2	NO
116-H-4 (pluto crib)	0.0	0.0	0.0	0.0	0.0	NA	None	NA	NA

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Table 2-6 100-HR-1 Waste Site Profile
(Page 2 of 2)

Waste Site (group)	Extent of Contamination					Media/ Material	Refined COPC	Maximum Concentration Detected (b)	Are Reduced Infiltration Concentrations Exceeded?
	Volume (m^3)	Length (m)	Width (m)	Area (m^2)	Depth (m)				
100 H pipeline (Pipeline)	(c)	(c)	(c)	(c)	(c)	Steel Concrete	<u>Radionuclides</u> ^{60}Co ^{137}Cs ^{152}Eu ^{154}Eu ^{155}Eu ^{63}Ni ^{238}Pu $^{239/240}Pu$ ^{90}Sr	assume data from pipeline group	NO(a)
132-H-1 Reactor Exhaust Stack (D&D facility)	0.0	0.0	0.0	0.0	0.0	NA	None	NA	NA
132-H-2 Filter Building (D&D facility)	0.0	0.0	0.0	0.0	0.0	NA	None	NA	NA
132-H-3 Effluent Pumping Station (D&D facility)	0.0	0.0	0.0	0.0	0.0	NA	None	NA	NA

(a) Based on group data.
(b) Where concentration exceeds Preliminary Remediation Goals.
(c) = no contaminated soil is associated with the site, therefore no volume of contamination is calculated; extent of contamination is limited to the pipeline itself.
COPC = contaminants of potential concern
NA = not applicable
D&D = decontamination and decommissioning

3.0 APPLICATION OF THE PLUG-IN APPROACH

This section summarizes the steps taken to implement the plug-in approach based on IRM candidate site characteristics which have been developed in the previous sections.

As stated in Section 3.0 of the Process Document, the group profiles were developed based on characteristics of IRM candidate sites from the 100-BC-1, 100-HR-1, and 100-DR-1 Operable Units. It is anticipated that there will be variations between site and group profiles which may require deviations from the remedial alternatives. The benefit of the plug-in approach however, is that the number of deviations will be minimized, and redundant analyses of alternatives are avoided to the maximum extent practicable.

The identification of appropriate groups for each site, an evaluation of the alternative applicability criteria, as well as a site-specific example of the manner in which a site is addressed by the plug-in approach are presented in the following sections.

3.1 GROUP IDENTIFICATION

Identification of the group to which the waste site belongs is accomplished by using the site descriptions defined in Section 2.0 and fitting the site into the appropriate group in Figure 1-3. It is also necessary to refer to the group descriptions defined in Section 3.0 of the Process Document. The appropriate group for each site is identified in Table 3-1.

3.2 EVALUATION AGAINST APPLICABILITY CRITERIA

The final step in the plug-in approach is an evaluation of waste site characteristics against the applicability criteria for each remedial alternative. The site characteristics are defined by the descriptions and profiles developed in Section 2.0. The applicability criteria and any enhancements for an alternative as defined in Section 4.0 of the Process Document are identified in Table 3-1.

The applicability criteria are elements which must be present for an alternative to be applicable at a given site. For example, for in situ vitrification to effectively address contaminants at a site, the contaminated lens must be no thicker than 5.8 m (19 ft), the maximum extent of influence realized by the technology.

Enhancements to alternatives are elements of an alternative which may be employed as necessary based on waste site characteristics, but do not limit or define the applicability of the alternative. Treatment is an alternative which has enhancements dependent upon the types of contaminants present at a site. One enhancement is thermal desorption which is used to treat organic contaminants. Presence of organic contaminants may warrant the use of thermal desorption, but is not required for the treatment alternative to apply since additional treatment technologies such as soil washing may be used to address other contaminants.

Table 3-1 presents the evaluation of the alternative applicability criteria for each IRM waste site. The evaluation represents step 6 of the plug-in approach and identifies which alternatives and enhancements apply to each site. Any deviation from alternatives developed for the appropriate group in the Process Document are identified by footnote. Sites with deviations will be developed further in subsequent sections, however, the general analysis of alternatives in the Process Document will be used for sites without deviations.

The deviations indicated in Table 3-1 are briefly summarized as follows:

- 116-H-7 retention basin has contamination <5.8 m thick, therefore in situ vitrification does apply.
- 116-H-1 process effluent trench has contamination which is >5.8 m thick, therefore in situ vitrification does not apply. Also, organic contaminants are present, therefore thermal desorption will be added as an enhancement to the treatment alternative.
- 100-H pipelines do not have soil contamination associated with them, therefore treatment is not applicable.
- 116-H-4 was removed and buried in the 118-H-5 burial ground in the past, therefore no interim action is warranted at the site.

3.3 EXAMPLE APPLICATION OF THE PLUG-IN APPROACH (116-H-7)

In order to achieve a further understanding of the plug-in approach, an example of its application has been developed. The example, site 116-H-7, will be evaluated as dictated by the plug-in approach. The waste site profile has been defined in Section 2.0 (completing step 4 of the approach). Steps 5 and 6 are completed below.

3.3.1 Identification of Appropriate Group

The 116-H-7 retention basin is assessed against the elements of Figure 1-3 to ensure that the appropriate group is identified.

Table 2-2 does not indicate that the site received solid waste, and states that the site held cooling water effluent from H Reactor for cooling/decay before release to the Columbia River. This indicates that it is a contaminated soil site used for liquid effluent transfer. Table 2-2 does indicate that the site is a reinforced concrete retention basin. It can be concluded that the appropriate group for 116-H-7 is the retention basins. The profile for the group and the associated detailed and comparative analyses are documented in the Process Document.

3.3.2 Evaluation of the Alternative Applicability Criteria

Based on the description and profile developed for 116-H-7 in Section 2.0, an evaluation of the alternative applicability criteria can be accomplished. The evaluation of each alternative is presented below.

No Interim Action - There is data indicating that there is contamination present at the site which warrants an interim action, therefore no interim action is not an acceptable alternative.

Institutional Controls - Refined COPC are identified for 116-H-7 in Table 2-3, which indicates that there are contaminants present which exceed PRG. Therefore, institutional controls will not effectively address contaminants at the site.

Containment - Because there are contaminants which exceed reduced infiltration concentrations, containment will not be applicable at the site.

Removal/Disposal - Because contaminants exceed PRG, this alternative may be applicable.

In Situ Treatment - Since contaminants exceed PRG, and the contaminated lens is <5.8 m (19 ft), the in situ treatment option may be applicable.

Removal/Treatment/Disposal - Because contaminants exceed PRG, this alternative may be applicable. Thermal desorption enhancement is not necessary since organic contaminants are not present at the site. For cost purposes, it was assumed that the percentage of contaminated soil that can be effectively treated by soil washing is 33%, this percentage was based on the depth, distribution, and concentration of contaminants at the waste site. This does not affect the application of the alternative but does impact the magnitude of volume reduction realized at the site.

This evaluation results in the identification of those alternatives which are applicable. These results are compared to the results of the group analysis presented in Table 5-1 of the Process Document to identify deviations.

	116-H-7 Alternatives	Group Alternatives
Applicable	Removal/Disposal In Situ Treatment Removal/Treatment/Disposal - no enhancements	Removal/Disposal Removal/Treatment/Disposal - no enhancements
Not Applicable	No Interim Action Institutional Controls Containment	No Interim Action Institutional Controls Containment In Situ Treatment

The alternatives for 116-H-7 are not the same as those for the retention basin group, therefore deviations are identified and the site does not completely plug into the analyses for the group. The deviation is with respect to the in situ treatment alternative. Contrary to the retention basin group, 116-H-7 has a lens of contamination that is <5.8 m (19 ft), therefore in situ vitrification may be applicable at the site.

Table 3-1 Comparison of Waste Sites to Remedial Alternatives (page 1 of 2)

Waste Site Group		116-H-7 Retention Basin	116-H-1 Process Effluent Trench	PIPELINES Pipeline	116-H-4 Pluto Crib	132-H-1 132-H-2 132-H-3 Decontamination and Decommissioning
Alternative	**Applicability Criteria and Enhancements**	**Are Applicability Criteria and Enhancements Met?**				
No Interim Action						
SS-1 SW-2	Criterion: • Has site been effectively addressed in the past	No	No	No	Yes (d)	Yes
Institutional Controls						
SS-2 SW-2	Criterion: • Contaminants < PRG	No	No	No	NA	NA
Containment						
SS-3 SW-3	Criteria: • Contaminants > PRG	Yes	Yes	Yes	NA	NA
	• Contaminants < reduced infiltration concentrations	No	No	Yes	NA	NA
Removal/Disposal						
SS-4 SW-4	Criterion: • Contaminants > PRG	Yes	Yes	Yes	NA	NA
In Situ Treatment						
SS-8A	Criteria: • Contaminants > PRG	Yes	Yes	NA	NA	NA
	• Contamination < 5.8 m in depth	Yes(d)	No(d)	NA	NA	NA
SS-8B	Criteria: • Contaminants > PRG	NA	NA	Yes	NA	NA
	• Contaminants < reduced infiltration concentrations	NA	NA	Yes	NA	NA
SW-7	Criteria: • Contaminants > PRG	NA	NA	NA	NA	NA
	• Contaminants < reduced infiltration concentrations	NA	NA	NA	NA	NA

Table 3-1 Comparison of Waste Sites to Remedial Alternatives (page 2 of 2)

Waste Site **Group**		**116-H-7** **Retention Basin**	**116-H-1** **Process Effluent Trench**	**PIPELINES** **Pipeline**	**116-H-4** **Pluto Crib**	**132-H-1** **132-H-2** **132-H-3** **Decontamination and Decommissioning**
Alternative	**Applicability Criteria and Enhancements**	**Are Applicability Criteria and Enhancements Met?**				
Removal/Treatment/Disposal						
SS-10	Criterion: • Contaminants > PRG	Yes	Yes	NA(d)	NA	NA
	Enhancements: • Organic contaminants (if yes, thermal desorption must be included in the treatment system)	No	Yes(d)	NA(d)	NA	NA
	• Percentage of contaminated volume less than twice the PRG for cesium-137.	33%	33%	NA(d)	NA	NA
SW-9	Criterion: • Contaminants > PRG	NA	NA	NA	NA	NA
	Enhancement: • Organic contaminants	NA	NA	NA	NA	NA

NA - not applicable
(d) - deviation from waste site group
PRG - Preliminary Remediation Goals

4.0 ALTERNATIVE DEVELOPMENT

In accordance with step 6 (see Section 1.1) of the plug-in approach, the degree to which an individual site plugs into the analyses presented in the Process Document is dependent on its compatibilities with the applicable group profiles. Deviations from the group profiles are addressed by alternative enhancement or site-specific alternative development.

Alternatives do not require further development if the site plugs directly into the group's alternatives (step 6a). The alternatives are originally developed in Section 4.0 of the Process Document (DOE-RL 1994a). The sites which meet this requirement include 132-H-1, 132-H-2, and 132-H-3.

The sites which do not plug in directly (step 6b) can be divided into two sets. The first set contains those sites which require enhancements to an alternative or an inclusion or dismissal of an alternative as originally proposed for a group. Alternatives for sites included in this first set do not have to be developed because the appropriate enhancements have already been developed in the Process Document (DOE-RL 1994a). The sites which meet this requirement, and the applicable deviation, are discussed below:

- 116-H-4 does not meet the applicability criteria for the pluto crib group alternatives identified in the Process document. Because this site was excavated and material buried in 118-H-5 (D&D) contamination is assumed to no longer exist at the site, thus it meets the applicability criteria for the no interim action alternative. Accordingly, this site deviates from the group due to a change in the applicable alternatives.

- 116-H-1 requires thermal desorption as an enhancement option (due to the presence of organic contamination) to the removal/treatment/disposal alternative. Additional development of the technology and alternative are not required since the Process Document discusses thermal desorption as a treatment enhancement. 116-H-1 does not meet the applicability criteria for in situ vitrification (unlike the process effluent trench group).

- 116-H-7 does meet the applicability criteria for the in situ treatment alternative due to its relatively shallow depth of contamination, thus deviates from the retention basin group. However, this deviation does not require additional development of technologies or alternatives.

- Pipelines in the 100-HR-1 Operable Unit have no identified contaminated soils associated with them, therefore, the removal/treatment/disposal alternative does not apply. This is a deviation from the group, however does not require additional development of technologies or alternatives.

