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Analysis of the Technical Capabilities of DOE Sites for Disposal of Residuals from the Treatment of Mixed Low-Level Waste

Robert D. Waters, Marilyn M. Gruebel, Brenda S. Langkopf, Paul B. Kuehne

Prepared by
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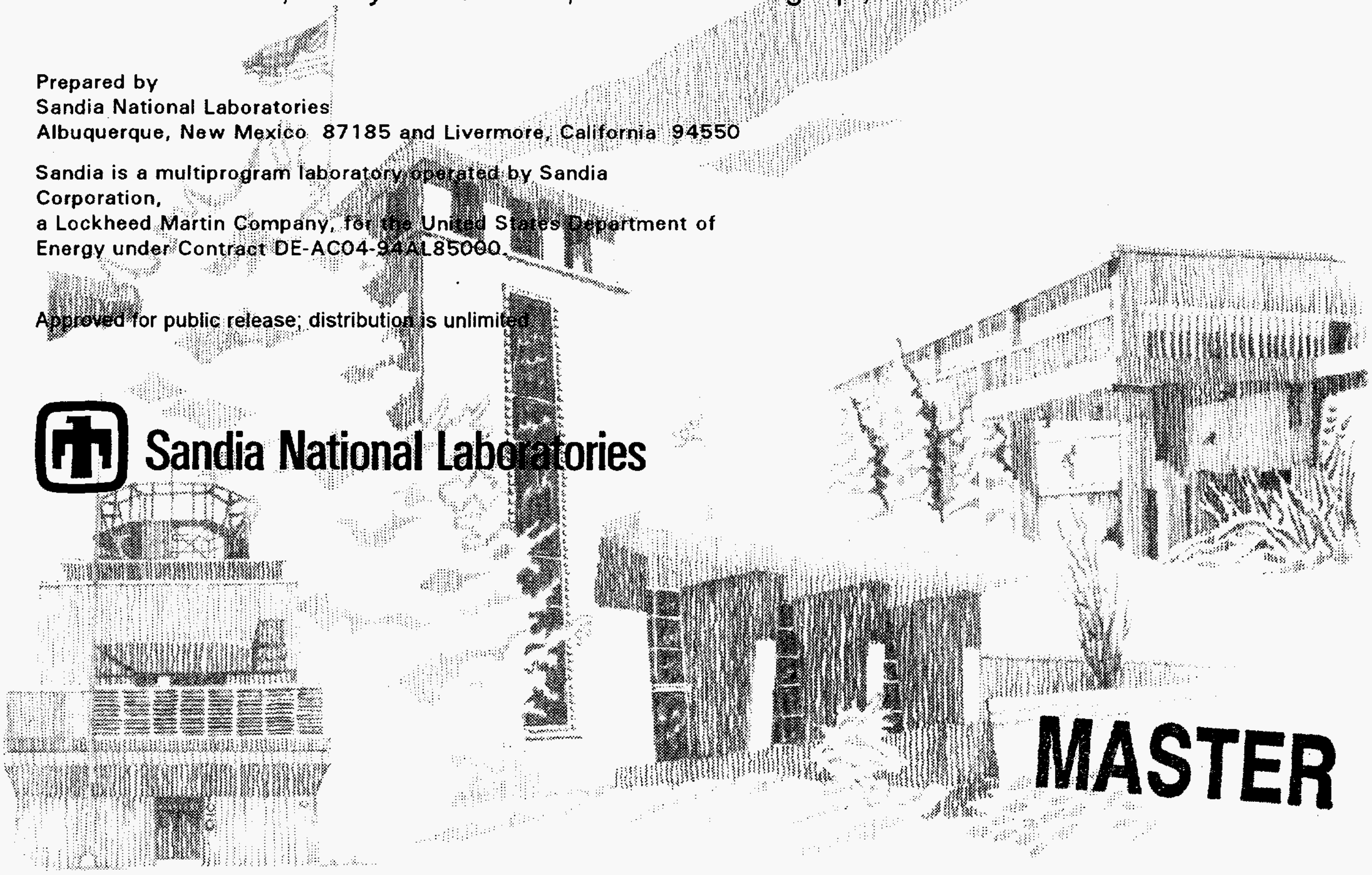

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Analysis of the Technical Capabilities of DOE Sites for Disposal of Residuals from the Treatment of Mixed Low-Level Waste

Prepared for the

Department of Energy (DOE) Office of Waste Management
Federal Facility Compliance Act Disposal Workgroup

by

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Abstract

The U.S. Department of Energy (DOE) has stored or expects to generate over the next five years more than 130,000 m^3 of mixed low-level waste (MLLW). Before disposal, MLLW is usually treated to comply with the land disposal restrictions of the Resource Conservation and Recovery Act. Depending on the type of treatment, the original volume of MLLW and the radionuclide concentrations in the waste streams may change. These changes must be taken into account in determining the necessary disposal capacity at a site. Treatment may remove the characteristic in some waste that caused it to be classified as mixed. Treatment of some waste may, by reduction of the mass, increase the concentrations of some transuranic radionuclides sufficiently so that it becomes transuranic waste. In this report, the DOE MLLW streams were analyzed to determine after-treatment volumes and radionuclide concentrations. The waste streams were reclassified as residual MLLW or low-level or transuranic waste resulting from treatment. The volume analysis indicated that about 89,000 m^3 of waste will require disposal as residual MLLW. Fifteen DOE sites were then evaluated to determine their capabilities for hosting disposal facilities for some or all of the residual MLLW. Waste streams associated with about 90% of the total residual MLLW volume are likely to present no significant issues for disposal and require little additional analysis. Future studies should focus on the remaining waste streams that are potentially problematic by examining site-specific waste acceptance criteria, alternative treatment processes, alternative waste forms for disposal, and pending changes in regulatory requirements.

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Nomenclature

AMR	activity per unit mass ratio
D&D	decontamination and decommissioning
DOE	Department of Energy
DU	depleted uranium
DWG	Disposal Workgroup
FFCAct	Federal Facility Compliance Act
LDR	land disposal restrictions
LLW	low-level waste
MAP	mixed activity products
MFP	mixed fission products
MLLW	mixed low-level waste
MWFA	Mixed Waste Focus Area
MWIR	Mixed Waste Inventory Report
MPC	matrix parameter categories
PA	performance assessment
PATT	Performance Assessment Task Team
PE	performance evaluation
RCRA	Resource Conservation and Recovery Act
SOF	sum of fractions
STP	site treatment plan
TRU	transuranic
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant

EXECUTIVE SUMMARY

The Federal Facility Compliance Act (FFCAct) of 1992 requires the U.S. Department of Energy (DOE) to work with its regulators and with members of the public to establish plans for the treatment of DOE's mixed low level waste (MLLW). Although the FFCAct does not specifically address disposal of treated MLLW, both DOE and the affected States recognize that disposal issues are an integral part of treatment discussions. The DOE established the FFCAct Disposal Workgroup to work with the States in identifying, from among the sites currently storing or expected to generate MLLW, those that might be suitable for the disposal of MLLW. The technical capabilities of the fifteen sites selected through this process were quantified and qualified in a recently completed performance evaluation (PE) project.

An additional task, which is the subject of this report, was to estimate volumes and radionuclide concentrations of treated MLLW considered under the FFCAct based on DOE's current and five-year projected inventory. The sites that were considered in this analysis and the associated volumes that are expected to be disposed of as MLLW after treatment, based on the results of this analysis, are shown in Table 1. Relevant data from both DOE's 1995 Mixed Waste Inventory Report (MWIR) and site treatment plans updated to reflect status as of mid-1996 were used in the calculations. The estimates were used, along with the results of the PE project, to analyze the technical capabilities of the fifteen identified sites for disposal of these treated wastes and to identify areas for further research and data collection. The general disposition of the MLLW as a result of this scoping-level analysis is shown in Figure 1.

The estimation of volumes of residual MLLW and the comparison of concentrations of radionuclides in residual MLLW with the limits estimated by the PE project were scoping-level analyses for two primary reasons. First, the method used to estimate residual MLLW volumes and radionuclide concentrations was a simplified approach to quantifying the effects of treatment processes. Second, the concentration limits estimated by the PE project were determined by using a set of modeling assumptions that included sufficient detail to capture major site-specific characteristics but were general enough for consistent application at all sites. Thus, the analysis described in this report was a scoping-level analysis to identify the residual MLLW for which disposal considerations should be given closer attention. The following conclusions and recommendations were derived from this analysis:

- Of the approximately 130,000 m^3 of MLLW considered under the FFCAct that is either currently stored or projected to be generated within the next five years and is designated for treatment, approximately 89,000 m^3 will require disposal as MLLW (the residual MLLW), an additional 6000 m^3 will require disposal as low-level waste, and 5000 m^3 will require disposal as transuranic waste. The net volume reduction due to treatment of this waste is approximately 21,000 m^3. The remaining 9000 m^3 of this waste was insufficiently characterized to be assigned a preferred alternative for treatment; 6000 m^3 of this waste was projected waste. Of the 89,000 m^3 of residual MLLW, approximately 49,000 m^3 is currently planned for disposal at commercial facilities; therefore, up to 40,000 m^3 of residual MLLW will require disposal at one or more DOE facilities or at a commercial site. The disposition of waste volumes is illustrated in the left-hand portion of Figure 1.

Table 1. Sites Considered in the Residuals Analysis Project and the Associated Volumes That Are Expected To Be Disposed of as MLLW After Treatment (sites shown in italics were evaluated for their disposal capabilities in the performance evaluation project [DOE, 1996]).

State	Site	Volume of Residual MLLW (m^3)
California	Energy Technology Engineering Center (ETEC)	<1
	General Atomics	— [a]
	Former Laboratory for Energy-Related Health Research	— [a]
	Lawrence Berkeley National Laboratory (LBL)	<1
	Mare Island Naval Shipyard (Mare Island NSY)	20
	Lawrence Livermore National Laboratory (LLNL)	970
Colorado	*Rocky Flats Environmental Technology Site (RFETS)*	26,000
Connecticut	Knolls Atomic Power Laboratory - Windsor (KAPL-W)	10
Hawaii	Pearl Harbor Naval Shipyard (Pearl Harbor NSY)	<1
Idaho	*Idaho National Engineering Laboratory (INEL)* (including Argonne National Laboratory - West [ANL-W])	60
Illinois	*Argonne National Laboratory - East (ANL-E)*	170
Iowa	Ames Laboratory	— [a]
Kentucky	*Paducah Gaseous Diffusion Plant (PGDP)*	20
Maine	Portsmouth Naval Shipyard (Portsmouth NSY)	2
Missouri	Weldon Springs Remedial Action Project	— [b]
	Missouri University Research Reactor (MURR)	<1
Nevada	*Nevada Test Site (NTS)*	<1
New Mexico	*Los Alamos National Laboratory (LANL)*	130
	Sandia National Laboratories (SNL)	120
New York	Knolls Atomic Power Laboratory - Kesselring (KAPL-K)	10
	Knolls Atomic Power Laboratory - Niskayuna (KAPL-N)	30
	Brookhaven National Laboratory (BNL)	<1
	West Valley Demonstration Project (WVDP)	<1
Ohio	Battelle Columbus Laboratories Decommissioning Project (Battelle)	<1
	Fernald Environmental Management Project (FEMP)	350
	Mound Plant (Mound)	2
	Portsmouth Gaseous Diffusion Plant (PORTS)	2,700
	RMI Titanium Company (RMI)	4
Pennsylvania	Bettis Atomic Power Laboratory (Bettis)	2
South Carolina	*Savannah River Site (SRS)*	410
Tennessee	*Oak Ridge Reservation (ORR)* (including K-25 Site, Oak Ridge National Laboratory [ORNL], Y-12 Plant)	49,000
Texas	*Pantex Plant (Pantex)*	130
Virginia	Norfolk Naval Shipyard (Norfolk NSY)	2
Washington	Puget Sound Naval Shipyard (Puget Sound NSY)	4
	Hanford Reservation (Hanford)	9,000

a Not included in analysis because of insufficient data

b Planned on-site disposal of MLLW in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cell

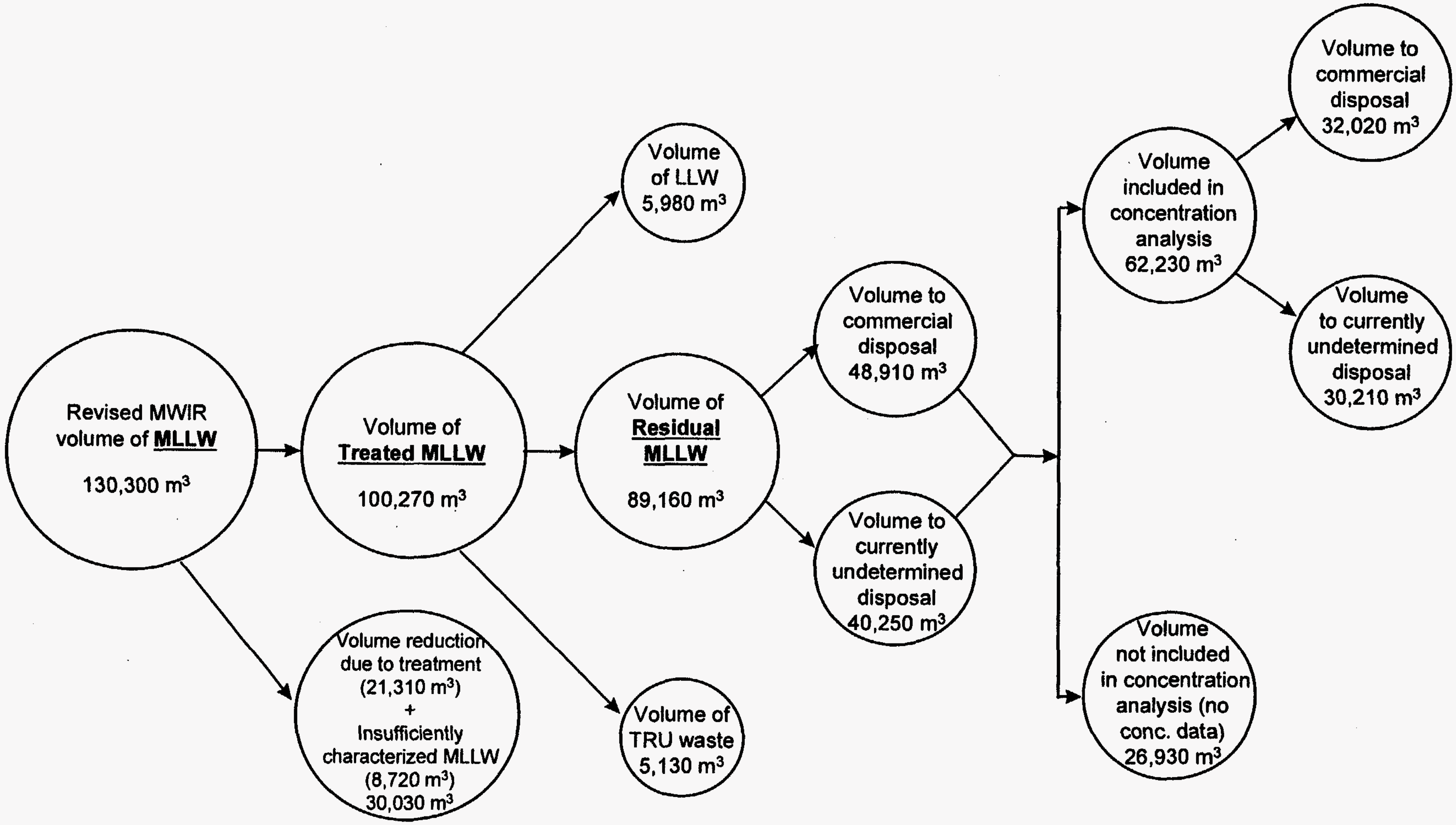

Figure 1. Disposition of waste volumes in the analysis of the technical capabilities of DOE sites for disposal of the radionuclides in treated residuals of mixed low-level waste (underlined words in this figure were used in this report to represent a particular category of MLLW)

As indicated in the PE project report, all 15 sites evaluated in this project have the technical capability to dispose of some residual MLLW, and sites located in the arid region of the country tend to have higher permissible limits on radionuclide concentrations in waste than sites in the humid region of the country. Comparing the limits estimated in the PE with estimates of radionuclide concentrations in residual MLLW indicates that up to 90% of the evaluated residual MLLW could be disposed of at several arid sites with little additional analysis; about 50% of this waste could be disposed of at several humid sites. More detailed analyses would likely increase both of these percentages. Also, more site-specific design of the disposal facilities could increase the percentages.

Based on the volume estimates calculated in this analysis, enough capacity currently exists in commercial sites and at Hanford and Nevada Test Site for disposal of all of DOE's residual MLLW. Additional disposal capacity may be required for MLLW generated by processes not managed under FFCAct agreements (e.g., wastes generated from future decontamination and decommissioning [D&D] and environmental restoration activities). This conclusion is based on the technical aspects of disposal only—ethical, social, economic, and policy considerations relevant to waste disposal were not considered in the analysis.

- The results of this scoping-level analysis indicate that waste streams associated with about 90% of the total residual MLLW volume evaluated in the concentration analysis are likely to present no significant technical issues for MLLW disposal and require little additional analysis. The remaining residual MLLW streams that were identified as potentially problematic require further evaluation of their treatment, disposal plans, and facility designs. Almost all of these potentially problematic waste streams are listed as such because disposal concentrations are limited by the assumed intrusion scenarios in the PE report; the effect of intrusion can be mitigated to some extent by burying the waste deeper.

- Additional waste characterization data should be collected. Of the total current and five-year projected volume of MLLW that has been reported, about 7% (9000 m^3) is attributed to waste streams that do not have enough characterization and treatment information to be included in the calculation of post-treatment volumes. Of the residual MLLW volume that was calculated in the analysis, about 30% (27,000 m^3) is attributed to waste streams that could not be included in the comparison of radionuclide concentrations with the limits estimated by the PE project due to lack of radiological characterization data. The data on these latter waste streams either did not include a listing of radionuclides or did not provide concentrations for any of the listed radionuclides. In addition, of the residual MLLW streams that were included in the comparison, many did not have concentrations for all of the listed radionuclides.

- Future studies should focus on the potentially problematic waste streams identified in this analysis. These waste streams should be re-evaluated with regard to

  ⇒ site-specific waste acceptance criteria and performance assessments,
  ⇒ alternative treatment processes,
  ⇒ alternative waste forms, and
  ⇒ different regulatory requirements (i.e., those that may change with the reissuance of DOE Order 5820).

1. INTRODUCTION

The Federal Facility Compliance Act (FFCAct) of 1992 (FFCAct, 1992) requires the U.S. Department of Energy (DOE) to work with its state and federal regulators and with members of the public to establish plans for the treatment of DOE's mixed low-level waste (MLLW). Along with other radioactive and hazardous waste, wastes that are now considered MLLW have been generated for more than 50 years through DOE activities related to the production of materials for nuclear weapons and research with nuclear materials; however, the regulatory recognition of MLLW originated in the Resource Conservation and Recovery Act (RCRA) of 1976 (RCRA, 1976). Although the FFCAct does not specifically address disposal of MLLW that remains after treatment (i.e., residual MLLW), both DOE and the States recognize that disposal issues are an integral part of treatment discussions.

The DOE established the FFCAct Disposal Workgroup (DWG) in June 1993 to work with the States in defining and developing a process for evaluating disposal options for treated MLLW. The focus of the DWG process and of discussions on disposal with the States has been to identify, from among the sites currently storing or expected to generate MLLW, those that are suitable for further evaluation in terms of their disposal capabilities. An additional task, which is the subject of this report, was to provide an estimate of the volumes of residual MLLW to be disposed of and the technical capabilities of the identified sites to dispose of DOE residual MLLW.

1.1 BACKGROUND

The DOE currently generates, stores, or expects to generate (over the next five years) about 130,000 m^3 of MLLW managed under FFCAct agreements at 39 sites in 19 states. Because MLLW has a hazardous component, it must usually be treated to comply with the land disposal restrictions (LDRs) of RCRA. However, there is insufficient capacity, and in some cases a lack of available technologies, to treat all of this waste. The FFCAct required the Secretary of Energy to develop and submit site treatment plans (STPs) for the development of treatment capacity for treating mixed waste for each facility where the DOE stores or generates this waste, unless otherwise required by the statute. These plans identify how the DOE will provide necessary treatment capacity for MLLW, including schedules for bringing new treatment facilities into operation. In collaboration with the States and the National Governors' Association, the DOE has developed the required treatment plans at 35 DOE sites. At most sites, these STPs have since resulted in consent orders with the appropriate state or federal regulating agency. Because it already had a Tri-Party agreement that addressed these issues, the Hanford Site is not required to produce a STP.

A three-volume report prepared by the DWG describes a performance evaluation that quantified and compared the potential capabilities of 15 DOE sites for disposal of stabilized residuals resulting from the treatment of MLLW (DOE, 1996). That report discusses the methodology, describes the evaluated sites, and provides estimates of permissible concentrations of radionuclides in residual MLLW for disposal at each site. The 15 sites considered in the performance evaluation (Figure 1-1) were selected from an initial universe of 49 DOE sites that either currently stored or were expected to generate MLLW over the next five years*. Details about the screening analyses are provided in the performance evaluation report (DOE, 1996, Vol. 2, Chpt. 2).

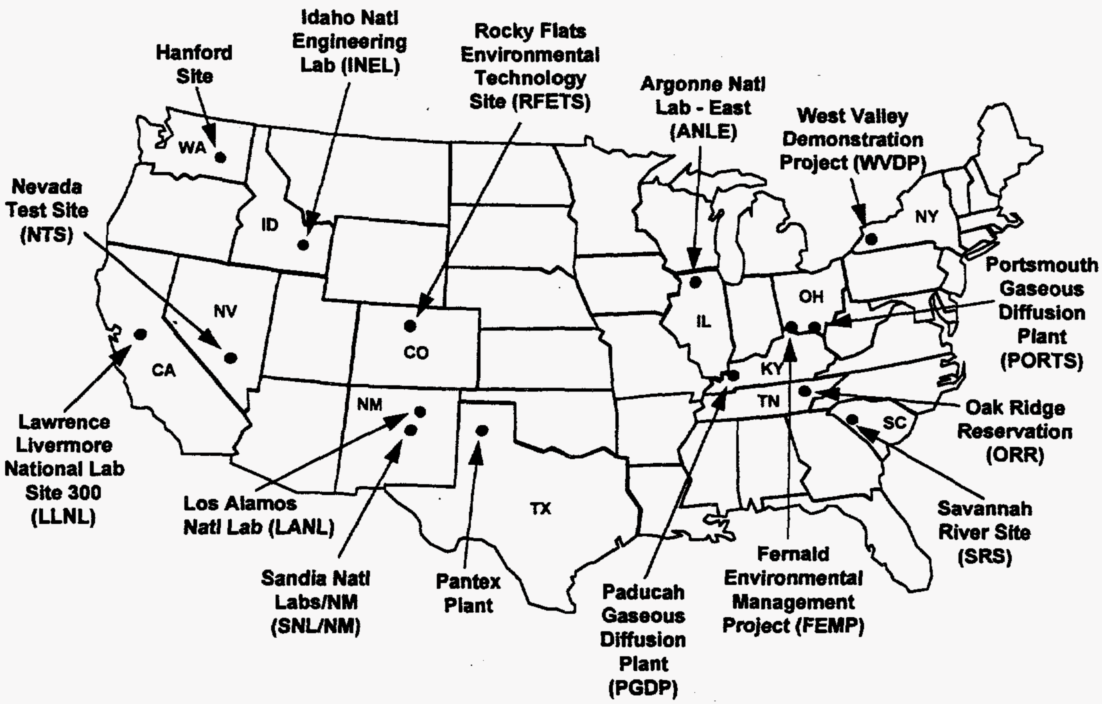

Figure 1-1. Sites considered in the performance evaluation for disposal of MLLW.

1.2 PURPOSE OF THIS REPORT

The performance evaluation provided scoping-level estimates of permissible concentrations of radionuclides in DOE residual MLLW that technically could be disposed of at 15 DOE sites. The analysis documented in this report used reported inventories of DOE MLLW to

- estimate the volume of treated MLLW to be disposed of as residual MLLW, as low-level waste (LLW), and as transuranic waste (TRU) (see Figure 1-2);
- estimate the capabilities of the 15 sites for disposal of DOE residual MLLW by comparing reported radionuclide concentrations in residual MLLW streams with the estimated permissible concentrations reported in the performance evaluation;

* Information compiled since 1993 indicates that the DOE currently generates, stores, or expects to generate (over the next five years) MLLW at 39 sites (DOE, 1996).

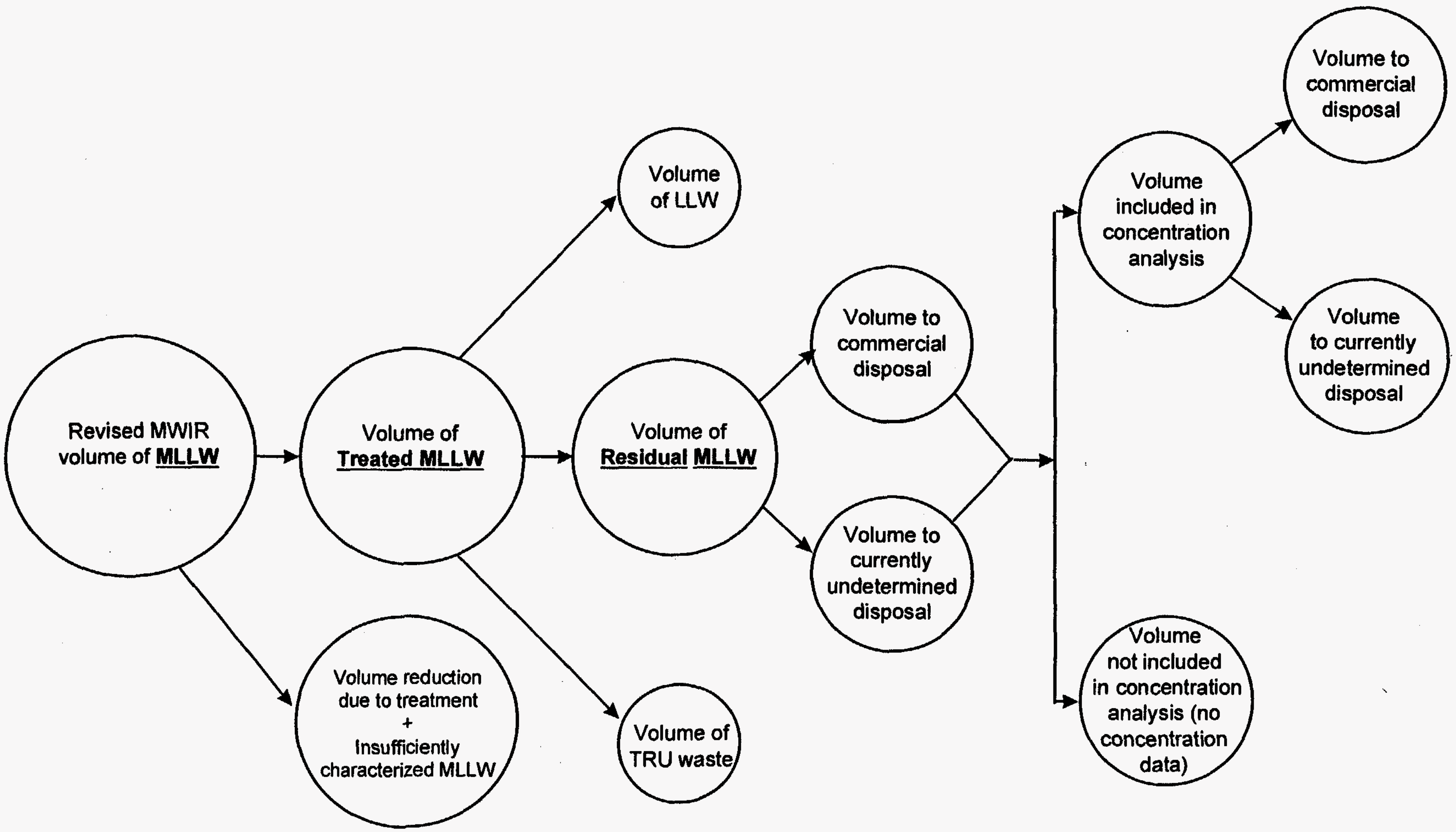

Figure 1-2. Disposition of waste volumes in the analysis of the technical capabilities of DOE sites for disposal of the radionuclides in the treated residuals of mixed low-level waste (bold underlined words in the figure were used in this report to represent a particular category of MLLW).

- identify potentially problematic combinations of residual MLLW streams and treatment plans with respect to disposal of the final waste form at some sites (thus allowing feedback to treatment and disposal planning); and
- identify areas for further data collection and treatment research.

Only the technical aspects of waste treatment and disposal were considered in this report; other considerations, including social, ethical, political, economic, and policy aspects of disposal, were not considered.

1.3 QUALITY OF DATA

The analyses described in this report were based on characterization data collected by the DOE in 1995 for its Mixed Waste Inventory Report (MWIR) (INEL, 1995) and on site-specific treatment plans compiled into a site treatment plan (STP) database. The MWIR report contains characterization data for MLLW streams managed under agreements resulting from implementation of the FFCAct. Other activities may also generate MLLW, including environmental restoration and decontamination and decommissioning.

The quality of the data used in this analysis is a function of the quality of both the initial input data from the MWIR and STP databases and the efforts used in this analysis to process the data.

Data collection for the 1995 version of the MWIR was conducted for DOE by the National Low-Level Waste Management Technical Support Program (TSP) located at INEL. Two uncontrollable factors that affect data quality were recognized by the TSP staff:

1. The sites differ significantly in the type of data, level of confidence, and resources to collect and provide data.
2. The quality of the data collected is a function of the time and efforts at the site.

With these factors in mind, a data quality program for the MWIR database was developed by the TSP staff. This program was comprised of eight areas:

1. Well-defined requirements based on site and end-user input were created, detailed instructions for the data collection questionnaire were created, and format and abbreviations were standardized.
2. Where possible, the system to collect the data was designed to limit the responses to standardized pick-lists, which minimizes cases of invalid or inappropriate data in the fields. However, sites that electronically downloaded data into the form were able to defeat some of these features.
3. Before the data call, a training session was held with site contacts to review the questionnaire and instructions.

4. On-site and telephone technical assistance was provided to a number of sites. In many cases, site resources were supplemented by TSP staff.
5. Each data version received from the sites was cataloged and tracked to ensure that the most recent data were being used. Electronic data received from the sites were electronically checked to verify absence of corruption due to importation.
6. Electronic and manual quality assurance (QA) of each waste stream and treatment system was completed. The purpose of the QA was to verify that the sites responded appropriately to each query. Each stream was reviewed for internal inconsistencies.
7. The TSP staff reviewed data and faxed questions to site contacts for resolutions. All questions and responses were marked on a hard copy version of the waste stream and retained in the master files.
8. Final site review and approval was obtained after comment resolutions were incorporated into the site data.