The second set of sites, which do not plug in, are those sites which require a significant modification to an alternative such as changes in the excavation process or disposal options. Alternatives for sites included in this second set will require additional development. None of the sites within the 100-HR-1 Operable Unit fit into this second set, therefore, additional alternative development is not required.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

This section presents the detailed analysis of the alternatives applicable to the individual waste sites within the 100-HR-1 Operable Unit. In the detailed analysis, each alternative is assessed against the evaluation criteria described in Section 5.1. The purpose of the detailed analysis is to provide a basis for the comparison of the alternatives and support a subsequent evaluation of the alternatives made by the decision makers in the remedy selection process.

The detailed analysis for the sites within the 100-HR-1 Operable Unit are presented in the following manner:

- The detailed analyses for those individual waste sites which do not deviate from the waste site groups are referenced to the group discussion presented in the Process Document (DOE-RL 1994a).
- The detailed analyses for those individual waste sites which deviate from the waste site groups are discussed in Section 5.2.

5.1 EVALUATION CRITERIA DESCRIPTION

Nine evaluation criteria have been developed by the EPA to address the statutory requirements and the additional technical and policy considerations proven to be important for selection of remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analysis during the FFS and for subsequently selecting an appropriate remedial action. An overview of the criteria is described as follows:

1. Overall Protection of Human Health and the Environment:

   This evaluation criterion assesses the alternatives with regard to the level of elimination, reduction, or control of risks for human health and the environment from refined COPC.

2. Compliance with ARAR:

   This criterion evaluates whether the sites comply with chemical-specific, location-specific, and action-specific ARAR.

3. Long-Term Effectiveness and Permanence:

   This criterion considers the magnitude of residual risk and adequacy and reliability of controls after remedial action objectives have been achieved.

4. Reduction of Toxicity, Mobility, or Volume:

This criterion focuses on the alternatives ability to address the principle threats at a site by destruction, or reduction of mass, volume, and mobility of contaminants.

5. Short-Term Effectiveness:

This criterion evaluates the time until protection is achieved, the health and safety of the community and workers during remedial actions, and environmental impacts of remedial actions.

Human health short-term impact are closely related to exposure duration, specifically, the amount of time a person may be exposed to hazards associated with the waste itself or the removal of the waste. The greater the exposure duration, the greater the potential risk. Ecological impacts are based primarily on the physical disturbance of habitat. Risks may also be associated with the potential disturbance of sensitive species such as the bald eagles which roost adjacent to the reactor areas.

The evaluation of short term risks can range from qualitative to quantitative (DOE-RL 1994c). A qualitative assessment of short term risk is appropriate considering that the risk associated with contamination at the waste sites was evaluated in a QRA. Furthermore, the sites evaluated in this FFS are high-priority waste sites that have been identified as warranting action on the near-term. The qualitative evaluation allows a sufficient differentiation between alternatives relative to short-term risks, therefore not requiring quantification. A qualitative estimation of short term risk is given below for both human and ecological receptors.

Remedial Alternative	Qualitative Short-Term Risk	
	Human	Ecological
Institutional Controls	low	low
Containment	low-medium	medium
In Situ Treatment	low-medium	medium
Removal/Treatment/Disposal	high	medium
Removal/Disposal	medium	medium

6. Implementability:

This criterion evaluates the alternatives with respect to technical feasibility, administrative feasibility, and availability of services and materials.

7. Cost:

   A detailed cost analysis of the alternatives is performed and involves estimating the expenditures required to complete each remedial alternative in terms of capital and operation and maintenance costs. Once these values have been identified and a present worth calculated for each alternative. An example of a present worth calculations can be found in Appendix B.

8. Regulatory Acceptance:

   This assessment evaluates the technical and administrative issues and concerns the state may have regarding each of the alternatives.

9. Community Acceptance:

   This assessment evaluates the technical and administrative issues and concerns the public may have regarding each of the alternatives.

5.2 SITE-SPECIFIC DETAILED ANALYSIS

Based on the comparison presented in Table 3-1, several of the individual waste sites within the 100-HR-1 Operable Unit plug into the waste site group alternatives, therefore, the detailed analysis for these individual waste sites can be referenced to the Process Document (DOE-RL 1994a). These individual waste sites include 132-H-1, 132-H-2, and 132-H-3.

The detailed analysis for the remaining waste sites (116-H-7, 116-H-1, 116-H-4, and 100-H pipelines) are discussed in the following sections. Table 5-1 summarizes the remedial alternatives applicable to each waste site and whether the detailed analysis is covered in the Process Document or discussed in this document. Tables 5-2 and 5-3 present the remediation costs and durations associated with all waste sites.

5.2.1 116-H-7 Retention Basin

This section evaluates the alternatives that deviate from the Process Document for the 116-H-7 retention basin site against the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) evaluation criteria. Alternatives SS-4, SS-8A, and SS-10 are applicable to this site. However, only Alternative SS-8A deviates from the Process Document, and therefore, will be evaluated.

5.2.1.1 Overall Protection of Human Health and the Environment. Alternative SS-8A involves in situ vitrification to thermally treat organic contaminants and immobilize inorganic contaminants applicable to the 116-H-7 retention basin. Alternative SS-8A will eliminate the human health and ecological pathways in approximately 8.1 years. Workers will not be exposed to contaminants during implementation.

5.2.1.2 Compliance with ARAR. Chemical-specific ARAR for Alternative SS-8A will be met by thermal destruction and encapsulation of contaminants in the soil. Location-specific ARAR can be met through proper planning and scheduling. Action-specific ARAR are met through appropriate design and operation.

5.2.1.3 Long-term Effectiveness and Permanence. The magnitude of the remaining risk for Alternative SS-8A is expected to be minimal due to the anticipated characteristics of the vitrified material and the soil cover. Sources of risk remain, however, in situ vitrification will eliminate all exposure pathways. Long-term management in the form of institutional controls and groundwater surveillance monitoring is required. Also, maintenance of the soil cover overlying the vitrified material may be needed.

5.2.1.4 Reduction of Toxicity, Mobility, or Volume. In situ vitrification is an irreversible process that will treat all of the contaminated soil to the maximum melt depth, effectively immobilizing the contaminants in the glass melt. Hydraulic infiltration is temporarily reduced and mobilization is eliminated. There will be minimal quantities of residuals from offgas treatment as condensate and contaminated filters. However, these can be disposed of directly into the melt. The principal exposure pathways at the site are eliminated.

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5.2.1.5 Short-Term Effectiveness. Risks to the community and workers during in situ vitrification include potential releases of fugitive dusts and gases. These releases can be controlled through proper operating procedures. No receptors are currently in the area. However, remedial activities can be scheduled to accommodate nesting or roosting species if encountered. All RAO are met upon completion of remedial alternative.

5.2.1.6 Implementability. Some difficulties are associated with the implementation of in situ vitrification. Some investigation may be required in order to locate the area proposed for treatment. In addition, soil particle sizes may vary from site to site. Existence of cobble layers and structural members may affect performance. It is very unlikely that technical problems will lead to schedule delays. All necessary equipment and specialists are readily available. Long-term deed restrictions may require coordination with state groundwater agencies and with local zoning authorities.

5.2.2 116-H-1 Process Effluent Trench

This section evaluates the alternatives that deviate from the Process Document for the 116-H-1 process effluent trench site against the CERCLA evaluation criteria. Alternatives SS-4 and SS-10 are applicable to this site. However, only Alternative SS-10 deviates from the Process Document, and therefore, will be evaluated.

5.2.2.1 Overall Protection of Human Health and the Environment. Alternative SS-8A is applicable to the process effluent trench group, but was eliminated for 116-H-1 in the evaluation of the alternative applicability criteria in Section 3.2.

Based on the presence of organics, Alternative SS-10 requires that thermal desorption be included for this waste site. The removal/treatment/disposal technologies associated with

Alternative SS-10 will result in protectiveness of human health and the environment regardless of the additional treatment by thermal desorption. Any additional short-term risk to the workers or the community can be minimized through engineering controls and proper health and safety protocol.

5.2.2.2 Compliance with ARAR. Chemical-specific ARAR for Alternative SS-10 will be met by desorption of organic compounds from the soil. Location-specific ARAR can be met through proper planning and scheduling. Action-specific ARAR are met through appropriate design and operation.

5.2.2.3 Long-term Effectiveness and Permanence. The addition of thermal desorption to Alternative SS-10 does not change the analysis of this alternative with respect to this criterion from the Process Document. Contaminated soil exceeding PRG will be permanently removed from the site.

5.2.2.4 Reduction of Toxicity, Mobility, or Volume. Thermal desorption is primarily an irreversible process in which nearly all of the volatile and semivolatile constituents will be reduced. Any of the remaining volatile and semivolatile organic contaminants will be rendered immobile. Thermal desorption may completely reduce the volume of soil, producing minimal amounts of residuals that will be transferred to a disposal facility.

5.2.2.5 Short-Term Effectiveness. Risks to the community and workers during thermal desorption include potential releases of fugitive gases. These releases can be controlled through vapor abatement and proper operating procedures. No receptors are currently in the area. However, remedial activities can be scheduled to accommodate nesting or roosting species if encountered. All RAO are met upon completion of remedial alternative.

5.2.2.6 Implementability. No difficulties are anticipated with the implementation of thermal desorption despite the absence of site-specific treatability study data. An influent soil particle size limitation of 2-in. exists. It is very unlikely that technical problems will lead to schedule delays. All necessary equipment and specialists are readily available and adjustments to Alternative SS-10 are easily accomplished as thermal desorption will be an off-line process. Due to removal, post closure monitoring will not be required.

5.2.3 116-H-4 Pluto Crib

This section evaluates the alternatives that deviate from the Process Document for the 116-H-4 pluto crib sites against the CERCLA evaluation criteria. Due to the elimination of contamination (through previous excavation and removal) only Alternative SS-1 applies, and therefore, will be evaluated.

5.2.3.1 Overall Protection of Human Health and the Environment. With the elimination of contamination by a previous action at the site, no interim action is warranted to be protective of human health and the environment. No further analysis is required.

5.2.3.2 Compliance with ARAR. The site has been previously addressed, therefore meets chemical-specific ARAR by the elimination of contamination. Location-specific and action-specific ARAR do not apply.

5.2.4 Pipelines

This section evaluates the 100-HR-1 pipeline sites against the CERCLA evaluation criteria. The removal/treatment/disposal alternative (SS-10) is applicable to sites which have contaminated soil. Current documentation indicates that the soil surrounding the 100-HR-1 pipelines is not contaminated (Dorian and Richards 1978). Therefore, the soil surrounding the pipelines will not require remedial action. Because the deviation for this site is just an omission of an alternative, no evaluation is required.

Table 5-1 Waste Site Remedia[l] Alternatives and Technologies

Alternatives		Technologies Included	Waste Site Group				
			116-H-7	116-H-1	Pipelines	116-H-4	132-H-1 132-H-2 132-H-3
No Action	SS-1 SW-1	None				O	P
Institutional Controls	SS-2 SW-2	Deed Restrictions					
		Groundwater Monitoring					
Containment	SS-3 SW-3	Surface Water Controls			P		
		Modified RCRA Barrier			P		
		Deed Restrictions			P		
		Groundwater Monitoring			P		
Removal, Disposal	SS-4 SW-4	Removal	P	P	P		
		Disposal	P	P	P		
In Situ Treatment	SS-8A	Surface Water Controls	O				
		In Situ Vitrification	O				
		Groundwater monitoring	O				
		Deed restrictions	O				
	SS-8B	Void Grouting			P		
		Modified RCRA Barrier			P		
		Surface Water Controls			P		
		Deed Restrictions			P		
		Groundwater Monitoring			P		
	SW-7	Dynamic Compaction					
		Modified RCRA Barrier					
		Surface Water Controls					
		Groundwater Monitoring					
		Deed Restrictions					
Removal, Treatment, Disposal	SS-10	Removal	P	P			
		Thermal Desorption		P,O			
		Soil Washing	P	P			
		Disposal	P	P			
	SW-9	Removal					
		Thermal Desorption					
		Compaction					
		ERDF Disposal					

Note:
P - Indicates the detailed analysis which is provided in the Process Document
O - Indicates the detailed analysis which is provided in the operable unit-specific report
blank - Technology does not apply to this Waste Site
RCRA - Resource Conservation and Recovery Act
ERDF - Environmental Restoration Disposal Facility

Table 5-2 100-HR-1 Site-Specific Alternative Costs

Site	Containment			Removal/Disposal			In Situ Treatment			Removal/Treatment/Disposal		
	Capital	O&M	Present Worth	Capital	O&M	Present Worth	Capital	O&M	Present Worth	Capital	O&M	Present Worth
100-HR-1 OPERABLE UNIT												
116-H-7				$2.94E+07	$0.00E+00	$2.80E+07	$6.69E+07	$5.49E+07	$9.80E+07	$3.19E+07	$4.05E+06	$3.42E+07
116-H-1				$6.08E+06	$0.00E+00	$5.79E+06				$6.53E+06	$8.25E+05	$7.02E+06
116-H-4	No interim action proposed at site											
100 H PIPELINES	$9.76E+06	$4.64E+06	$1.19E+07	$2.27E+06	$0.00E+00	$2.16E+06	$9.42E+05	$0.00E+00	$8.98E+05			
132-H-1	No interim action proposed at site											
132-H-2	No interim action proposed at site											
132-H-3	No interim action proposed at site											

Blank Cell = Not Applicable

Table 5-3 100-HR-1 Site-Specific Alternative Durations

Site	Containment Duration (yrs)	Removal/Disposal Duration (yrs)	In Situ Treatment Duration (yrs)	Removal/Treatment/Disposal Duration (yrs)
100-HR-1 OPERABLE UNIT				
116-H-7		0.5	8.1	1.0
116-H-1		0.2		0.2
116-H-4	No interim action proposed at site			
100 H PIPELINES	0.5	0.3	0.1	
132-H-1	No interim action proposed at site			
132-H-2	No interim action proposed at site			
132-H-3	No interim action proposed at site			

Blank Cell = Not Applicable

6.0 COMPARATIVE ANALYSIS

This section presents the comparative analysis of remedial alternatives which involves evaluation of the relative performance of each alternative with respect to the evaluation criteria presented in Section 5.0. The purpose of this comparison is to identify the advantages and disadvantages of each alternative so that key tradeoffs can be identified.

Following the methodology of the Process Document (DOE-RL 1994a), the comparative analysis of the 100-HR-1 alternatives is presented in tabular format (Tables 6-1 through 6-3). The tables present the alternatives applicable to each waste site and a comparison of the relative differences between each alternative. The comparison consists of identifying the relative rank of the alternative (relative to other applicable alternatives) along with the cost[1], and a discussion of its specific advantages and disadvantages. To determine which alternative ranks highest overall for a waste site, the reader must determine what criteria are most important, then consult the appropriate table to see which alternatives rank highest in those criteria. Table 6-4 presents a summary of the comparative analysis of the applicable alternatives for each waste site.

No interim action is identified as the only applicable alternative for the 116-H-4 pluto crib (see Section 5.0 of this document and the Process Document). Because there are no other alternatives to compare against, the site is not included in the comparative analysis. Likewise, the Process Document identifies no interim action for the D&D groups. Thus, these sites (132-H-1, 132-H-1, and 132-H-3) are not presented in the following tables.

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[1] Estimates of durations for each alternative are presented in Section 5.0, Table 5-2.

Table 6-1 Comparative Analysis - 116-H-7 Retention Basin
(page 1 of 2)

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COMPARATIVE EVALUATION CRITERIA	REMOVAL/DISPOSAL SS-4	IN SITU TREATMENT SS-8A	REMOVAL/TREATMENT/DISPOSAL SS-10
Overall Protection of Human Health and the Environment	Nearly as effective as SS-10 but more effective than SS-8A. Potential risk is eliminated by removal of the source. Contaminated material exceeding PRG is excavated and transported to a common disposal facility (i.e., W-025 or ERDF).	Less effective than SS-4 and SS-10. Potential exposure risk pathways are reduced by immobilization of the contaminated material through encapsulation (i.e., vitrification). However, the encapsulated material remains at the waste site.	More effective than SS-4 and SS-8A since any potential risk is eliminated by removal and treatment of the source. Contaminated material, exceeding PRG, is excavated, treated, and transported to a common disposal facility (i.e., W-025 or ERDF).
Compliance with ARAR	SS-4, SS-8A, and SS-10 comply with all chemical-, location-, and action-specific ARAR.		
Long-Term Effectiveness and Permanence	More effective than SS-8A and equally effective as SS-10 in achieving RAO. Contaminated material exceeding PRG is removed and disposed thereby eliminating the potential source at the waste site.	Nearly as effective as SS-4 and SS-10. Remedial action objectives are achieved; however, contaminated material exceeding PRG is vitrified and remains at the waste site. Long-term O&M requirements consist of: maintenance of soil cover, deed restrictions, operation and maintenance of the vitrification system, and groundwater surveillance monitoring.	More effective than SS-8A and equally effective as SS-4 in achieving RAO. Contaminated material, exceeding PRG, is removed and ultimately disposed of thereby eliminating the potential source at the waste site.
Reduction of Toxicity, Mobility, or Volume	Less effective than SS-8A and SS-10. All contaminated material, exceeding PRG, is removed and transported to a common disposal facility. No treatment is proposed, therefore, no reduction of mobility, toxicity, or volume is achieved. Radionuclides present in the contaminated material will naturally degrade.	More effective than SS-4 and SS-10. Contaminants, exceeding PRG, are effectively immobilized and principle exposure pathways are eliminated through in situ treatment (i.e., vitrification). Hydraulic infiltration and contaminant mobilization are eliminated. Radionuclides present in the contaminated material will naturally degrade.	Nearly as effective as SS-8A but more effective than SS-4. All contaminated material, exceeding PRG, is removed, treated, and transported to a common disposal facility. Treatment (i.e., soil washing) is proposed, therefore, the mass of contaminants present will be reduced (by approximately 49%). Radionuclides present in the contaminated material will naturally degrade.
Short-Term Effectiveness	Nearly as effective as SS-8A but more effective than SS-10. Remedial action objectives are achieved within approximately 0.5 years. Potential sources of risk are removed through excavation and disposal of contaminated materials exceeding PRG. Potential exists for worker exposure to contaminants during excavation.	More effective than SS-4 and SS-10. Remedial action objectives are achieved within approximately 8.1 years. Potential sources of risk remain at the waste site; however, treatment immobilizes the contaminants and eliminates exposure pathways. Slight potential exists for worker exposure to contaminant offgas during treatment.	Less effective than SS-4 and SS-8A. Remedial action objectives are achieved within approximately 1.0 years. Potential sources of risk are removed through excavation and the ultimate disposal of contaminated materials exceeding PRG. Potential exists for worker exposure to contaminants during excavation and treatment.

Table 6-1 Comparative Analysis - 116-H-7 Retention Basi
(page 2 of 2)

COMPARATIVE EVALUATION CRITERIA	REMOVAL/DISPOSAL SS-4	IN SITU TREATMENT SS-8A	REMOVAL/TREATMENT/DISPOSAL SS-10
Implementability	SS-4 offers a higher level of implementability compared to SS-8A and SS-10 since excavation is well demonstrated and no treatment is proposed.	SS-8A is less implementable compared to SS-4 and SS-10 since it is an innovative technology provided by one exclusive vendor. Site-specific parameters such as location and subsurface geology must be adequately defined prior to implementation of the in situ treatment. In situ vitrification is has been proven to be effective to a maximum depth of 5.8 meters.	SS-10 offers a higher level of implementability compared to SS-8A but is less implementable than SS-4. Excavation is well demonstrated; however, a study is necessary to examine the effectiveness of the implementability of soil washing at the field scale.
Present Worth*	$28,000,000	$9,800,000	$34,200,000

* 5% discount rate
ARAR - applicable or relevant and appropriate requirement
O&M - operation and maintenance
PRG - preliminary remediation goal
RAO - remedial action objectives
ERDF - Environmental Restoration Disposal Facility
W-025 - Radioactive Mixed Waste Disposal Facility

Table 6-2 Comparative Analysis - 116-H-1 Process Effluent Trenche

COMPARATIVE EVALUATION CRITERIA	REMOVAL/DISPOSAL SS-4	REMOVAL/TREATMENT/DISPOSAL SS-10
Overall Protection of Human Health and the Environment	Nearly as effective as SS-10. Potential risk is eliminated by removal of the source. Contaminated material, exceeding PRG, is excavated and transported to a common disposal facility (i.e., W-025 or ERDF).	More effective than SS-4 since any potential risk is eliminated by removal and treatment of the source. Contaminated material, exceeding PRG, is excavated, treated, and transported to a common disposal facility (i.e., W-025 or ERDF).
Compliance with ARAR	SS-4 and SS-10 comply with all chemical-, location-, and action-specific ARAR.	
Long-Term Effectiveness and Permanence	Equally effective as SS-10 in achieving RAO. Contaminated material, exceeding PRG, is removed and disposed thereby eliminating the potential source at the waste site.	Equally effective as SS-4 in achieving RAO. Contaminated material, exceeding PRG, is removed and ultimately disposed of thereby eliminating the potential source at the waste site.
Reduction of Toxicity, Mobility, or Volume	Less effective SS-10. All contaminated material, exceeding PRG, is removed and transported to a common disposal facility. No treatment is proposed, therefore, no reduction of mobility, toxicity, or volume is achieved. Radionuclides present in the contaminated material will naturally degrade.	More effective than SS-4. All contaminated material, exceeding PRG, is removed, treated, and transported to a common disposal facility. Treatment (i.e., soil washing and thermal desorption) is proposed, therefore, the mass of contaminants present will be reduced (by approximately 23%). Radionuclides present in the contaminated material will naturally degrade.
Short-Term Effectiveness	More effective than SS-10. Remedial action objectives are achieved within approximately 0.2 years. Potential sources of risk are removed through excavation and disposal of contaminated materials exceeding PRG. Potential exists for worker exposure to contaminants during excavation.	Less effective than SS-4. Remedial action objectives are achieved within approximately 0.2 years. Potential sources of risk are removed through excavation and the ultimate disposal of contaminated materials exceeding PRG. Potential exists for worker exposure to contaminants during excavation and treatment.
Implementability	SS-4 offers a higher level of implementability compared to SS-10 since excavation is well demonstrated and no treatment is proposed.	SS-10 is less implementable than SS-4. Excavation is well demonstrated; however, a study is necessary to examine the effectiveness of the implementability of soil washing at the field scale.
Present Worth*	$5,790,000	$7,020,000

* 5% discount rate
ARAR - applicable or relevant and appropriate requirement
O&M - operation and maintenance
PRG - preliminary remediation goal
RAO - remedial action objectives
ERDF - Environmental Restoration Disposal Facility
W-025 - Radioactive Mixed Waste Disposal Facility

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Table 6-3 Comparative Analysis - 100 H Pipelines

COMPARATIVE EVALUATION CRITERIA	CONTAINMENT SS-3	REMOVAL/DISPOSAL SS-4	IN SITU TREATMENT SS-8B
Overall Protection of Human Health and the Environment	Less effective than SS-4 and SS-8B. Potential exposure risk pathways are reduced/eliminated by installation of a engineered barrier over the pipeline and associated contaminated material. However, the pipeline and contaminated material remains at the waste site.	More effective than SS-3 and SS-8B. Potential risk is eliminated by removal of the pipeline and associated contaminated material. The pipeline is excavated, and along with any contaminated material is parted to a common disposal facility (i.e., W-025 or ERDF).	More effective than SS-3 but less effective than SS-4. Potential exposure risk pathways are reduced by immobilization of the contaminated material through encapsulation (i.e., grouting the pipeline), and installation of an engineered barrier over the pipeline and associated contaminated material. However, the pipeline and contaminated material remain at the waste site.
Compliance with ARAR	SS-3, SS-4, and SS-8B comply with all chemical-, location-, and action-specific ARAR.		
Long-Term Effectiveness and Permanence	Less effective than SS-4 and SS-8B. Remedial action objectives are achieved; however, contaminated material and the pipeline remain at the waste site. Long-term O&M requirements consist of: repair and maintenance of the engineered barrier, deed restrictions, and groundwater surveillance monitoring.	More effective than SS-3 and SS-8B in achieving RAO. The pipeline and associated contaminated material is removed and disposed thereby eliminating the potential source at the waste site.	Nearly as effective as SS-4 but more effective than SS-3. Remedial action objectives are achieved. Contaminated material (i.e., sludge) will be stabilized through grouting the pipeline. Additionally, an engineered barrier will be installed over the pipeline and the associated contaminated material. The contaminated materials; however, remain at the waste site. Long-term O&M requirements consist of: maintenance of the engineered barrier, deed restrictions, and groundwater surveillance monitoring.
Reduction of Toxicity, Mobility, or Volume	Less effective than SS-4 and SS-8B. All contaminated material, remains at the waste site. No treatment is proposed, therefore, no reduction of mobility, toxicity, or volume is achieved. Contaminants are effectively immobilized by the engineered barrier through reduction in hydraulic infiltration. Radionuclides present in the contaminated material will naturally degrade.	Less effective than SS-8B but more effective than SS-3. All contaminated material is removed and transported to a common disposal facility. No treatment is proposed, therefore, no reduction of mobility, toxicity, or volume is achieved. Radionuclides present in the contaminated material will naturally degrade.	More effective than SS-3 and SS-4. Contaminants are effectively immobilized and principle exposure pathways are eliminated through in situ treatment (i.e., grouting). Principle exposure pathways are also eliminated through installation of an engineered barrier. Hydraulic infiltration and contaminant mobilization are eliminated. Radionuclides present in the contaminated material will naturally degrade.
Short-Term Effectiveness	More effective than SS-4 and SS-8B. Remedial action objectives are achieved within approximately 0.5 years. Potential sources of risk remain at the waste site; however, installation of an engineered barrier effectively immobilizes the contaminants and eliminates exposure pathways.	Nearly as effective as SS-8B and less effective than SS-3. Remedial action objectives are achieved within approximately 0.3 years. Potential sources of risk are removed through excavation and disposal of contaminated materials. Potential exists for worker exposure to contaminants during excavation.	More effective than SS-4 but not as effective as SS-3. Remedial action objectives are achieved within approximately 0.1 years. Potential sources of risk remain at the waste site; however, grouting of the pipeline immobilizes the contaminants and installation of an engineered barrier eliminates exposure pathways.
Implementability	SS-3 is more implementable than SS-4 and SS-8B since no intrusive activities are proposed. Installation of an engineered barrier is well demonstrated.	SS-4 offers a higher level of implementability compared to SS-8B but is less implementable compared to SS-3. Excavation is well demonstrated and no treatment is proposed.	SS-8B is less implementable compared to SS-3 and SS-4 since it is an innovative technology provided by one exclusive vendor. Extent of contamination needs to be adequately defined prior to implementation of the remedial action. Location of existing buildings and waste sites needs to be considered.
Present Worth*	$11,900,000	$2,160,000	$898,000