The development of the STP database consisted of electronically incorporating data contained in site-specific treatment plans, and QA efforts were directed at ensuring that the data were incorporated correctly (e.g., review of input data). Little formal interaction with the site contacts was conducted.

The QA efforts for the evaluation summarized in this report involved review of input data and results of analyses by site contacts and assurance that the electronic database and calculations were error free. As discussed in Chapter 2 of this report, the input data and results of the calculations were reviewed by the site contacts (see Appendix A) on two separate occasions. Comments received during these reviews and resolution of these comments were entered into a QA catalog for the project. For each waste stream considered in the analysis, this QA catalog contains a record of all comments from the site and disposition of the comment by the project staff. In addition, it contains the basis for inclusion or exclusion of the waste stream for different parts of the evaluation described in this report.

Assurance that the electronic database and calculations used in the project were error free was provided by peer review of the calculations by technical staff at Sandia National Laboratories. When required data were missing or not available for a waste stream, that waste stream was identified as lacking data and not analyzed.

While the input data sets used in this analysis contain many gaps and uncertainties, the MWIR and STP databases represent the best available, centralized source of data for DOE MLLW. Used with circumspection and caution, these data appear to be adequate for use in a scoping-level analysis.

1.4 LIMITATIONS OF THE ANALYSIS

The estimation of volumes of residual MLLW and the comparison of concentrations of radionuclides in residual MLLW with the limits estimated by the PE project were scoping-level analyses for two primary reasons. First, the method used to estimate volumes and radionuclide concentrations in residual MLLW streams was a simplified approach to quantifying the effects of treatment processes: estimates were made of initial and after-treatment bulk densities of the waste and of the volume changes that would occur in using the preferred treatment processes. Second, the concentration limits estimated by the PE project were determined by using a set of modeling assumptions that included sufficient detail to capture major site-specific characteristics but were general enough for consistent application at all sites. Thus, the analysis described in this report was a scoping-level analysis to identify those residual MLLW streams for which disposal considerations should be given closer attention. Detailed analyses of the effects of treatment may provide different results than those presented here.

Prior to operating a disposal facility for MLLW, DOE must develop site-specific performance assessments and other performance analyses to ensure that prescribed dose objectives contained in DOE Order 5820.2A (DOE, 1988) will be achieved; these analyses result in the radiological component of a site-specific WAC. These WAC are used to determine acceptability of specific waste streams for disposal at a particular facility. DOE Order 5820.2A, which governs disposal of these wastes, is currently being revised. One of the revisions is expected to be related to evaluation of the consequences of inadvertent intrusion. Because most of the limiting concentrations for radionuclides used in the PE were based on consideration of intrusion, changes to the approach for evaluating these scenarios may substantially affect the results of the PE and, therefore, this analysis.

Residual MLLW streams identified in this analysis as being potentially problematic should not be considered as wastes that cannot be disposed of at any of the 15 sites evaluated in the PE project; instead, they should be viewed as wastes that need more careful scrutiny. Almost all of these potentially problematic waste streams are listed as such because disposal concentrations are limited by the assumed intrusion scenarios in the PE report; the effect of intrusion can be mitigated to some extent (e.g., by burying the waste deeper). Conversely, all other waste streams evaluated in this analysis are likely to present no significant technical issues for disposal. In this sense, the scoping-level nature serves to eliminate from further analysis waste streams that appear to present no significant issues for disposal and to focus attention on the wastes that require more analysis.

An additional "potentially problematic waste streams" report is currently being developed (Waters et al., draft of 4/24/97) that will provide the results of a more refined analysis of the disposability of the residuals from treatment of MLLW than those provided by this report. Specific waste streams requiring additional evaluation and research will be identified. By identifying the waste streams that may still pose problems for disposal, research and development can be funded in the needed areas. The final "potentially problematic waste streams" report will provide input to documents prepared by DOE's Mixed Waste Focus Area for DOE's Environmental Management customers, including Waste Management (EM-30), Environmental Restoration (EM-40), and Facility Transition (EM-60) divisions.

2. METHODOLOGY

The DOE has been collecting characterization information for its MLLW for over three years and has developed STPs for the MLLW streams at each of its sites that stores or may generate this waste. In this report, disposal considerations related to the currently available STPs are presented. One of the primary disposal considerations addressed in this project was an estimate of the volume of residual MLLW for disposal. This information will aid in DOE's determination of the size and number of disposal facilities that will be required to manage DOE LLW. Another disposal consideration addressed in this project was an estimate of concentrations of radionuclides in the residual MLLW. By comparing these concentrations with the limiting concentrations of radionuclides in waste developed in the performance evaluation (PE) report (DOE, 1996), information was provided about the acceptability of residual MLLW for disposal and about waste streams that require further evaluation.

The general methodology for the project is shown by the flow diagrams in Figures 2-1 and 2-2. As indicated in the blocks of each flow diagram, the steps of the methodology are discussed in the identified sections of this chapter.

2.1 SELECTION OF WASTE STREAMS FOR EVALUATION

Mixed low-level waste streams have been identified by DOE sites for inclusion in site-specific treatment plans. Characterization data for these waste streams are stored in the database for the MWIR, which was last updated in June 1995. Each site with MLLW streams continually updates its own characterization data related to the waste streams; the incorporation of these changes is discussed later in this section.

The plans for treating each waste stream are contained in the STP for each site. These plans provide the basis for the consent orders between the sites and their regulating agencies. The details of the STPs are contained in database format. More recent estimates of waste stream volumes than those in the MWIR database are also contained in the STP database. The MWIR and STP databases are largely consistent but not completely so because of the dynamic nature of the development of characterization data and subsequent identification of waste streams that contain MLLW at each site.

The waste streams for all sites that have both MWIR data and an STP were included in this analysis. In addition, although the Hanford Site was not required to develop an STP because it has a Tri-Party Agreement (FFCAct §102 (c)(5), 1992), the waste streams at this site were also included in the analysis. The sites considered in this analysis are listed in Table 2-1.

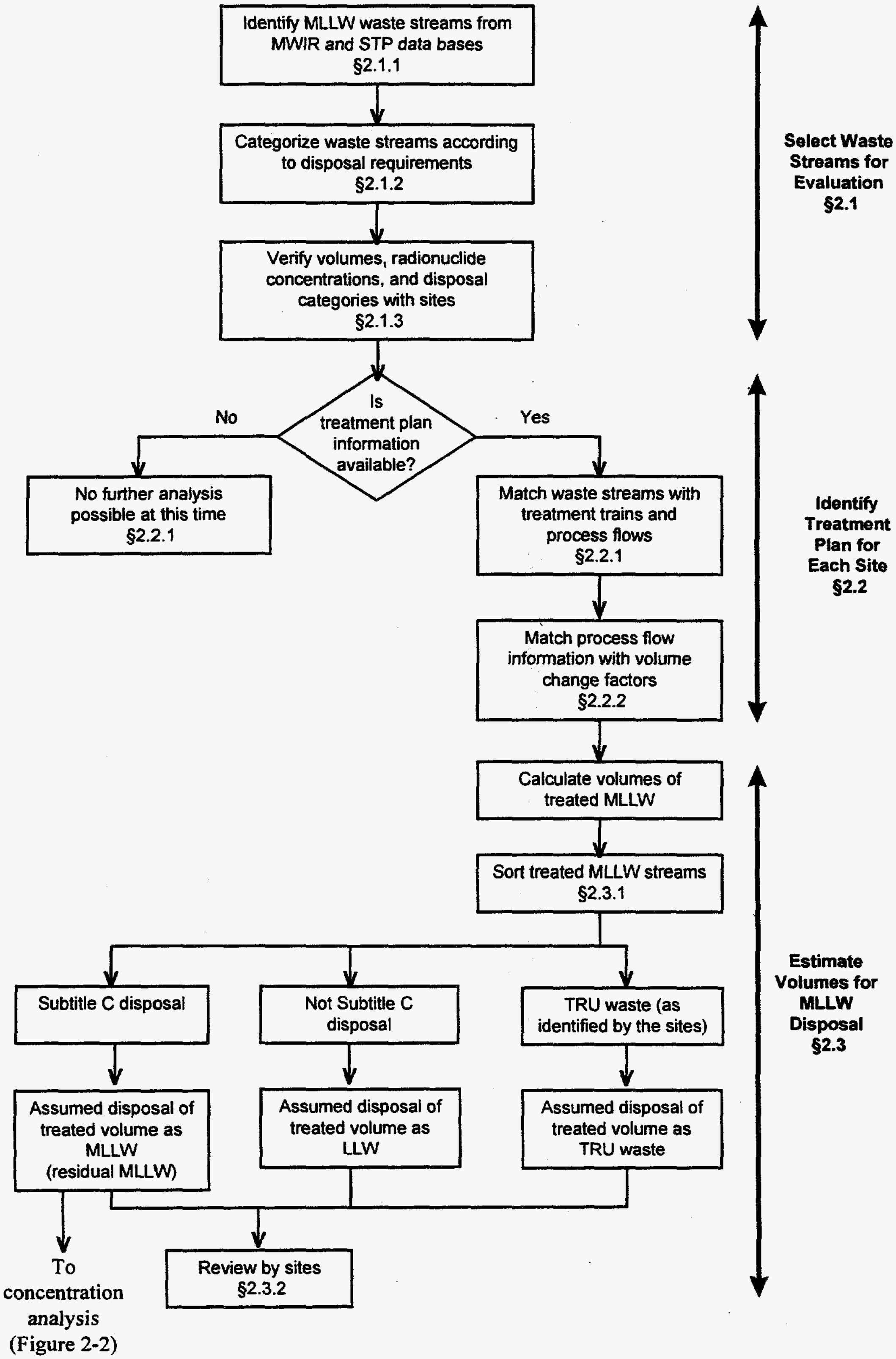

Figure 2-1. Flow diagram for analysis of MLLW.

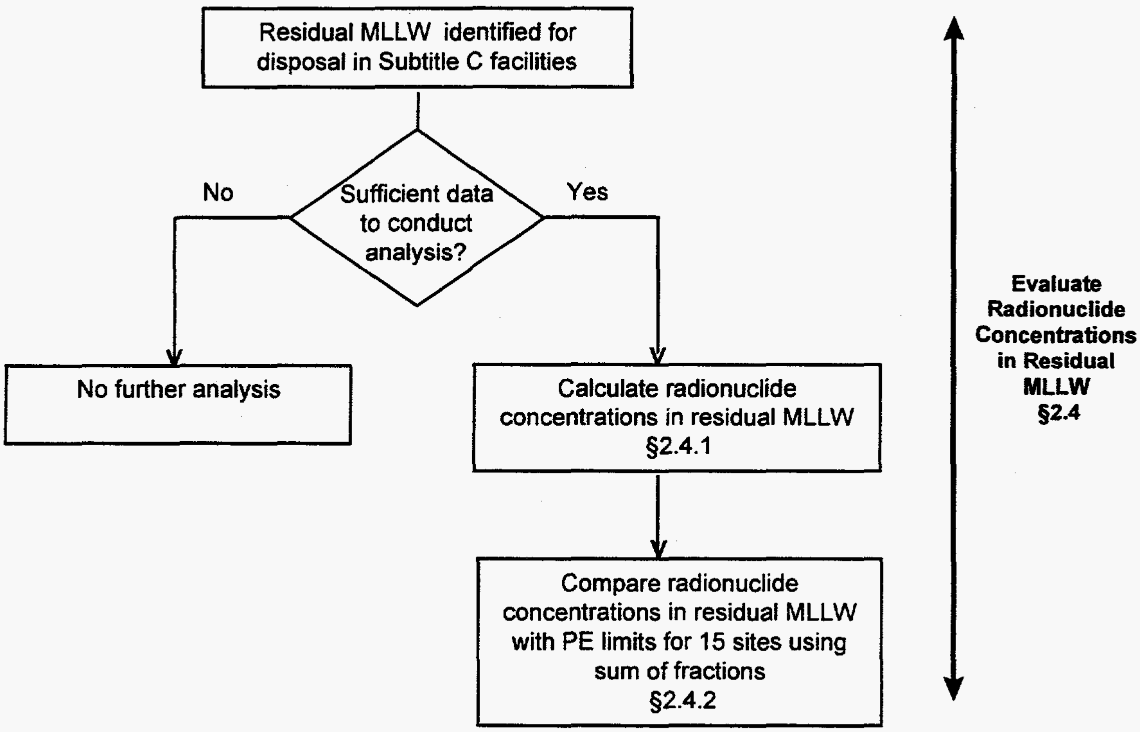

Figure 2-2. Flow diagram for analysis of radionuclide concentrations in residual MLLW.

Table 2-1. Sites Considered in the Residuals Analysis Project (sites shown in italics were evaluated for their disposal capabilities in the performance evaluation project [DOE, 1996]).

State	Site
California	Energy Technology Engineering Center (ETEC) General Atomics Former Laboratory for Energy-Related Health Research Lawrence Berkeley National Laboratory (LBL) Mare Island Naval Shipyard (Mare Island NSY) *Lawrence Livermore National Laboratory (LLNL)*
Colorado	*Rocky Flats Environmental Technology Site (RFETS)*
Connecticut	Knolls Atomic Power Laboratory - Windsor (KAPL-W)
Hawaii	Pearl Harbor Naval Shipyard (Pearl Harbor NSY)
Idaho	*Idaho National Engineering Laboratory (INEL)* (including Argonne National Laboratory - West [ANL-W])
Illinois	*Argonne National Laboratory - East (ANL-E)*
Iowa	Ames Laboratory
Kentucky	*Paducah Gaseous Diffusion Plant (PGDP)*
Maine	Portsmouth Naval Shipyard (Portsmouth NSY)
Missouri	Weldon Springs Remedial Action Project Missouri University Research Reactor (MURR)
Nevada	*Nevada Test Site (NTS)*
New Mexico	*Los Alamos National Laboratory (LANL)* *Sandia National Laboratories (SNL)*
New York	Knolls Atomic Power Laboratory - Kesselring (KAPL-K) Knolls Atomic Power Laboratory - Niskayuna (KAPL-N) Brookhaven National Laboratory (BNL) *West Valley Demonstration Project (WVDP)*
Ohio	Battelle Columbus Laboratories Decommissioning Project (Battelle) *Fernald Environmental Management Project (FEMP)* Mound Plant (Mound) *Portsmouth Gaseous Diffusion Plant (PORTS)* RMI Titanium Company (RMI)
Pennsylvania	Bettis Atomic Power Laboratory (Bettis)
South Carolina	*Savannah River Site (SRS)* Charleston Naval Shipyard (Charleston NSY)
Tennessee	*Oak Ridge Reservation (ORR)* (including K-25 Site, Oak Ridge National Laboratory [ORNL], Y-12 Plant)
Texas	*Pantex Plant (Pantex)*
Virginia	Norfolk Naval Shipyard (Norfolk NSY)
Washington	Puget Sound Naval Shipyard (Puget Sound NSY) *Hanford Reservation (Hanford)*

2.1.1 Identify MLLW Streams Common to the MWIR and STP Databases

The waste streams initially identified for evaluation in this project were the 1689 streams that were contained in both the MWIR and STP databases. The preliminary volumes for the waste streams were those associated with the MWIR database, with site-specific updates provided during site reviews. A comparison of the total waste stream volumes for the two databases (Table 2-2) shows that the two estimates of volumes are within 1.5%. Differences in the volumes assigned to the waste streams in the two databases are due to revised estimates at the time of the database calls, newly generated waste associated with a stream, the combination of previously distinct waste streams, or treatment of waste associated with a stream.

Table 2-2. Volumes of MLLW Associated with the MWIR and STP Databases

Waste Streams	MWIR Database (# of streams)	MWIR Database (m^3)	STP Database (# of streams)	STP Database (m^3)
in MWIR and STP	1689	113,300	1689	115,024
in MWIR and not STP	193	373	-	-
in STP and not MWIR	-	-	174	467

Some waste streams were reported in the MWIR and not reported in the STP for a number of reasons: treatment was not required for the waste stream; the waste stream was not subject to the FFCAct process; or the waste stream was redistributed to other existing or new streams. Some streams were reported in the STP and not reported in the MWIR: they were either newly generated waste streams or redefined MWIR waste streams resulting in new waste streams.

2.1.2 Categorize Waste Streams by Disposal Requirements

The 1689 MLLW streams in both MWIR and STP databases were sorted depending on whether the RCRA hazardous constituents they contain are defined as characteristic or listed hazardous wastes. In general, a waste containing a hazardous characteristic is required by RCRA to be treated to remove the characteristic. These wastes may then be disposed of in RCRA non-Subtitle C disposal facilities. In this report, MLLW that contains only characteristic wastes and is treated to meet the LDRs of RCRA was assumed to be disposed of as LLW; MLLW disposal capacity is not required for these wastes.

Due to the "derived from" requirements of RCRA (40 CFR Part 261.3 (c)(2)), waste streams categorized in RCRA as listed hazardous wastes will remain MLLW even after treatment to remove the listed constituent. These wastes will be disposed of in Subtitle C disposal facilities, and MLLW disposal capacity was assumed to be required for these wastes. Treated wastes containing combinations of listed and characteristic hazardous constituents were assumed to be disposed of in facilities for MLLW due to the presence of the listed wastes. In addition, MLLW debris containing listed or characteristic wastes that are treated under the debris rule using waste stabilization methods must still be disposed of in a Subtitle C disposal facility; MLLW disposal capacity was assumed to be required for these wastes.

Many states have been delegated authority for regulation of RCRA, and some states have developed additional requirements that are different than those contained in the Code of Federal Regulations. While these state regulations will apply to certain of the waste streams considered in this evaluation, only the federal regulations were used in this evaluation for several reasons: (1) the locations for treatment and disposal of waste streams are often not known, so that the specific state regulations cannot be selected and (2) the compilation, incorporation, and evaluation of the most recent changes to state regulations is beyond the scope of this analysis.

2.1.3 Review by DOE Sites

Summaries of the characteristics of waste streams common to both the MWIR and STP databases and sorted by anticipated disposal as MLLW or LLW were reviewed by each site. These reviews were used to update waste volumes, radionuclide concentrations, and classifications of hazardous constituents; to add new waste streams; and to delete waste streams that were no longer considered MLLW or which had already been treated and disposed of. In addition, the type of disposal required for each of the waste streams was reviewed and modified by the sites.

The review served as a site-specific quality check for the waste stream data used in the analysis. The site contacts listed in the MWIR database were the primary site contacts for this review.

2.2 IDENTIFY TREATMENT PLANS FOR EACH WASTE STREAM

The DOE sites have identified their preferred treatment alternatives for each of the MLLW streams, and these plans are contained in the STP database. These treatment processes, represented by process flow diagrams, were used as the basis for determining the effects of treatment on the volume of waste and on the concentrations of radionuclides in treated waste. While most of the sites identified existing treatment facilities for many of their waste streams, some sites either identified new, unbuilt treatment facilities or described the preferred treatment process for some of their wastes in general terms. For these latter two cases, either (1) assumptions were made to arrive at a process flow diagram or (2) the waste streams were identified as not having enough information to make reasonable assumptions.

2.2.1 Relate Waste Streams to Process Flows

For the waste streams that were clearly associated with a known treatment process, the characteristics of that treatment process were used to estimate the changes in waste volumes and radionuclide concentrations in waste. For waste streams with an associated treatment process that was less specific, assumptions about the treatment processes made by the DOE Mixed Waste Focus Area (MWFA) were used.

The MWFA has been evaluating combinations of waste streams and treatment processes using an approach similar to that explained here to help them prioritize their technology development needs by identifying the current technology barriers to treatment of MLLW. In the course of their work, the MWFA made assumptions about the treatment processes associated with the waste streams based both on the MWIR and STP data and on interaction and review by the DOE sites (MWFA, 1996). In this project, the process flow diagrams identified by the MWFA were used as the basis for estimating the changes in waste volumes and radionuclide concentrations in waste for waste streams with poorly defined plans for treatment.

Some waste streams in the MWIR and STP databases had no associated information about the preferred treatment process. These streams were either poorly characterized or had unique characteristics that made identifying a preferred treatment process difficult. These streams were identified in this project as having no known treatment process, and they were not analyzed further. Additional site-specific decisions for type of treatment will be required before plans for disposal can be determined.

2.2.2 Match Process Flows to Volume Change Factors

Given the waste characteristics and the assumptions about the treatment processes for each waste stream, estimates were made for the changes in volumes of waste due to treatment. The volume of waste after treatment, V_F, was estimated using Equation 1 and assumptions based on work done at the Savannah River Site (SRS) (WSRC, 1995), which are summarized in Table 2-3.

$$V_F = (V_{CI} + V_P) \times AMR \times \frac{\rho_{b-initial}}{\rho_{b-final}} \qquad (1)$$

where

V_{CI} is the current inventory for the waste stream (m^3);
V_P is the 5-year projected inventory for the waste stream (m^3);
AMR is the activity-per-unit-mass ratio (the ratio of the activity per unit mass before treatment to the activity per unit mass after treatment), given in Table 2-3 (dimensionless);
$\rho_{b\text{-}initial}$ is the initial bulk density of the waste (g/cm^3); and
$\rho_{b\text{-}final}$ is the final bulk density of the treated waste (g/cm^3).

The preliminary estimates for $\rho_{b\text{-}initial}$ for the waste streams were based on the matrix parameter categories (MPC) associated with each waste stream in the MWIR database. The definitions for the MPC are contained in Kirkpatrick (1995). The sites reviewed and updated the estimates for all parameter values, including AMR, for each of the waste streams. The ranges of AMRs selected by the sites are shown in the last column in Table 2-3.

2.3 ESTIMATE VOLUMES OF TREATED MLLW FOR DISPOSAL

An estimate of the volume of treated MLLW was made for each waste stream using Equation 1 and the preliminary estimates for parameter values.

Table 2-3. Activity Per Unit Mass Ratio (AMR) for Selected Waste Types (from Ades, 1996)

Waste Type	Treatment Process	AMR $(A_1/m_1)/(A_2/m_2)$[a]	Range or Value Used by Sites
Wastewater	Thermal	0.01	0.01 - 0.1
	Non-Thermal	0.25	0.001 - 0.25
	Direct Stabilization	2	0.2
Combustible Organics	Thermal	<0.01	0.01 - 2
	Non-Thermal	2	0.01 - 2
Inorganic Homogeneous Soils and Solids	Thermal	2	0.01 - 2
	Thermal Desorption	2	1 - 2
	Non-Thermal	2	1 - 2
	Non-Thermal Extraction Oxidation	2	2
Debris	Thermal	0.05	0.01 - 2
	Non-Thermal	2	2
	Stabilization	2	1 - 2
	Thermal Desorption	2	--[b]
Lab Packs	Thermal Oxidation	0.05	0.01 - 1
	Chemical Oxidation	2	2 - 100
	Chemical Precipitation	Variable	--[b]
Elemental Mercury	Amalgamation	10-20	2 - 15
Hazardous Metals (Pb, Cd, Be)	Surface Decontamination	0.05	0.05 - 0.5
Batteries	Surface Decontamination Liquid/Solid Separation Neutralization	2	--[b]
Reactive Metals	Deactivation	2	--[b]
Explosives/Propellants	Thermal Oxidation/Incineration	0.05 (solids) 0.01 (liquids)	--[b] --[b]
	Chemical Deactivation	2	2
Compressed Gases/Aerosols	Thermal Oxidation/Incineration	0.01	1
	Chemical Redox	2	1

[a] A_1/m_1 is the radioactivity per unit mass ratio before treatment; A_2/m_2 is the radioactivity per unit mass ratio after treatment; the radioactivity is assumed to be the same before and after treatment. Except for amalgamation and surface decontamination of hazardous metals, values include a factor of 2.0 to account for stabilization of residual wastes. For example, the AMR of 1/100 for thermal treatment of wastewater is the product of 1/200 for thermal treatment and 2 for stabilization of the residuals.

[b] Not used in the analysis

2.3.1 Sort Waste Streams by Disposal Type

As discussed in Section 2.1.2 and shown in Figures 1-2 and 2-1, the treated MLLW was categorized based on whether it was expected to be disposed of as residual MLLW or LLW. In the previous site review discussed in Section 2.1.3, some sites identified waste streams known to contain TRU radionuclides with concentrations between 10 and 100 nCi/g. Treatment of these waste streams by a process that reduces the mass of waste by more than a factor of 10 (e.g., incineration) will result in TRU waste. Because the resulting concentrations of TRU radionuclides will be greater than 100 nCi/g, the regulatory threshold for TRU waste, the resulting wastes cannot be disposed of as MLLW. In general, these wastes are expected to be disposed of at the Waste Isolation Pilot Plant (WIPP), a TRU waste repository under construction in New Mexico.

Waste streams that will become TRU waste after treatment were identified by some sites and are identified in this report as TRU waste resulting from treatment of MLLW.

2.3.2 Review by DOE Sites

The assumptions pertaining to the treatment processes and the preliminary estimates of values for parameters were reviewed and modified by each site to reflect the current knowledge of the site treatment personnel. These reviews were used to update the estimates of final waste volumes and concentrations of radionuclides (discussed in the next section). In some instances, this new information allowed the addition or deletion of waste streams.

2.4 EVALUATE RADIONUCLIDE CONCENTRATIONS IN TREATED WASTE

Many of the waste streams identified in the MWIR and STP databases had sufficient radiological characterization to make estimates of the treated concentrations of radionuclides in the waste. For this project, sufficient radiological characterization meant that a listing of at least one of the radionuclides in a waste stream and an estimate of its concentration was available from the MWIR database or from site input. These waste streams were identified, estimates of radionuclides concentrations in the residual MLLW were made, and the resulting concentrations were compared with the permissible radionuclide concentrations in waste estimated by the PE project (DOE, 1996). Waste streams with insufficient radiological characterization were identified and not analyzed further in this evaluation; additional radiological characterization will be required prior to evaluating these waste streams.

2.4.1 Estimate Radionuclide Concentrations in Residual MLLW

Using both the physical, chemical, and radiological characteristics of the waste streams reported in the MWIR database and the assumptions about the treatment processes for each waste stream, estimates were made for the changes in radionuclide concentrations in waste due to treatment. The concentration in the residual MLLW streams for each radionuclide i, C_{Fi}, was estimated using Equation 2 and assumptions similar to those associated with Equation 1.

$$C_{Fi} = C_{Ii} \times \frac{1}{AMR} \times \frac{\rho_{b-final}}{\rho_{b-initial}} \tag{2}$$

where

C_{Ii} is the initial concentration of radionuclide i for the waste stream ($\mu Ci/m^3$).

Radionuclides with half-lives less than 5 years were not included in either this analysis or the PE project due to their limited effect on the long-term aspects of disposal.

When data were available, the values assumed for C_{Ii} were those given in the MWIR database. When mean concentration values were not given, the geometric mean was calculated based on the range of concentrations given in the MWIR. An approximation of the geometric mean, $\overline{C}_{Ii-g}$, was calculated using the following equation:

$$\overline{C}_{Ii-g} = \sqrt{\overline{C}^2_{Ii-a} - (f)\left(\frac{\Delta C_{Ii}}{2}\right)^2} \tag{3}$$

where

$\overline{C}_{Ii-a}$ is the arithmetic mean;

$f = 0.99$ and is the fraction of the distribution used to represent the reported minimum and maximum values; and

ΔC_{Ii} is the difference between the maximum and minimum values.

Mean values were used instead of maximum values because (1) treatment processes tend to provide a homogenization that results in concentrations of radionuclides near their mean, and (2) the range of radionuclide concentrations was generally based on a smaller scale (e.g., drums), which results in a wider range of values than when aggregated to a larger scale (e.g., waste stream).

Distributions of radionuclides were assumed for residual MLLW streams that identified radionuclides as mixed fission products (MFP), mixed activity products (MAP), depleted uranium (DU), and natural uranium (Table 2-4). These distributions were based on an average decay of 20 years (an estimate of the average time between waste characterization and disposal), and radionuclides with half-lives less than 5 years were not included. If site-specific information about the mixed fission or activity products or about depleted or natural uranium was available, the initial distributions were revised to reflect the site-specific information.

For residual MLLW streams that had one or more radionuclides without concentrations, the concentrations of the remaining radionuclides were evaluated and the missing data noted.

Table 2-4. Assumed Distributions for Mixed Fission Products (MFP), Mixed Activity Products (MAP), Depleted Uranium (DU), and Natural Uranium

Radionuclide	Relative Activity (%)
MFP	
SR-90 (and Y-90)	47.0
Tc-99	0.02
Cs-137	49.0
Cd-113m	0.13
Sn-121	0.09
Sm-151	1.4
Eu-152	2.0
Eu-154	0.36
DU	
U-238	100.0

Radionuclide	Relative Activity (%)
MAP	
C-14	7.0
Co-60	67.0
Cs-137	5.0
Eu-152	3.0
Eu-154	18.0
Natural Uranium	
U-234	48.7
U-235	2.2
U-238	49.1

2.4.2 Compare Radionuclide Concentrations in Residual MLLW with Concentration Estimates in the PE Report

The grouted waste form was used in the PE project (DOE, 1996) to develop estimates of limiting concentrations of radionuclides in waste. However, waste forms other than grout are also expected to be used for MLLW. In this analysis, the final waste form for each waste stream was based on both site-specific treatment plans and input received from site reviews. For residual MLLW streams that resulted in grouted residuals, polyethylene microencapsulation, polyethylene macroencapsulation, or glass waste forms, the concentrations of radionuclides were compared with limiting concentrations derived for the 15 DOE sites in the PE project. The comparisons allowed accounting for the differing performances of these waste forms in the groundwater pathway. Residual MLLW streams that resulted in other waste forms were compared with the PE limits for grout.

Leach rate models for polyethylene microencapsulation, polyethelene macroencapsulation, and glass waste forms were recently summarized for DOE (SNL, 1996). Because the water pathway analysis used in the PE project allows the substitution of other waste forms in place of grout, the results of the leach rate modeling enabled the determination of permissible concentrations for the other three waste forms. The results of these recent analyses using the three waste forms (polyethylene microencapsulation, polyethylene macroencapsulation, and glass) are presented in Appendix B and account for the differing performances of these waste forms in the groundwater pathway. For radionuclides that were limited by the intrusion pathway, the limits based on intrusion for the grouted waste form from the PE project were used for all four waste forms.

The comparisons of radionuclide concentrations were made using the sum-of-fractions (*SOF*) method described in 10 CFR Part 61.55:

$$SOF = \sum_i \frac{C_{i-waste}}{C_i} \tag{4}$$

where

$C_{i\text{-}waste}$ is the concentration of radionuclide i in the treated waste ($\mu Ci/m^3$); and
C_i is the concentration limit for radionuclide i in waste as estimated in the PE report ($\mu Ci/m^3$).

The comparisons of radionuclide concentrations in residual MLLW with the concentration limits from the PE for the 15 DOE sites were placed into one of four categories, depending on the result of the calculation in Equation 4. These categories are summarized in Table 2-5.

Table 2-5. Categories for Comparison of Radionuclide Concentrations in Residual MLLW with the PE Limits

Category Symbol	Sum of Fractions (SOF)	Description
○	SOF ≤ 0.1	Concentrations in residual MLLW are one or more than one orders of magnitude below the PE limits. These wastes are highly likely to be technically suitable for disposal at that site.
□	0.1 < SOF ≤ 1.0	Concentrations in residual MLLW are equal to or less than one order of magnitude below the PE limits. These wastes are also likely to be technically suitable for disposal at that site but by a smaller margin than the category described above.
■	1.0 < SOF ≤ 10	Concentrations in residual MLLW are less than or equal to one order of magnitude above the PE limits. Although the combined concentrations of radionuclides in waste are greater than the PE limits for these streams, many conservative assumptions were used to develop the PE and the residuals analysis, and more detailed analyses (i.e., site-specific performance assessments) may show that these waste streams will also be technically suitable for disposal.
●	SOF > 10	Concentrations in residual MLLW are more than one order of magnitude above the PE limits. As with the wastes in the previous classification, more detailed analyses (i.e., site-specific performance assessments) may show that these waste streams will also be technically suitable for disposal. However, a revised treatment plan, disposal design, or disposal location may also be required for some of these wastes.

3. RESULTS

The results of the analysis are presented in terms of (1) volumes of treated MLLW for disposal and (2) comparisons of radionuclide concentrations in residual MLLW to the limiting concentrations of radionuclides in waste that were estimated by the PE project (DOE, 1996). The volumes of waste are associated with the sites that have generated or expect to generate the waste. While treatment may occur either on-site or off-site, an assumption used in this analysis to track individual waste streams was that the waste stream remained associated with the site that generated the waste stream unless a final disposal location had been identified or some other agreement had been made for a particular waste stream. This approach is consistent with the general language contained in most FFCAct consent orders.

3.1 VOLUMES OF WASTE FOR DISPOSAL

The waste streams evaluated in this report consist of the MLLW that was identified (1) in both the 1995 update to the MWIR database and in the site treatment plans and consent orders required by the FFCAct and (2) through site review in which some sites added newly generated waste streams. In this report, the volume of MLLW was estimated by using site-specific updates to the volume estimates in the 1995 version of the MWIR database. These site-specific updates were performed during April through July of 1996 and were coordinated with the site contacts identified in the MWIR database. Because the estimates of actual and projected volumes of waste change with time, the volume estimates presented in this report may be different than those in other DOE reports.

3.1.1 Complex-Wide Volumes of Waste for Disposal

Based on the information in the MWIR and STP databases and on site reviews, the initial total volume of MLLW before treatment used in this analysis is estimated to be 130,300 m^3. This initial total volume has been divided into three main categories in Figure 3-1: volume of treated MLLW for disposal; volume reduced due to treatment; and volume not included in the analysis due to lack of data. Based on the assumptions outlined in Chapter 2, the volumes of treated MLLW for disposal can be further subdivided into three categories: residual MLLW, LLW, and TRU waste. These "after treatment" volumes of waste are based on the type of hazardous constituents in the waste, the method chosen to treat the waste, and the assumed changes in volume due to treatment.

About 7% (9000 m^3) of the initial total volume of MLLW was not included in the analysis because a preferred treatment process had not been specified by the sites. As characterization of waste continues and feasible treatment alternatives are identified, this volume is expected to decrease. Some of the waste streams represented by this volume, typically those that either were poorly characterized or had unique characteristics that made identifying a preferred treatment process difficult, may be candidates for advanced treatment processes being developed by DOE.

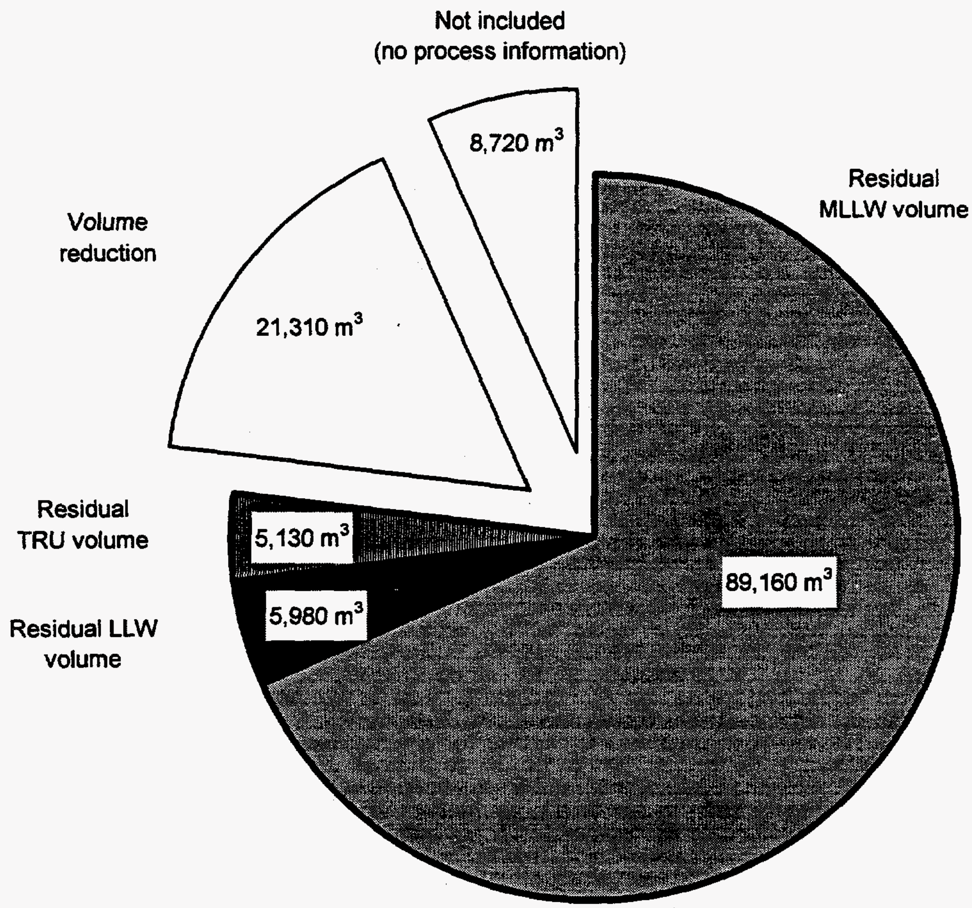

Figure 3-1. Categorization of the initial total volume of MLLW.

The initial estimate for volume reduction of MLLW due to treatment and subsequent stabilization is expected to be about 16% (21,000 m^3). Some waste streams will increase in volume due to treatment (e.g., the addition of a stabilizing agent such as Portland cement). Other waste streams will be reduced in volume due to treatment (e.g., incineration of combustible materials). This estimate of volume reduction is the aggregate of the volume changes for each individual waste stream and treatment process combination.

Of the initial total volume of MLLW, about 68% (89,000 m^3) is estimated to require disposal as MLLW. This volume of waste is composed of waste streams that contain one or more "listed" RCRA constituents and hazardous debris wastes that are immobilized under the debris rule. One of the major types of MLLW that will require disposal as MLLW is "homogeneous solids and soils," a category of waste that does not significantly change volume due to treatment (Table 3-1). The waste stream-specific input data and results are contained in Appendix C.

Table 3-1. Waste Types and Projected Treatment of Residual MLLW

Waste Type and Projected Treatment	MWIR Current and 5-Yr Projected Volume (m^3)	Treated Volume (m^3)	Number of Waste Streams
Combustible Organics	**4,311**	**158**	**231**
Non-Thermal	1,596	146	30
Incineration/Thermal	2,708	11	192
Retort/Thermal treatment/Chemical reduction	7	1	9
Debris	**15,130**	**13,900**	**162**
Stabilization	12,403	12,596	138
Non-Thermal	2,045	1,293	7
Macroencapsulation	6	6	5
Thermal	674	3	11
Thermal treatment/Chemical reduction	2	3	1
Inorganic Homogeneous Solids and Soils	**32,121**	**36,166**	**141**
Stabilization	25,094	31,122	101
Thermal Desorption	3,175	3,664	3
Thermal	3,454	904	30
Extraction/Oxidation	397	475	5
Incineration/Thermal	1	1	1
Retort/Thermal treatment/Chemical reduction	0.1	0.03	1
Lab Packs	**543**	**375**	**40**
Thermal treatment/Deactivation/Chemical reduction	488	179	32
Chemical Oxidation	12	135	2
Stabilization	42	60	3
Chemical reduction	1	1	3
Wastewater	**2,275**	**96**	**53**
Non-Thermal	553	58	17
Thermal	1,714	37	33
Direct Stabilization	5	1	1
Stabilization	1	0.1	1
Incineration/Thermal	3	0.01	1
Other	**27,798**	**38,466**	**37**
Unstabilized Pond Sludge, Stabilization	10,734	21,467	1
Stabilized Pond Sludge, Stabilization	16,455	16,455	1
Backlog soils, Meet BDAT	284	284	2
TSCA Residues, Stabilization	61	122	1
Elemental mercury, Amalgamation	4	67	7
Lead, cadmium, beryllium, and other hazardous metals, Macroencapsulation	215	67	15
Scintillation Cocktails, Stabilization	43	2	1
Explosives/propellants, Chemical Deactivation	0.2	0.4	1
Compressed gases/aerosols, Chemical redox	0.5	0.4	1
Liquid, Chemical reduction/Stabilization/Deactivation	0.3	0.3	1
Compressed gases/aerosols, Thermal oxidation	0.2	0.2	2
Sr Organic Waste, Thermal Oxidation	0.1	0.005	1
Organic Extraction Waste, Thermal Oxidation	0.1	0.004	1
Liquid, Thermal	0.2	0.001	1
Pu Scintillation, Thermal Oxidation	0.004	0.0001	1

The procedure for reporting waste stream data in the MWIR database sometimes causes the volume estimate for waste that will require disposal as MLLW to be high by an unknown amount. In the MWIR database, if any part of a waste stream contains a particular RCRA constituent, then that RCRA constituent code was applied to the entire waste stream. Therefore, if only one drum in a waste stream contains a "listed" RCRA code, then the entire waste stream is reported as containing that listed waste. In actuality, as waste characterization continues, some of the waste identified as MLLW may eventually be determined to be LLW or non-radioactive hazardous waste. Both of these situations have occurred at several sites since data were compiled for the 1995 MWIR database, as indicated by comments during site reviews.

About 5% (6,000 m^3) of the initial total volume of MLLW is expected to result in waste that can be managed and disposed as LLW. This volume of waste is composed of waste streams that either contain only "characteristic" RCRA wastes or are hazardous debris wastes that are treated with an extraction or destruction process under the debris rule.

About 4% (5,000 m^3) of the initial total volume of MLLW is expected to require disposal as TRU waste. This volume of waste is composed of waste streams that contain high activities of one or more TRU radionuclides that, when concentrated by volume reduction in treatment, will exceed the TRU concentration limit of 100 nCi/g.

3.1.2 Complex-Wide Volumes of Residual MLLW Planned for Commercial Disposal

As part of the review process for this project, the sites were asked to identify waste streams that they planned to send to commercial sites for disposal. Based on that response, of the estimated 89,000 m^3 of residual MLLW, the DOE sites are planning to dispose of about 49,000 m^3 (55% of total residual MLLW) at commercial facilities (Figure 3-2). The sites indicated for the remaining 45% of residual MLLW that either disposal plans were incomplete or the waste was designated for disposal at a DOE site yet to be determined.

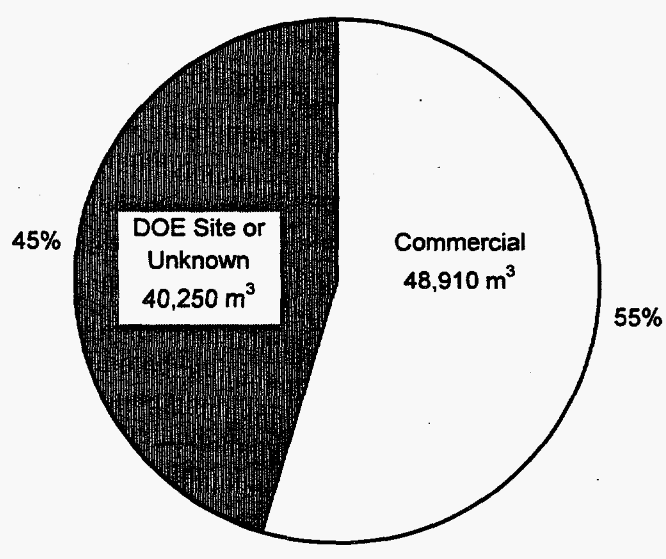

Figure 3-2. Planned disposal of residual MLLW.

Many of the site contacts indicated that the commercial disposal option was being pursued because there were no other viable options for disposal of MLLW. Some site contacts indicated that they were evaluating commercial disposal for some of their wastes but that existing plans were too preliminary to identify these waste streams as being planned for disposal at commercial facilities. Based on this input, 55% of total residual MLLW may represent a low estimate of waste volumes planned for commercial disposal by the DOE sites. As shown in the following section, the largest volumes of waste for disposal at commercial facilities are from the ORR.

3.1.3 Site-Specific Volumes of Treated MLLW for Disposal

The site-specific estimates of volumes of residual MLLW are shown in Figure 3-3. Ten of the 35 sites have estimated volumes of less than 1 m^3 each; 17 of the sites have estimated volumes of less than 10 m^3 each; 22 of the sites have estimated volumes of less than 100 m^3 each. About half of the waste is located at the Oak Ridge Reservation (ORNL, K-25 site, and Y-12 plant); approximately 97% of the waste is located at four sites (ORR, PORTS, RFETS, and Hanford).

The ORR has both the largest volume of residual MLLW and the largest volume planned for disposal at a commercial facility. The largest volume of the ORR wastes planned for commercial disposal is the pond sludges already contracted for disposal at Envirocare of Utah. The RFETS has the largest volume of residual MLLW that is not currently planned for commercial disposal. Hanford is planning for on-site disposal of its residual MLLW. Accounting for the disposal plans of ORR and Hanford, approximately 32,000 m^3 of residual MLLW have no planned location for disposal.

The site-specific estimates of volumes of treated MLLW that will be managed as LLW are shown in Figure 3-4. Most of the sites have relatively small volumes of this LLW; only 3 sites (ANL-W, Hanford, and SRS) will have over 1000 m^3 of this waste.

The site-specific estimates of volumes of treated MLLW that will be managed as TRU waste are shown in Figure 3-5. These TRU wastes result from treatment of MLLW containing TRU radionuclides with concentrations between 10 and 100 nCi/g; the concentrations increase to above the TRU limit of 100 nCi/g as the mass of waste is reduced by thermal treatment. The majority of this waste is located at INEL.

3.2 EVALUATION OF RADIONUCLIDE CONCENTRATIONS IN RESIDUAL MLLW

In the MWIR database, two parameters related to radiological characteristics of the waste streams – mean concentrations and concentration ranges for the radionuclides in the waste streams – were used in the concentration analysis. However, not all of the listings of waste streams in the MWIR database include information about these radiological characteristics. For the waste streams that result in residual MLLW, the available radiological data were used to compare the concentrations of radionuclides in residual MLLW with the permissible concentrations of radionuclides in waste that were estimated by the PE project (DOE, 1996).

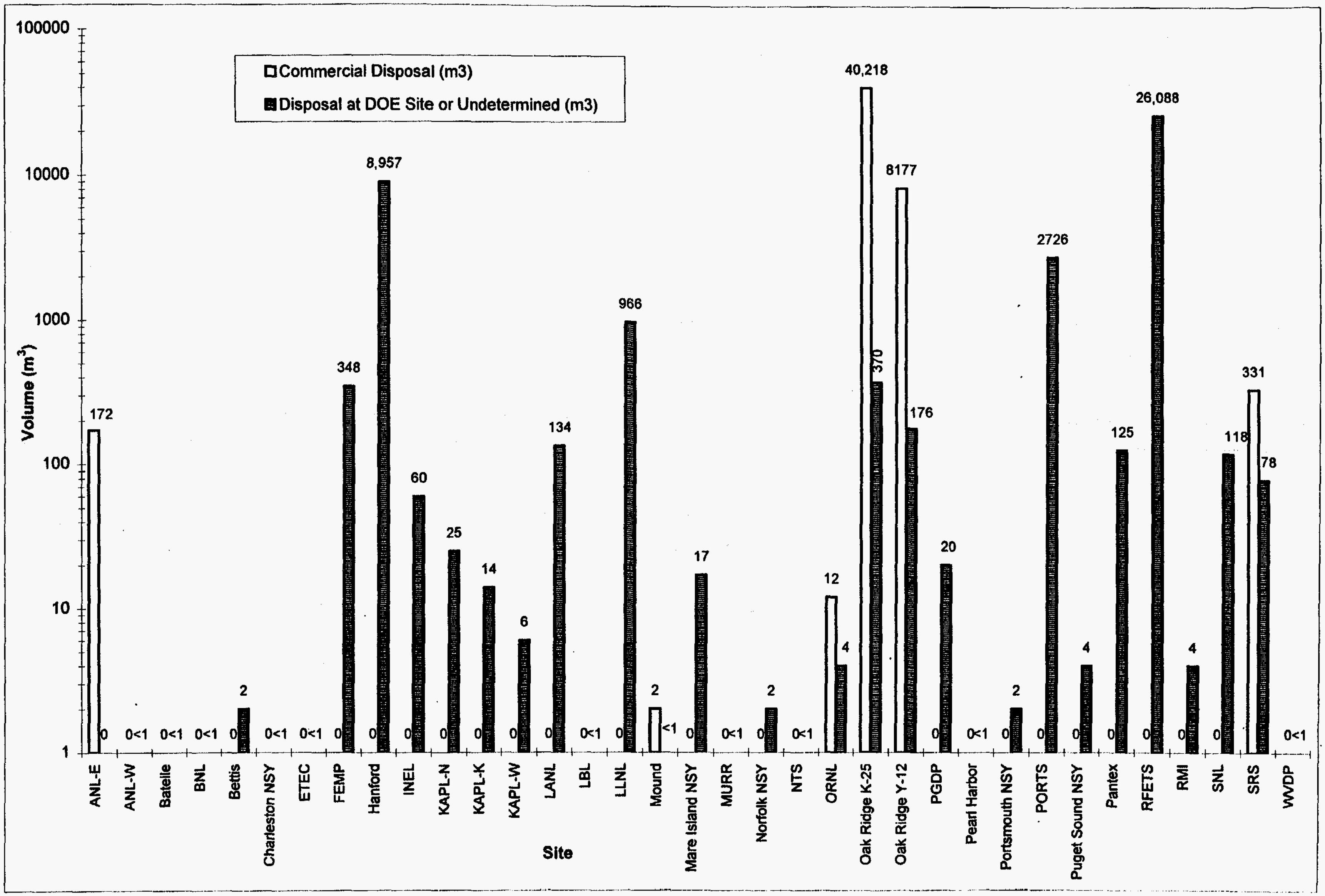

Figure 3-3. Volumes of residual MLLW by site.

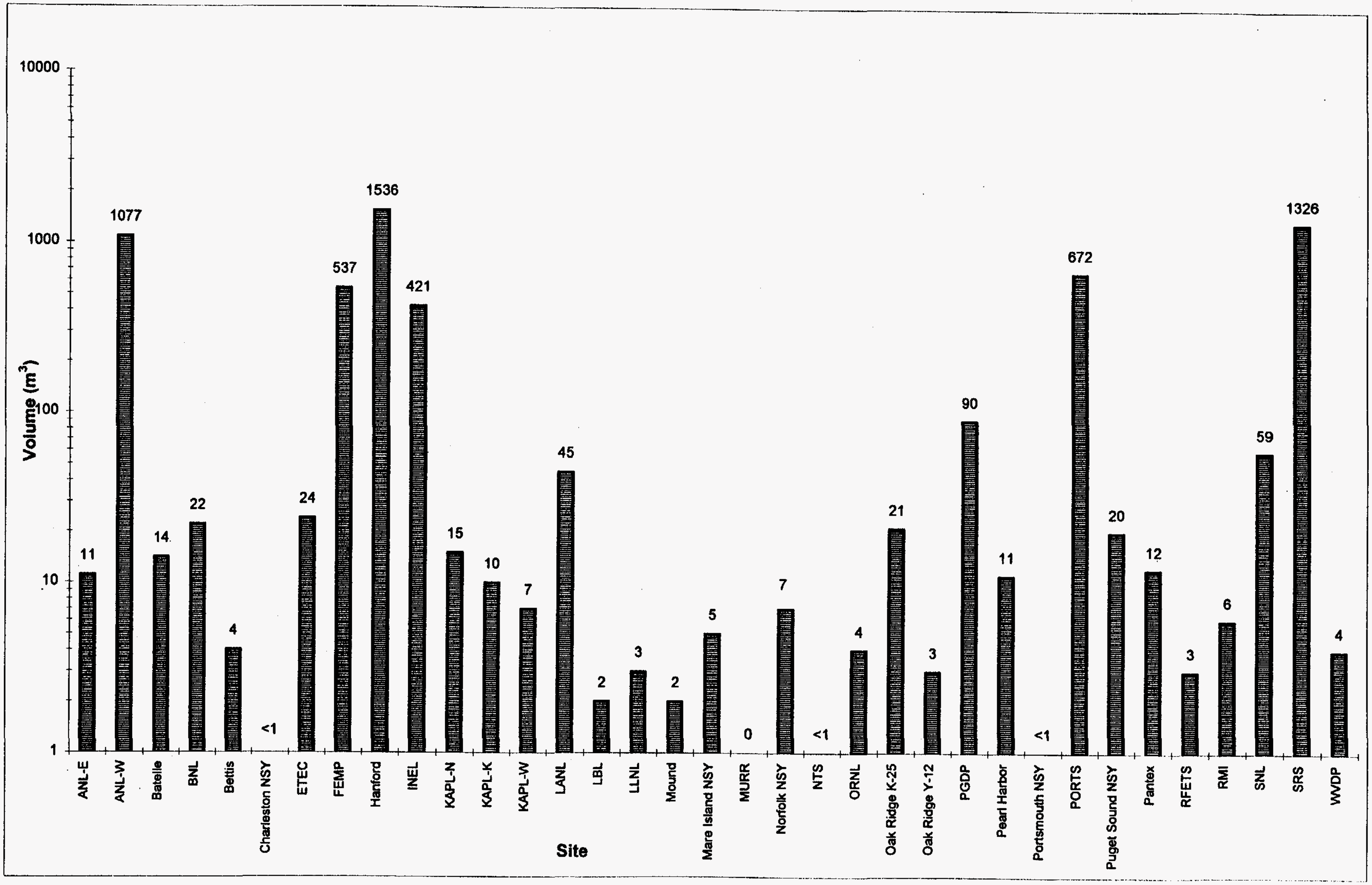

Figure 3-4. Volumes of LLW by site.

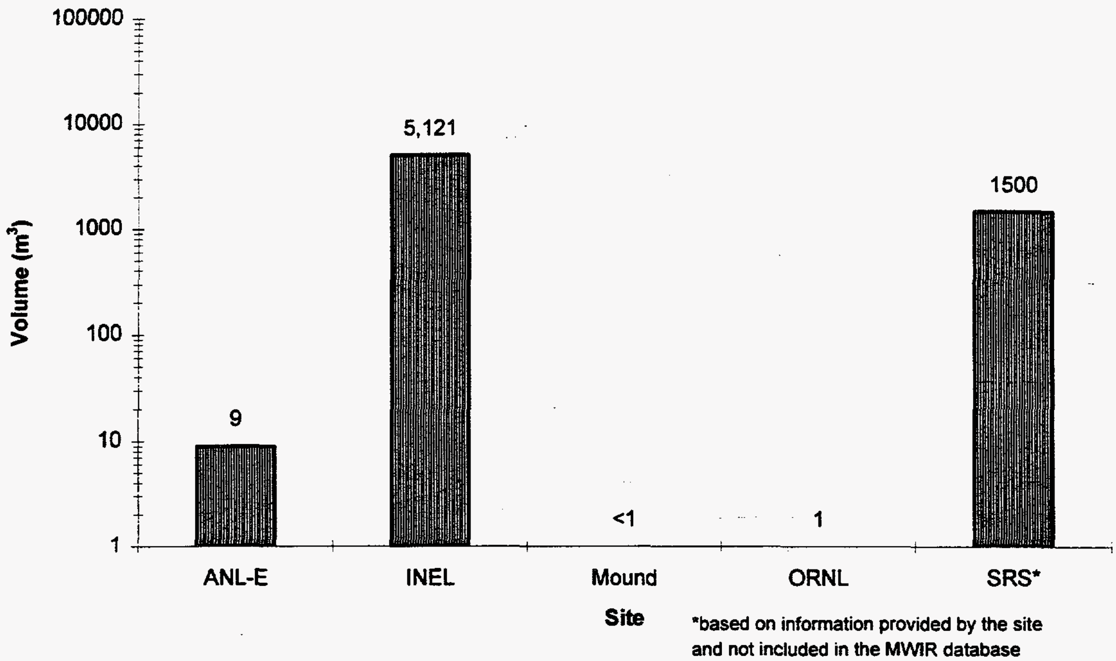

Figure 3-5. Volumes of TRU waste by site.

3.2.1 Waste Volumes Included in the Analysis of Radionuclide Concentrations

About 70% (62,000 m^3) of the estimated volume of residual MLLW is included in the comparison with the PE limits (Figure 3-6). This volume of waste is associated with about 61% (388) of the 635 residual MLLW streams. Therefore, about two-thirds of the residual MLLW has sufficient radiological characterization data to make comparisons with the PE limits. The percentage of waste streams that have sufficient radiological characterization data is less than the concomitant percentage of waste volumes because several waste streams with smaller volumes do not yet have radiological characterization data.

The concentrations of radionuclides are unknown for approximately 1/3 of the residual MLLW; this data gap results in a significant uncertainty related to disposal of these wastes. However, viewed from another perspective, the data in Figure 3-6 indicate that the size of the evaluated sample of residual MLLW is approximately 2/3 of the total residual MLLW. In addition, about 1/4 of the residual MLLW volume that currently does not have associated radiological characterization is from 5-year projections of waste to be generated. Continued efforts to characterize waste will provide more information.

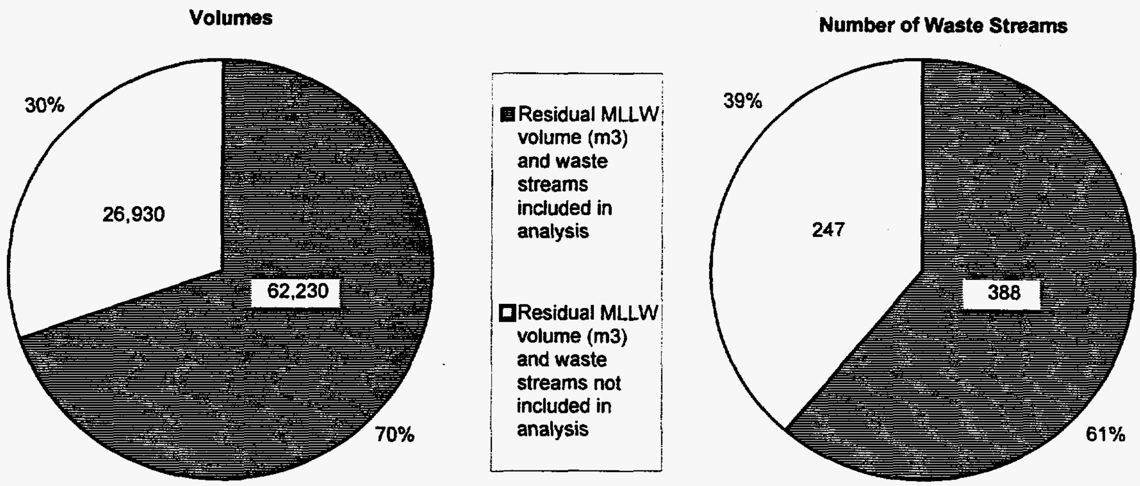

Figure 3-6. Residual MLLW volume and waste streams included in the analysis of radionuclide concentrations.

3.2.2 Comparison of Radionuclide Concentrations in Residual MLLW to the PE-Derived Limits

Sum-of-Fraction Results for Individual Waste Streams

The PE project (DOE, 1996) provided estimates of permissible concentrations in waste for 58 radionuclides that are expected to be present in residual MLLW. The analyses used in the PE project were simple and conservative representations of the disposal facility environment compared to most site-specific performance assessments. The disposal facility designs evaluated in the PE project were a below-ground trench design and an above-ground tumulus design. The waste form evaluated in the PE project was grouted treatment residuals.

While grouted treatment residuals are expected to compose a large portion of the disposed MLLW, other waste forms are also likely be used. The analysis framework used in the PE project was designed to allow for substitution of other waste form models. Models for evaluating the performance of polyethylene micro- and macroencapsulation and glass waste forms in MLLW disposal facility environments have recently been summarized (SNL, 1996). To establish permissible radionuclide concentrations for these other waste forms, these waste form models were used in place of the grouted waste form model in a PE-type analysis (see Appendix B). This set of concentrations for the three new waste forms was used to categorize waste streams that are expected to be disposed of as a micro-encapsulated polyethylene waste form, a macro-encapsulated polyethylene waste form, or a glass waste form.

The permissible concentrations estimated in the PE were based on the assumption that each radionuclide contributed the entire permissible dose to the limiting pathway. This approach was taken to provide PE-derived results that are appropriate to use with the sum-of-fractions calculations when evaluating waste streams with multiple radionuclides.

For both the limiting concentrations of radionuclides estimated in the PE project and the estimated radionuclide concentrations in the residual MLLW streams, identical units were used for radionuclide concentrations (i.e., $\mu Ci/m^3$). However, the volume scales for which these concentrations are derived are different, so that direct comparisons must be made with circumspection. The radionuclide concentrations derived from the PE project were based on the average concentration of all waste in the disposal facility. The concentrations of radionuclides in the residual MLLW streams were averaged for the volume of the waste stream, a volume which is generally much less than the total waste volume in the disposal facility.

Because of the differences in scale and because of the conservative nature of the analyses in the PE project related to site-specific performance assessments, direct comparisons of the concentrations of radionuclides in residual MLLW streams with the PE-derived limits cannot result in definitive statements about the acceptability of a particular waste stream at a particular site. However, the comparison of the concentrations of radionuclides in the waste streams to the PE-derived limits can provide an indication of the potential acceptability of the waste streams for disposal.