* 5% discount rate
O&M - operation and maintenance
RAO - remedial action objectives
W-025 - Radioactive Mixed Waste Disposal Facility
ARAR - applicable or relevant and appropriate requirement
PRG - preliminary remediation goal
ERDF - Environmental Restoration Disposal Facility

Table 6-4 Comparative Analysis Summary[1]

CERCLA Comparative Evaluation Criteria — Waste Sites (Table Reference)	116-H-7 Retention Basin (Table 6-1)			116-H-1 Process Effluent Trenches (Table 6-2)		100-H Pipelines (Table 6-3)		
Alternatives[2]	SS-4	SS-8A	SS-10	SS-4	SS-10	SS-3	SS-4	SS-8B
Overall Protection of Human Health and Environment	Better	Good	Best	Better	Best	Good	Best	Better
Compliance with ARAR[3]	Best	Best	Best	Best	Best	Best	Best	Best
Long-Term Effectiveness and Permanence	Best	Better	Best	Best	Best	Good	Best	Better
Reduction of Toxicity, Mobility, and Volume	Fair	Best	Good	Fair	Better	Good	Better	Best
Short-Term Effectiveness	Better	Best	Good	Better	Good	Best	Good	Better
Implementability	Best	Good	Better	Best	Better	Best	Better	Good
Present Worth[4] (millions $)	28.0	98.0	34.2	5.8	7.0	11.9	2.2	0.9

Notes:

1. Comparative Analysis Summary is based on Tables 6-1 through 6-3. Comparisons are made between relevant alternatives for each individual waste site group only.
2. Alternatives are summarized from Table 5-1.
   - SS-3 Containment
   - SS-4 Removal & Disposal
   - SS-8A In Situ Treatment of Soils
   - SS-8B In Situ Treatment of Pipelines
   - SS-10 Removal, Treatment & Disposal of Soil
3. ARAR - applicable or relevant and appropriate requirement
4. Cost is present worth at 5% discount rate.

Key:
- Best
- Better
- Good
- Fair
- Poor

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7.0 REFERENCES

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APPENDIX A

WASTE SITE VOLUME ESTIMATES

Volume Estimate
100-HR-1 Operable Unit

OBJECTIVE:

Provide estimates of:

- The volume of contaminated materials within selected waste sites in the 100-HR-1 Operable Unit.
- The volume of materials which will need to be excavated to remove the contaminated materials.
- The areal extent of contamination.

Estimates are provided for the following waste sites:

Site Number	Site Name	Page
116-H-1	107-H Liquid Waste Disposal Trench	A-7
116-H-4	105-H Pluto Crib	A-9
116-H-7	107-H Retention Basin	A-10
132-H-1	Reactor Exhaust Stack	A-12
132-H-2	117-H Filter Building	A-13
132-H-3	1608-H Wastewater Pumping Station	A-14
Pipelines	107-H Process Pipelines	A-15

Volume Estimate
100-HR-1 Operable Unit

METHOD:

The following steps are used to calculate volumes and areas for each waste site:

- Estimate the dimensions of each waste site.
- Estimate the location of the site.
- Estimate the extent of contamination present at each site.
- Estimate the extent of the excavation necessary to remove the contamination present.
- Calculate the volume of contamination present, the volume of material to be removed, and the areal extent of contamination.

Waste Site Dimensions -
Dimensions of the waste site are derived from all pertinent references. The reference used is noted in brackets [].

Waste Site Location -
Location of the waste site is derived from pertinent references, confirmed by field visit. The specific reference or method used to locate each site is discussed in a separate brief (see reference 9). Coordinates for each waste site are converted to Washington State coordinates (see reference 9). Resulting Washington State coordinates are presented herein.

Contaminated Volume Dimensions -
The extent of contamination present at the waste site is estimated from analytical data which exists for the site. The data used, assumptions made, and method for estimating extent is discussed in a separate brief (see reference 10). Dimensions are summarized herein.

Excavated Volume Dimensions -
The extent of the excavation necessary to remove the contamination is based on a 1.5 H : 1.0 V excavation slope with the extent of contamination at depth serving as the bottom of the excavation.

Volume and Area Calculations -
The above information is used to construct a digital terrain model of each site within the computer program AutoCad. The computer program DCA is then used to calculate volumes and areas for the waste site.

ASSUMPTIONS:

The following assumptions were used to locate and/or provide dimensions for a waste site if no other data exists. See reference 10 for assumptions concerning extent of contamination and reference 9 for assumptions concerning location of the waste site.

Volume Estimate
100-HR-1 Operable Unit

ASSUMPTIONS (continued):

Burial Grounds -
- Burial ground dimensions are 20 ft wide at the bottom, 20 ft deep, and have 1.0 H : 1.0 V side slopes.
- Five feet of additional cover was provided.
- Burial grounds were filled completely.

Liquid Waste Sites -
- Trenches were built with 1.0 H : 1.0 V side slopes.
- Tops of cribs are 6 ft below grade.

The following assumptions were used in calculating volumes and areas:
- No site interferences or overlaps are considered, volumes and areas are calculated for each waste site separately.

All depths are below grade unless noted.

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2. 100-H Area Technical Baseline Report.

3. Hanford Site Drawings and Plans (P-1220, P-1221, M-1904-H, Sheet 4).

4. Site topographic maps, Drawings.

5. Historical photographs of the 100-H Area (#9621, Box 16273).

6. Dorian, J.J., and V.R. Richards, "Radiological Characterization of the Retired 100 Areas", UNI-946, May 1978, United Nuclear Industries, Richland, Washington.

7. U.S. Department of Energy, Richland Operations Office (DOE-RL), 1993, "Limited Field Investigations Report for the 100-HR-1 Operable Unit. DOE/RL-93-51, Draft A, U.S. Department of Energy, Richland, Washington.

8. LFI Report for 100-HR-3 OU.

9. IT Corporation, 1994, "100-HR-1 Waste Site Locations", IT Corporation Calculation Brief, Project Number 199806.409.

10. IT Corporation, 1994, "100-HR-1 Waste Site Contaminated Extent", IT Corporation Calculation Brief, Project Number 199806.409.

Volume Estimate
100-HR-1 Operable Unit

REFERENCES (continued):

11. IT Corporation, 1994, "100-HR-1 Pipe Locations", IT Corporation Calculation Brief, Project Number 199806.409.

Volume Estimate
100-HR-1 Operable Unit

SITE NUMBER: 116-H-1
SITE NAME: 107-H Liquid Waste Disposal Trench

WASTE SITE DIMENSIONS:

Length - 106 ft (32.3 m) along bottom, 193 ft (58.8 m) at surface [5]
Width - 37 ft (11.2 m) along bottom, 110 ft (33.5 m) at surface [5]
Depth - 15 ft (4.6 m) [5]
Slopes - Varies
Orientation - North-South [5]

Waste site consists of three lobes that were oriented from north to south [2]. Second lobe bottom is 405 ft x 120 ft (123.4 m x 36.6 m), third lobe bottom is 377 ft x 120 ft (114.9 m x 36.6 m) [5]. Second and third lobes appear to be approximately 5 ft deep [5]. Waste site has been backfilled to the surface [1]. The second and third lobes have not been documented as being used, therefore are not considered in the contaminated volume.

CONTAMINATED VOLUME DIMENSIONS:

Trench was filled to graded with liquids, side slopes and substrate are contaminated from the surface to groundwater [10].

Length - 193 ft (58.8 m) [10]
Width - 110 ft (33.5 m) [10]
Depth - 20 ft (6.1 m) [10]

EXCAVATED VOLUME DIMENSIONS:

Base of excavation is 193 ft (58.8 m) long by 110 ft (33.5 m) wide at a depth of 20 ft (6.1 m).

Excavation Slopes - 1.5 H : 1.0 V

WASTE SITE LOCATION:

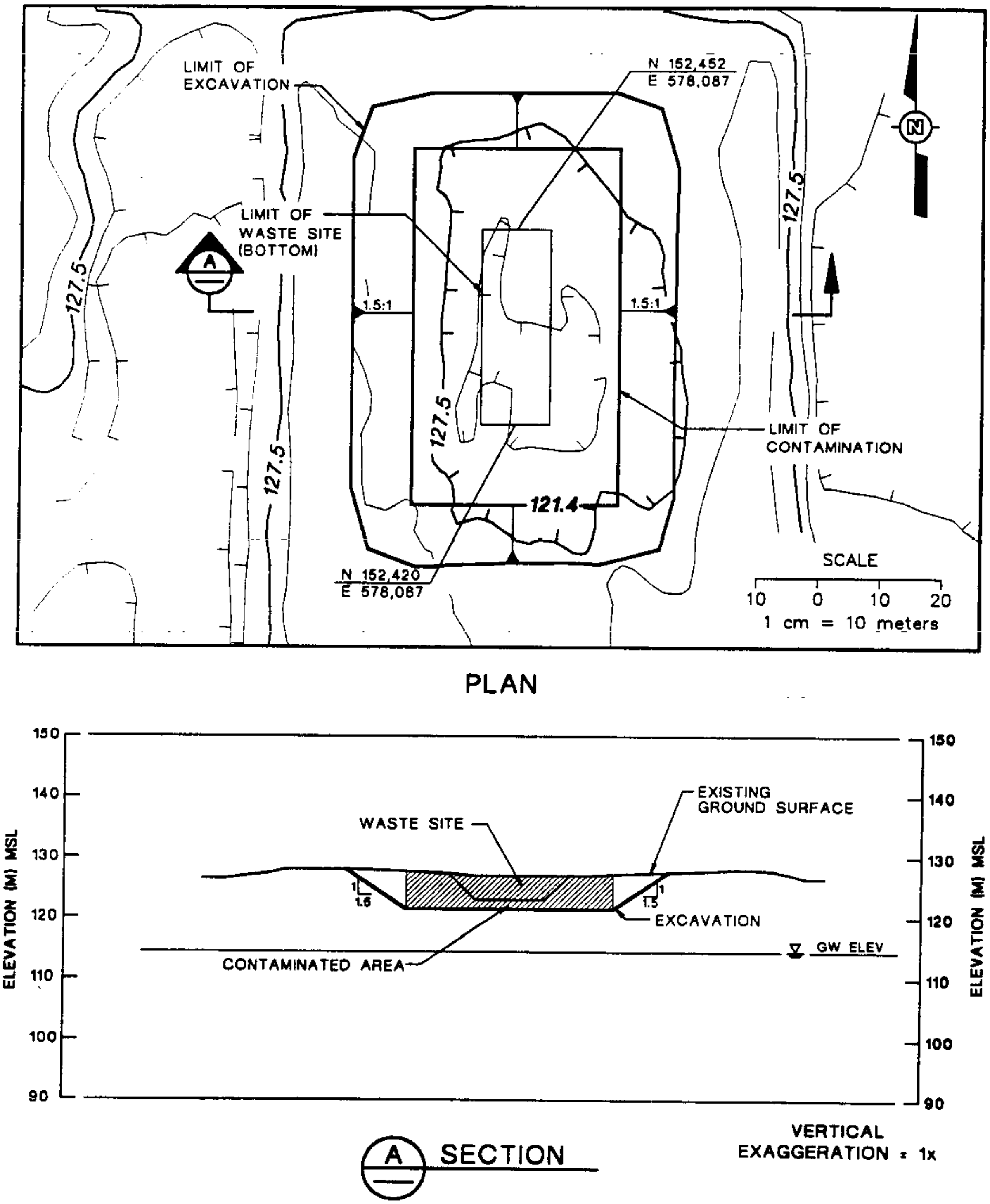
Northing: 152,452 [9]
Easting: 578,087 [9]
Center of N edge