The radionuclide concentrations in the individual waste streams were compared with the PE-derived limits using the four sum-of-fractions (SOF) categories and symbols defined in Table 2-5. The SOF rule (Equation 4) was used because many waste streams contain multiple radionuclides.

The radionuclide concentrations for each specific waste streams were compared to the PE-derived limits for radionuclide concentrations for disposal at each of the 15 DOE sites. These comparisons are presented in two tables in Appendix D (one for a trench facility design and the other for a tumulus design). For purposes of illustration, a hypothetical example of site-specific results for several waste streams is presented in Table 3-2. The five waste streams in the hypothetical example are presented solely to show how such comparisons might be made and to provide background on the summary tables presented later in this section. The data, as presented in Table 3-2, could apply to either a trench or tumulus disposal facility design.

In Table 3-2, the concentrations of radionuclides in five hypothetical waste streams are compared with the PE-derived limits for radionuclide concentrations at the 15 sites. For this purpose, each waste stream is categorized using the SOF symbols defined in Table 2-5. Waste streams 1, 2, and 3 illustrate cases in which one or more sites result in either the ○- or □-symbol, indicating that the combined radionuclide concentrations in the waste stream are below the limiting concentration estimated in the PE project. Although waste stream 3 has an ●-symbol for the disposal facility at ORR, all other disposal facilities offer more favorable technical options for accepting this waste stream. In a subsequent table, the results are reported for a separate analysis in which each waste stream is assumed to be disposed of in the facility that presents the most optimal characteristics for accepting it.

Table 3-2. Hypothetical Comparison of Waste Streams and Sites with Site-Specific PE Results (see Appendix C for waste streams included in the analysis)

		Arid								Humid						
Waste Stream #	Final Volume (m^3)	LLNL	Han-ford	NTS	INEL	RFETS	SNL	LANL	Pan-tex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WV DP
1	150	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2	22	○	○	○	○	□	○	○	○	□	○	○	□	□	○	○
3	119	□	□	□	□	□	□	□	□	□	□	□	□	●	□	□
4	35	■	■	■	■	●	■	■	■	■	●	●	●	●	●	■
5	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Definition of Symbols (see Table 2-5 for details)

○ SOF $\leq$ 0.1

□ 0.1 < SOF $\leq$ 1.0

■ 1.0 < SOF $\leq$ 10

● SOF > 10

As shown in Table 3-2, hypothetical waste stream 4 is represented primarily by the ■-symbol at the arid disposal sites and primarily by the ●-symbol at the humid disposal sites. With more refined (i.e., less conservative) analyses, this waste stream would likely be acceptable for disposal in facilities at one or more of the arid sites and may be acceptable for disposal in facilities at one or more of the humid sites. Hypothetical waste stream 5 is represented by the ●-symbol for disposal facilities at all the sites; the gray shading highlights this situation. Again, with more refined (i.e., less conservative) analyses, this waste stream would likely be acceptable for disposal in facilities at one or more of the sites; however, such disposal may require a different waste form or a different treatment process.

Technical Capability of the 15 Potential DOE Disposal Sites

A site-specific summary of the comparisons of the technical capability of the facilities at the 15 DOE sites to dispose of all the residual MLLW is shown in Table 3-3. Table 3-3 (a) is based on the assumption that none of the residual MLLW is sent to a commercial disposal facility; Table 3-3 (b) is based on the assumption that approximately 32,000 m^3 of the residual MLLW are sent to a commercial facility for disposal, leaving 30,000 m^3 for disposal at a single DOE facility. Each DOE site was evaluated for both the trench (Table 3-3, left side) and the tumulus (Table 3-3, right side) designs. The results show the percentages of the volumes of all the residual MLLW that would fall into each of the SOF categories represented by the ○-, □-, ■-, and ●-symbols for each particular disposal site.

In Table 3-3 (a), the numbers in the first row are based on the assumption that all of the residual MLLW from throughout the DOE complex would be sent to LLNL for disposal, and the distribution of the acceptabilities of the waste is shown by the sum-of-fractions symbols in the four categories. Subsequent rows present similar results for the other 14 potential disposal sites.

Table 3-3. Volume Percentage (%) of Residual MLLW by Category for Each of the 15 DOE Sites Evaluated for Disposal

(a) Distribution of Total Estimated Volume of Residual MLLW (total volume = 62,230 m^3)

	Site[a]	Trench (% of Total Volume)				Tumulus (% of Total Volume)			
		○ SOF ≤ 0.1	□ 0.1 < SOF ≤ 1.0	■ 1.0 < SOF ≤ 10	● SOF > 10	○ SOF ≤ 0.1	□ 0.1 < SOF ≤ 1.0	■ 1.0 < SOF ≤ 10	● SOF > 10
Arid	LLNL	10	22	57	10	10	22	59	8
	Hanford	10	18	62	10	10	18	64	8
	NTS	10	22	57	10	11	22	59	8
	INEL	10	22	58	10	10	22	60	8
	RFETS	9	17	18	56	10	17	23	50
	SNL	10	18	27	45	10	18	29	43
	LANL	10	22	57	10	10	22	59	8
	Pantex	10	22	57	10	10	23	59	8
Humid	ANLE	9	17	18	56	10	16	24	50
	PGDP	10	18	62	11	10	21	60	8
	FEMP	9	17	21	52	10	17	30	44
	PORTS	9	17	18	56	9	17	24	50
	ORR	<1	1	10	89	<1	1	14	85
	SRS	0	<1	25	74	12	15	20	53

[a] WVDP was not included because disposal was evaluated only for waste streams generated at the site. Only one WVDP waste stream, with a treated volume of <1 m^3 in the □-category, was considered in this analysis.

(b) Distribution of Total Estimated Volume of Residual MLLW Minus the Volume Planned for Commercial Disposal (total volume minus volume planned for commercial disposal =30,210 m^3)

	Site[a]	Trench (% of Total Volume)				Tumulus (% of Total Volume)			
		○ SOF ≤ 0.1	□ 0.1 < SOF ≤ 1.0	■ 1.0 < SOF ≤ 10	● SOF > 10	○ SOF ≤ 0.1	□ 0.1 < SOF ≤ 1.0	■ 1.0 < SOF ≤ 10	● SOF > 10
Arid	LLNL	20	43	20	16	21	44	24	12
	Hanford	20	34	30	16	20	35	34	12
	NTS	21	43	20	16	21	43	24	12
	INEL	20	42	21	16	20	42	26	12
	RFETS	19	34	7	40	19	34	19	28
	SNL	19	35	29	16	20	34	33	12
	LANL	21	43	20	16	20	44	24	12
	Pantex	21	43	20	16	21	44	23	12
Humid	ANLE	19	34	7	40	20	34	19	27
	PGDP	20	34	30	17	20	42	26	12
	FEMP	19	34	15	32	20	34	32	14
	PORTS	19	34	7	40	19	34	19	27
	ORR	<1	1	20	79	<1	1	28	70
	SRS	1	<1	22	76	24	30	12	34

[a] WVDP was not included because disposal was evaluated only for waste streams generated at the site. Only one WVDP waste stream, with a treated volume of <1 m^3 in the □-category, was considered in this analysis.

Based on the assumptions applying to Table 3-3 (a) and assuming disposal in a facility using the trench design, about 10% of the residual MLLW for disposal in facilities at the arid sites and about 50 to 90% of the residual MLLW for disposal in facilities at the humid sites would be in the category represented by the ●-symbol. This observation indicates that, in general, disposal facilities located at DOE sites in the arid regions of the country have better capabilities for accepting treated MLLW than do those located in humid regions of the country. The differences in these percentages for disposal facilities based on trench versus tumulus designs are not significant for disposal facilities located at DOE sites in arid regions of the country; however, the tumulus design does offer a slight long-term advantage for disposal facilities located in the humid regions. This information confirms the benefits of using engineered barriers in disposal facilities located in humid regions. More refined (i.e., less conservative) analyses may lead to increases in the percentages of the residual MLLW that could be considered acceptable for disposal at each of the DOE sites.

In Table 3-3 (a), RFETS and SNL have much higher percentages of residual MLLW that fall into the ●-symbol category than do other DOE facilities located in arid regions, and PGDP has a much lower percentage in this category than do other DOE facilities located in humid sites. As discussed in the PE report (DOE, 1996), RFETS, even though located in the western U.S., has characteristics typical of a more humid site (e.g., a higher recharge rate and a thinner unsaturated zone). As a result, RFETS has limits for acceptable radionuclide concentrations similar to sites in the humid region of the country. At SNL, the acceptable concentration limits for Tc-99, based on the PE analysis, are lower than for disposal facilities at other arid sites because it is limited by the water pathway, and some large-volume waste streams containing this radionuclide result in higher percentages of waste associated with the ●-symbol. The hydrological characteristics at PGDP result in higher dilution than at other humid sites when leachate is assumed to be mixed with the groundwater. As a result, when compared with the PE limits for disposal at PGDP, the large-volume waste streams containing Tc-99 fall into the category represented by the ■-symbol.

The volume percentages associated with the ●-symbol in Table 3-3 (b) tend to be higher than in Table 3-3 (a), indicating that the residual MLLW with lower concentrations of radionuclides are planned for commercial disposal. This information is consistent with the knowledge that Envirocare of Utah, the only operating commercial disposal facility for MLLW, has relatively restrictive disposal limits.

Best Technical Combinations for Disposal of Waste from Each Generating Site

Each residual MLLW waste stream, having been analyzed for disposal acceptability at 15 different DOE sites, is evaluated in this section with regard to its best technical acceptability among the 15 DOE sites. The volume of each residual MLLW waste stream is assigned to the best technical SOF category that is indicated in Appendix C for that particular waste stream. The results of this analysis are summarized in Table 3-4 according to the analyzed residual MLLW volume at each of the DOE waste-generating sites that own residual MLLW. In Table 3-4, none of the waste is assumed to be sent to a commercial disposal facility, and, as before, results for both trench and tumulus designs are presented.

Table 3-4. Summary of Best Technical Combinations of Waste and Disposal Sites for Residual MLLW, Based on Radionuclide Content

Site Generating Waste[a] (vol. % of site's residual MLLW included in the analysis)	Trench (m³)[b]				Tumulus (m³)[b]			
	○ SOF ≤ 0.1	□ 0.1 < SOF ≤ 1.0	■ 1.0 < SOF ≤ 10	● SOF > 10	○ SOF ≤ 0.1	□ 0.1 < SOF ≤ 1.0	■ 1.0 < SOF ≤ 10	● SOF > 10
ANL-E (100%)	11	121	35	6	11	121	35	6
Battelle (~100%)	<1	0	0	0	<1	0	0	0
BNL (~100%)	<1	0	0	0	<1	0	0	0
Bettis (~100%)	<1	<1	<1	1	<1	<1	<1	1
Charleston NSY (~100%)	<1	0	0	0	<1	0	0	0
ETEC (~100%)	0	<1	0	0	<1	0	0	0
FEMP (97%)	148	30	48	111	148	30	48	111
Hanford (~100%)	448	2,144	4,309	2,056	2,096	892	4,114	1,855
INEL (incl. ANL-W) (4%)	4	<1	2	<1	4	<1	2	<1
KAPL-N (12%)	3	<1	0	0	3	<1	0	0
KAPL-K (29%)	4	0	0	0	4	0	0	0
LANL (93%)	63	0	62	<1	69	0	56	<1
LLNL (100%)	0	<1	69	897	0	<1	180	786
Mare Island NSY (100%)	17	0	0	0	17	0	0	0
Mound (<1%)	0	<1	0	0	0	<1	0	0
Univ. of Missouri (~100%)	0	0	<1	0	0	0	<1	0
NTS (~100%)	<1	0	0	1	<1	0	0	1
Norfolk NSY (100%)	2	0	0	0	2	0	0	0
ORR (K-25 and Y-12 Sites) (65%)	0	624	29,769	1,349	0	624	29,769	1,349
Pearl Harbor NSY(~100%)	<1	0	0	0	<1	<1	0	0
Portsmouth NSY (<1%)	<1	0	0	0	<1	0	0	0
PORTS (99%)	276	2,361	<1	64	255	2,382	<1	63
Puget Sound NSY (~100%)	4	<1	0	0	4	<1	0	0
Pantex (51%)	63	0	0	0	63	0	0	0
RFETS (64%)	5,177	8,562	1,298	1,678	5,177	8,562	2,602	374
SRS (97%)	170	0	35	204	247	0	14	147
WVDP (~100%)	0	<1	0	0	0	<1	0	0
Totals	**6,389**	**13,842**	**35,628**	**6,365**	**8,099**	**12,612**	**36,819**	**4,693**

a Does not include General Atomics, Former Laboratory for Energy-Related Health Research, Lawrence Berkeley, Knolls Windsor, Ames, Paducah, Weldon Springs, Sandia Labs, RMI, and Oak Ridge Lab. Insufficient data were available to calculate waste stream concentrations for these sites.

b Based on the most favorable comparison of waste stream concentrations with the PE limits

The first line of Table 3-4 shows results for the Argonne National Laboratory East (ANL-E) site. It indicates that 100% of the residual MLLW at that site is included in the analysis. The results for ANL-E are the same for both the trench and tumulus designs. The results can be interpreted as follows: 11 m^3 of ANL-E's residual MLLW fall, most favorably, into a SOF ○-category at one or more of the 15 DOE sites being considered for potential MLLW disposal; 121 m^3 fall, most favorably, into the SOF □-category at one or more of the 15 DOE sites; 35 m^3 fall, most favorably, into a SOF ■-category at one or more of the 15 DOE sites; and 6 m^3 fall into a SOF ●-category at one or more of the 15 DOE sites.

The last line of Table 3-4 totals the residual MLLW volumes by SOF categories. For the trench design, the combined volumes of waste that fall into the categories represented by the , ○-, □-, or ■-symbols are 55,859 m^3 (6,389 + 13,842 + 35,628); for the tumulus design, the comparable total is 57,530 m^3 (8,099 + 12,612 + 36,819). The majority of the waste that falls into the ■-category are the pond sludges at ORR that are planned for disposal in the commercial facilities operated by Envirocare of Utah.

In Table 3-4, the combined volumes for the various SOF categories are generally shifted slightly to the left (i.e., to more technically acceptable disposal combinations) for the tumulus design compared with the trench design. This shift is indicative of the slight additional performance gained by using the tumulus design. The additional benefit of using a tumulus design instead of a trench design is small because the best technical combinations of waste streams and disposal sites for both facility types typically represent disposal at more arid sites; these sites typically do not benefit from use of facilities with additional engineered barriers. The additional performance gained by using additional engineered barriers is greater at humid disposal sites; additional engineered barriers are used at ORR and SRS for disposal of low-level waste.

<u>Summary of Residual MLLW by Controlling Radionuclides</u>

The controlling radionuclides for those MLLW streams that are potentially problematic for disposal at all 15 sites are listed in Table 3-5. These waste streams are shown in Appendix D with gray shading. Table 3-5 was compiled by assigning the treated volume of the residual MLLW stream to each associated controlling radionuclide, summing the volumes assigned to each controlling radionuclide, and calculating the resulting volume percentage of residual MLLW for each controlling radionuclide. The total volumes of potentially problematic MLLW differ for the trench (6360 m^3) and tumulus (4700 m^3) designs, so the results in Table 3-5 must be compared with caution. In addition, most waste streams have more than one controlling radionuclide, so the total volume percentage in the table exceeds 100%. Controlling radionuclides with a volume percentage greater than 5% are indicated by gray shading in Table 3-5; those with volume percentage greater than 25% are indicated by bold italics. While several radionuclides are in more than 55% of the waste volume, U-234, U-235, Pu-239 and Pu-240 are associated with the largest volumes of potentially problematic MLLW.

Table 3-5. Volume Percentages of Potentially Problematic MLLW Associated with Their Associated Controlling Radionuclides

Controlling Radionuclide[a]	Trench (% of Total Volume)[b]	Tumulus (% of Total Volume)[c]
H-3	1.7	<1
C-14	2.8	3.5
Al-26	<1	<1
K-40	1.4	1.9
Ni-63	1.1	1.5
Sr-90	9.1	8.0
Tc-99	17.0	23.0
I-129	<1	<1
Cs-137	5.5	2.2
Ra-226	5.7	7.7
Th-230	14.6	19.8
Th-232	1.5	2.0
U-232	1.4	1.9
U-233	1.4	1.9
U-234	***31.7***	***43.0***
U-235	***40.1***	***54.4***
U-236	<1	<1
U-238	12.0	16.2
Np-237	16.0	21.7
Pu-238	1.4	1.9
Pu-239	***32.7***	16.5
Pu-240	***26.4***	8.0
Pu-242	1.4	1.9
Am-241	1.8	<1
Am-243	1.4	1.9

a A controlling radionuclide is defined as one that exceeds its individual disposal limit.
b Based on a total volume of 6360 m^3
c Based on a total volume of 4760 m^3

3.2.3 Estimated Total Inventory of Radionuclides in Residual MLLW

An estimate of the inventory of radionuclides in the residual MLLW is shown in Table 3-6 for the waste streams that have sufficient radiological characterization to make comparisons with the PE limits. This estimate was developed by multiplying the initial (untreated) volume for each waste stream by the initial average concentrations of radionuclides in that waste stream, and then summing the inventories of each radionuclide over all waste streams. The total initial (untreated) volume of waste associated with these inventories is approximately 53,300 m^3. Because some waste streams in the MWIR database have insufficient radiological characterization data to be included in this analysis, this inventory is likely to represent a lower bound estimate.

Table 3-6. Estimate of Inventory of Radionuclides in DOE Residual MLLW

Radionuclide	Total Activity (Ci)	Radionuclide	Total Activity (Ci)	Radionuclide	Total Activity (Ci)
H-3	2.8E+06	Sn-126	2.7E-10	U-232	1.9E+00
C-14	2.7E+02	I-129	4.7E-02	U-233	1.6E-01
Al-26	4.5E-02	Cs-135	1.9E-10	U-234	4.0E+01
K-40	2.4E-01	Cs-137	9.9E+05	U-235 [a]	2.3E+01
Co-60	3.0E+03	Ba-133	3.6E-05	U-236	2.3E-01
Ni-59	8.5E+01	Sm-151	2.9E+02	U-238 [a]	4.1E+02
Ni-63	9.9E+03	Eu-152	4.2E+02	Np-237	2.4E+01
Se-79	3.6E-10	Eu-154	7.5E+01	Pu-238	1.5E+02
Kr-85	2.5E-06	Pb-210	1.2E-02	Pu-239	8.2E+02
Sr-90	1.3E+04	Bi-207	1.2E-02	Pu-240	6.6E+02
Zr-93	2.8E-09	Bi-208	4.2E-04	Pu-241	8.4E+02
Nb-93m	2.9E-10	Ra-226	4.1E+01	Pu-242	9.5E-01
Nb-94	1.1E-07	Ra-228	2.4E-01	Pu-244	1.5E-04
Tc-99	3.2E+02	Th-229	7.0E-08	Am-241	3.7E+00
Cd-113m	2.7E+01	Th-230	7.3E+00	Am-243	2.7E-01
Sn-121	1.9E+01	Th-232 [a]	9.2E+00	Cm-243	1.4E-02
Sn-121m	4.1E-11	Pa-231	7.8E-02	Cm-244	1.1E-02

[a] Total combined activities appear unreasonably high, possibly indicating incorrect data in the MWIR database.

3.2.4 Waste Forms for Disposal

The waste forms selected for evaluation were based on data in the site-specific STPs and on assumptions pertaining to treatment made by the MWFA and reviewed by several sites. Based on the waste streams that have sufficient radiological characterization to make comparisons with the PE-derived limits, the percentage of residual MLLW volume associated with the preferred waste forms are shown in Figure 3-7. Grouted residuals represent the largest amount, nearly 80% of the total volume of residual MLLW; when combined with waste streams that will be stabilized with grout or polymer, this percentage increases to 88%. Soils represent 10% of the total volume of residual MLLW. Current planning at the DOE sites does not indicate planned use of enhanced waste forms for large volumes of MLLW.

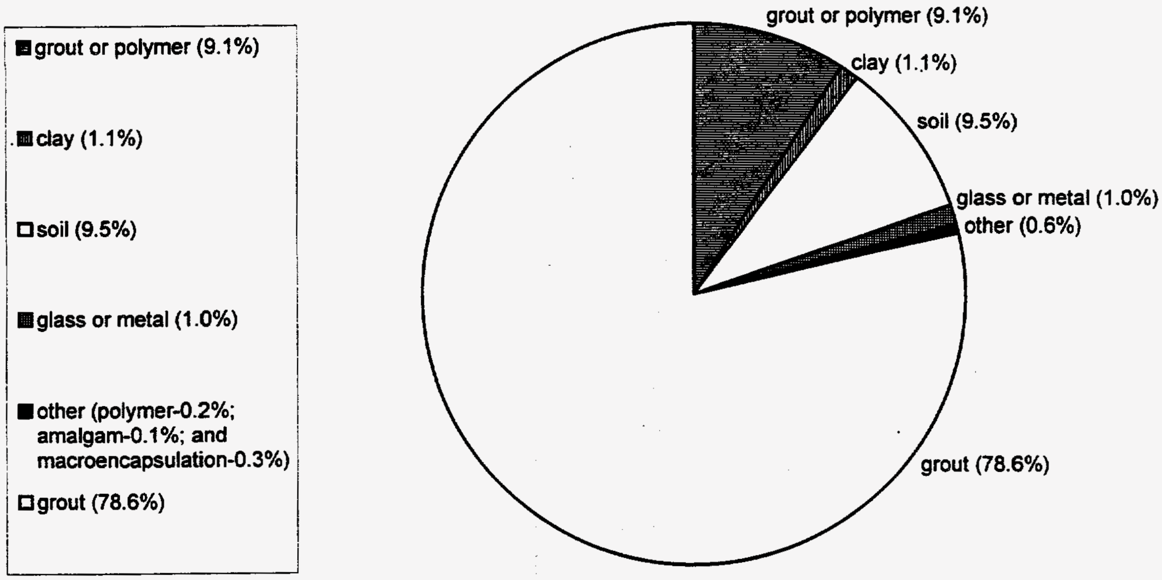

Figure 3-7. Estimate of volumes associated with various waste forms for DOE residual MLLW, based on a volume of 62,230 m^3.

4. DISCUSSION

The results presented in this report are based on a scoping-level analysis to provide technical information to DOE decision makers, their regulators, and stakeholders associated with disposal of DOE MLLW managed under the FFCAct. Many simplifying assumptions were made in the development of this analysis. Additionally, there are many uncertainties in the waste stream characterization data, in the plans for treatment of wastes, and the effects of treatment on waste volumes and radionuclide concentrations. The effects of these assumptions and uncertainties on the results of the analysis are discussed in this section. Additionally, a discussion is provided that places the magnitude of MLLW disposal in perspective with disposal of DOE LLW.

4.1. Assumptions and Uncertainties

The assumptions and uncertainties in the analysis for the volume changes in the waste are discussed in Section 4.1.1, and those for the concentrations of radionuclides are discussed in Section 4.1.2.

4.1.1. Volumes of Waste for Disposal

Several assumptions and uncertainties are important in estimating volumes of waste for disposal. They are important to (1) the use of the data for estimating waste stream volumes and (2) the selection and evaluation of treatment options.

<u>Data for Estimating Waste Stream Volumes</u>

The primary sources of input data for volumes of waste used in the analyses were the 1995 MWIR database and updates based on site-specific reviews. The MWIR database has evolved over the last four years in response to additional waste characterizations and increased knowledge of waste characteristics at the DOE sites, and the site-specific updates reflect more recent changes due to treatment of waste and better estimates of existing waste volumes and projections of future wastes.

The volumes of wastes associated with current inventories of each waste stream are known; very little uncertainty exists in these numbers because they have been measured. However, larger uncertainties exist in the volume estimates associated with the 5-year projections of wastes to be generated; there are often uncertainties in the operations that will generate these wastes. The values used for these projected volumes reflect the best estimates of the DOE site personnel responsible for generating these wastes. The actual generation rates may be higher or lower than estimated for some waste streams, and the duration of the waste generation may be longer or shorter than the five-year period for which estimates are provided.

<u>Selection and Evaluation of Treatment Options</u>

The treatment processes selected for each of the waste streams were based on "preferred alternatives" in site treatment plans. While many of the preferred alternatives were associated with specific, existing treatment facilities, preferred alternatives for some waste streams were either non-specific, were based on proposed facilities that have no operating data, or were not specified.

For waste streams associated with existing, operating treatment facilities, no major assumptions were required to estimate the results of treatment; the operating parameters of the treatment process were supplied by the site contacts during the review process. For waste streams associated with either treatment facilities that were non-specific or not existing, professional judgment was used to develop estimates of the effects of treatment on the waste streams. Research conducted at the SRS (WSRC, 1995) was used as the basis for the estimates of the effects of treatment used in this analysis. This work at SRS contained an analysis for wastes at that site that is similar to the one described in this report. The uncertainties about the selection of the actual treatment process to be used for these wastes are larger than the uncertainties about the effects of specific treatment processes on wastes. For example, a waste tentatively planned for incineration and grout stabilization (AMR = 1/100) may eventually be treated solely by stabilization in grout (AMR = 2), with a resulting change in estimated final volume of 200. This potential difference is much greater than that due to the uncertainty about the effects of grout-stabilizing wastes (e.g., if the AMR for this treatment ranges from 1.5 to 3).

Waste streams that had no preferred alternative treatment were identified but not analyzed, so that no assumptions were required to analyze these wastes. However these waste streams present a significant uncertainty for disposal due to the lack of plans for their treatment.

4.1.2. Concentrations of Radionuclides

Topics discussed in this section are (1) the effect of assumptions and uncertainties related to concentrations of radionuclides in residual MLLW for the input data used in the analysis, (2) the effects of treatment on radionuclide concentrations in residual MLLW, (3) the conservatism incorporated into the PE-type analysis of disposal with which these concentrations are compared, and (4) the effects of scale on the average concentrations used in this analysis.

Data for Estimating Radionuclide Concentrations in Waste Streams

The primary sources of data for waste characterization were the 1995 MWIR database and updates based on site-specific reviews. Much of the data are based on detailed characterizations of the MLLW, but a large portion of the data are based on "process knowledge" of the engineers and operators of the production processes that created these wastes. Some of the waste streams listed in the database remain sufficiently uncharacterized to preclude assigning a preferred treatment alternative.

Although the MWIR database is the product of a complex-wide data call, the quality of data from site to site is not expected to be uniform. Differences in the type and amount of wastes, the available resources to characterize the waste, and the experience of site personnel with waste characterization result in differences in data quality among the sites. Therefore, detailed inter-site comparisons of specific data should be made with caution, and site contacts should be utilized for more detailed evaluations of data.

Characterization data for many waste streams in the MWIR database are based on relatively small sample sizes of the individual waste streams. In addition, many of the waste streams in the MWIR are actually aggregations of smaller waste streams that are expected to have similar treatability characteristics, and many of these wastes are highly heterogeneous. The combination of these conditions tends to result in larger uncertainties in the characterization data, and results of detailed analyses based on these data must be interpreted with circumspection. However, the data used in this analysis represent the best available characterization data for DOE MLLW, and the quality of the data is consistent with use in a scoping-level analysis.

About 30% of the total residual MLLW volume is attributed to waste streams that were insufficiently characterized to determine the presence of specific radionuclides or estimate their concentrations. These waste streams were identified but not analyzed further. Therefore, no major assumptions were associated with the analysis of these waste streams. However, these waste streams represent an uncertainty of unknown magnitude in the MLLW disposal configuration due to the lack of characterization.

The Effects of Treatment on Radionuclide Concentrations

For waste streams associated with existing, operating treatment facilities, no major assumptions were required to estimate the results of treatment; the operating parameters of the treatment process were supplied by the site contacts during the review process. For waste streams associated with either treatment facilities that were non-specific or non-existing, professional judgment was used to develop estimates of the effects of treatment on the radionuclide concentrations in the waste streams. The research conducted at the SRS (WSRC, 1995) was the primary basis for estimating the effects of treatment on radionuclide concentrations, with site reviews either confirming or modifying these assumptions. Waste streams that had no preferred alternative treatment were identified but not analyzed, so that no assumptions were needed for these wastes.

The assessment of the fate of radionuclides in a treatment process is inherently more uncertain than the estimation of the change in volume of waste due to treatment. For example, the specific temperature, pressure, and redox conditions in a treatment process combined with the specific chemical and physical characteristics of the radionuclide will determine the distribution of its mass in the residual solids, liquids, and gases. An analysis based on this level of detail is beyond the scope of this project and is generally beyond the level of available data and plans for specific treatment. This area represents a significant uncertainty; it can be reduced by more definitive plans for use of specific treatment processes and by more detailed analyses of those treatment processes.

The Conservative Nature of the PE Analysis

The PE analysis, which provided estimates of permissible concentrations of radionuclides for disposal that were used to compare with concentrations of radionuclides in residual MLLW, was a scoping-level analysis designed to be more conservative than most site-specific performance assessments. Because the radiological limits of site-specific WAC are based on site-specific performance assessments, these limits may be greater than those estimated in the PE analysis. Therefore, some residual MLLW streams identified as being potentially problematic for disposal may be shown to be less problematic when compared to the site-specific WACs. As site-specific facilities for disposal of MLLW are selected and their performance assessments and WACs are developed, the uncertainty related to the concentration limits for radionuclides will diminish.

Scale and Its Effect on Average Concentrations

The PE methodology, or any existing performance assessment methodology, can support statements about total inventories in a disposal facility or concentrations of radionuclides averaged for the entire volume of the disposal facility. In general, these performance analyses cannot support definitive statements about acceptability of specific waste streams based on their radionuclide content due to the differences in scale between the facility and individual waste packages for which radionuclide concentrations are averaged. The acceptability of a waste stream for disposal depends not only on the inventory and concentration of radionuclides in the waste, but also on the type and activity of waste that has already been loaded into the disposal facility.

The issues of scaling and concentration averaging are discussed more fully in the Performance Assessment Task Team (PATT) guidance (Wood et al., 1994), which recommends the establishment of an inventory tracking system to facilitate management of the loading of waste into the facility. This tracking system is designed to ensure that the maximum activity of the various radionuclides is not exceeded when the volumetric capacity of the disposal facility is achieved. The WAC documentation for a disposal site provides the guidance for limiting concentrations or inventories of radionuclides in a waste package and instructions on how to proceed (usually additional waste packaging and administrative approvals) when a waste package exceeds these limits.

Because of the differences in scale and because of the conservative nature of the the PE methodology, direct comparisons of the concentrations of radionuclides in waste streams with the PE-derived limits cannot result in definitive statements about the acceptability of a particular waste stream at a particular site. However, the comparison of the concentrations of radionuclides in the residual MLLW streams to the PE-derived limits can provide an indication of the potential acceptability of the waste streams for disposal by comparing the concentrations of radionuclides in waste with those estimated to be limiting for the disposal facility.

4.2. *Analysis Results in Perspective*

In this section, several topics are discussed which provide a perspective for the magnitude of the disposal issue regarding residual MLLW and for the way that this analysis should and should not be interpreted. The discussion is presented in terms of volumes of waste for disposal, concentrations of radionuclides in residual MLLW, and limitations of the analysis.

4.2.1. Volumes of Waste for Disposal

Two topics related to volumes of waste for disposal—a comparison with the historical rates for disposal of LLW and a comparison with existing disposal capacity for MLLW—provide some perspective on the magnitude of the residual MLLW disposal issue and the work that remains to be done to resolve this issue.

Volumes of MLLW Relative to Historical Disposal Rates for LLW

Based on the analysis contained in this report, approximately 89,000 m^3 of treated MLLW will require disposal as MLLW (i.e., residual MLLW). Of this amount, approximately 49,000 m^3 was planned to be disposed of at commercial facilities, resulting in approximately 40,000 m^3 of waste for disposal at DOE sites or as yet undetermined locations. These volumes for disposal are based on waste that is either currently stored or projected to be generated over the next five years.

The DOE has disposed of approximately 50,000 m^3 of LLW at its sites every year since 1990, and has disposed of approximately 100,000 m^3 of this waste every year between 1982 and 1989. The DOE estimates that it has disposed of a total cumulative volume of about 3 million cubic meters of LLW (IDB, 1995).

If the 40,000 m^3 of residual MLLW estimated in this report were disposed of over the 5-year period of the projected volumes, it would be disposed of at a rate equal to about one-sixth that of LLW being disposed of throughout the 1990s. Additionally, the 40,000 m^3 total volume of residual MLLW to be disposed of at DOE sites is less than 2% of the total volume of LLW disposed of by DOE. These comparisons indicate that the magnitude of disposal of MLLW, both in terms of rates and total volumes, will be much smaller than that of LLW.

Existing and Proposed DOE Capacity for Disposal of MLLW

Two DOE sites, Hanford and NTS, have developed disposal capacity for residual MLLW in anticipation of disposing of their own wastes. At Hanford, approximately 43,000 m^3 of RCRA-compliant capacity for waste in drums has been developed. At NTS approximately 91,000 m^3 of proposed capacity is available. From a technical viewpoint, these two sites, in conjunction with the planned use of commercial disposal, provide more than enough capacity for disposal of the estimated volumes of residual MLLW under agreements resulting from implementation of the FFCAct. Additional disposal capacity may also be required for MLLW generated by processes not managed under FFCAct agreements (e.g., wastes generated from future decontamination and decommissioning [D&D] and environmental restoration activities). Many other factors, including ethical, social, economic, and policy considerations relevant to disposal of MLLW, need to be addressed in determining the preferred configuration for disposal of DOE MLLW.

4.2.2. Concentrations of Radionuclides

Two topics related to concentrations of radionuclides in waste—the need for additional waste characterization, and the focusing on potentially problematic waste streams—provide some perspective on the magnitude of the disposal issue regarding residual MLLW and the work that remains to be done to resolve these issues.

Need for Additional Waste Characterization

While a large amount of data related to MLLW streams have been developed and summarized, more detailed and complete characterization will be required for many waste streams before treatment of these wastes can commence and their acceptability for disposal determined. The characterization of approximately 9000 m^3 of MLLW was insufficient to determine a preferred treatment alternative. These wastes lack the most basic characterization data. About 6000 m^3 of the 9000 m^3 of MLLW is from 5-year projections of waste to be generated.

Approximately one-third of the residual MLLW volumes analyzed in this evaluation were associated with waste streams that had insufficient radiological characterization to permit comparison with estimates of concentration limits. Lack of knowledge of both specific radionuclide content and concentrations of known radionuclides contribute to this problem. Additional sampling and analysis will be required for many waste streams to verify waste characterization prior to treatment and disposal. Procedures such as statistical analyses could be applied to assure collection of representative samples while maintaining cost effectiveness.

Because additional characterization data will generally be required prior to treatment of waste, it will also be available for evaluating disposal options for these wastes.

Focus on Potentially Problematic Waste Streams

The comparison of radionuclide concentrations in treated wastes with the PE-derived limits is considered a scoping-level analysis to identify those wastes for which disposal considerations should be given closer attention. Waste streams that result in a sum-of-fraction greater than 10, represented by the ●-symbol (see Table 2-5 for symbol definition), at all disposal sites should not be considered as wastes that cannot be disposed of at any of these 15 sites; instead, they should be considered as wastes that should be scrutinized more carefully. Conversely, wastes that fall into one of the other three comparison categories can be considered likely to present few significant issues for disposal. In this sense, the scoping-level nature of this analysis serves to eliminate waste streams of little concern and to focus attention on the waste streams that require more analysis.

About 90% of the residual MLLW streams evaluated in this analysis are represented by one of the three categories that should present no significant issues for disposal, and the remaining 10% of the waste streams will require more detailed evaluations to determine if they will present a problem for disposal.

Some of the ways to evaluate these waste streams in more detail are to compare the conservatism used in the PE methodology to that used in site-specific performance assessments, to evaluate the treatment processes in more detail, and to evaluate the use of alternative waste forms. Site-specific WAC are not available for DOE MLLW disposal facilities. Therefore, evaluating the waste streams using the performance assessments and WAC for LLW disposal facilities may provide a reasonable alternative. These facilities exist at several DOE sites, and comparing the radionuclide concentrations in the waste streams with the limits in the WACs at one or two of these sites will indicate the number of waste streams that may be acceptable for disposal based on a more refined analysis of disposal performance.

In this analysis, the effects of the treatment processes on the concentrations of radionuclides were evaluated with a simple approach. More detailed technical analyses of these treatment processes may provide a better estimate of the acceptability of residual MLLW for disposal. The greatest benefit of conducting more detailed analyses will likely be for the more advanced treatment processes, which are more difficult to represent by simple analyses. These include incineration, vitrification, and other chemical/physical treatment processes. Conversely, the more simple treatment processes, such as direct stabilization with grout or polymer, are likely to be relatively well represented by the simple analyses described in this report.

Some waste streams may require stabilization in a more durable waste form to ensure their acceptability for disposal in a MLLW facility. These more durable waste forms may be either ones that are already developed but not selected for the particular waste streams or modifications of existing waste forms.

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5. CONCLUSIONS AND RECOMMENDATIONS

The analysis described in this report was a scoping-level evaluation. Although the analysis provided quantitative results that indicate the technical capability of a site to dispose of the evaluated waste streams, the conclusions derived from this evaluation are more of a general nature than a site-specific or waste stream-specific one. The analysis was based on a simple approach for representing treatment processes; it compared results to disposal limits derived from another scoping-level analysis that relied on simple models to represent site environmental conditions. The major strengths of the evaluation described in this report are that (1) it provides a substantiated estimate of the overall volume of residual MLLW that will require disposal, (2) it delineates those residual MLLW streams that are potentially problematic, allowing the DOE to focus its attention on a smaller portion of the MLLW inventory and narrow the scope of further analysis, and (3) it indicates the need for further waste characterization and continued updating of existing databases.

5.1. Conclusions

- Of the approximately 130,000 m^3 of MLLW considered under the FFCAct that is either currently stored or projected to be generated within the next five years and is designated for treatment, approximately 89,000 m^3 will require disposal as residual MLLW, an additional 6000 m^3 will require disposal after treatment as LLW, and 5000 m^3 will require disposal after treatment as TRU waste. The net volume reduction due to treatment of this waste is approximately 21,000 m^3. The remaining 9000 m^3 of this waste was insufficiently characterized to be assigned a preferred alternative for treatment; 6000 m^3 of this waste was projected waste. Of the 89,000 m^3 of waste requiring disposal as MLLW, approximately 49,000 m^3 is currently planned for disposal at commercial facilities; therefore, up to 40,000 m^3 of MLLW will require disposal at one or more DOE facilities.

  As indicated in the PE project report, all 15 sites evaluated in this project have the technical capability to dispose of some residual MLLW, and sites located in the arid region of the country tend to have higher permissible limits on radionuclide concentrations in waste than sites in the humid region of the country. Comparing the PE-derived limits with estimates of concentrations of radionuclides in residual MLLW indicates that up to 90% of the residual MLLW could be disposed of at several arid sites with little additional analysis; about 50% of this waste could be disposed of at several humid sites. More detailed analyses would likely increase both of these percentages.

  Based on the volume estimates calculated in this analysis, enough capacity currently exists in commercial sites and at DOE's Hanford Reservation and Nevada Test Site for disposal of all of DOE's residual MLLW. Additional disposal capacity may also be required for MLLW generated by processes not managed under FFCAct agreements (e.g., wastes generated from future decontamination and decommissioning [D&D] and environmental restoration activities). This conclusion is based on the technical aspects of disposal only—ethical, social, economic, and policy considerations relevant to waste disposal were not considered in the analysis.

- The results of this scoping-level analysis indicate that waste streams associated with about 90% of the total residual MLLW volume evaluated in the concentration analysis are likely to present no significant technical issues for disposal and require little additional analysis. The remaining residual MLLW streams that were identified as potentially problematic require further evaluation of their treatment and disposal plans. Almost all of these potentially problematic waste streams are listed as such because disposal concentrations are limited by the assumed intrusion scenarios in the PE report; the effect of intrusion can be mitigated to some extent by burying the waste deeper.

5.2. Recommendations

- Additional waste characterization data should be collected. Of the total current and 5-year projected volume of MLLW that has been reported, about 7% (9000 m^3) is attributed to waste streams that do not have enough characterization and treatment information to be included in the calculation of post-treatment volumes. Of the residual MLLW that was calculated in the analysis, about 30% (27,000 m^3) is attributed to waste streams that could not be included in the comparison of radionuclide concentrations with the limits estimated by the PE project. The data on these latter waste streams either did not include a listing of radionuclides or did not provide concentrations for any of the listed radionuclides. In addition, of the residual MLLW streams that were included in the comparison, many did not have concentrations for all of the listed radionuclides.

- Future technical studies should focus on the residual MLLW streams identified in this analysis as potentially problematic. These waste streams should be re-evaluated with regard to

  ⇒ site-specific WAC and performance assessments,
  ⇒ alternative treatment processes,
  ⇒ alternative waste forms for disposal, and
  ⇒ different regulatory requirements (i.e., those that may change with the reissue of DOE Order 5820).

6. REFERENCES

Ades, 1996. Letter from Dr. Maurice J. Ades of Westinghouse Savannah River Company to Dr. R. D. Waters of Sandia National Laboratories re: *Volume Ratios and Densities for the Residuals Analysis (U)*. March 28, 1996.

DOE (Department of Energy), 1988. "Low-Level Waste," Chap. III in *Radioactive Waste Management*, Order 5820.2A.

DOE (Department of Energy), 1996. *Performance Evaluation of the Technical Capabilities of DOE Sites for Disposal of Mixed Low-Level Waste*. DOE/ID-10521. 3 vol. Idaho Falls, ID: U.S. Department of Energy, Office of Waste Management (EM-30).

FFCAct, 1992. Federal Facility Compliance Act (FFCAct) of 1992. P.L. 102-386, October, 1992.

IDB, 1995. *Integrated Data Base Report - 1994: U.S. Spent Nuclear Fuel and Radioactive Waste Inventories, Projections, and Characteristics*, Revision 11. Prepared for the U.S. Department of Energy Office of Civilian Radioactive Waste Management, Office of Environmental Restoration and Waste Management. Oak Ridge, TN: Oak Ridge National Laboratory. September 1995.

INEL (Idaho National Engineering Laboratory), 1995. *MWIR-1995, DOE National Mixed and TRU Waste Database Users Guide*, DOE/LLW-233, Radioactive Waste Technical Support Program, Lockheed Idaho Technologies Company, Idaho Falls, Idaho.

Kirkpatrick, T. D., 1995. *DOE Waste Treatability Group Guidance*, DOE/LLW-217, Rev. 0, Radioactive Waste Technical Support Program, Lockheed Idaho Technologies Company, Idaho Falls, Idaho.

MWFA (Mixed Waste Focus Area), 1996. *Mixed Waste Focus Area Integrated Technical Baseline Report, Phase 1*, DOE/ID-10524, Rev. 0, Lockheed Idaho Technologies Company, Idaho Falls, Idaho.

RCRA, 1976. *Resource Conservation and Recovery Act (RCRA) of 1976*, P.L. 94-580, Stat. 2795.

SNL (Sandia National Laboratories), 1996. *Waste Form Performance Assessment Task, Draft Letter Report*, TTP-AL2-6-TI-012, Sandia National Laboratories, Albuquerque, New Mexico, July.

Waters, R.D., P.I. Pohl, W. Cheng, M.M. Gruebel, T.A. Wheeler, and B.S. Langkopf, draft of 4/24/97. *Evaluation of the Capabilities of the Hanford Reservation and Envirocare of Utah for Disposal of Potentially Problematic Mixed Low-Level Waste Streams, Draft.* Albuquerque, NM: Sandia National Laboratories.

Wood, D. E., R. U. Curl, D. R. Armstrong, J. R. Cook, M. R. Dolenc, D. C. Kocher, K. W. Owens, E. P. Regnier, G. W. Roles, R. R. Seitz, and M. I. Wood, 1994. *Performance Assessment Task Team Progress Report.* DOE/LLW-157, Rev. 1, Idaho Falls, ID: Idaho National Engineering Laboratory.

WSRC (Westinghouse Savannah River Company), 1995. *Conceptual Report on Onsite and Commercial Disposal Options for SRS Mixed Waste Streams (U),* WSRC-RP-95-783, Rev. 0, Solid Waste Engineering, Westinghouse Savannah River Company, Aiken, South Carolina.

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Appendix B:

PERMISSIBLE RADIONUCLIDE CONCENTRATIONS FOR THE POLYETHYLENE MICROENCAPSULATION, POLYETHYLENE MACROENCAPSULATION, AND GLASS WASTE FORMS BASED ON THE PE METHODOLOGY

Calculations similar to those completed for the water pathway in the performance evaluation (PE) (DOE, 1996) using a grout waste form have been completed for a macroencapsulated polyethylene waste form, a microencapsulated polyethylene waste form, and a vitreous waste form. The results of these calculations are presented in the tables in this appendix. The values shown in the tables are those that changed because of the substitution in the PE of a waste form model other than grout. Because the additional modeling affects only sites that are evaluated for a water pathway, NTS is not included in the tables.

The source terms that were used for encapsulated polyethylene waste forms and the vitreous waste form are briefly summarized below. More detailed information regarding the development of the source terms for these waste forms can be found in the "Waste Performance Assessment Task, Draft Letter Report" (SNL, 1996).

The source term model in the PE provided the correlation between radionuclide concentrations in the waste form and concentrations in the leachate that exits the bottom of the disposal facility. The source model is used to formulate the source concentration reduction factor, CRF_{Source}:

$$CRF_{Source} = C_{Waste} / C_{Leachate} \tag{1}$$

where

C_{Waste} is the concentration in the waste form for each radionuclide averaged over the entire volume of waste in the disposal facility (µCi/L), and

$C_{Leachate}$ is the corresponding concentration in the leachate for each radionuclide as it exits the bottom of the disposal facility (µCi/L).

Encapsulated Polyethylene Waste Form Source Term

The source model chosen for encapsulated polyethylene is a function of waste form size and waste loading. In these calculations, the waste form was assumed to be a 1 × 1-m cylinder (i.e., roughly the size of a 55-gallon drum) and the waste loading was 50%. For use in the PE model, the dependent variable was represented in terms of leachate concentrations rather than fraction leached. In order to accomplish this translation, a mass balance was used, stating that what leaves the waste form goes into the infiltrating water:

$$C_{Leachate} = \frac{1}{Q}\frac{dF}{dt} V f_m C_{Waste} \tag{2}$$

where

Q is the flow rate of water through the waste site (m^3/yr);

F is the fraction of waste leached based on the diffusion model used (unitless);
t is time (yr);
V is the volume of the waste form (m^3); and
f_m is the mixing fraction, defined as the ratio of the volume of waste disposed in a unit volume of the facility trench.

The PE project arrived at concentrations by assuming that the contaminants in the waste forms are not depleted with time, so that the source term is constant. Hence, from Equations 1 and 2, the concentration reduction factor for waste stored in polyethylene is:

$$CRF_{Source} = \frac{Q}{\frac{dF}{dt} V f_m} \tag{3}$$

where dF/dt is assumed to be constant throughout the period of performance.

This source model was used for macroencapsulated waste only after the waste had been disposed of for 100 years; it was assumed that the polyethylene surrounding the waste started to crack and the waste began to diffuse from the waste form after 100 years. The source concentration factors were determined at 20°C.

Vitreous Source Term

In the glass leach model, it was assumed that radionuclides can only be released from properly formulated waste glass as a result of breakdown of the glass network. A straightforward model (Cunnane and Allison, 1994) was adopted. The fraction (F) of a canistered waste glass that corrodes per year after exposure to repository groundwater environment is:

$$\frac{dF}{dt} = \frac{RA}{W} \tag{4}$$

where

R is the glass corrosion rate (g/m^2-yr);
W is the mass (g) of the glass in a canister; and
A is the surface area (m^2) of the glass contacted by water.

A/W can be replaced by the specific surface area, A_{sp}, which is a function of the degree of cracking. Hence, the CRF_{Source} is computed as:

$$CRF_{Source} = \frac{Q}{R A_{sp} V f_m} \tag{5}$$

Since the PE was meant to provide conservative analysis, the forward dissolution rate at 20°C was used as the release rate. Any effects of crystallization and solution pH on the glass release rate were neglected. The forward dissolution rate for the borosilicate glass waste form was assumed to be 0.0001 g/m^2-d at a loading of 30 wt% waste.

Table B-1 (a). Permissible Radionuclide Concentrations for Polyethylene Microencapsulated Waste - Trench Design

Radio-nuclide	LLNL		Hanford		INEL		RFETS		SNL		LANL		Pantex		ANLE		PGDP		FEMP		PORTS		ORR		SRS		WVDP	
	C_W[a]	Path[b]	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path
Am-241							1E+03								2E+03						2E+03		1E+01					
Am-243																							5E-01					
C-14							5E+02								2E+03		1E+04	I	4E+03		1E+03		6E+02		5E+03		1E+02	
Cf-249																							6E+00					
Cf-250																							2E+02					
Cf-251																							2E+00					
Cl-36			2E+02	I			2E+02	I							2E+02	I	2E+02	I	2E+02	I	2E+02	I	2E+02	I	2E+02	I		
Cm-243																							4E+02		3E+03			
Cm-244																							2E+02		3E+03			
Cm-245																							3E-01					
Cm-246																							6E-01					
Cm-247																							3E-01					
Cm-248																							1E-01					
Cs-135			1E+03																		3E+02				1E+03			
H-3			7E+07	I			7E+06								7E+07	I	7E+07	I	2E+07		8E+05		7E+05		5E+07			
I-129			4E+01		4E+02		3E+00								8E+00		7E+01		3E+01		9E+00		5E+00		3E+01		8E-01	
K-40					7E+02	I	4E+01								1E+02		7E+02	I	4E+02		1E+02		1E+02		6E+02			
Nb-93m																									1E+06			
Nb-94																							9E+01	I				
Ni-59																					1E+04							
Np-237							2E-01								3E-01		4E+00		2E+00		3E-01		4E-01		3E+00			
Pa-231			6E-01																						4E-01			
Pd-107																	2E+05		5E+04		1E+04		1E+04		7E+04			
Pu-238																					2E+04		1E+04		5E+04			
Pu-239																							5E-01		4E+04			
Pu-240																							6E-01		7E+00			
Pu-241							4E+04								4E+05								3E+02		2E+05	I		
Pu-242																							5E-01		3E+00			
Pu-244																							3E-01		1E+00			
Ra-226																					2E+01							
Se-79			1E+03																1E+03		3E+02		2E+02		1E+03			
Si-32																												
Sn-126																					8E+01	I	6E+01					
Tc-99	7E+03		7E+03		2E+04	I	5E+02		6E+02		1E+04		5E+03		1E+03		1E+04		4E+03		2E+03		1E+03		7E+03		2E+02	
Th-229																							5E-01					
Th-230																							3E-01					
Th-232																							4E-01					
U-232			8E+01																3E+01									
U-233			4E+01														2E+01		3E+01		3E+00		2E+00		5E+00			
U-234			4E+01														4E+01		3E+01		6E+00		5E+00		3E+01			
U-235			4E+01														1E+01		3E+01		3E+00		1E+00		4E+00			
U-236			4E+01														8E+01		4E+01		6E+00		6E+00		4E+01			
U-238			4E+01														8E+01		3E+01		6E+00		6E+00		4E+01			
Zr-93																									4E+03			

a Maximum permissible concentration in the waste; blank cells indicate that the values are the same as those in the PE (Waters and Gruebel, 1996)

b Controlling pathway is the same as in the PE (Waters and Gruebel, 1996) unless otherwise noted: I = intruder

Table B-1 (b). Permissible Radionuclide Concentrations for Polyethylene Microencapsulated Waste - Tumulus Design

Radio-nuclide	LLNL		Hanford		INEL		RFETS		SNL		LANL		Pantex		ANLE		PGDP		FEMP		PORTS		ORR		SRS		WVDP	
	C_W[a]	Path[b]	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path
H-3																							7E+07	I	2E+13			
C-14							1E+03								3E+03				9E+03		2E+03		2E+03		1E+04	I	3E+02	
Si-32																												
Cl-36			2E+02	I			2E+02	I									2E+02	I	2E+02	I	2E+02	I	2E+02	I	2E+02	I		
K-40					7E+02	I	1E+02										7E+02	I	7E+02	I	2E+02		2E+02		7E+02	I		
Ni-59																												
Se-79			2E+03																				4E+02		2E+03			
Zr-93																									9E+03			
Nb-93m																									3E+10			
Nb-94																												
Tc-99	1E+04		1E+04		2E+04	I	1E+03		1E+03		2E+04	I	8E+03		3E+03		2E+04	I	1E+04		3E+03		2E+03		1E+04		3E+02	
Pd-107																			1E+05		3E+04		2E+04		1E+05			
Sn-126																							8E+01	I				
I-129			8E+01		2E+02		7E+00								2E+01		2E+02		8E+01		2E+01		1E+01		7E+01		2E+00	
Cs-135			3E+03																									
Ra-226																												
Th-229																							1E+00					
Th-230																							6E-01					
Th-232																							7E-01					
Pa-231			1E+00																						8E-01			
U-232			2E+03																3E+03									
U-233			8E+01														2E+01		4E+01		3E+00		4E+00		8E+00			
U-234			8E+01														4E+01		5E+01		9E+00		1E+01		3E+01			
U-235			8E+01														1E+01		3E+01		2E+00		2E+00		5E+00			
U-236			8E+01														2E+02		5E+01		2E+01		1E+01		8E+01			
U-238			8E+01														2E+02		5E+01		2E+01		1E+01		7E+01			
Np-237							4E-01								9E-01		1E+01		4E+00		9E-01		6E-01		4E+00			
Pu-238																					3E+04		3E+04		8E+04			
Pu-239																							1E+00					
Pu-240																							1E+00					
Pu-241																							6E+02					
Pu-242																							1E+00					
Pu-244																							6E-01					
Am-241																							3E+01					
Am-243																							1E+00					
Cm-243																							6E+02					
Cm-244																							4E+02					
Cm-245																							5E-01					
Cm-246																							1E+00					
Cm-247																							6E-01					
Cm-248																							2E-01					
Cf-249																							1E+01					
Cf-250																							5E+02					
Cf-251																							4E+00					

a Maximum permissible concentration in the waste; blank cells indicate that the values are the same as those in the PE (Waters and Gruebel, 1996)

b Controlling pathway is the same as in the PE (Waters and Gruebel, 1996) unless otherwise noted: I = intruder

Table B-2 (a). Permissible Radionuclide Concentrations for Polyethylene Macroencapsulated Waste - Trench Design

Radio-nuclide	LLNL		Hanford		INEL		RFETS		SNL		LANL		Pantex		ANLE		PGDP		FEMP		PORTS		ORR		SRS		WVDP	
	C_W[a]	Path[b]	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path
Am-241							1E+03								2E+03						2E+03		1E+01					
Am-243																							5E-01					
C-14							5E+02								2E+03		1E+04	I	4E+03		1E+03		6E+02		5E+03		1E+02	
Cf-249																							6E+00					
Cf-250																							2E+02					
Cf-251																							2E+00					
Cl-36			2E+02	I			2E+02	I							2E+02	I	2E+02	I	2E+02	I	2E+02	I	2E+02	I	2E+02	I		
Cm-243																							4E+02		3E+03			
Cm-244																							2E+02		3E+03			
Cm-245																							3E-01					
Cm-246																							6E-01					
Cm-247																							3E-01					
Cm-248																							1E-01					
Cs-135			1E+03																		3E+02				1E+03			
H-3			7E+07	I			7E+07	I							7E+07	I	7E+07	I	7E+07	I	7E+07	I	7E+07	I	1E+10			
I-129			4E+01		4E+02		3E+00								8E+00		7E+01		3E+01		9E+00		5E+00		3E+01		8E-01	
K-40					7E+02	I	4E+01								1E+02		7E+02	I	4E+02		1E+02		1E+02		6E+02			
Nb-93m																									9E+07			
Nb-94																							9E-01	I				
Ni-59																					1E+04							
Np-237							2E-01								3E-01		4E+00		2E+00		3E-01		4E-01		3E+00			
Pa-231			6E-01																						4E-01			
Pd-107																	2E+05		5E+04		1E+04		1E+04		7E+04			
Pu-238																					2E+04		1E+04		5E+04			
Pu-239																							5E-01		4E+04			
Pu-240																							6E-01		7E+00			
Pu-241							4E+04								4E+05								3E+02		2E+05	I		
Pu-242																							5E-01		3E+00			
Pu-244																							3E-01		1E+00			
Ra-226																					2E+01							
Se-79			1E+03																1E+03		3E+02		2E+02		1E+03			
Si-32																												
Sn-126																					8E+01	I	6E+01					
Tc-99	7E+03		7E+03		2E+04	I	5E+02		6E+02		1E+04		5E+03		1E+03		1E+04		4E+03		2E+03		1E+03		7E+03		2E+02	
Th-229																							5E-01					
Th-230																							3E-01					
Th-232																							4E-01					
U-232			8E+01																7E+01									
U-233			4E+01														2E+01		3E+01		3E+00		2E+00		5E+00			
U-234			4E+01														4E+01		3E+01		6E+00		5E+00		3E+01			
U-235			4E+01														1E+01		3E+01		3E+00		1E+00		4E+00			
U-236			4E+01														8E+01		4E+01		6E+00		6E+00		4E+01			
U-238			4E+01														8E+01		3E+01		6E+00		6E+00		4E+01			
Zr-93																									4E+03			

a Maximum permissible concentration in the waste; blank cells indicate that the values are the same as those in the PE (Waters and Gruebel, 1996)

b Controlling pathway is the same as in the PE (Waters and Gruebel, 1996) unless otherwise noted: I = intruder

Table B-2 (b). Permissible Radionuclide Concentrations for Polyethylene Macroencapsulated Waste - Tumulus Design

Radio-nuclide	LLNL		Hanford		INEL		RFETS		SNL		LANL		Pantex		ANLE		PGDP		FEMP		PORTS		ORR		SRS		WVDP	
	C_W[a]	ath	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path
H-3																							7E+07	I	4E+15			
C-14							1E+03								3E+03				9E+03		2E+03		2E+03		1E+04	I	3E+02	
Si-32																												
Cl-36			2E+02	I			2E+02	I									2E+02	I	2E+02	I	2E+02	I	2E+02	I	2E+02	I		
K-40					7E+02	I	1E+02										7E+02	I	7E+02	I	2E+02		2E+02		7E+02	I		
Ni-59																												
Se-79			2E+03																				4E+02		2E+03			
Zr-93																									9E+03			
Nb-93m																									2E+12			
Nb-94																												
Tc-99	1E+04		1E+04		2E+04	I	1E+03		1E+03		2E+04	I	8E+03		3E+03		2E+04	I	1E+04		3E+03		2E+03		1E+04		3E+02	
Pd-107																			1E+05		3E+04		2E+04		1E+05			
Sn-126																							8E+01	I				
I-129			8E+01		2E+02		7E+00								2E+01		2E+02		8E+01		2E+01		1E+01		7E+01		2E+00	
Cs-135			3E+03																									
Ra-226																												
Th-229																							1E+00					
Th-230																							6E-01					
Th-232																							7E-01					
Pa-231			1E+00																						8E-01			
U-232			2E+03																7E+03									
U-233			8E+01														2E+01		4E+01		3E+00		4E+00		8E+00			
U-234			8E+01														4E+01		5E+01		9E+00		1E+01		3E+01			
U-235			8E+01														1E+01		3E+01		2E+00		2E+00		5E+00			
U-236			8E+01														2E+02		5E+01		2E+01		1E+01		8E+01			
U-238			8E+01														2E+02		5E+01		2E+01		1E+01		7E+01			
Np-237							4E-01								9E-01		1E+01		4E+00		9E-01		6E-01		4E+00			
Pu-238																					3E+04		3E+04		8E+04			
Pu-239																							1E+00					
Pu-240																							1E+00					
Pu-241																							6E+02					
Pu-242																							1E+00					
Pu-244																							6E-01					
Am-241																							3E+01					
Am-243																							1E+00					
Cm-243																							6E+02					
Cm-244																							4E+02					
Cm-245																							5E-01					
Cm-246																							1E+00					
Cm-247																							6E-01					
Cm-248																							2E-01					
Cf-249																							1E+01					
Cf-250																							5E+02					
Cf-251																							4E+00					

a Maximum permissible concentration in the waste; blank cells indicate that the values are the same as those in the PE (Waters and Gruebel, 1996)

b *Controlling pathway is the same as in the PE (Waters and Gruebel, 1996) unless otherwise noted: I = intruder*

Table B-3 (a). Permissible Radionuclide Concentrations for Waste in Glass - Trench Design