Northing: 152,420 [9]
Easting: 578,087 [9]
Center of S edge

ELEVATIONS:

Surface: 418 ft (127.5 m) [6]
Groundwater: 376 ft (114.5 m) [8]

Figure A-1 IRM Site: 116-H-1



EXTENT OF CONTAMINATION

SURFACE AREA = 1,970 sq. meters
VOLUME = 12,015 cu. meters

EXTENT OF EXCAVATION

SURFACE AREA = 3,951 sq. meters
VOLUME = 17,142 cu. meters

116H1

Volume Estimate
100-HR-1 Operable Unit

SITE NUMBER: 116-H-4
SITE NAME: 105-H Pluto Crib

WASTE SITE DIMENSIONS:

Length - 10 ft (3.1 m) [2]
Width - 10 ft (3.1 m) [2]
Depth - 10 ft (3.1 m) [2]
Slopes - Vertical
Orientation - North-South

Waste site was covered with 10 ft (3.1 m) of soil then exhumed and moved to 118-H-5 burial ground [1,2].

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CONTAMINATED VOLUME DIMENSIONS:

Site was excavated and removed for construction of the 117-H filter building. It is assumed that during construction of the 117-H filter building all contaminants at depth were removed [10]. Assume no contaminated volume.

EXCAVATED VOLUME DIMENSIONS:

Not Applicable.

WASTE SITE LOCATION:

Northing: 152,479 [9]
Easting: 577,706 [9]

Reference Point: Center of crib.

ELEVATIONS:

Surface: 421 ft (128.5 m) [4]
Groundwater: 376 ft (114.7 m) [8]

Volume Estimate
100-HR-1 Operable Unit

SITE NUMBER: 116-H-7
SITE NAME: 107-H Retention Basin

WASTE SITE DIMENSIONS:

Length - 632 ft (192.6 m) [3,5]
Width - 276 ft (84.1 m) [3,5]
Depth - 20 ft (6.1 m) [2], bottom of basin @ elevation 396 ft (120.7 m) [4]
Slopes - Vertical
Orientation - Lengthwise N-S

Site was backfilled to 4 ft (1.2 m) above floor [1].

CONTAMINATED VOLUME DIMENSIONS:

Contamination extends 15 ft (4.5 m) in all directions [10].

Length - 662 ft (201.8 m) [10]
Width - 306 ft (93.3 m) [10]
Depth - 10 ft (3.0 m) [10] (below top of basin fill)

EXCAVATED VOLUME DIMENSIONS:

Bottom of excavation corresponds with contamination limits.

Excavation Slopes - 1.5 H : 1.0 V

WASTE SITE LOCATION:

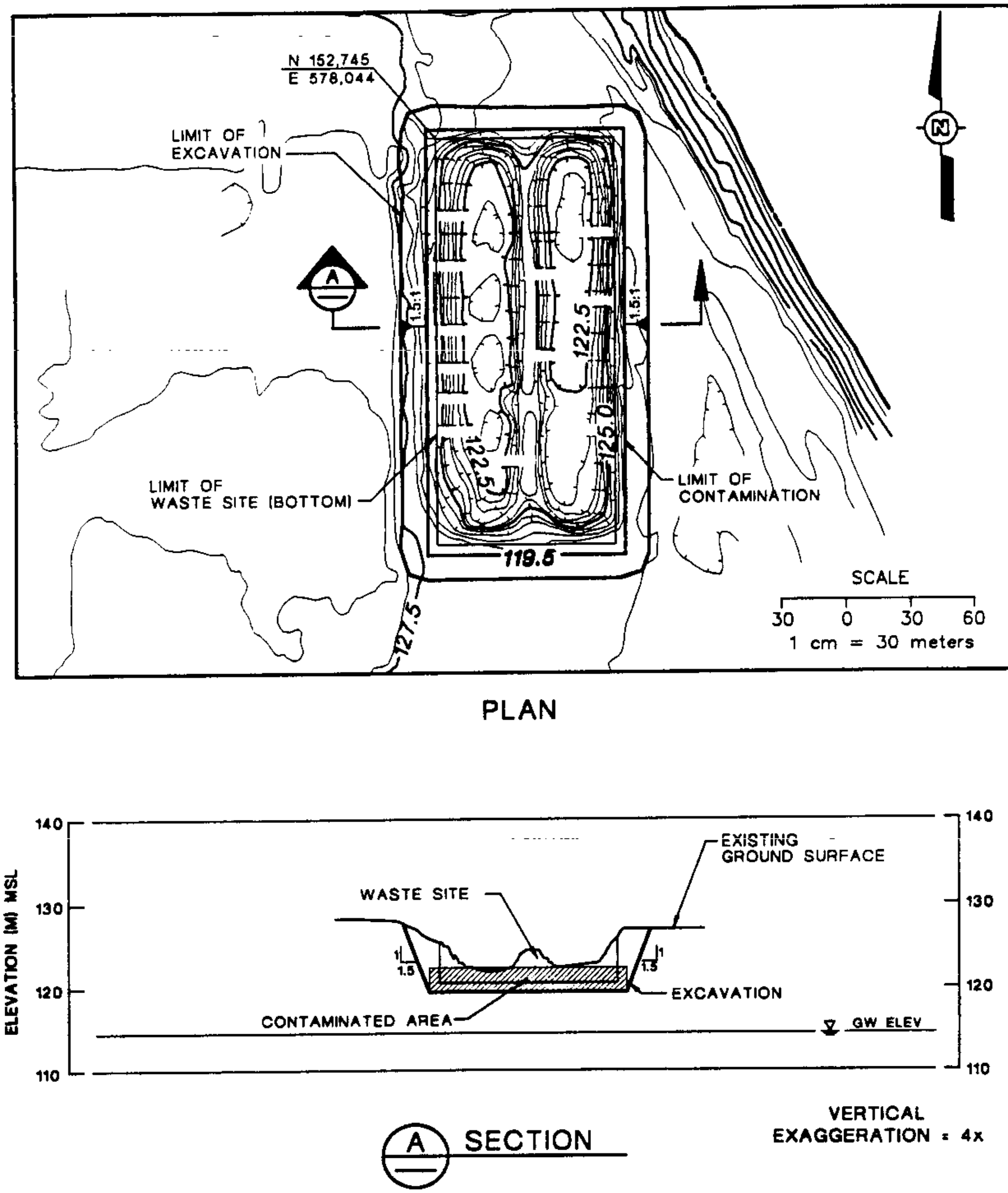
Northing: 152,745 [9]
Easting: 578,044 [9]

Reference Point: Northwest corner

ELEVATIONS:

Surface: 402 ft (122.5 m) [4]
Groundwater: 376 ft (114.6 m) [8]

Figure A-2 IRM Site: 116-H-7



EXTENT OF CONTAMINATION

SURFACE AREA = 18,828 sq. meters
VOLUME = 56,483 cu. meters

EXTENT OF EXCAVATION

SURFACE AREA = 25,900 sq. meters
VOLUME = 107,105 cu. meters

Volume Estimate
100-HR-1 Operable Unit

SITE NUMBER: 132-H-1
SITE NAME: Reactor Exhaust Stack

WASTE SITE DIMENSIONS:

Length - 200 ft (61.0 m) along bottom, 220 ft (67.1 m) at top of trench [2]
Width - 5 ft (1.5 m) along bottom, 25 ft (7.6 m) at top of trench [2]
Depth - 15 ft (4.6 m) [2]
Slopes - 1.0 H : 1.0 V
Orientation - East-West lengthwise

Stack was decontaminated, demolished, and buried between 117-H and 105-H buildings [2]. Site has been covered with 5 ft (1.5 m) of clean fill

CONTAMINATED VOLUME DIMENSIONS:

The site was decontaminated and decommissioned to ARCL methodology. Contamination is not expected at the site.

EXCAVATED VOLUME DIMENSIONS:

Not Applicable.

WASTE SITE LOCATION:

Northing: 152,504 [9]
Easting: 577,737 [9]

Reference Point: Center of east side of bottom of trench.

ELEVATIONS:

Surface: 418 ft (127.5 m) [4]
Groundwater: 376 ft (114.7 m) [8]

Volume Estimate
100-HR-1 Operable Unit

SITE NUMBER: 132-H-2
SITE NAME: 117-H Filter Building

WASTE SITE DIMENSIONS:

Length - 74 ft (22.6 m) [5]
Width - 41 ft (12.5 m) [5]
Depth - 29 ft (8.8 m) [1]
Slopes - Vertical
Orientation - East-West lengthwise

Site was originally 35 ft (10.7 m) tall with 32 ft (9.7 m) below grade [wids]. It was demolished in situ with 3 ft (1 m) of cover.

CONTAMINATED VOLUME DIMENSIONS:

The site was decontaminated and decommissioned to ARCL methodology. Contamination is not expected at the site.

EXCAVATED VOLUME DIMENSIONS:

Not Applicable.

WASTE SITE LOCATION:

Northing: 152,495 [9]
Easting: 577,698 [9]

Reference Point: Northwest corner

ELEVATIONS:

Surface: 418 ft (127.5 m)
Groundwater: 376 ft (114.7 m)

Volume Estimate
100-HR-1 Operable Unit

SITE NUMBER: 132-H-3
SITE NAME: 1608-H Wastewater Pumping Station

WASTE SITE DIMENSIONS:

Length - 36 ft (11.0 m) [2]
Width - 34 ft (10.4 m) [2]
Depth - 3 ft (1.0 m) to 32 ft (9.7 m) [2]
Slopes - Vertical
Orientation - North-South lengthwise

Site was originally 44 ft (10.7 m) tall with 32 ft (9.7 m) below grade [2]. It was demolished in situ with 3 ft (1 m) of cover.

CONTAMINATED VOLUME DIMENSIONS:

The site was decontaminated and decommissioned to ARCL methodology. Contamination is not expected at the site.

EXCAVATED VOLUME DIMENSIONS:

Not Applicable.

WASTE SITE LOCATION:

Northing: 152,480 [9]
Easting: 577,744 [9]

Reference Point: Northeast corner

ELEVATIONS:

Surface: 418 ft (127.5 m)
Groundwater: 376 ft (114.7 m)

Volume Estimate
100-HR-1 Operable Unit

SITE NUMBER:
SITE NAME: Effluent Pipelines (soil and sludge)

WASTE SITE DIMENSIONS:

Length - 2,961 ft (902.5 m) [3]
Width - 5 ft (1.5 m) diameter [3]
Depth - Varies [11]
Slopes - Varies
Orientation - Varies

Length - 1,068 ft (325.5 m) [3]
Width - 20" (0.51 m) [3]
Depth - Varies [11]
Slopes - Varies
Orientation - Varies

CONTAMINATED VOLUME DIMENSIONS:

Soil around pipe- No contamination along length of pipe.

Sludge inside pipe- All pipes have contaminated sludge along bottom. Volume of sludge is insignificant, the volume calculated will be that of pipe void.

EXCAVATED VOLUME DIMENSIONS:

Depends on depth of pipe. Base of excavation is 2 ft (0.6 m) on each side of the pipe and begins 3 inches below invert of pipe.