Radio-nuclide	LLNL		Hanford		INEL		RFETS		SNL		LANL		Pantex		ANLE		PGDP		FEMP		PORTS		ORR		SRS		WVDP	
	C_W[a]	ath	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path	C_W	Path
Am-241							7E+03	I							7E+03	I							5E+02					
Am-243																							2E+01					
C-14							1E+04	I							1E+04	I	1E+04	I	1E+04	I	1E+04	I	1E+04	I	1E+04	I	6E+03	
Cf-249																							3E+02					
Cf-250																							1E+04					
Cf-251																							8E+01					
Cl-36																												
Cm-243																							2E+04		1E+05			
Cm-244																							1E+04		1E+05			
Cm-245																							1E+01					
Cm-246																							3E+01					
Cm-247																							1E+01					
Cm-248																							5E+00					
Cs-135			6E+04																		1E+04				6E+04			
H-3	NP[c]		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP	
I-129	NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP	
K-40					7E+02	I	7E+02	I							7E+02	I	7E+02	I	7E+02	I	7E+02	I	7E+02	I	7E+02	I		
Nb-93m																									6E+07			
Nb-94																							9E+01	I				
Ni-59																					5E+05							
Np-237							7E+00								1E+01		2E+02		8E+01		2E+01		2E+01		1E+02			
Pa-231			2E+01																						2E+01			
Pd-107																	6E+06	I	2E+06		6E+05		5E+05		3E+06			
Pu-238																					7E+04	I	7E+04	I	7E+04	I		
Pu-239																							2E+01		2E+02			
Pu-240																							3E+01		3E+02			
Pu-241							2E+05	I							2E+05	I							1E+04		2E+05	I		
Pu-242																							2E+01		1E+02			
Pu-244																							1E+01		6E+01			
Ra-226																					8E+01	I						
Se-79			6E+04																6E+04		1E+04		9E+03		5E+04			
Si-32																												
Sn-126																					8E+01	I	8E+01	I				
Tc-99	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+02	
Th-229																							2E+01					
Th-230																							1E+01					
Th-232																							2E+01					
U-232			1E+03																1E+03									
U-233			7E+02	I													7E+02	I	7E+02	I	7E+02		8E+01		2E+02			
U-234			1E+03	I													1E+03	I	1E+03	I	3E+02		2E+02		1E+03	I		
U-235			6E+02	I													5E+02		6E+02	I	2E+02		5E+01		2E+02			
U-236			1E+03														3E+03		1E+03		3E+02		3E+02		2E+03			
U-238			1E+03														3E+03		1E+03		3E+02		3E+02		2E+03			
Zr-93																									2E+05			

a Maximum permissible concentration in the waste; blank cells indicate that the values are the same as those in the PE (Waters and Gruebel, 1996)
b Controlling pathway is the same as in the PE (Waters and Gruebel, 1996) unless otherwise noted: I = intruder
c Not Present: volatile radionuclide that would not be present in this waste form

Table B-3 (b). Permissible Radionuclide Concentrations for Waste in Glass - Tumulus Design

Radio-nuclide	LLNL		Hanford		INEL		RFETS		SNL		LANL		Pantex		ANLE		PGDP		FEMP		PORTS		ORR		SRS		WVDP	
	C_w[a]	Path[b]	C_w	Path	C_w	Path	C_w	Path	C_w	Path	C_w	Path	C_w	Path	C_w	Path	C_w	Path	C_w	Path	C_w	Path	C_w	Path	C_w	Path	C_w	Path
H-3	NP[c]		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP	
C-14							1E+04	I							1E+04	I			1E+04	I	1E+04	I	1E+04	I	1E+04	I	1E+04	I
Si-32																												
Cl-36																												
K-40					7E+02	I	7E+02	I									7E+02	I	7E+02	I	7E+02	I	7E+02	I	7E+02	I		
Ni-59																												
Se-79			1E+05																				2E+04		1E+05			
Zr-93																									4E+05			
Nb-93m																									1E+12			
Nb-94																												
Tc-99	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	2E+04	I	3E+02	
Pd-107																			4E+06		1E+06		1E+06		6E+06	I		
Sn-126																							8E+01	I				
I-129	NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP		NP	
Cs-135			1E+05																									
Ra-226																												
Th-229																							5E+01					
Th-230																							3E+01					
Th-232																							3E+01					
Pa-231			4E+01																						3E+01			
U-232			1E+04	I															1E+04	I								
U-233			7E+02	I													7E+02	I	7E+02	I	1E+02		2E+02		3E+02			
U-234			1E+03	I													1E+03	I	1E+03	I	5E+02		5E+02		1E+03	I		
U-235			6E+02	I													5E+02		6E+02	I	9E+01		1E+02		2E+02			
U-236			4E+03														7E+03		2E+03		8E+02		5E+02		3E+03			
U-238			4E+03														5E+03	I	2E+03		8E+02		5E+02		3E+03			
Np-237							1E+01								4E+01		4E+02	I	2E+02		6E+01		3E+01		2E+02			
Pu-238																					1E+05		1E+05	I	4E+05	I		
Pu-239																							5E+01					
Pu-240																							5E+01					
Pu-241																							3E+04					
Pu-242																							5E+01					
Pu-244																							3E+01					
Am-241																							1E+03					
Am-243																							5E+01					
Cm-243																							3E+04					
Cm-244																							2E+04					
Cm-245																							2E+01					
Cm-246																							6E+01					
Cm-247																							2E+01					
Cm-248																							1E+01					
Cf-249																							5E+02					
Cf-250																							2E+04					
Cf-251																							2E+02					

a Maximum permissible concentration in the waste; blank cells indicate that the values are the same as those in the PE (Waters and Gruebel, 1996)

b *Controlling pathway is the same as in the PE (Waters and Gruebel, 1996) unless otherwise noted: I = intruder*

c Not Present: volatile radionuclide that would not be present in this waste form

References

Cunnane, J.C., and J.M. Allison, 1994. "High-Level Waste Glass Compendium; What It Tells Us Concerning the Durability of Borosilicate Waste Glass," Scientific Basis for Nuclear Waste Management XVII, MRS Vol. 333, p. 87-93.

DOE (Department of Energy), 1996. *Performance Evaluation of the Technical Capabilities of DOE Sites for Disposal of Mixed Low-Level Waste*. DOE/ID-10521. 3 vol. Idaho Falls, ID: U.S. Department of Energy, Office of Waste Management (EM-30).

SNL, 1996. "Waste Performance Assessment Task, Draft Letter Report." Albuquerque, NM: Sandia National Laboratories.

Waters, R.D., and M.M. Gruebel, eds., 1996. "Performance Evaluation of the Technical Capabilities of DOE Sites for Disposal of Mixed Low-Level Waste - Vol. 3: Site Evaluations," DOE/ID-10521/3, SAND96-0721/3. Prepared by Sandia National Laboratories for the U.S. Department of Energy, March, 1996.

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Appendix C:

SUMMARY OF DATA USED IN THE CALCULATION OF TREATED VOLUMES OF MLLW

This appendix contains the basic data used in and results of the volume estimates for treated mixed low-level waste (MLLW). All values in this table have been reviewed and updated, when necessary, by the site contacts. Each row in the table represents a waste stream that results in MLLW after treatment. Waste streams that result in LLW or TRU waste after treatment are not listed.

The last column of this table, Treated MLLW Volume (m^3), is the result of the following calculation:

$$Treated\ MLLW\ Volume = (MWIR\ Current + 5 - yr\ Volume) \times AMR \times \frac{Inital\ Bulk\ Density}{Final\ Bulk\ Density}$$

AMR is the activity-per-unit-mass ratio (initial values are given in Table 2-3 of the report, which were modified for some waste streams at some sites), which represents the change in mass due to treatment of the waste. The summation of the last column in this table equals the total estimated volume of 130,300 m^3 for treated MLLW that will be disposed of as MLLW.

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Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
Argonne East									
AE-W015	1.07	0.1216	Lab Packs, Chemical Oxidation	polymer	X6100	100	1	1	119
AE-W023	0.26	1.448	Debris, Stabilization	grout	S5121	2	1.6	2.4	2
AE-W026	3.5	1.6	Elemental cadmium, Macroencapsulation	macroencapsulation	X7220	2	5	5	10
AE-W033	12.2	57.392	Lead, Macroencapsulation	macroencapsulation	X7212	0.5	11	11	35
AE-W035	11.1	0	Lead, Macroencapsulation	macroencapsulation	X7219	0.5	11	11	6
AE-W044	0.2	0	Elemental mercury, Amalgamation	amalgam	X7100	2	10.9	10	0.4
Argonne West									
AW-W009	0.63	0	Debris, Thermal	grout	S3130	0.05	1.6	2.4	0.02
Batelle Columbus									
BC-W002	0	1.151	Lab Packs, Thermal Oxidation	polymer	X6100	0.05	1	1.4	0.04
Brookhaven									
BN-W004	0.91	0.1	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.004
Bettis									
BT-W007	0.42	0	Combustible Organics, Thermal	grout	S3219	0.01	1	2.4	0.002
BT-W009	0.63	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S4100	2	1.6	2.4	0.8
BT-W010	0.48	0	Combustible Organics, Incineration/Thermal	grout	L2220	0.01	0.9	2.4	0.002
BT-W013	0.84	0	Inorganic Homogeneous Solids and Soils, Incineration/Thermal	grout	S4100	2	1.6	2.4	1
BT-W018	0	0.02	Combustible Organics, Thermal	grout	L2190	0.01	1	2.4	0.0001
BT-W020	0	0.05	Debris, Macroencapsulation	macroencapsulation	S5112	1	5.7	5.7	0.1
BT-W028	2.1	0.63	Wastewater, Incineration/Thermal	grout	L1130	0.01	1	2.4	0.01
BT-W029	0.84	0.63	Combustible Organics, Thermal	grout	S3223	0.01	1.2	2.4	0.01
BT-W031	2.73	1.05	Combustible Organics, Incineration/Thermal	grout	S3223	0.01	1.2	2.4	0.02
Charleston Naval									
CN-W005	0.00003	0	Debris, Macroencapsulation	macroencapsulation	S5119	1	4	4	0.00003
CN-W006	0.8	0	Debris, Macroencapsulation	macroencapsulation	S5119	1	4	4	0.8
ORR K-25 Site									
DP-W002	82.747	3.935	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3100	2	1.3	2.4	94
DP-W007	140.955	171.16	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3100	2	2.4	2.4	624
DP-W011	16455.43	0	Stabilized Pond Sludge, Stabilization	grout	S3100	1	2.4	2.4	16455
DP-W019	10733.63	0	Unstabilized Pond Sludge, Stabilization	grout	S3100	2	2.4	2.4	21467
DP-W027	188.642	95.45	Wastewater, Thermal Treatment	grout	L1000	0.001	1.1	2.4	0.1

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
DP-W030	31.787	21.645	Wastewater, Thermal Treatment	grout	L1000	0.001	1.1	2.4	0.02
DP-W034	33	14.585	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.2
DP-W140	436.415	420	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3100	2	1.3	2.4	928
DP-W141	290.045	0	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	145
DP-W143	38.021	0	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.1
DP-W144	60.822	0.285	TSCA Residues, Stabilization	grout	S5100	2	2.4	2.4	122
DP-W146	271.978	0	Combustible Organics, Thermal	grout	S3200	0.01	1.2	2.4	1
DP-W147	196.137	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4000	2	1.5	2.4	245
DP-W148	164.072	0	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	82
DP-W149	123.599	11.285	Wastewater, Thermal Treatment	grout	L1000	0.001	1.1	2.4	0.1
DP-W150	95.026	40.205	Wastewater, Thermal Treatment	grout	L1000	0.001	1.1	2.4	0.1
DP-W151	3.135	0.44	Wastewater, Thermal Treatment	grout	L1000	0.001	1.1	2.4	0.002
DP-W152	234.935	100.455	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	1
DP-W153	21.115	0.875	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.1
DP-W154	21.056	1.635	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.1
DP-W155	3.398	0	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	2
DP-W156	112.041	4.855	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	58
DP-W157	84.537	74.18	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	79
DP-W158	36.183	0.315	Combustible Organics, Thermal	grout	S3200	0.01	1.2	2.4	0.2
DP-W160	21.905	1.915	Combustible Organics, Thermal	grout	S3200	0.01	1.2	2.4	0.1
DP-W161	27.117	0.3	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4000	2	1.5	2.4	34
DP-W162	24.286	48.83	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4000	2	1.5	2.4	91
DP-W163A	24.094	0.235	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4000	2	1.5	2.4	30
DP-W166	2.91	0.195	Debris D018-D043, Stabilization	grout	S5100	2	2.4	2.4	6
DP-W170	18.48	41.225	Debris D018-D043, Stabilization	grout	S5400	2	2.4	2.4	119
Energy Tech									
ET-W020	0.15	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.001
Fernald									
FM-W005	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W009	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W013	0.8	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	0.8
FM-W014	0.6	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
FM-W019	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W023	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W025	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W027	0.4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
FM-W030	12	1	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.1
FM-W031	1.8	0.2	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.01

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
FM-W032	2	0.1	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.01
FM-W035	8.2	0.9	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.04
FM-W036	44.4	3.2	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.2
FM-W037	0.2	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.001
FM-W041	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W044	0.4	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	0.4
FM-W046	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W047	0.2	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	0.2
FM-W050	0.4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
FM-W051	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W054	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W055	1.2	0	Combustible Organics, Thermal	grout	S3222	0.01	1.2	2.4	0.01
FM-W068	1.4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.01
FM-W069	0.2	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.001
FM-W075	2.6	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.01
FM-W076	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W080	0.2	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	0.3
FM-W085	0.2	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	0.3
FM-W088	0.2	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	0.3
FM-W089	0.4	0.5	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.003
FM-W091	0.4	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	1
FM-W093	0.2	0	Combustible Organics, Non-Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W094	1.2	0	Wastewater, Non-Thermal	grout	L1130	0.01	1	2.4	0.01
FM-W102	0.2	0	Debris, Non-Thermal	grout	S5112	2	5.7	2.4	1
FM-W104	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W107	1.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.005
FM-W114	2.2	3	Wastewater, Non-Thermal	grout	L1130	0.01	1	2.4	0.02
FM-W115	2.6	0	Wastewater, Non-Thermal	grout	L1110	0.25	1	2.4	0.3
FM-W117	0.4	6.3	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.03
FM-W119	3.4	7.5	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.04
FM-W121	1.2	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	2
FM-W122	0.2	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	0.3
FM-W123	4.8	15.4	Debris, Stabilization	grout	S5112	2	5.7	2.4	96
FM-W124	1.2	0.3	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.01
FM-W125	4.8	0	Debris, Stabilization	grout	S5490	2	0.6	2.4	2
FM-W126	2.8	0	Combustible Organics, Non-Thermal	grout	S3222	0.01	1.2	2.4	0.01
FM-W127	4.4	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.02
FM-W129	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W130	0.6	0	Combustible Organics, Non-Thermal	grout	S3222	0.01	1.2	2.4	0.003
FM-W131	0.4	0	Combustible Organics, Non-Thermal	grout	S3223	0.01	1.2	2.4	0.002

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
FM-W132	105.8	0	Combustible Organics, Non-Thermal	grout	L2120	0.01	1	2.4	0.4
FM-W137	1.2	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	1
FM-W140	0.4	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	0.4
FM-W144	4.4	0	Debris, Stabilization	grout	S5123	2	1.6	2.4	6
FM-W145	7.8	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	8
FM-W146	2.8	0	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.01
FM-W147	2	0	Combustible Organics, Non-Thermal	grout	S3223	0.01	1.2	2.4	0.01
FM-W148	1.6	0	Combustible Organics, Thermal	grout	S3222	0.01	1.2	2.4	0.01
FM-W149	0.6	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
FM-W150	0.6	0	Combustible Organics, Non-Thermal	grout	S3223	2	1.2	2.4	0.6
FM-W151	0.4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
FM-W152	0.2	0	Lab Packs, Thermal Oxidation	polymer	X6100	0.05	1	1.4	0.01
FM-W153	0.2	0	Lab Packs, Thermal Oxidation	polymer	X6100	0.05	1	1.4	0.01
FM-W154	56	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.2
FM-W158	3	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.01
FM-W161	2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.01
FM-W162	1.8	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.01
FM-W165	0.8	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3119	2	1.2	2.4	0.8
FM-W166	0.6	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3190	2	1.5	2.4	0.8
FM-W167	0.4	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.002
FM-W168	0.4	0	Combustible Organics, Non-Thermal	grout	L2210	0.01	0.9	2.4	0.002
FM-W171	0.2	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3119	2	1.2	2.4	0.2
FM-W172	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W173	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W181	0.2	0	Combustible Organics, Non-Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W185	15.8	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	16
FM-W187	10.6	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	11
FM-W188	4.2	0	Combustible Organics, Non-Thermal	grout	S3223	2	1.2	2.4	4
FM-W191	3.4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.01
FM-W192	17	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.1
FM-W194	0.8	0	Combustible Organics, Non-Thermal	grout	S3223	2	1.2	2.4	0.8
FM-W196	0.8	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	0.8
FM-W197	0.6	0	Combustible Organics, Thermal	grout	S3223	0.01	1.2	2.4	0.003
FM-W198	2	0	Combustible Organics, Non-Thermal	grout	S3223	2	1.2	2.4	2
FM-W215	31	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3129	2	1.3	2.4	34
FM-W216	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W217	1	0	Debris, Thermal	grout	S5330	0.05	0.6	2.4	0.01
FM-W218	0.2	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.001
FM-W221	1.8	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3111	2	1.2	2.4	2

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
FM-W224	1.4	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3149	2	1.4	2.4	2
FM-W225	13.4	0	Combustible Organics, Thermal	grout	S3223	0.01	1.2	2.4	0.1
FM-W226	0.4	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3129	2	1.3	2.4	0.4
FM-W227	0.6	0	Combustible Organics, Thermal	grout	S3222	0.01	1.2	2.4	0.003
FM-W229	0.2	0	Combustible Organics, Non-Thermal	grout	S3229	2	1.2	2.4	0.2
FM-W233	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W234	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W240	7.6	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3144	2	1.4	2.4	9
FM-W241	1	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3144	2	1.4	2.4	1
FM-W243	8.4	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3144	2	1.4	2.4	10
FM-W244	32.6	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3190	2	1.5	2.4	41
FM-W247	0.8	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3149	2	1.4	2.4	0.9
FM-W250	1	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3149	2	1.4	2.4	1
FM-W253	0.4	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3119	2	1.2	2.4	0.4
FM-W258	0.2	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3190	2	1.5	2.4	0.3
FM-W262	2.2	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3129	0.01	1.3	2.4	0.01
FM-W264	0.2	0	Combustible Organics, Thermal	grout	S3223	0.01	1.2	2.4	0.001
FM-W267	3.2	0	Combustible Organics, Thermal	grout	S3223	0.01	1.2	2.4	0.02
FM-W277	0.6	0	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.003
FM-W278	2.6	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.01
FM-W279	3.2	0	Combustible Organics, Non-Thermal	grout	S3223	0.01	1.2	2.4	0.02
FM-W280	0.2	0	Wastewater, Thermal	grout	L1130	0.01	1	2.4	0.001
FM-W282	69.4	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3144	2	1.4	2.4	81
FM-W283	4.2	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.02
FM-W284	0.2	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	0.3
FM-W285	2.4	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.01
FM-W288	0.4	0	Combustible Organics, Thermal	grout	S3223	0.01	1.2	2.4	0.002
FM-W289	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W297	0.4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
FM-W301	0.2	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.001
FM-W306	0.2	0.2	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
FM-W308	2.4	16.8	Wastewater, Thermal Treatment	grout	L1110	0.01	1	2.4	0.1
FM-W309	0.4	0.2	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.002
FM-W312	1.8	4.8	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.02
FM-W313	1.8	6.9	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.03
FM-W316	0.4	0.9	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.005
FM-W318	0.8	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3150	2	1.8	2.4	1
FM-W323	0.4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
FM-W324	0.2	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.001
FM-W327	0.8	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.003

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
FM-W328	2	9.5	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.05
FM-W330	0.2	0.9	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.005
FM-W332	0.2	1	Wastewater, Non-Thermal	grout	L1110	0.25	1	2.4	0.1
FM-W333	1.4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.01
FM-W335	0.4	2	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.01
FM-W341	0.4	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3144	2	1.4	2.4	0.5
FM-W346	0.4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
FM-W351	4	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.02
FM-W352	0.6	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.002
FM-W353	1.6	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.01
FM-W354	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W355	0.8	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.003
FM-W356	0.8	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.003
FM-W357	10.6	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.04
FM-W358	2.4	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.01
FM-W365	0.4	0	Combustible Organics, Thermal	grout	S3223	0.01	1.2	2.4	0.002
FM-W369	3.8	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3121	2	1.3	2.4	4
FM-W370	0.2	0	Combustible Organics, Thermal	grout	S3223	0.01	1.2	2.4	0.001
FM-W375	0.4	0	Debris, Non-Thermal	grout	S5112	2	5.7	2.4	2
FM-W378	0.2	0.6	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.003
FM-W379	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W380	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
FM-W383	2.4	0	Wastewater, Thermal Treatment	grout	L1130	0.001	1	2.4	0.001
FM-W384	0.6	0	Wastewater, Thermal Treatment	grout	L1130	0.001	1	2.4	0.0003
FM-W385	4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.02
FM-W388	0.8	0	Combustible Organics, Thermal	grout	S3223	0.01	1.2	2.4	0.004
FM-W394	0.4	0	Wastewater, Thermal Treatment	grout	L1130	0.001	1	2.4	0.0002
FM-W400	17	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.1
FM-W401	0.2	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.001
FM-W402	0.6	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
FM-W403	0.2	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.001
FM-W404	0.4	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.002
FM-W405	0.8	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.003
FM-W406	0.8	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.003
FM-W407	0.4	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.002
FM-W408	0.2	0	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.001
FM-W409	0.2	0	Combustible Organics, Thermal	grout	S3222	0.01	1.2	2.4	0.001
FM-W410	12	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.05
FM-W412	10.4	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.04
FM-W418	0.1	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S4200	2	1.6	2.4	0.1

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
INEL									
IN-W005	0.21	0.0095	Lab Packs, Thermal Oxidation	polymer	X6100	0.05	1	1.4	0.01
IN-W007	0.21	0	Lab Packs, Thermal Oxidation	polymer	X6200	0.05	1	1.4	0.01
IN-W008	0.21	0	Debris, Thermal	grout	S3000	0.05	1.3	2.4	0.0057
IN-W014	0.21	0	Debris, Stabilization	grout	S5113	2	4.4	2.4	1
IN-W035	1.87	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3122	2	1.3	2.4	2
IN-W038	5.89	0	Wastewater, Thermal Treatment	grout	L1290	0.01	1.1	2.4	0.03
IN-W047	0.21	0	Debris, Thermal	grout	S5300	0.05	0.7	2.4	0.0031
IN-W050	0.21	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
IN-W057	0.08	0	Debris, Thermal	grout	S5440	0.05	0.7	2.4	0.0012
IN-W058A	2.1675	0	Debris, Stabilization	grout	S5110	1	4	2.4	4
IN-W061	0.04	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.000
IN-W062	0.13	0	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.001
IN-W077	0.03	0	Debris, Stabilization	grout	X7210	2	5.7	2.4	0.1
IN-W084	3.6	0	Lead, cadmium, beryllium, and other hazardous metals	macroencapsulation	X7210	0.05	5.7	11	0.0933
IN-W089	0.05	0	Debris, Thermal	grout	S5400	0.05	0.6	2.4	0.0006
IN-W096	0.32	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
IN-W100	1.77	0	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.01
IN-W111	28.1	45.7	Lead, cadmium, beryllium, and other hazardous metals	macroencapsulation	X7210	0.05	5.7	11	1.9121
IN-W117	0	0.59	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.0022
IN-W118A	4.123	0	Debris, Stabilization	grout	S5110	1	2.4	2.4	4
IN-W119	0.27	7	Wastewater, Thermal Treatment	grout	L1110	0.01	1	2.4	0.03
IN-W120	2.6	7	Wastewater, Thermal Treatment	grout	L1110	0.01	1	2.4	0.04
IN-W122A	169.1	380	Debris, Thermal	grout	S5300	0.01	0.7	2.4	2
IN-W153	23.6	1.4	Lead, cadmium, beryllium, and other hazardous metals	macroencapsulation	X7210	0.05	5.7	11	0.6477
IN-W376	0.31	2.1	Lab Packs, Thermal Oxidation	polymer	X6300	0.05	1	1.4	0.1
IN-W381	0.46	6.18	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3100	2	1.3	2.4	7
IN-W387	0	10.9	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3120	2	1.3	2.4	12
IN-W388	0	4.25	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3110	2	0.9	2.4	3
IN-W396	1.81	4.5	Debris, Stabilization	grout	S5110	2	4	2.4	21
IN-W399	0.724	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S4100	2	1.6	2.4	1
IN-W400	0	0.02	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.0001
IN-W402	0	9.2	Lead, cadmium, beryllium, and other hazardous metals	macroencapsulation	X7210	0.05	5.7	11	0.2384
IN-W404	0	0.55	Lead, cadmium, beryllium, and other hazardous metals	macroencapsulation	X7210	0.05	5.7	11	0.0143

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
Knolls Schenectady									
KA-W001	0.014	2	Lab Packs, Thermal treatment/Chemical reduction	polymer	X6900	0.05	1	1.4	0.1
KA-W002	0	0.1	Combustible Organics, Thermal treatment/Chemical reduction	grout	L2900	0.01	0.9	2.4	0.0004
KA-W005	0.187	0	Debris, Stabilization	grout	S5125	2	1	2.4	0.2
KA-W007	0.224	2	Combustible Organics, Thermal treatment/Chemical reduction	grout	L2900	0.01	0.9	2.4	0.01
KA-W008	0.002	0.6	Lab Packs, Chemical reduction	polymer	X6900	2	1	1.4	1
KA-W014	0	0.4	Combustible Organics, Thermal treatment/Chemical reduction	grout	S3290	0.01	0.8	2.4	0.001
KA-W015	0	16.8	Inorganic Homogeneous Solids and Soils, Thermal treatment/Chemical reduction	grout	S4900	2	1.5	2.4	21
KA-W018	0.033	1	Combustible Organics, Retort/Thermal treatment/Chemical reduction	grout	S3290	2	0.8	2.4	0.7
KA-W020	0.029	0.08	Elemental mercury, Amalgamation	amalgam	X7100	15	10.9	10	2
Knolls Kesselring									
KK-W002	0	1	Debris, Stabilization	grout	S5113	2	4.4	2.4	4
KK-W003	0	0.25	Combustible Organics, Thermal treatment/Chemical reduction	grout	L2900	0.01	0.9	2.4	0.001
KK-W004	0.01	0.25	Lab Packs, Thermal treatment/Deactivation/Chemical reduction	polymer	X6900	0.05	1	1.4	0.01
KK-W008	0	0.75	Combustible Organics, Thermal treatment/Chemical reduction	grout	S3290	0.01	0.8	2.4	0.003
KK-W011	0	0.4	Combustible Organics, Thermal treatment/Chemical reduction	grout	L2900	0.01	0.9	2.4	0.002
KK-W012	0	0.25	Lab Packs, Deactivation/Chemical reduction	polymer	X6900	2	1	1.4	0.4
KK-W013	0	7.5	Inorganic Homogeneous Solids and Soils, Thermal treatment/Chemical reduction	grout	S4100	2	1.6	2.4	10
KK-W016	0	0.001	Elemental mercury, Amalgamation	amalgam	X7100	15	10.9	10	0.02
Knolls Windsor									
KW-W001	0	0.45	Combustible Organics, Thermal treatment/Chemical reduction	grout	L2900	0.01	0.9	2.4	0.002
KW-W002	0	0.02	Lab Packs, Chemical reduction	polymer	X6900	2	1	1.4	0.03
KW-W006	0	1.6	Combustible Organics, Thermal treatment/Chemical reduction	grout	S3290	0.01	0.8	2.4	0.01
KW-W008	0	0.3	Lab Packs, Thermal treatment	polymer	X6900	0.05	1	1.4	0.01
KW-W009	0	4.2	Inorganic Homogeneous Solids and Soils, Thermal treatment/Chemical reduction	grout	S4100	2	1.6	2.4	6
KW-W010	0	0.05	Inorganic Homogeneous Solids and Soils, Retort/Thermal treatment/Chemical reductio	grout	S3290	2	0.8	2.4	0.03
LANL									
LA-W069	15.89	0.01	Combustible Organics, Thermal	grout	L2190	0.01	1	2.4	0.1
LA-W070	2.47	4	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.02
LA-W073	39.32	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	52
LA-W074	1.65	0.5	Wastewater, Non-Thermal	grout	L2190	0.25	1	2.4	0.2
LA-W075	16.58	5.5	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.1
LA-W076	14.34	10	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.1
LA-W077	3.75	3	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.03
LA-W078	0.74	0.2	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.004
LA-W080	13.82	1.5	Debris, Stabilization	grout	S5390	2	0.7	2.4	9

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
LA-W083	0.13	0.01	Wastewater, Non-Thermal	grout	L1290	0.25	1.1	2.4	0.02
LA-W084	6.03	0.2	Debris, Stabilization	grout	S5900	2	0.6	2.4	3
LA-W085	0.35	0.1	Compressed gases/aerosols, Chemical redox	grout	X7700	1	2	2.4	0.4
LA-W088	0.5	0.05	Elemental mercury, Amalgamation	amalgam	X7100	15	10.9	10	9
LA-W089	15.6	1	Debris, Stabilization	grout	S5119	2	4	2.4	55
LA-W090	5.62	3	Debris, Stabilization	grout	S5900	2	0.6	2.4	4
Lawrence Berkeley									
LB-W001	0.93	0.9	Wastewater, Thermal	grout	L1110	0.01	1	2.4	0.01
LB-W002	0.123	1.22	Wastewater, Thermal	grout	L1120	0.01	1	2.4	0.01
LB-W003	0.00035	0.55	Wastewater, Non-Thermal	grout	L1140	0.25	1	2.4	0.1
LB-W004	0.751	3.42	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.02
LB-W007	0.046	0.042	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.0003
LB-W011	0.01	0.1	Wastewater, Thermal	grout	L1110	0.01	1	2.4	0.0005
LB-W012	0	0.13	Wastewater, Thermal	grout	L1120	0.01	1	2.4	0.001
LB-W014	0	0.38	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.001
LB-W017	0	0.004	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.00002
LB-W019	0.001	0.015	Debris, Thermal	grout	S5440	0.05	0.7	2.4	0.0002
LLNL									
LL-W001	5.83	5	Lab Packs, Chemical Oxidation	polymer	X6400	2	1	1.4	15
LL-W002	124.8	110	Inorganic Homogeneous Solids and Soils, Stabilization	clay	S3121	2	1.3	2.4	254
LL-W004	72.99	1350	Combustible Organics, Non-Thermal	clay	L2120	0.15	1	2.4	89
LL-W005	5.6	5	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3129	2	1.3	2.4	11
LL-W006	18.8	5	Debris, Non-Thermal	grout	S5111	2	4	2.4	79
LL-W007	4.37	5	Debris, Stabilization	grout	S5123	2	1.6	2.4	12
LL-W008	7.2	10	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.1
LL-W009	3.6	8.5	Combustible Organics, Thermal	grout	L2290	0.01	0.9	2.4	0.05
LL-W010	12.2	10	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	30
LL-W014	15.67	20	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.1
LL-W015	3.49	15	Debris, Stabilization	grout	S5410	2	1	2.4	15
LL-W016	0.46	1	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.01
LL-W017	58.96	50	Debris, Thermal	grout	S5490	0.05	0.6	2.4	1
LL-W023	6.6	30	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4300	2	1.9	2.4	58
LL-W025	141.3	125	Inorganic Homogeneous Solids and Soils, Stabilization	clay	S3150	2	1.8	2.4	399
LL-W026	1.2	5	Combustible Organics, Thermal	grout	S3229	0.01	1.2	2.4	0.03
Mound									
MD-W001	43.3	0	Scintillation Cocktails, Stabilization	grout	X6400	0.05	1	1.4	2
MD-W012	0.0204	0.02	Debris, Stabilization	grout	S5311	2	1.8	2.4	0.1

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
Mare Island									
MI-W004	0.45	0	Thallium, Decontamination/Macroencapsulation	macroencapsulation	X7290	1	4	4	0.5
MI-W008	2.83	0	Debris, Macroencapsulation	macroencapsulation	S5119	1	4	4	3
MI-W014	3.68	0	Debris, Stabilization	grout	S5113	2	4.4	2.4	13
Univ. of Missouri									
MU-W001	1.4	4	Debris, Stabilization	grout	S5440	2	0.17	2.4	0.8
Norfolk Naval									
NN-W003	0.08	1.89	Debris, Macroencapsulation	macroencapsulation	S5119	1	4	4	2
NTS									
NT-W015	0.21	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.001
ORNL									
OR-W008	18.95	0	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.1
OR-W048	17.732	15.83	Wastewater, Thermal Treatment	grout	L1000	0.001	1.1	2.4	0.02
OR-W049	3.642	15.455	Wastewater, Thermal Treatment	grout	L1000	0.001	1.1	2.4	0.01
OR-W050	0.831	2.925	Wastewater, Thermal Treatment	grout	L1000	0.001	1.1	2.4	0.002
OR-W051	37.572	49.445	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.3
OR-W053	1.021	1.66	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.01
OR-W054	0.074	0.06	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	0.1
OR-W055	2.299	1.23	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	2
OR-W056	1.488	1.68	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	2
OR-W057	0.023	0.045	Combustible Organics, Thermal	grout	S3200	0.01	1.2	2.4	0.0003
OR-W058	0.011	0	Combustible Organics, Thermal	grout	S3200	0.01	1.2	2.4	0.0001
OR-W061	1.88	7.645	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4000	2	1.5	2.4	12
OR-W062A	0.31	0.005	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4000	2	1.5	2.4	0.4
OR-W082	2.103	4.545	Combustible Organics, Thermal	grout	L9000	0.01	1	2.4	0.03
Paducah GDP									
PA-W005	0.05	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.0002
PA-W040	3.41	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.01
PA-W043	0.02	0	Lab Packs, Thermal Oxidation	polymer	X6100	0.05	1	1.4	0.001
PA-W044	1.72	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.01
PA-W046	0.52	0	Wastewater, Non-Thermal	grout	L1140	0.25	1	2.4	0.1
PA-W055	7.4	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.03
PA-W056	1.06	0	Combustible Organics, Thermal	grout	L2290	0.01	0.9	2.4	0.004

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
PA-W058	5.18	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3132	2	1.6	2.4	7
PA-W060	0.52	0	Combustible Organics, Thermal	grout	S3290	0.01	0.8	2.4	0.002
PA-W065	0.24	0	Lab Packs, Thermal Oxidation	polymer	X6100	0.05	1	1.4	0.01
PA-W073	10.84	0	Wastewater, Thermal Treatment	grout	L1110	0.01	1	2.4	0.05
PA-W075	2.13	0	Wastewater, Thermal Treatment	grout	L1190	0.01	1	2.4	0.01
PA-W147	2.89	0	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.01
PA-W148	2.41	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.01
PA-W149	0.4	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3132	2	1.6	2.4	1
PA-W150	0.01	0	Combustible Organics, Thermal	grout	L2120	0.01	1	2.4	0.00004
PA-W151	0.72	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3114	2	1	2.4	1
PA-W152	0.4	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3129	2	1.3	2.4	0.4
PA-W153	0.6	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3139	2	1.6	2.4	1
PA-W154	3.59	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	4
PA-W155	0.2	0	Combustible Organics, Thermal	grout	S3290	0.01	0.8	2.4	0.001
PA-W165	3.15	0	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.01
PA-W166	31	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.1
PA-W167	5	0	Combustible Organics, Non-Thermal	grout	S3222	2	1.2	2.4	5
PA-W170	0.32	0	Wastewater, Thermal Treatment	grout	L1130	0.01	1	2.4	0.001
PA-W171	1	0	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.004
PA-W172	0.2	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.001
PA-W177	0.2	0	Explosives/propellants, Chemical Deactivation	polymer	X7600	2	1.5	1.4	0.4
PA-W181	0.41	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
PA-W188	1	0	Combustible Organics, Non-Thermal	grout	S3229	2	1.2	2.4	1
Pearl Harbor									
PH-W002	0.04	0	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.0002
PH-W007	0.04	0.1	Debris, Stabilization	grout	S5900	2	0.6	2.4	0.1
Portsmouth Naval									
PN-W004	0.45	0.13	Debris, Stabilization	grout	S5119	2	4	2.4	2
PN-W005	0	0.148	Debris, Stabilization	grout	S5410	2	1	2.4	0.1
Portsmouth GDP									
PO-W002	0.416	0	Combustible Organics, Thermal	grout	S3222	0.01	1.2	2.4	0.002
PO-W014	2.08	0	Wastewater, Non-Thermal	grout	L1240	0.25	1.1	2.4	0.2
PO-W017	37.05	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3132	2	1.6	2.4	49
PO-W018	70.942	2	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3115	2	1	2.4	61
PO-W019	147.147	0	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.6
PO-W022	12.787	0	Combustible Organics, Thermal	grout	S3229	0.01	1.2	2.4	0.1

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
PO-W025	0.435	0	Debris, Stabilization	grout	S5330	2	0.6	2.4	0.2
PO-W027	1.712	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3111	2	1.2	2.4	2
PO-W028	2.912	0	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.01
PO-W030	9.02	0	Lab Packs, Stabilization	polymer	X6900	2	1	1.4	13
PO-W031	7.332	0	Lab Packs, Thermal Oxidation	polymer	X6900	0.05	1	1.4	0.3
PO-W032	2.932	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3132	2	1.6	2.4	4
PO-W039A	2260.322	100	Inorganic Homogeneous Solids and Soils, Thermal Desorption	soil	S4100	1	2	2	2360
PO-W040	0.643	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.002
PO-W044	0.208	0	Wastewater, Thermal Treatment	grout	L1230	0.001	1.1	2.4	0.0001
PO-W046	10.623	0	Debris, Stabilization	grout	S5390	2	0.7	2.4	6
PO-W047	14.53	0	Lab Packs, Stabilization	polymer	X6900	2	1	1.4	21
PO-W053	18.587	0	Wastewater, Thermal Treatment	grout	L1110	0.001	1	2.4	0.01
PO-W057	53.952	0	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.2
PO-W058	135.46	105	Combustible Organics, Thermal	grout	S3211	0.01	0.8	2.4	0.8
PO-W059	0.656	0	Debris, Stabilization	grout	S5440	2	2.4	2.4	1
PO-W066	8.112	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3129	2	1.3	2	11
PO-W069	154.873	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4900	2	1.5	2.4	194
PO-W070	0.208	0	Compressed gases/aerosols, Thermal oxidation	other	X7700	1	2	2	0.2
PO-W072	2.496	0	Combustible Organics, Thermal	grout	S3219	0.01	1	2.4	0.01
PO-W073	3.12	0	Debris, Stabilization	grout	S5390	2	0.7	2.4	2
PO-W076	0.569	0	Combustible Organics, Non-Thermal	grout	L2120	0.25	1	2.4	0.1
PO-W077	3.442	9	Combustible Organics, Thermal	grout	L2110	0.01	1	2.4	0.1
Puget Sound									
PS-W004	0.19	0	Liquid, Thermal	grout	L9000	0.01	1	2.4	0.001
PS-W006	0.84	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3150	2	1.8	2.4	1
PS-W012	0.16	2	Debris, Thermal treatment/Chemical reduction	grout	S9000	2	1.5	2.4	3
PS-W018	0.3	0	Liquid, Chemical reduction/Stabilization/Deactivation	grout	L9000	2	1	2.4	0.3
Pantex									
PX-W010	18.9	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3111	2	1.2	2.4	19
PX-W021	57.4	24.4	Debris, Stabilization	grout	S5330	2	0.6	2.4	41
PX-W023	9.5	21	Debris, Stabilization	grout	S5330	2	0.6	2.4	15
PX-W024	1.5	0.5	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.01
PX-W025	11.2	95.4	Debris, Stabilization	grout	S5119	2	0.4	2.4	36
PX-W027	2.3	5	Debris, Stabilization	grout	S5440	2	0.7	2.4	4
PX-W028	1.7	1.8	Debris, Stabilization	grout	S5122	2	1.6	2.4	5
PX-W029	1.5	7.6	Debris, Stabilization	grout	S5490	2	0.6	2.4	5
PX-W032	0.4	0.33	Combustible Organics, Thermal	grout	S3139	0.01	1.6	2.4	0.005
PX-W034	1.6	0.6	Wastewater, Non-Thermal	grout	L1290	0.25	1.1	2.4	0.3

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
PX-W038	0.003	0	Compressed gases/aerosols, Thermal oxidation	grout	X7700	1	2	2.4	0.003
PX-W040	0	2.9	Lab Packs, Thermal Oxidation	polymer	X6100	0.05	1	1.4	0.1
PX-W044	0.21	0	Debris, Stabilization	grout	S5000	2	1.5	2.4	0.3
Rocky Flats									
RF-W003	95.4	0	Inorganic Homogeneous Solids and Soils, Extraction/Oxidation	grout	S3150	2	1.8	2.4	143
RF-W005	163.13	1059.32	Debris, Stabilization	grout	S5112	2	5.7	2.4	5807
RF-W006	1226.94	753	Debris, Non-Thermal	grout	S5440	2	0.7	2.4	1155
RF-W007	66.36	0	Inorganic Homogeneous Solids and Soils, Extraction/Oxidation	grout	S3144	2	1.4	2.4	77
RF-W009	457.38	11.16	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3121	2	1.3	2.4	508
RF-W015	41.63	0	Combustible Organics, Thermal	grout	L2290	0.01	0.9	2.4	0.2
RF-W017	39.01	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.1
RF-W018	5708.07	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3150	2	1.8	2.4	8562
RF-W019	3451.45	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3150	2	1.8	2.4	5177
RF-W020	3.15	0	Lead, cadmium, beryllium, and other hazardous metals	macroencapsulation	X7300	0.05	1.3	11	0.02
RF-W022	10.92	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3111	2	1.2	2.4	11
RF-W024	10.29	12.45	Inorganic Homogeneous Solids and Soils, Thermal Desorption	soil	S5122	2	1.6	2	36
RF-W025	0.29	0	Inorganic Homogeneous Solids and Soils, Extraction/Oxidation	grout	S3114	2	1	2.4	0.2
RF-W027	1.15	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3132	2	1.6	2.4	2
RF-W030	3.57	27.69	Debris, Stabilization	grout	S5311	2	1.8	2.4	47
RF-W031	0.21	11.13	Debris, Stabilization	grout	S5311	2	1.8	2.4	17
RF-W035	0.42	0	Debris, Stabilization	grout	S5112	2	5.7	2.4	2
RF-W042	1.13	0	Debris, Stabilization	grout	S5119	2	4	2.4	4
RF-W043	2.52	19.93	Debris, Stabilization	grout	S5122	2	1.6	2.4	30
RF-W045	2.94	4.65	Debris, Stabilization	grout	S5129	2	1.2	2.4	8
RF-W046	48.22	0	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.2
RF-W047	4.44	0	Wastewater, Non-Thermal	grout	L1190	0.25	1	2.4	0.5
RF-W049	1.94	27.2	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.1
RF-W050	406.05	386	Inorganic Homogeneous Solids and Soils, Thermal Desorption	soil	S4200	2	1.6	2	1267
RF-W054	0.44	0	Wastewater, Non-Thermal	grout	L1140	0.25	1	2.4	0.05
RF-W062	0.42	0	Inorganic Homogeneous Solids and Soils, Extraction/Oxidation	grout	S3150	2	1.8	2.4	0.6
RF-W071	87.6	146.53	Inorganic Homogeneous Solids and Soils, Extraction/Oxidation	grout	S3129	2	1.3	2.4	254
RF-W074	4.14	7.8	Debris, Stabilization	grout	S5410	2	1	2.4	10
RF-W075	2.52	44.25	Debris, Stabilization	grout	S5410	2	1	2.4	39
RF-W078	169.8	0	Wastewater, Non-Thermal	grout	L1130	0.25	1	2.4	18
RF-W079	56.2	11.15	Wastewater, Non-Thermal	grout	L1290	0.25	1.1	2.4	8
RF-W080	0	1425	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3143	2	1.4	2.4	1663
RF-W081	10.81	0	Debris, Non-Thermal	grout	S5330	2	0.6	2.4	5
RF-W082	0.52	0	Debris, Non-Thermal	grout	S5119	2	4	2.4	2

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
RF-W083	40.46	13.49	Lab Packs, Thermal Oxidation	polymer	X6900	0.05	1	1.4	2
RF-W085	4.92	13.45	Lab Packs, Stabilization	polymer	X6900	2	1	1.4	26
RF-W086	2	13.45	Lab Packs, Thermal Oxidation	polymer	X6900	0.05	1	1.4	1
RF-W087	293.1	0	Wastewater, Non-Thermal	grout	L1190	0.25	1	2.4	31
RF-W088	1086	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3122	2	1.3	2.4	1177
Hanford									
RL-W019	0.888	1.198	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3119	2	1.2	2.4	2
RL-W020	47.388	63.916	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3129	2	1.3	2.4	121
RL-W023	19.629	13.915	Debris, Stabilization	grout or polymer	S5490	2	0.6	2.4	17
RL-W024	3.36	2.382	Debris, Stabilization	grout or polymer	S5420	2	1.2	2.4	6
RL-W025	2.626	1.861	Debris, Stabilization	grout or polymer	S5420	2	1.2	2.4	4
RL-W026	4.728	76.515	Debris, Stabilization	grout or polymer	S5190	2	1.2	2.4	81
RL-W028	3.068	2.175	Debris, Stabilization	grout or polymer	S5420	2	1.2	2.4	5
RL-W030	12.72	9.017	Debris, Stabilization	grout or polymer	S5490	2	0.6	2.4	11
RL-W032	14.279	10.123	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	14
RL-W033	1.046	0.742	Debris, Stabilization	grout or polymer	S5490	2	0.6	2.4	0.9
RL-W036	0.63	10.196	Debris, Stabilization	grout or polymer	S5122	2	1.6	2.4	14
RL-W037	1.45	1.956	Elemental mercury, Amalgamation	amalgam in grout	X7100	15	10.9	10	56
RL-W041	13.187	9.349	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	13
RL-W042	7.309	9.858	Lab Packs, Thermal Oxidation	glass/metal slag	X6900	1	1	2.2	8
RL-W046	11.292	15.23	Lab Packs, Thermal Oxidation	glass/metal slag	X6100	1	1	2.2	12
RL-W049	39.678	46.465	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4200	2	1.6	2.4	115
RL-W050	1.243	1.456	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4200	2	1.6	2.4	4
RL-W051	0.21	0.246	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	0.6
RL-W052	3.085	4.161	Inorganic Homogeneous Solids and Soils, Stabilization	glass/metal slag	S3114	1	1	2.2	3
RL-W053	1.487	2.005	Inorganic Homogeneous Solids and Soils, Stabilization	glass/metal slag	S3114	1	1	2.2	2
RL-W054	10.624	14.33	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3129	2	1.3	2.4	27
RL-W055	55.388	39.264	Debris, Stabilization	grout or polymer	S5490	2	0.6	2.4	47
RL-W056	58.314	41.339	Debris, Stabilization	grout or polymer	S5410	2	1	2.4	83
RL-W057	227.314	524.574	Debris, Stabilization	grout or polymer	S5390	2	0.7	2.4	439
RL-W058	13.036	9.241	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	13
RL-W059	6.48	4.594	Debris, Stabilization	grout or polymer	S5490	2	0.6	2.4	6
RL-W060	34.01	24.109	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	34
RL-W061	1.05	1.416	Inorganic Homogeneous Solids and Soils, Stabilization	glass/metal slag	S3114	1	1	2.4	1
RL-W062	2.659	1.728	Elemental lead, Macroencapsulation	macroencapsulation	X7219	2	1.5	7	2
RL-W063	3.508	4.732	Lab Packs, Thermal Oxidation	glass/metal slag	X6900	1	1	2.2	4
RL-W064	36.588	49.35	Lab Packs, Thermal Oxidation	glass/metal slag	X6900	1	1	2.2	39
RL-W065	29.891	40.317	Lab Packs, Thermal Oxidation	glass/metal slag	X6900	1	1	2.2	32
RL-W066	9.681	13.057	Lab Packs, Thermal Oxidation	glass/metal slag	X6900	1	1	2.2	10

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
RL-W067	0.21	0.283	Lab Packs, Thermal Oxidation	glass/metal slag	X6100	1	1	2.2	0.2
RL-W068	543.68	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3122	2	1.3	2.4	589
RL-W069	1099.314	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3122	2	1.3	2.4	1191
RL-W087	7.144	9.636	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3119	2	1.2	2.4	17
RL-W092	0.03	0.041	Lab Packs, Thermal Oxidation	glass/metal slag	X6100	1	1	2.2	0.03
RL-W093	18.89	13.391	Debris, Stabilization	grout or polymer	S5490	2	0.6	2.4	16
RL-W094	36.755	49.575	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3190	2	1.5	2.4	108
RL-W095	119.416	84.653	Debris, Stabilization	grout or polymer	S5420	2	1.2	2.4	204
RL-W097	10.584	7.503	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	11
RL-W098	9.119	10.679	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	26
RL-W099	0.63	0.85	Lab Packs, Thermal Oxidation	glass/metal slag	X6200	1	1	2.2	0.7
RL-W100	33.765	45.542	Lab Packs, Thermal Oxidation	glass/metal slag	X6900	1	1	2.2	36
RL-W113	15	0	Debris, Stabilization	grout or polymer	S5490	2	0.6	2.4	8
RL-W114	0.835	1.126	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3119	2	1.2	2.4	2
RL-W115	1.24	0.879	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	1
RL-W116	1.815	1.287	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	2
RL-W117	0.2	0.141	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	0.2
RL-W118	1.05	0.744	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	1
RL-W119	0.2	0.234	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4200	2	1.6	2.4	0.6
RL-W122	10.7	12.53	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4200	2	1.6	2.4	31
RL-W124	1.26	1.699	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3119	2	1.2	2.4	3
RL-W126	0.2	0.141	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	0.2
RL-W127	1.041	0.738	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	1
RL-W128	0.208	0.148	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	0.2
RL-W129	0.834	0.591	Debris, Stabilization	grout or polymer	S5490	2	0.6	2.4	0.7
RL-W130	2.851	3.845	Lab Packs, Thermal Oxidation	glass/metal slag	X6900	1	1	2.2	3
RL-W131	0.2	0.141	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	0.2
RL-W132	1.626	2.193	Lab Packs, Thermal Oxidation	glass/metal slag	X6900	1	1	2.2	2
RL-W140	67.873	79.483	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4200	2	1.6	2.4	196
RL-W141	10.56	7.486	Debris, Stabilization	grout or polymer	S5410	2	1	2.4	15
RL-W142	54.742	885.912	Debris, Stabilization	grout or polymer	S5119	2	4	2.4	3136
RL-W143	0.322	0.436	Inorganic Homogeneous Solids and Soils, Stabilization	glass/metal slag	S3114	1	1	2.2	0.3
RL-W144	0.208	0.28	Lab Packs, Thermal Oxidation	glass/metal slag	X6900	1	1	2.2	0.2
RL-W146	0.418	0.297	Debris, Stabilization	grout or polymer	S5440	2	0.7	2.4	0.4
RL-W149	0.208	0.28	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3119	2	1.2	2.4	0.5
RL-W150	0.208	0.148	Debris, Stabilization	grout or polymer	S5420	2	1.2	2.4	0.4
RL-W151	0.2	0.141	Debris, Stabilization	grout or polymer	S5420	2	1.2	2.4	0.3
RL-W152	1.112	0.722	Lead, cadmium, beryllium, and other hazardous metals, Macroencapsulation	macroencapsulation	X7219	2	1.5	7	0.8
RL-W153	0.208	0.243	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4100	2	1.6	2.4	0.6
RL-W170	1.4574	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3110	2	0.9	2.4	1

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
RL-W173	0.2082	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3110	2	0.9	2.4	0.2
RL-W174	5.8296	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4200	2	1.6	2.4	8
RL-W175	1.2492	0	Debris, Stabilization	grout or polymer	S5110	2	4	2.4	4
RL-W176	5.8296	0	Debris, Stabilization	grout or polymer	S5300	2	0.7	2.4	3
RL-W177	40.0068	0	Lab Packs, Thermal Oxidation	glass/metal slag	X6100	1	1	2.2	18
RL-W180	0.2082	0	Inorganic Homogeneous Solids and Soils, Stabilization	glass/metal slag	L2200	1	0.9	2.2	0.1
RL-W181	0.2082	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3110	2	0.9	2.4	0.2
RL-W182	19.3282	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3110	2	0.9	2.4	14
RL-W184	21.8166	0	Backlog soils, Meet BDAT	soil	S4200	1	2.2	2.2	22
RL-W185	261.7322	0	Backlog soils, Meet BDAT	soil	S4200	1	2.2	2.2	262
RL-W186	121.8378	0	Debris, Stabilization	grout or polymer	S5110	2	4	2.4	406
RL-W187	26.5612	0	Debris, Stabilization	grout or polymer	S5120	2	1.5	2.4	33
RL-W188	126.7592	0	Debris, Stabilization	grout or polymer	S5125	2	1	2.4	106
RL-W189	1257.531	0	Debris, Stabilization	grout or polymer	S5300	2	0.7	2.4	734
RL-W190	63.2016	0	Debris, Stabilization	grout or polymer	S5400	2	0.6	2.4	32
RL-W192	0.2082	0	Lead, cadmium, beryllium, and other hazardous metals, Macroencapsulation	macroencapsulation	X7210	2	5.7	7	0.3
RL-W196	4.0694	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3110	2	0.9	2.4	3
RL-W197	7.4952	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3110	2	0.9	2.4	6
RL-W199	0.4164	0	Debris, Stabilization	grout or polymer	S5400	2	0.6	2.4	0.2
RL-W200	8.2624	0	Debris, Stabilization	grout or polymer	S5110	2	4	2.4	28
RL-W201	1.2492	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3110	2	0.9	2.4	0.9
RL-W202	2.631	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3110	2	0.9	2.4	2
RL-W203	1.4764	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3110	2	0.9	2.4	1
RL-W205	1.6656	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3110	2	0.9	2.4	1
RL-W206	1.041	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4200	2	1.6	2.4	1
RL-W208	16.383	0	Debris, Stabilization	grout or polymer	S5110	2	4	2.4	55
RL-W209	0.2082	0	Debris, Stabilization	grout or polymer	S5125	2	1	2.4	0.2
RL-W210	47.1851	0	Debris, Stabilization	grout or polymer	S5300	2	0.7	2.4	28
RL-W211	49.7692	0	Debris, Stabilization	grout or polymer	S5400	2	0.6	2.4	25
RL-W215	17.4888	0	Lab Packs, Thermal Oxidation	glass/metal slag	X6100	1	1	2.2	8
RL-W216	6.8706	0	Lab Packs, Thermal Oxidation	glass/metal slag	X6900	1	1	2.2	3
RL-W217	6.4542	0	Lead, cadmium, beryllium, and other hazardous metals, Macroencapsulation	macroencapsulation	X7210	2	5.7	7	11
RL-W226	98.601	0	Debris, Stabilization	grout or polymer	S5120	2	1.5	2.4	123
RL-W227	0.2082	0	Debris, Stabilization	grout or polymer	S5300	2	0.7	2.4	0.1
RL-W228	37.5342	0	Debris, Stabilization	grout or polymer	S5400	2	0.6	2.4	19
RL-W231	31.855	0	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4200	2	1.6	2.4	42
RL-W232	8.7	0	Debris, Stabilization	grout or polymer	S5110	2	4	2.4	29
RL-W233	43.5	0	Debris, Stabilization	grout or polymer	S5300	2	0.7	2.4	25
RL-W234	21.7	0	Debris, Stabilization	grout or polymer	S5110	2	4	2.4	72

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
RMI									
RM-W009	1.5	0.23	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.01
RM-W010	6.4	0.23	Debris, Stabilization	grout	S5390	2	0.7	2.4	4
RM-W011	5.1	0.23	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.02
RM-W013	0	0.23	Debris, Stabilization	grout	S5123	2	1.6	2.4	0.3
RM-W014	0.23	0.23	Debris, Stabilization	grout	S5330	2	0.6	2.4	0.2
SNL									
SA-W196	0.04	0.5	Lead, cadmium, beryllium, and other hazardous metals, Macroencapsulation	macroencapsulation	X7219	0.05	5.7	11	0.01
SA-W198	0.000067	0	Elemental mercury, Amalgamation	amalgam	X7100	15	10.9	10	0.001
SA-W201	6.6	60	Debris, Stabilization	grout	S5190	2	1.2	2.4	67
SA-W202	29	0	Debris, Non-Thermal	grout	S5490	2	2	2.4	48
SA-W203	2.7	50	Combustible Organics, Thermal	grout	L2900	0.01	0.9	2.4	0.2
SA-W204	0.9	1	Debris, Stabilization	grout	S5390	2	2	2.4	3
Savannah River									
SR-W001	8.4	5	Lab Packs, Thermal Oxidation	grout	X6400	0.01	0.9	2.4	0.1
SR-W003	9.3	2.6	Debris, Thermal	grout	S5330	0.1	0.6	2.4	0.3
SR-W004	850	20	Inorganic Homogeneous Solids and Soils, Thermal	vit	S3121	0.2	1.2	2.6	80
SR-W005	15.4	0	Inorganic Homogeneous Solids and Soils, Thermal	vit	S3121	0.2	1.1	2.6	1
SR-W009	10.2	3.1	Inorganic Homogeneous Solids and Soils, Stabilization	Macroencapsulation	S3119	1	0.65	0.65	13
SR-W015	9.9	253.24	Debris, Stabilization	Macroencapsulation	S5119	1	0.63	7.8	21
SR-W018	260	0	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3121	0.1	1.3	2.4	14
SR-W029	1	0.4	Inorganic Homogeneous Solids and Soils, Thermal	vit	S3150	0.2	1.8	2.6	0.2
SR-W031	0.6	0	Wastewater, Stabilization	vit	S3129	0.2	1.3	2.6	0.1
SR-W037	1579	0	Inorganic Homogeneous Solids and Soils, Thermal	vit	S3120	0.2	1.2	2.6	146
SR-W038	0.4	0	Inorganic Homogeneous Solids and Soils, Thermal	vit	S3120	0.2	1.3	2.6	0.04
SR-W039	5	0	Wastewater, Direct Stabilization	vit	L1210	0.2	1	2.6	0.5
SR-W042	5.4	7	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3131	0.01	1.6	2.4	0.1
SR-W046	0	124	Inorganic Homogeneous Solids and Soils, Thermal	grout	S3111	0.1	1.2	2.4	6
SR-W047	0	800	Wastewater, Thermal Treatment	grout	L1230	0.1	1.1	2.4	37
SR-W060	0.2	0	Wastewater, Non-Thermal	macroencapsulation	S3113	1	1.2	2.1	0.1
SR-W069	73.5	15	Debris, Stabilization	macroencapsulation	X7210	1	5.7	5.7	89
SR-W079	0.4	1.6	Wastewater, Thermal	grout	L2110	0.01	1	2.4	0.008
SR-W080	1.7	0	Debris, Thermal	grout	S5390	0.1	0.6	2.4	0.04

Data Used in Estimating Post-Treatment MLLW Volumes

MWIR Survey ID	MWIR Current Volume (m^3)	MWIR 5-Yr Projected Volume (m^3)	Waste Type, Process Flow	Primary Waste Form	Matrix Parameter Category	Activity-Per-Unit-Mass Ratio	Initial Bulk Density (g/cm^3)	Final Bulk Density (g/cm^3)	Treated MLLW Volume (m^3)
West Valley									
WV-W003	0.0836	0.041	Organic Extraction Waste, Thermal Oxidation	polymer	L2210	0.05	0.9	1.4	0.004
WV-W005	0.0522	0	Combustible Organics, Thermal	grout	L2210	0.01	0.9	2.4	0.0002
WV-W006	0.0039	0	Pu Scintillation, Thermal Oxidation	polymer	X6100	0.05	1	1.4	0.0001
WV-W009	0.0023	0.0015	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.00001
WV-W014	0.0716	0.0648	Sr Organic Waste, Thermal Oxidation	polymer	L2120	0.05	1	1.4	0.005
WV-W016	0.0003	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.000001
WV-W019	1.9382	2.5	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.02
WV-W032	0.0038	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.00001
WV-W043	0.0019	0.002	Combustible Organics, Non-Thermal	grout	L2190	.2	1	2.4	0.003
WV-W044	0.0183	0	Combustible Organics, Thermal	grout	L2220	0.01	0.9	2.4	0.0001
WV-W045	0.0004	0	Elemental mercury, Amalgamation	amalgam	X7100	15	10.9	10	0.01
ORR Y-12 Site									
YP-W003	4.56	0.015	Combustible Organics, Thermal	grout	S5300	0.01	0.7	2.4	0.01
YP-W005	6386.273	1143.31	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S3100	2	1.3	2.4	8157
YP-W183	113.443	0	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.4
YP-W187	36.659	119.485	Wastewater, Thermal Treatment	grout	L1000	0.001	1.1	2.4	0.1
YP-W188	3.403	3.42	Wastewater, Thermal Treatment	grout	L1000	0.001	1.1	2.4	0.003
YP-W189	0.066	0.065	Wastewater, Non-Thermal	grout	L1000	0.001	1.1	2.4	0.0001
YP-W190	186.722	128.39	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	1
YP-W191	4.619	7.83	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.05
YP-W192	8.896	36.66	Combustible Organics, Thermal	grout	L2000	0.01	0.9	2.4	0.2
YP-W193	3.132	0.27	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	2
YP-W194	44.337	136.095	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	90
YP-W195	42.178	13.45	Inorganic Homogeneous Solids and Soils, Stabilization	glass	S3100	1	1.3	2.6	28
YP-W196	42.291	6.09	Combustible Organics, Thermal	grout	S3200	0.01	1.2	2.4	0.2
YP-W198	1.464	0.97	Combustible Organics, Thermal	grout	S3200	0.01	1.2	2.4	0.01
YP-W200	10.417	5.185	Inorganic Homogeneous Solids and Soils, Stabilization	grout	S4000	2	1.5	2.4	20
YP-W201A	10.23	1.58	Inorganic Homogeneous Solids and Soils, Stabilization	grout	L2000	2	0.9	2.4	9
YP-W204	2.806	1.905	Debris D018-D043, Stabilization	grout	S5100	2	2	2.4	8
YP-W208	6.951	16.005	Debris D018-D043, Stabilization	grout	S5400	2	2	2.4	38

Appendix D:

SUMMARY OF COMPARISONS OF WASTE STREAM CONCENTRATIONS WITH RESULTS OF THE PERFORMANCE EVALUATION

This appendix contains summary tables of comparisons of radionuclide concentrations in residual MLLW with estimates of limiting concentrations for the 15 sites evaluated in the performance evaluation (PE) report. Table C-1 contains comparisons based on a generic trench disposal facility and Table C-2 contains similar comparisons for a generic tumulus disposal facility.