Excavation Slopes - 1.5 H : 1.0 V

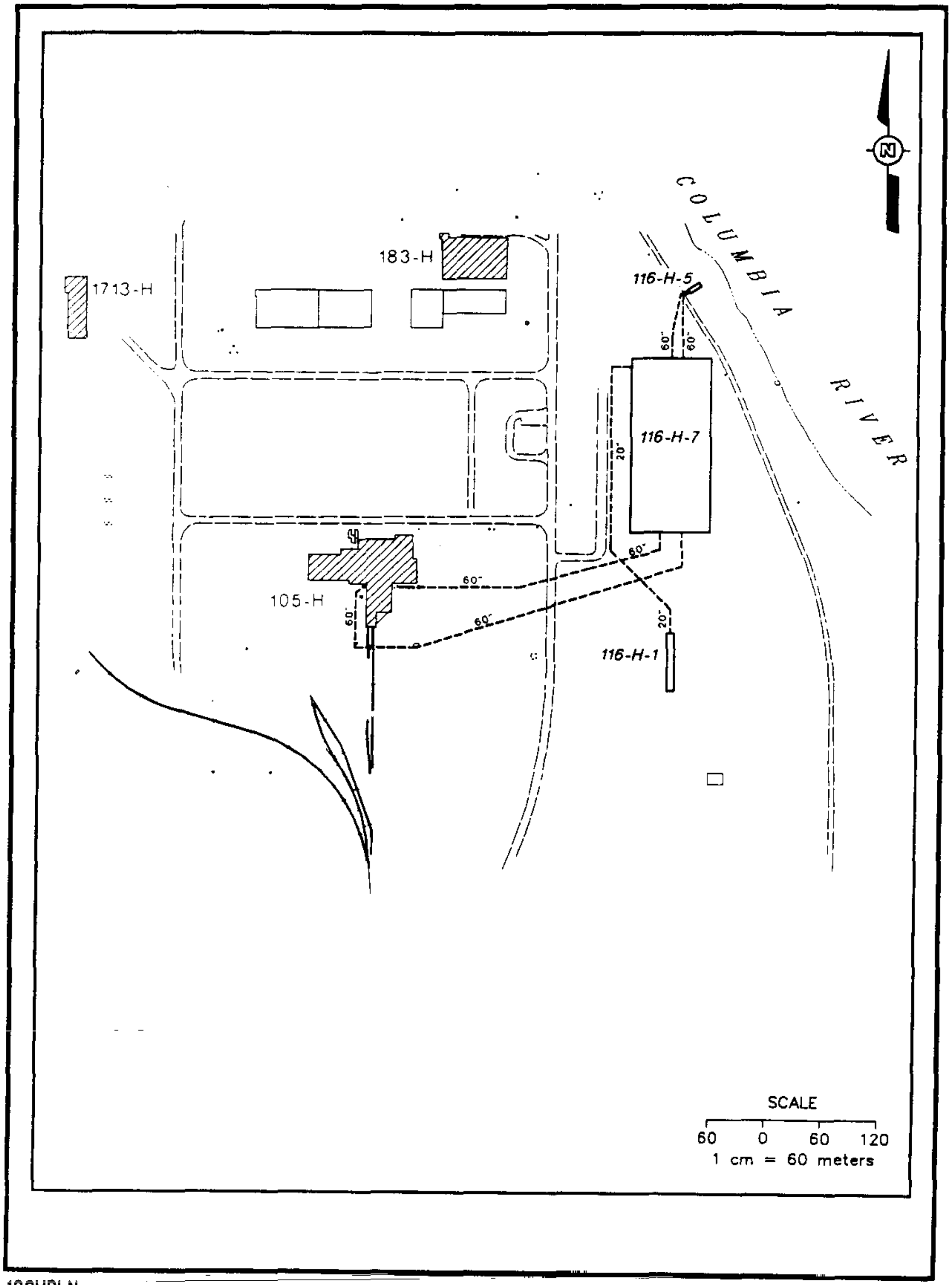
WASTE SITE LOCATION:

See figure.

ELEVATIONS:

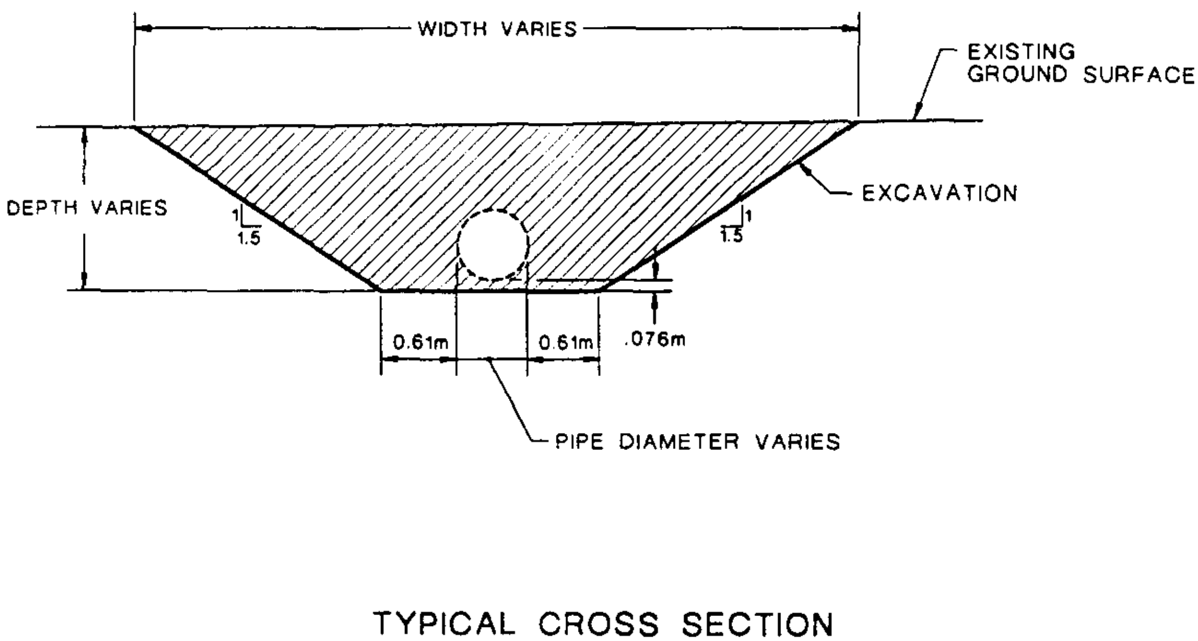
See figure.

Figure A-3 IRM Site: 100-H Pipelines



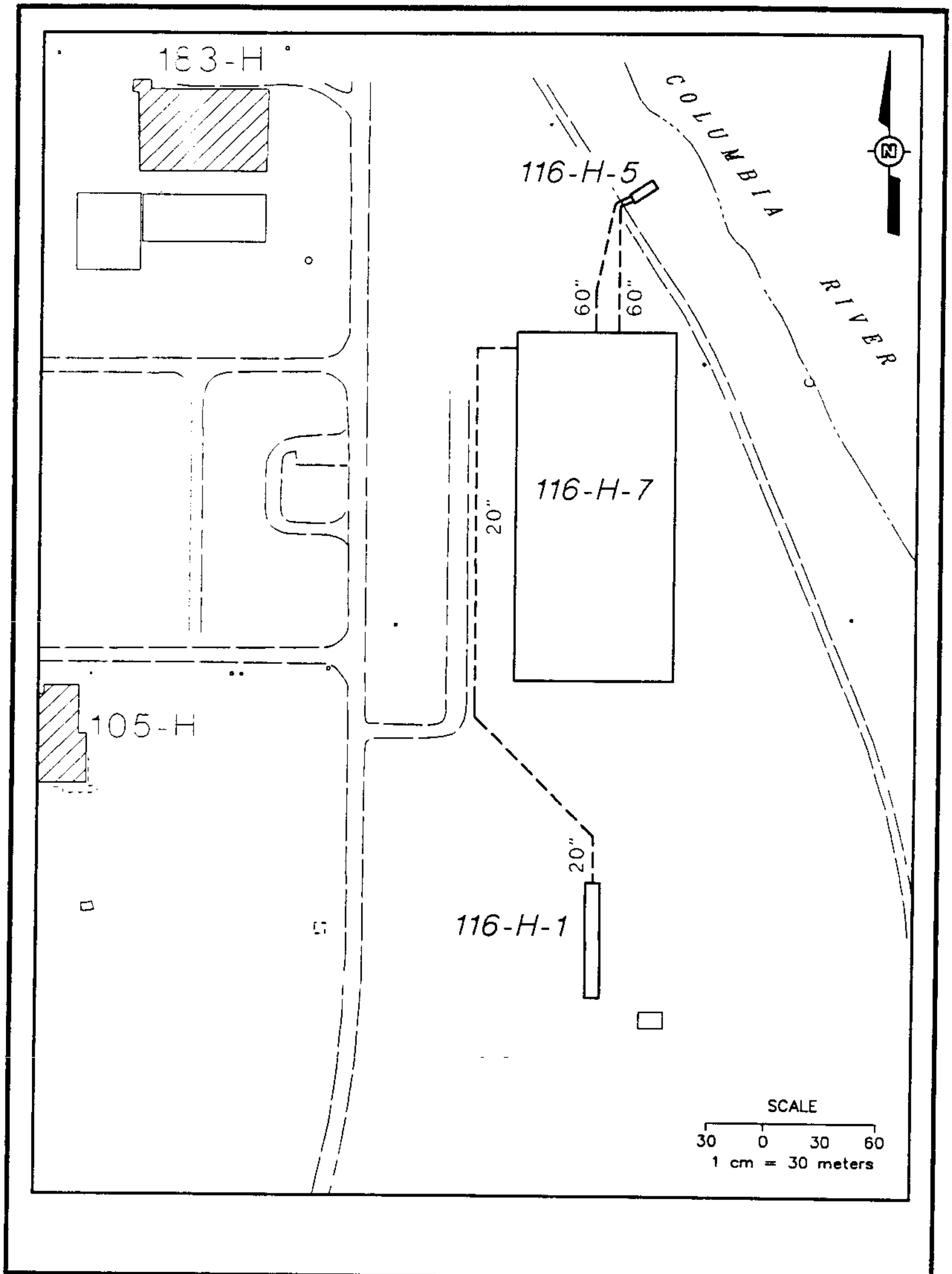
100HPLN

Figure A-4 Typical Pipeline Excavation Cross Section



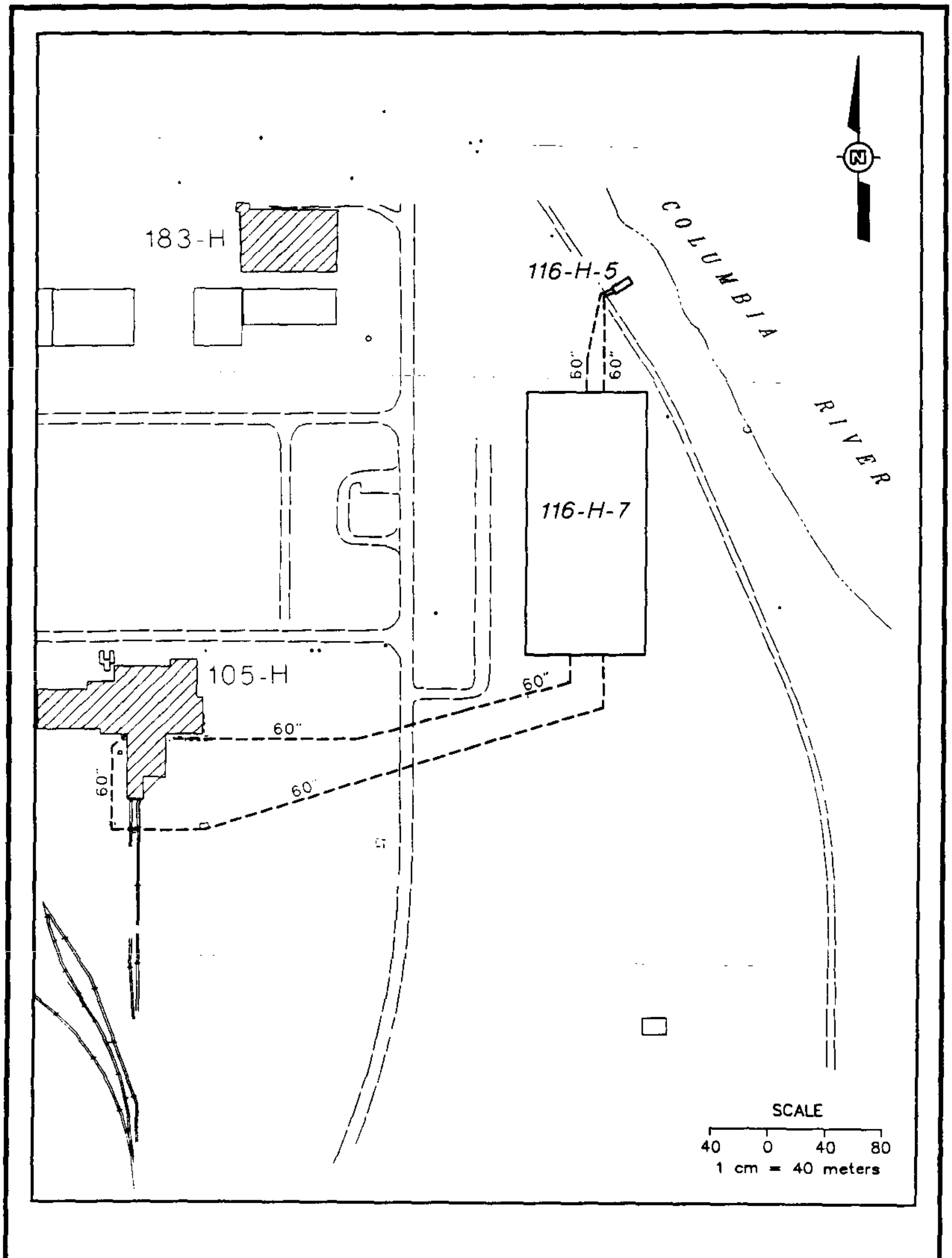
PEXSEC

Figure A-5 100-H 20 inch Pipelines



PLN20H

Figure A-6 100-H 60 inch Pipelines



PLN60H

APPENDIX B

100-HR-1 OPERABLE UNIT WASTE SITE COST ESTIMATES

1.0 COST ESTIMATE SUMMARIES

This appendix has two primary purposes. The first is to describe the cost models developed to support the source operable unit focused feasibility study reports. The second is to document the cost estimates developed for each waste site using the cost models.