Each row in the tables represents a waste stream with one or more radionuclides for which sufficient radiological data were available to estimate concentrations of radionuclides in waste. For each combination of waste stream and site, the sum-of-fractions calculation was performed for all known radionuclides in the waste stream. The results of these calculations are summarized using symbols:

Symbol	Sum-of-Fractions (SOF)
○	SOF < 0.1
□	0.1 < SOF ≤ 1.0
■	1.0 < SOF ≤ 10
●	SOF > 10

For waste streams that resulted in a calculated sum-of-fractions greater than 10 at any site, the controlling radionuclide is listed. The controlling radionuclides are those whose individual fractions are greater than 1 prior to being summed. Waste streams highlighted by gray shading indicate that the results of sum-of-fractions calculations for every site were greater than 10 (represented by the ●-symbol).

In both tables, the only entry for the West Valley Demonstration Project (WVDP) is for a West Valley waste stream, WV-W019. Because the WVDP Act of 1980 does not authorize disposal of off-site waste, only on-site waste streams were considered in the analysis.

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Table D-1. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Trench Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
Argonne East																	
AE-W015	119	□	□	□	□	■	□	□	□	■	□	□	■	●	□		
AE-W023	2	□	□	□	□	□	□	□	□	□	□	□	■	■	□		
AE-W026	10	○	○	○	○	■	○	○	○	□	○	□	■	■	□		
AE-W033	35	■	■	■	■	●	■	■	■	■	●	●	●	●	●		
AE-W035	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Ra-226, Th-232, Am-241
AE-W044	<1	○	○	○	○	○	○	○	○	○	○	○	○	□	○		
Argonne West																	
AW-W009	<1	□	□	□	□	□	□	□	□	□	□	□	■	■	○		
Batelle Columbus																	
BC-W002	<1	○	□	○	○	○	○	○	○	○	□	□	■	■	□		
Brookhaven																	
BN-W004	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Bettis																	
BT-W007	<1	□	●	□	●	●	□	□	□	●	●	●	●	●	●		
BT-W009	<1	○	○	○	○	○	○	○	○	○	○	○	○	■	○		
BT-W010	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
BT-W013	1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
BT-W028	<1	○	○	○	○	○	○	○	○	○	○	○	○	■	○		
BT-W029	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
BT-W031	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Th-232, U-234
Charleston Naval																	
CN-W006	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Energy Tech																	
ET-W020	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
Fernald																	
FM-W005	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W013	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W014	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W019	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W023	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W025	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W027	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W041	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W044	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W046	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W047	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W050	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W051	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W054	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		

Table D-1. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Trench Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m³)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
FM-W055	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W069	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W075	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W076	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W089	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W094	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W104	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W107	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W114	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-238
FM-W115	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W117	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W123	96	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W125	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235
FM-W126	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W127	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W129	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W130	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W131	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W132	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W137	1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W140	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W144	6	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W145	8	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W146	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W147	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W148	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W150	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W154	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W158	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W161	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W162	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W165	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W166	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W167	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W168	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W171	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W172	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W173	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W181	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W185	16	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W187	11	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W188	4	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W191	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W192	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		

Table D-1. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Trench Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
FM-W194	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W196	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W197	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W198	2	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W215	34	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W216	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W217	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W218	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W221	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W224	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W225	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W226	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W227	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W229	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W233	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W234	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W240	9	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W241	1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W243	10	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W244	41	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W247	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W250	1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W253	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W258	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W262	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W264	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W267	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W277	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W278	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W279	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W280	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W282	81	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W283	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W284	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	□		
FM-W285	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W288	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W289	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W297	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W301	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W318	1	○	□	○	○	○	○	○	○	○	□	□	■	■	■		
FM-W327	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W330	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W332	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W333	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		

Table D-1. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Trench Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
FM-W341	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W351	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W352	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W353	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W354	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W355	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W356	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W357	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W358	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W365	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W370	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W379	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W380	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W385	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W388	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W400	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W402	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W403	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W404	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W407	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W408	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W409	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W410	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W412	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W418	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
INEL																	
IN-W005	<1	■	■	■	■	●	■	■	■	●	■	■	●	●	■		
IN-W007	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Np-237, Am-241
IN-W008	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
IN-W035	2	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
IN-W038	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Am-241, Pu-238, Pu-239, Sr-90, U-234, U-235, U-238
IN-W047	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
IN-W050	<1	□	□	□	□	●	□	□	□	●	■	■	●	●	●		
IN-W057	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Cs-137
IN-W058A	4	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
IN-W061	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	■		
IN-W062	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Cs-137
IN-W077	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
IN-W089	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
IN-W096	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Knolls Schenectady																	
KA-W001	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
KA-W005	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		

Table D-1. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Trench Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
KA-W007	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
KA-W018	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
KA-W020	2	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Knolls Kesselring																	
KK-W002	4	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
LANL																	
LA-W070	<1	○	○	○	○	●	○	○	○	□	■	●	●	●	●		
LA-W073	52	■	■	■	■	■	■	■	■	■	■	■	■	●	●		
LA-W074	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Am-241, Pu-238, Pu-239, U-238
LA-W075	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Al-26, C-14, Sr-90, Tc-99, Th-232, U-232, U-238, Pu-240
LA-W076	<1	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
LA-W077	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		H-3, U-235, U-238, Pu-239
LA-W078	<1	○	○	○	○	●	○	○	○	□	■	●	●	●	●		
LA-W083	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14, Tc-99
LA-W084	3	●	●	■	●	●	●	●	●	●	●	●	●	●	●		
LA-W088	9	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
LA-W089	55	○	○	○	○	□	○	○	○	□	○	□	□	□	□		
LA-W090	4	○	○	○	○	○	○	○	○	○	○	○	○	□	○		
LLNL																	
LL-W001	15	●	●	●	●	●	●	●	●	●	●	●	●	●	●		H-3, C-14
LL-W002	254	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Sr-90, Ra-226
LL-W004	89	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14,K-40,Sr-90,Cs-137,Pu-238,Pu-242,Ra-226,Tc-99, Th-232,U-232,U-233,U-234,U-235,U-238,Np-237,Am-243
LL-W005	11	■	■	■	●	●	■	■	■	●	●	●	●	●	●		
LL-W006	79	●	●	●	●	●	●	●	●	●	●	●	●	●	●		H-3, Am-241
LL-W007	12	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Ra-226, U-238
LL-W008	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		H-3, K-40, U-235, U-238
LL-W009	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
LL-W010	30	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Sr-90, Am-241
LL-W014	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		H-3, C-14, K-40, Cs-137, U-238, Pu-239
LL-W015	15	●	●	●	●	●	●	●	●	●	●	●	●	●	●		H-3
LL-W016	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14, H-3
LL-W017	1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14, K-40, Pu-239, Th-232, U-233, U-235, U-238, Np-237, Am-241
LL-W023	58	■	■	■	■	■	■	■	■	■	■	■	●	●	■		
LL-W025	399	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, U-238
LL-W026	<1	□	□	□	■	●	□	□	□	●	●	●	●	●	●		
Mound																	
MD-W012	<1	□	□	□	□	●	□	□	□	■	●	●	●	●	●		
Mare Island																	
MI-W004	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
MI-W008	3	○	○	○	○	○	○	○	○	○	○	○	○	○	○		

Table D-1. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Trench Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
MI-W014	13	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Univ. of Missouri																	
MU-W001	<1	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
Norfolk Naval																	
NN-W003	2	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
NTS																	
NT-W015	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
ORR (K-25 & Y-12)																	
DP-W002	94	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235
DP-W007	624	□	□	□	□	■	□	□	□	■	□	■	■	●	■		
DP-W019	21467	■	■	■	■	●	●	■	■	●	■	●	●	●	●		
DP-W140	926	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Np-237, Tc-99, Th-230, U-238
DP-W141	145	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
DP-W147	245	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235
DP-W148	82	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235
YP-W005	8157	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
Pearl Harbor																	
PH-W002	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	○		
PH-W007	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Portsmouth Naval																	
PN-W005	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Portsmouth GDP																	
PO-W014	<1	□	□	○	□	●	■	□	□	■	■	■	■	●	■		
PO-W017	49	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
PO-W018	61	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99
PO-W019	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
PO-W022	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
PO-W027	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99, U-234, U-235, U-238
PO-W028	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99, U-234
PO-W032	4	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
PO-W039A	2360	□	■	□	□	●	■	□	□	●	■	■	●	●	●		
PO-W040	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
PO-W044	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
PO-W046	6	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
PO-W047	21	□	□	○	○	■	■	○	□	□	□	□	■	■	□		
PO-W053	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234
PO-W057	<1	■	■	□	■	●	●	■	■	●	■	●	●	●	●		
PO-W058	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99, Th-230
PO-W069	194	○	○	○	○	□	□	○	○	□	○	□	□	□	□		
PO-W072	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99, U-234, U-235, U-238
PO-W073	2	○	○	○	○	○	○	○	○	○	○	○	○	○	○		

Table D-1. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Trench Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
Puget Sound																	
PS-W004	<1	■	■	■	□	■	■	■	□	■	■	■	■	●	■		
PS-W006	1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
PS-W012	3	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
PS-W018	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Pantex																	
PX-W010	26	○	○	○	○	■	○	○	○	■	□	■	■	■	■		
PX-W025	36	○	○	○	○	■	○	○	○	■	□	□	■	■	■		
PX-W027	4	○	○	○	○	□	○	○	○	□	○	□	□	■	□		
PX-W028	5	○	○	○	○	□	○	○	○	□	○	○	□	□	□		
Rocky Flats																	
RF-W003	143	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RF-W006	1155	■	■	■	■	■	■	■	■	■	■	■	■	●	●		
RF-W017	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W018	8562	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RF-W019	5177	○	○	○	○	○	○	○	○	○	○	○	○	■	■		
RF-W024	36	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W025	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W027	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W030	47	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W031	17	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W035	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W042	4	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W043	30	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W045	8	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W046	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W047	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W049	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W050	1267	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W062	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W071	254	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W074	10	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
Hanford																	
RL-W019	2	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W020	121	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W023	17	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W024	6	■	●	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W025	4	■	●	■	■	●	●	■	■	●	■	●	●	●	●		
RL-W026	81	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W028	5	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W030	11	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W032	14	■	■	■	■	●	■	■	■	●	■	●	●	●	●		

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		Arid								Humid							
MWIR ID	Final Volume (m³)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
RL-W033	<1	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W036	14	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W037	56	○	□	○	□	■	□	○	○	■	□	□	■	●	■		
RL-W041	13	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W042	8	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W046	12	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W049	115	□	■	□	■	●	■	□	□	●	■	●	●	●	●		
RL-W050	4	□	■	□	■	●	■	□	□	●	■	●	●	●	●		
RL-W051	<1	□	■	□	■	●	■	□	□	●	■	●	●	●	●		
RL-W052	3	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W053	2	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W054	27	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W055	47	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W056	83	■	■	■	■	■	■	■	■	■	■	■	■	●	●		
RL-W057	439	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W058	13	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W059	6	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W060	34	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W061	1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W062	2	■	●	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W063	4	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W064	39	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W065	32	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W066	10	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W067	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W068	589	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235
RL-W069	1191	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235
RL-W087	17	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W092	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	●		
RL-W093	16	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W094	108	□	■	□	■	●	■	□	□	●	■	●	●	●	●		
RL-W095	204	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Cs-137, Sr-90
RL-W097	11	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W098	26	□	■	□	■	●	■	□	□	●	■	●	●	●	●		
RL-W099	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W100	36	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W113	8	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W114	2	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W115	1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W116	2	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W117	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W118	1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W119	<1	□	■	□	■	●	■	□	□	●	■	●	●	●	●		
RL-W122	31	□	■	□	■	●	■	□	□	●	■	●	●	●	●		

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		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
RL-W124	3	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W126	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W127	1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W128	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W129	<1	■	■	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W130	3	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W131	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W132	2	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W140	196	□	■	□	■	●	■	□	□	●	■	●	●	●	●		
RL-W141	15	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W142	3136	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W143	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W144	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RL-W146	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W149	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W150	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W151	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W152	<1	■	●	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W153	<1	□	■	□	■	●	■	□	□	●	■	●	●	●	●		
RL-W170	1	○	□	○	○	■	□	□	○	□	□	□	■	●	■		
RL-W173	<1	○	□	○	○	■	□	□	○	□	□	□	■	●	■		
RL-W174	8	○	○	○	○	□	○	○	○	□	□	□	■	●	■		
RL-W175	4	○	○	○	○	□	○	○	○	□	○	□	□	■	■		
RL-W176	3	○	□	□	○	■	□	□	○	■	□	□	■	●	■		
RL-W177	18	□	□	□	□	□	□	□	□	□	□	□	□	■	□		
RL-W180	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	■		
RL-W181	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RL-W182	14	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RL-W184	22	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RL-W185	262	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RL-W186	406	□	□	□	□	□	□	□	□	□	□	□	□	●	■		
RL-W187	33	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RL-W188	106	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RL-W189	734	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RL-W190	32	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RL-W192	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	■		
RL-W196	3	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W197	6	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W199	<1	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W200	28	○	□	○	□	●	□	○	○	■	■	■	■	●	●		
RL-W201	<1	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W202	2	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W203	1	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W205	1	□	■	□	□	●	□	□	□	●	■	●	●	●	●		

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		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
RL-W206	1	□	□	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W208	55	○	□	○	□	●	□	○	○	■	■	■	■	●	●		
RL-W209	<1	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W210	28	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W211	25	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W215	8	□	□	□	□	■	□	□	□	■	□	□	■	●	■		
RL-W216	3	□	□	□	□	■	□	□	□	■	□	□	■	■	■		
RL-W217	11	○	□	○	○	●	□	○	○	●	■	■	●	●	■		
RL-W226	123	□	■	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W227	<1	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W228	19	□	■	□	□	●	□	□	□	●	■	●	●	●	●		
RL-W231	42	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RL-W232	29	□	□	□	□	□	□	□	□	□	□	□	□	●	■		
RL-W233	25	□	□	□	□	□	□	□	□	□	□	□	□	●	●		
RL-W234	72	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14, Ni-63
Savannah River																	
SR-W001	<1	■	■	■	■	■	■	■	■	■	■	■	●	●	●		
SR-W003	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
SR-W004	80	○	□	○	○	○	○	○	○	○	○	□	□	□	□		
SR-W005	1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-236, U-238
SR-W009	13	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Cs-137, I-129
SR-W015	21	●	●	●	●	●	●	●	●	●	●	●	●	●	■		
SR-W018	14	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
SR-W029	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
SR-W031	<1	■	■	■	■	■	■	■	■	■	●	■	●	●	●		
SR-W037	146	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
SR-W038	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
SR-W039	<1	○	□	○	○	○	○	○	○	○	○	□	□	□	□		
SR-W046	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Cs-137
SR-W047	37	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Cs-137
SR-W060	0.1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		H-3
SR-W069	89	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
West Valley																	
WV-W019	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	●	□	

Table D-2. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Tumulus Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
Argonne East																	
AE-W015	119	□	□	□	□	□	□	□	□	□	□	□	□	●	□		
AE-W023	2	□	□	□	□	□	□	□	□	□	□	□	□	■	□		
AE-W026	10	○	○	○	○	□	○	○	○	□	○	○	□	■	□		
AE-W033	35	■	■	■	■	●	■	■	■	■	●	●	●	●	●		
AE-W035	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Ra-226, Th-232, Am-241
AE-W044	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Argonne West																	
AW-W009	<1	○	○	○	○	□	○	○	○	○	□	□	■	■	■		
Batelle Columbus																	
BC-W002	<1	○	□	○	○	○	○	○	○	○	○	□	□	■	□		
Brookhaven																	
BN-W004	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Bettis																	
BT-W007	<1	□	●	□	●	●	□	□	□	●	●	●	●	●	●		
BT-W009	<1	○	○	○	○	○	○	○	○	○	○	○	○	■	○		
BT-W010	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
BT-W013	1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
BT-W028	<1	○	○	○	○	○	○	○	○	○	○	○	○	■	○		
BT-W029	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
BT-W031	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Th-232, U-234
Charleston Naval																	
CN-W006	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Energy Tech																	
ET-W020	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Fernald																	
FM-W005	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W013	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W014	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W019	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W023	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W025	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W027	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W041	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W044	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W046	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W047	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W050	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W051	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W054	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		

Table D-2. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Tumulus Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
FM-W055	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W069	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W075	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W076	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W089	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W094	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W104	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W107	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W114	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-238
FM-W115	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W117	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W123	96	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W125	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235
FM-W126	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W127	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W129	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W130	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W131	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W132	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W137	1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W140	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W144	6	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W145	8	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W146	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W147	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W148	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W150	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W154	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W158	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W161	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W162	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W165	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W166	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W167	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W168	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W171	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W172	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W173	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W181	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W185	16	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W187	11	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W188	4	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W191	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W192	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		

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		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
FM-W194	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W196	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W197	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W198	2	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W215	34	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W216	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W217	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W218	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W221	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W224	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W225	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W226	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W227	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W229	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W233	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W234	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W240	9	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W241	1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W243	10	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W244	41	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W247	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W250	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W253	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W258	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W262	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W264	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W267	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W277	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W278	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W279	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W280	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W282	81	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W283	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W284	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	□		
FM-W285	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W288	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W289	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W297	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W301	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W318	1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W327	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W330	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W332	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W333	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		

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		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
FM-W341	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W351	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W352	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W353	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W354	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W355	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W356	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W357	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W358	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W365	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W370	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W379	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W380	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W385	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W388	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W400	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W402	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W403	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W404	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W407	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
FM-W408	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FM-W409	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235, U-238
FM-W410	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W412	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
FM-W418	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
INEL																	
IN-W005	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
IN-W007	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Np-237, Am-241
IN-W008	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
IN-W035	2	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
IN-W038	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Am-241, Pu-238, Pu-239, Sr-90, U-234, U-235, U-238
IN-W047	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
IN-W050	<1	□	□	□	□	●	□	□	□	□	■	■	■	●	■		
IN-W057	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	■		
IN-W058A	4	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
IN-W061	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	□		
IN-W062	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Cs-137
IN-W077	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
IN-W089	<1	□	□	□	□	□	□	□	□	□	□	□	□	■	○		
IN-W096	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		

Table D-2. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Tumulus Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
Knolls Schenectady																	
KA-W001	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
KA-W005	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
KA-W007	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
KA-W018	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
KA-W020	2	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Knolls Kesselring																	
KK-W002	4	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
LANL																	
LA-W070	<1	○	○	○	○	○	○	○	○	○	○	○	○	□	○		
LA-W073	52	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
LA-W074	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Am-241, Pu-239, U-238
LA-W075	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Al-26,C-14,Sr-90,Tc-99,Th-232,U-232,U-238,Pu-240
LA-W076	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	○		
LA-W077	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		H-3, U-235, U-238, Pu-239
LA-W078	<1	○	○	○	○	○	○	○	○	○	○	○	○	□	○		
LA-W083	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14, Tc-99
LA-W084	3	●	●	■	●	●	●	●	●	●	●	●	●	●	●		
LA-W088	9	■	■	■	■	■	■	■	■	■	■	■	■	●	○		
LA-W089	55	○	○	○	○	□	○	○	○	○	○	○	□	□	□		
LA-W090	4	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
LLNL																	
LL-W001	15	●	●	●	●	●	●	●	●	●	●	●	●	●	■		
LL-W002	254	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Sr-90, Ra-226
LL-W004	89	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14,K-40,Sr-90,Tc-99,Cs-137,Pu-238,Ra-226,Th-232, U-232,U-233,U-234,U-235,U-238,Np-237,Pu-242,Am-243
LL-W005	11	■	■	■	■	●	■	■	■	■	●	●	●	●	●		
LL-W006	79	●	●	●	●	●	●	●	●	●	●	●	●	●	■		
LL-W007	12	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Ra-226, U-238
LL-W008	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		H-3, K-40, U-235, U-238
LL-W009	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
LL-W010	30	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Sr-90, Am-241
LL-W014	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14, H-3, K-40, Cs-137, Pu-239, U-238
LL-W015	15	●	●	●	●	●	●	●	●	●	●	●	●	●	■		
LL-W016	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14, H-3
LL-W017	1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14, K-40, U-233, U-235, U-238, Am-241, Th-232, Np-237, Pu-239
LL-W023	58	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
LL-W025	399	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-238, Pu-239
LL-W026	<1	□	□	□	■	●	□	□	□	□	■	●	●	●	●		

Table D-2. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Tumulus Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
Mound																	
MD-W012	<1	□	□	□	□	□	□	□	□	□	□	□	□	■	○		
Mare Island																	
MI-W004	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
MI-W008	3	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
MI-W014	13	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Univ. of Missouri																	
MU-W001	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
Norfolk Naval																	
NN-W003	2	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
NTS																	
NT-W015	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
ORR (K-25 & Y-12)																	
DP-W002	94	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235
DP-W007	624	□	□	□	□	■	□	□	□	■	□	■	■	●	■		
DP-W019	21467	■	■	■	■	●	●	■	■	●	■	●	●	●	●		
DP-W140	928	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99, Np-237, Th-230
DP-W141	145	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
DP-W147	245	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235
DP-W148	82	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-235
YP-W005	8157	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
Pearl Harbor																	
PH-W002	<1	□	□	□	□	□	□	□	□	□	□	□	□	□	○		
PH-W007	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Portsmouth Naval																	
PN-W005	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Portsmouth GDP																	
PO-W014	<1	□	□	□	□	■	■	□	□	■	□	■	■	■	■		
PO-W017	49	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
PO-W018	61	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99
PO-W019	<1	●	●	■	■	●	●	■	■	●	●	●	●	●	●		
PO-W022	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
PO-W027	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99, U-234, U-235, U-238
PO-W028	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99, U-234
PO-W032	4	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
PO-W039A	2360	□	■	□	□	■	■	□	□	■	□	■	■	■	●		
PO-W040	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
PO-W044	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
PO-W046	6	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
PO-W047	21	□	■	□	□	■	■	□	□	□	●	●	●	●	●		

Table D-2. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Tumulus Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
PO-W053	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99, U-234
PO-W057	<1	■	■	□	□	●	■	□	□	●	■	■	●	●	●		
PO-W058	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99, Th-230
PO-W069	194	○	○	○	○	□	○	○	○	□	○	○	□	□	□		
PO-W072	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Tc-99, U-234, U-238
PO-W073	2	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Puget Sound																	
PS-W004	<1	□	■	■	□	■	■	■	□	■	□	■	■	■	■		
PS-W006	1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
PS-W012	3	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
PS-W018	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Pantex																	
PX-W010	26	○	○	○	○	■	○	○	○	○	□	□	■	■	■		
PX-W025	36	○	○	○	○	■	○	○	○	○	□	□	■	■	■		
PX-W027	4	○	○	○	○	□	○	○	○	○	○	□	□	□	□		
PX-W028	5	○	○	○	○	□	○	○	○	○	○	○	○	□	○		
Rocky Flats																	
RF-W003	143	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RF-W006	1155	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RF-W017	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W018	8562	□	□	□	□	□	□	□	□	□	□	□	□	●	□		
RF-W019	5177	○	○	○	○	○	○	○	○	○	○	○	○	■	○		
RF-W024	36	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RF-W025	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W027	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W030	47	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W031	17	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W035	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W042	4	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W043	30	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W045	8	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W046	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W047	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W049	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W050	1267	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
RF-W062	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W071	254	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
RF-W074	10	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Pu-239, Pu-240
Hanford																	
RL-W019	2	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W020	121	■	■	■	■	●	■	■	□	●	■	■	●	●	●		
RL-W023	17	■	■	■	■	●	■	■	■	●	■	●	●	●	●		

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		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
RL-W024	6	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W025	4	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W026	81	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W028	5	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W030	11	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W032	14	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W033	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W036	14	□	■	□	■	●	■	□	□	●	■	■	●	●	●		
RL-W037	56	○	□	○	○	■	○	○	○	■	□	□	■	■	■		
RL-W041	13	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W042	8	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W046	12	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W049	115	□	■	□	■	●	■	□	□	●	■	■	●	●	●		
RL-W050	4	□	■	□	■	●	■	□	□	●	■	■	●	●	●		
RL-W051	<1	□	■	□	■	●	■	□	□	●	■	■	●	●	●		
RL-W052	3	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W053	2	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W054	27	■	■	■	■	●	■	■	□	●	■	■	●	●	●		
RL-W055	47	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W056	83	■	■	■	■	■	■	■	■	■	■	■	■	●	○		
RL-W057	439	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W058	13	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W059	6	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W060	34	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W061	1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W062	2	■	●	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W063	4	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W064	39	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W065	32	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W066	10	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W067	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W068	589	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235
RL-W069	1191	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235
RL-W087	17	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W092	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W093	16	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W094	108	□	■	□	■	●	■	□	□	●	■	■	●	●	●		
RL-W095	204	●	●	●	●	●	●	●	●	●	●	●	●	●	□		
RL-W097	11	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W098	26	□	■	□	■	●	■	□	□	●	■	■	●	●	●		
RL-W099	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W100	36	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W113	8	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W114	2	■	■	■	■	●	■	■	■	●	■	■	●	●	●		

Table D-2. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Tumulus Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
RL-W115	1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W116	2	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W117	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W118	1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W119	<1	□	■	□	■	●	■	□	□	●	■	■	●	●	●		
RL-W122	31	□	■	□	■	●	■	□	□	●	■	■	●	●	●		
RL-W124	3	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W126	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W127	1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W128	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W129	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W130	3	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W131	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W132	2	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W140	196	□	■	□	■	●	■	□	□	●	■	■	●	●	●		
RL-W141	15	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W142	3136	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W143	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W144	<1	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
RL-W146	<1	■	■	■	■	●	■	■	■	●	■	●	●	●	●		
RL-W149	<1	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W150	<1	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W151	<1	■	■	■	■	●	■	■	■	●	■	■	●	●	●		
RL-W152	<1	■	●	■	■	●	■	■	■	●	●	●	●	●	●		
RL-W153	<1	□	■	□	■	●	■	□	□	●	■	●	●	●	●		
RL-W170	1	○	□	○	○	□	□	○	○	□	□	□	□	■	□		
RL-W173	<1	○	□	○	○	□	□	○	○	□	□	□	□	■	□		
RL-W174	8	○	○	○	○	□	○	○	○	□	○	□	□	■	□		
RL-W175	4	○	○	○	○	□	○	○	○	○	○	○	□	■	○		
RL-W176	3	○	□	□	○	□	□	□	○	□	□	□	□	●	□		
RL-W177	18	□	□	□	□	□	□	□	□	□	□	□	□	□	○		
RL-W180	<1	□	□	□	□	□	□	□	□	□	□	□	□	■	○		
RL-W181	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W182	14	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W184	22	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W185	262	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W186	406	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W187	33	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W188	106	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W189	734	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W190	32	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W192	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W196	3	□	□	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W197	6	□	□	□	□	●	□	□	□	●	■	■	●	●	●		

Table D-2. Comparison of Waste Stream Concentrations with the Estimated PE Concentration Limits for a Tumulus Disposal Facility at 15 DOE Sites

		Arid								Humid							
MWIR ID	Final Volume (m^3)	LLNL	Hanford	NTS	INEL	RFETS	SNL	LANL	Pantex	ANLE	PGDP	FEMP	PORTS	ORR	SRS	WVDP	Controlling Nuclide(s)
RL-W199	<1	□	■	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W200	28	○	□	○	○	■	○	○	○	■	□	■	■	●	■		
RL-W201	<1	□	□	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W202	2	□	□	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W203	1	□	□	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W205	1	□	□	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W206	1	□	□	○	□	●	□	○	○	■	■	■	■	●	■		
RL-W208	55	○	□	○	○	■	○	○	○	■	□	■	■	●	■		
RL-W209	<1	□	□	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W210	28	□	■	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W211	25	□	■	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W215	8	□	□	□	□	■	□	□	□	■	□	□	□	■	□		
RL-W216	3	□	□	□	□	■	□	□	□	■	□	□	□	■	□		
RL-W217	11	○	□	○	○	●	○	○	○	●	■	■	●	●	■		
RL-W226	123	□	□	○	□	●	□	□	□	■	■	■	■	●	■		
RL-W227	<1	□	■	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W228	19	□	■	□	□	●	□	□	□	●	■	■	●	●	●		
RL-W231	42	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W232	29	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W233	25	□	□	□	□	□	□	□	□	□	□	□	□	●	○		
RL-W234	72	●	●	●	●	●	●	●	●	●	●	●	●	●	●		C-14, Ni-63
Savannah River																	
SR-W001	<1	■	■	■	■	■	■	■	■	■	■	■	■	●	■		
SR-W003	<1	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
SR-W004	80	○	○	○	○	○	○	○	○	○	○	□	□	□	○		
SR-W005	1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-236, U-238
SR-W009	13	●	●	●	●	●	●	●	●	●	●	●	●	●	●		Cs-137, I-129
SR-W015	21	●	●	●	●	●	●	●	●	●	●	●	●	●	○		
SR-W018	14	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
SR-W029	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
SR-W031	<1	■	■	■	■	■	■	■	■	■	●	■	●	●	●		
SR-W037	146	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
SR-W038	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	●		U-234, U-235, U-238
SR-W039	<1	○	○	○	○	○	○	○	○	○	○	□	□	□	○		
SR-W046	6	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
SR-W047	37	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
SR-W060	<1	●	●	●	●	●	●	●	●	●	●	●	●	●	○		
SR-W069	89	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
West Valley																	
WV-W019	<1	□	□	□	□	□	□	□	□	□	□	□	□	●	□	□	

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