1.1 DESCRIPTION OF COST MODELS

A cost model defines the remedial alternative activities and provides a method in which to estimate the associated cost. Each cost model is developed using the MCACES[1] software package.

The focused feasibility study cost models are based on the Environmental Restoration cost models used for developing the fiscal year planning baselines. The Environmental Restoration cost models were modified for the source operable unit focused feasibility studies to include all costs associated with the remedial alternatives. Project Time and Cost, Inc., supported both the baseline and focused feasibility study cost estimating activities. The fourteen cost models associated with the source operable unit focused feasibility studies are presented in the *100 Area Source Operable Unit Focused Feasibility Study Cost Models* (WHC 1994).

All cost models were developed based on a common work breakdown structure. There are three main elements within the structure; Offsite Analytical Services (ANA), Fixed Price Contractor (SUB), and Westinghouse Hanford Company (WHC).[2] Each of the three main elements is defined further by additional levels. Table B-1 describes each element and level of a cost model. The work breakdown structure discussion is applicable for each cost model.

1.2 WASTE SITE COST ESTIMATES

Cost estimates were developed for each waste site addressed by the focused feasibility study based on the applicable cost model. The present worth for each estimate is based on a 5% discount rate and a disposal fee of $70/cubic yard. Due to current uncertainty as to the actual disposal fee, a sensitivity analysis is presented based on $700/cubic yard and $7,000/cubic yard besides $70/cubic yard. A matrix of the waste site, cost estimate table, and cost comparison figure is presented on Table B-2.

[1] MCACES: Micro Computer Aided Cost Estimating System.

[2] The cost model terminology has not been updated to reflect the current change in the environmental restoration primary contractor.

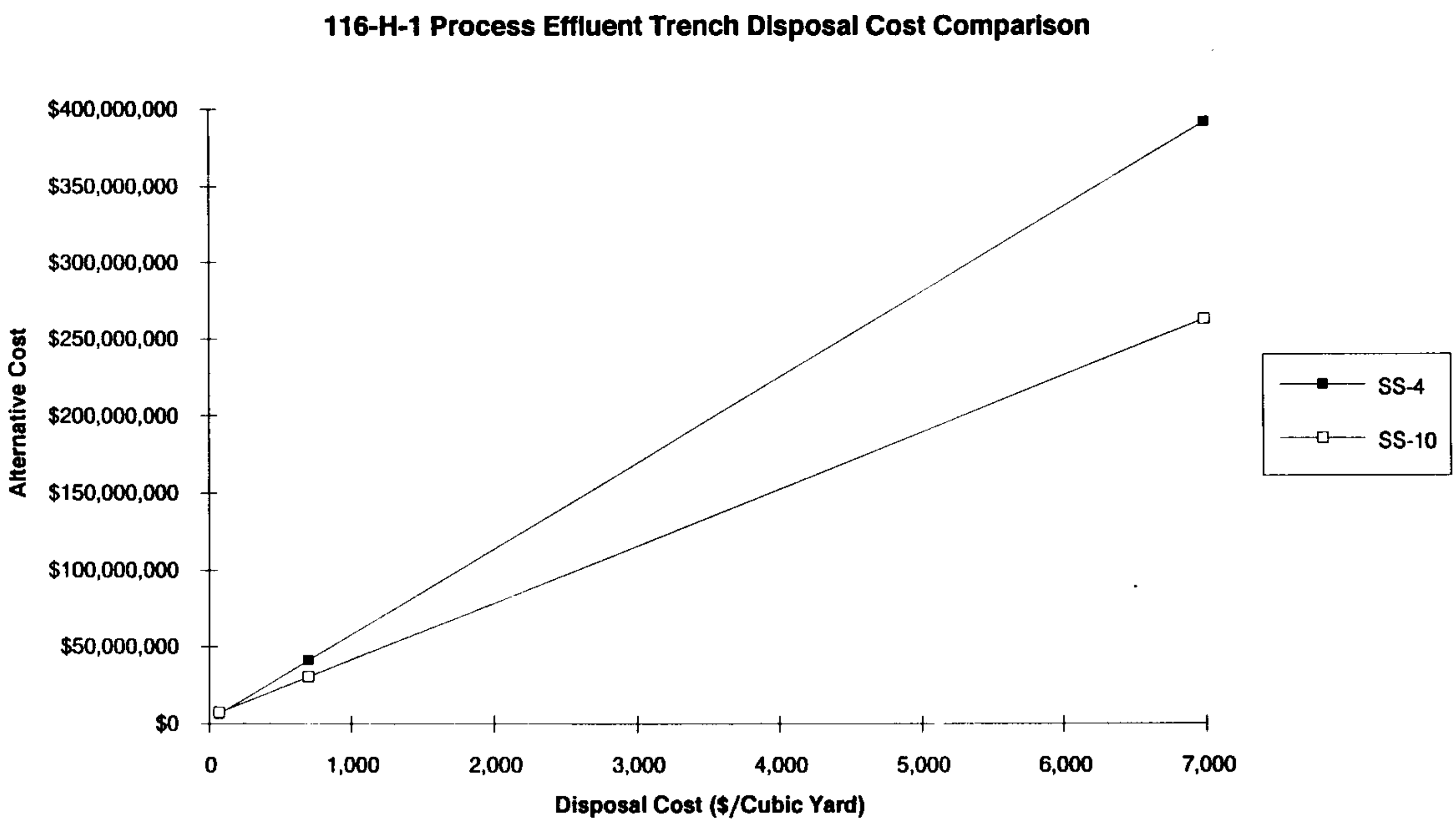


Figure B-1 116-H-1 Process Effluent Trench Disposal Cost Comparison

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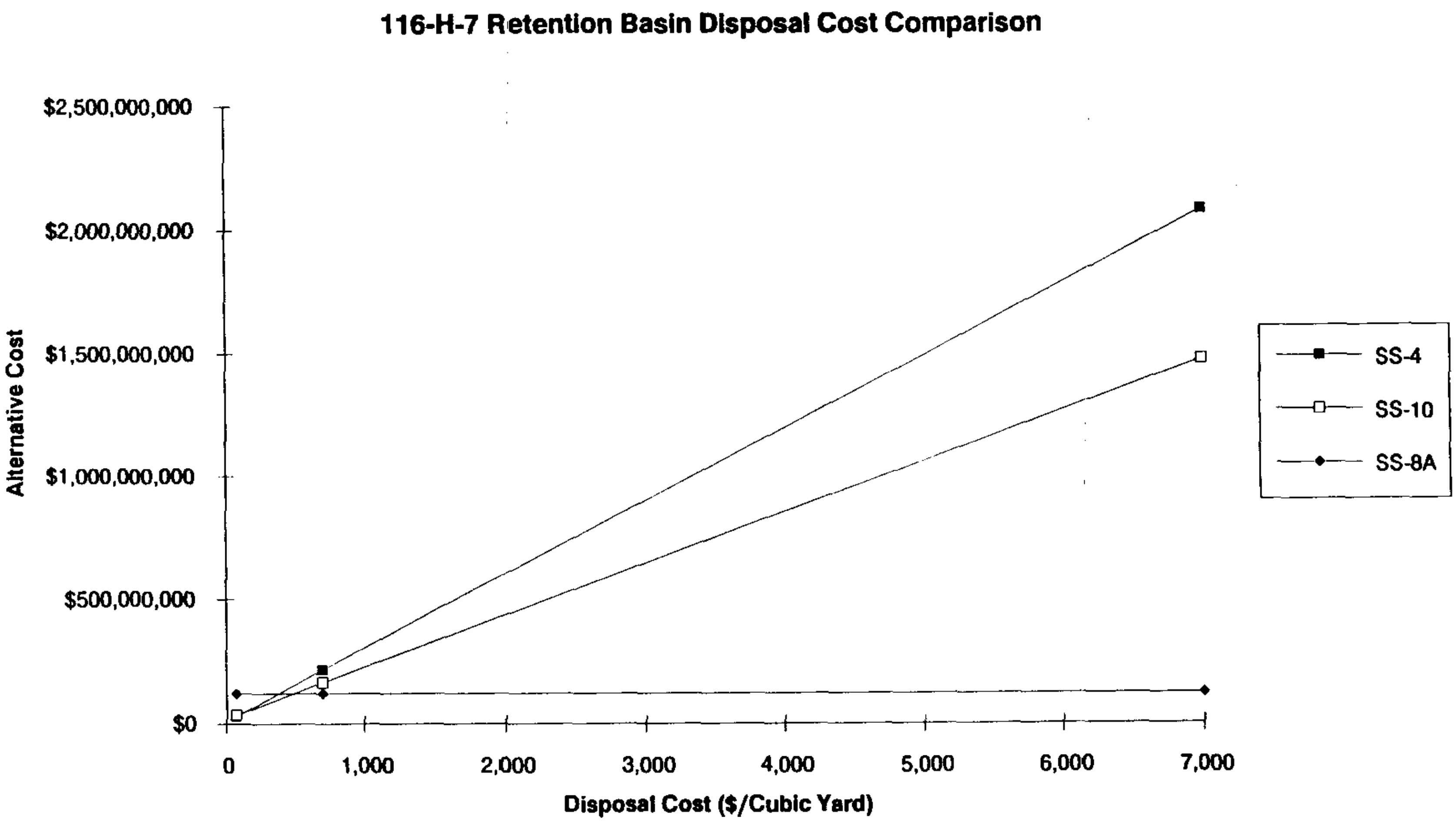

Figure B-2 116-H-7 Retention Basin Disposal Cost Comparison

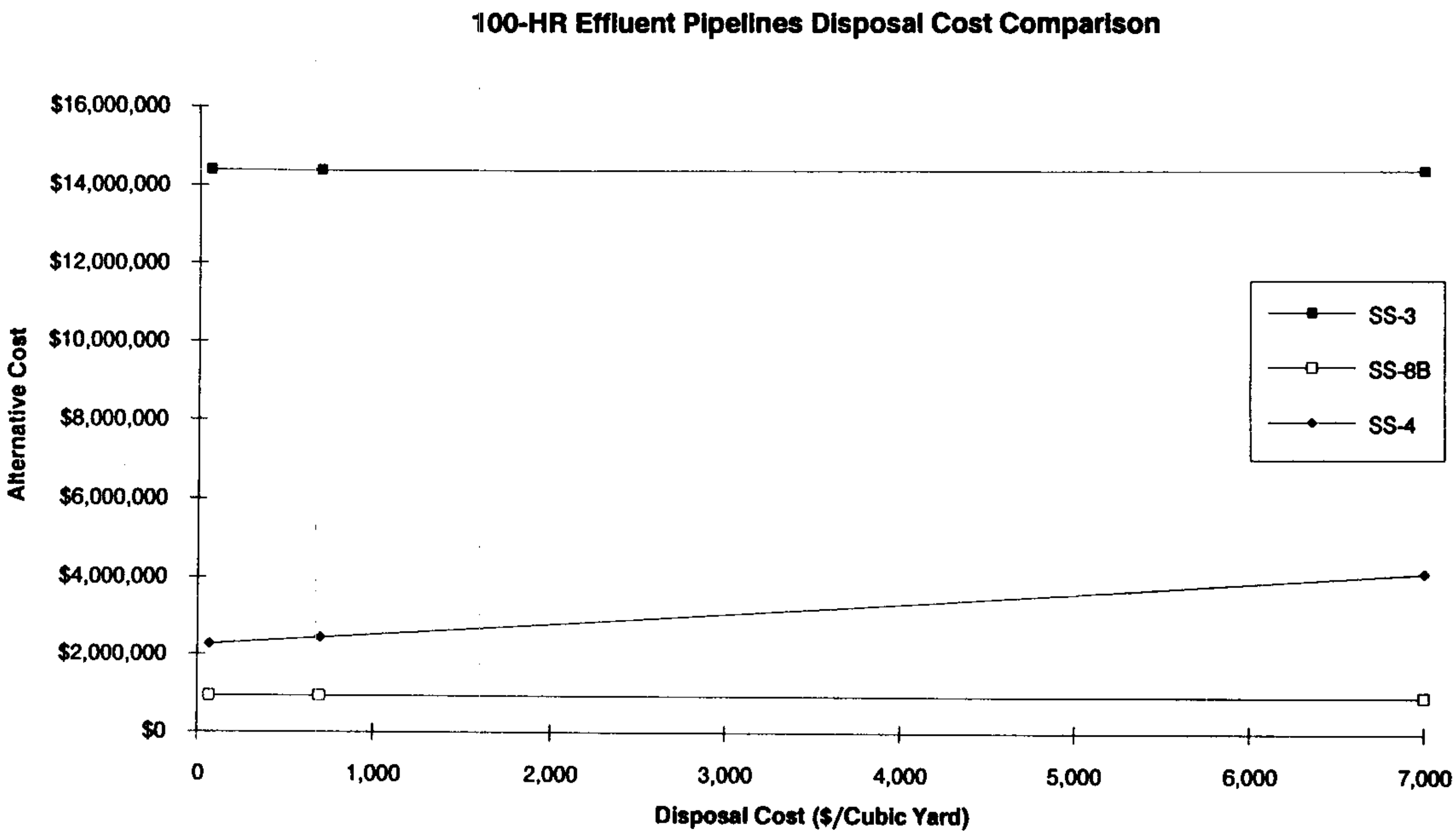

Figure B-3 100-HR Effluent Pipelines Disposal Cost Comparison

Table B-1 Cost Model Work Breakdown Structure Discussion (page 1 of 3)

ELEMENTS AND LEVELS	DESCRIPTION
ANA: Offsite Analytical Services	This element represents the offsite contractor performing laboratory analysis of samples.
ANA:02 Monitoring, Sampling, & Analysis	This level includes the laboratory analysis of samples. 10% of routine samples and all quality control samples were assumed to be analyzed using level III and level V analysis. Site certification samples were assumed to be analyzed using level IV and V analysis.
SUB: Fixed Price Contractor	This element represents the activities performed by the fixed price contractor supporting the Department of Energy's prime environmental restoration contractor.
SUB:01 Mobilization & Preparatory	This level includes mobilization of personnel and equipment, preparation for temporary facilities, and construction of temporary facilities.
SUB:02 Monitoring, Sampling & Analysis	This level includes in situ monitoring and field sampling for onsite or offsite analysis. Assumptions for sampling include one regular sample per 32 cubic yards removed (one per container) and one quality control sample per twenty regular samples. Site certification samples were assumed to be taken at one per 2,500 square feet of bottom area with a minimum of four samples. Additional activities included treatment process sampling which was assumed to be at a rate of one sample per 1,000 cubic yards of feed material.
SUB:08 Solids Collection & Containment	This level includes excavation, capping, dynamic compaction, and personnel training. The excavation activity includes excavation of non-contaminated soil, excavation of contaminated soil, and demolition of solid waste materials. The capping activity includes all steps necessary to construct the appropriate cap layers. The dynamic compaction activity includes the physical compaction and dust suppression. Personnel training included the standard 40-hour course, a fundamentals of radiation safety course, and an 8-hour supervisor course.
SUB:13 Physical Treatment	This level includes both soil washing and solid waste compaction activities such as mobilization/setup, personnel training, operation, system maintenance, demobilization, and pre- and post-treatment plan submittals. Assumptions include a swell factor of 25% for the material being hauled from the excavation. 90% of the contaminated material was assumed to be compactible.

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Table B-1 Cost Model Work Breakdown Structure Discussion (page 2 of 3)

ELEMENTS AND LEVELS	DESCRIPTION
SUB:14 Thermal Treatment	This level includes thermal desorption mobilization/setup, personnel training, system operation, demobilization, and pre- and post-treatment plan submittals. It is assumed that 5% of contaminated soil is organically contaminated and will be thermally treated should organics be present. An additional assumption includes a swell factor of 25% for the material being hauled from the excavation.
SUB:15 Stabilization/Fixation	This level inlcudes in situ vitrification mobilization/setup, personnel training, system operation, demobilization, and pre- and post-construction submittals.
SUB:18 Disposal (Other than Commercial)	This level includes transport to the disposal facility and disposal fees/taxes. Assumptions include a 60% swell factor for demolition waste and a 25% swell factor for soils. Reduction in volume is achieved and quantified based on the treatment process. A disposal fee of $70/cubic yard was assumed based on current estimates for initial construction, operations/maintenance, and anticipated expansion of the environmental restoration disposal facility.
SUB:20 Site Restoration	This level includes activities such as load/haul borrow materials, spread/compact borrow and stockpiled materials, revegetation, and irrigation. Assumptions include the availability of on-site borrow materials at no additional charge.
SUB:21 Demobilization	This level includes the demobilization of temporary facilities. Note: Because multiple sites will be cleaned up within an operable unit and a cost for mobilization between sites is already included, no allowance for demobilization is made. Only the cost for removal of temporary utilities, fencing, and decontamination facilities are included.
WHC: Westinghouse Hanford Company	This element represents activities performed by the prime contractor.
WHC:02 Monitoring, Sampling, & Analysis	This level includes mobile laboratory support, quality assurance/safety oversight, and health physics support. 90% of routine soil and solid waste samples were assumed to be analyzed using level III analysis. Routine sampling was assumed to occur at one sample per every 32 cubic yards removed(one per container.)
WHC:08 Solids Collection & Containment	This level includes personnel protection services including equipment, maintenance, and laundry services.

Table B-1 Cost Model Work Breakdown Structure Discussion (page 3 of 3)

ELEMENTS AND LEVELS	DESCRIPTION
Subcontractor Material Procurement Rate	The materials procurement rate reflects the activities associated with procurement or direct materials, inventories and, subcontracts.
Project Management/Construction Management	This cost accounts for project management, construction management, and office support personnel.
General & Administrative/Common Support Pool	The general and administrative costs consist of indirect costs of activities which benefit the company and can not be identified to a specific end cost objective. The common support pool provides for site-wide services of which the company pays a proportional share.
Contingency	A contingency value is calculated for the various waste site groups based on an evaluation of the various levels, the relative importance of the factor to successful completion of the action, and the probability that the factor will change.
Total, Capital, Annual Operations and Maintenance	The total represents the costs associated with the remedial action. The total cost includes capital and operations and maintenance of a cap. These costs are accounted for through the year 2018.
Present Worth	Present worth is calculated using a 5% discount rate over the life of the activity.

Table B-2 Waste Site Cost Presentation Matrix

WASTE SITE	COST SUMMARY TABLE	COST COMPARISON FIGURE
116-H-7 Retention Basin	Table B-3	Figure B-1
116-H-1 Process Effluent Trench	Table B-4	Figure B-2
Effluent Pipelines	Table B-5	Figure B-3

Table B-3 116-H-7 Retention Basin Disposal Cost Comparison

Cost Element		SS-4	SS-8A	SS-10
ANA: Offsite Analytical Services				
ANA:02	Monitoring, Sampling & Analysis	513,620	-	964,090
SUB: Fixed Price Contractor				
SUB:01	Mobilization & Preparatory	89,650	75,170	81,697
SUB:02	Monitoring, Sampling & Analysis	194,690	119,320	479,882
SUB:08	Solids Collection & Containment	683,550	324,360	1,114,691
SUB:13	Physical Treatment	-	-	4,210,439
SUB:14	Thermal Treatment	-	-	-
SUB:15	Stabilization/Fixation	-	54,987,930	-
SUB:18	Disposal (Other than Commercial)	11,353,920	-	8,658,098
SUB:20	Site Restoration	1,719,930	1,131,090	1,768,917
SUB:21	Demobilization	18,610	17,440	17,087
WHC: Westinghouse Hanford Company				
WHC:02	Monitoring, Sampling & Analysis	390,960	4,926,780	917,727
WHC:08	Solids Collection & Containment	40,100	817,870	98,482
Subcontractor Materials Procurement Rate		140,600	566,550	163.308
Project Management/Construction Management		2,194,800	9,444,980	2,626,549
General & Administration/Common Support Pool		4,290,840	18,464,930	5,134,904
Contingency		7,787,260	30,897,990	9,707,272
Total		29,418,520	121,774,430	35,943,144
Capital		29,418,520	66,915,600	31,890,902
Annual Operations & Maintenance		0	6,772,695	4,052,242
Present Worth		28,022,466	97,972,216	34,242,818

SS-3/SW-3: Containment
SS-4/SW-4: Removal/Disposal
SS-8A/S-8B/SW7: In Situ Treatment
SS-10/SW-9: Removal/Treatment/Disposal

Table B-4 116-H-1 Process Effluent Trench Disposal Cost Comparison

Cost Element		SS-4	SS-10
ANA: Offsite Analytical Services			
ANA:02	Monitoring, Sampling & Analysis	138,930	235,760
SUB: Fixed Price Contractor			
SUB:01	Mobilization & Preparatory	61,290	67,940
SUB:02	Monitoring, Sampling & Analysis	58,950	89,580
SUB:08	Solids Collection & Containment	119,860	142,910
SUB:13	Physical Treatment	-	986,430
SUB:14	Thermal Treatment	-	-
SUB:15	Stabilization/Fixation	-	-
SUB:18	Disposal (Other than Commercial)	2,038,160	1,417,850
SUB:20	Site Restoration	411,940	358,950
SUB:21	Demobilization	15,050	15,240
WHC: Westinghouse Hanford Company			
WHC:02	Monitoring, Sampling & Analysis	134,830	233,540
WHC:08	Solids Collection & Containment	10,200	21,100
Subcontractor Materials Procurement Rate		197,480	224,760
Project Management/Construction Management		457,160	533,740
General & Administration/Common Support Pool		893,760	1,043,470
Contingency		1,542,790	1,987,370
Total		6,080,400	7,358,630
Capital		6,080,400	6,533,600
Annual Operations & Maintenance		0	825,030
Present Worth		5,793,890	7,018,407

SS-3/SW-3: Containment
SS-4/SW-4: Removal/Disposal
SS-8A/SS-8B/SW-7: In Situ Treatment
SS-10/SW-9: Removal/Treatment/Disposal

Table B-5 Effluent Pipelines Disposal Cost Comparison

Cost Element		SS-3	SS-4	SS-8B
ANA: Offsite Analytical Services				
ANA:02	Monitoring, Sampling & Analysis	-	63,150	-
SUB: Fixed Price Contractor				
SUB:01	Mobilization & Preparatory	28,130	48,040	17,630
SUB:02	Monitoring, Sampling & Analysis	-	84,900	-
SUB:08	Solids Collection & Containment	4,032,330	293,990	428,890
SUB:13	Physical Treatment	-	-	-
SUB:14	Thermal Treatment	-	-	-
SUB:15	Stabilization/Fixation	-	-	-
SUB:18	Disposal (Other than Commercial)	-	10,070	-
SUB:20	Site Restoration	463,150	407,980	-
SUB:21	Demobilization	8,750	11,160	8,650
WHC: Westinghouse Hanford Company				
WHC:02	Monitoring, Sampling & Analysis	179,870	154,350	25,880
WHC:08	Solids Collection & Containment	4,220	21,100	1,410
Subcontractor Materials Procurement Rate		330,860	62,500	4,550
Project Management/Construction Management		757,100	164,110	73,050
General & Administration/Common Support Pool		1,480,130	320,840	142,820
Contingency		2,476,740	624,030	238,980
Total		9,761,290	2,266,210	941,870
Capital		9,761,290	2,266,210	941,870
Annual Operations & Maintenance		201,617	0	0
Present Worth		11,887,957	2,160,625	897,876

SS-3/SW-3: Containment
SS-4/SW-4: Removal/Disposal
SS-8A/SS-8B/SW-7: In Situ Treatment
SS-10/SW-9: Removal/Treatment/Disposal

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