RPP-21633
Revision 0

Preliminary Closure Plan for the Integrated Disposal Facility

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-08RV14800

P.O. Box 850
Richland, Washington 99352

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H. L. Baune
Washington River Protection Solutions

Date Published
October 2004

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Operating Record for Treatment, Storage, and Disposal Units

Published Date: 06/30/2014 **Effective Date: 06/30/2014**

Appendix B - TSD-Unit Specific Operating Record Information

Record Date: 10-25-04
Record Title: Preliminary Closure Plan for Integrated Disposal Facility (Addresses DOE Order 435.1 Requirements)

Document No. (if applicable): RPP-21633 REV 0

TSD Unit: IDF

Note: if this cover sheet applies to more than one TSD-Unit please check all appropriate boxes.

☐ Nonradioactive Dangerous Waste Landfill
☐ 216-B-3 main Pond
☐ 216-B-3-3 ditch
☐ 216-A-29 Ditch
☐ 216-A-36B Crib
☐ 216-A-37-1 Crib
☐ 216-B-63 Trench
☐ 216-S-10 Pond and Ditch
☐ 241-CX Tank System
☐ B Plant
☐ Central Waste Complex (CWC)
☐ Hexone Storage & Treatment Facility
xx☐ Integrated Disposal Facility (IDF)
☐ Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility (LERF/ETF)
☐ Low-Level Burial Grounds (Trenches 31-34-94)
☐ Low-Level Burial Grounds (Other Locations)
☐ PUREX Plant
☐ PUREX Storage Tunnels
☐ T-Plant Complex
☐ Waste Encapsulation and Storage Facility (WESF)
☐ Waste Receiving and Processing Facility (WRAP)
☐ 207-A South Retention Basin
☐ 400 Area Waste Management Unit
☐ 600 Area Purgewater Storage and Treatment Facility

Submitted By (print/sign/date): Kym Tarter Kym Tarter 5/7/15

☐ Electronic submittal: Submit Completed Appendix B and attached Operating Record information electronically to ^WSS Records Management.

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Preliminary Closure Plan for the Integrated Disposal Facility

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CH2M HILL Hanford Group, Inc.
Richland, WA 99352
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Abstract: This closure plan is written in accordance with the, "Format and Content Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Closure Plans," dated November 10, 1999 (DOE 1999c). It is a living document that will be updated throughout the operational life of the disposal site with specific information about the disposal of MLLW and LLW and partial closure cells within the disposal unit, and other activities necessary to achieve the facility's final closed state.

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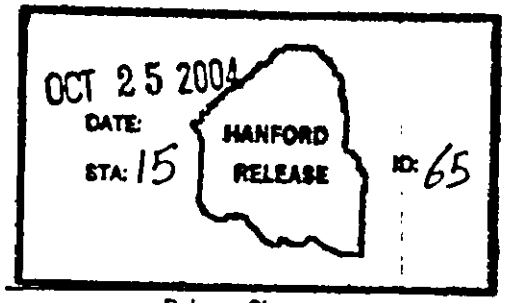

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EXECUTIVE SUMMARY

The mission of the U.S. Department of Energy, Office of River Protection (ORP) is environmental remediation of the Hanford Site via retrieval, pretreatment, immobilization, interim storage, and disposal of the high-level radioactive tank waste. During pretreatment, the waste will yield a low-activity waste (LAW) stream that subsequently will be immobilized in the Waste Treatment and Immobilization Plant (WTP). The Tank Farm Contractor will be responsible for work scope that includes receipt of immobilized low-activity waste (ILAW) from the WTP, safe transportation of the waste to the onsite disposal facility, and final disposal and closure monitoring. The immobilized low-activity waste (ILAW) packages, other mixed low-level waste (MLLW), and low-level waste (LLW) will be disposed of on site in the Integrated Disposal Facility (IDF) expandable landfill.

The IDF project replaces the previous remote handled waste (RHW) trench concept. This document updates the RHW trench concept closure process presented in *Preliminary Closure Plan for Immobilized Low-Activity Waste Disposal Facility*, RPP-6911, Rev. 1. The RHW trench concept has evolved from an ILAW only concept to an expandable disposal facility that provides ORP and the Department of Energy Richland Operations Office with greater waste disposal capacity and flexibility.

The IDF is a *Resource Conservation and Recovery Act of 1976* (RCRA)-compliant landfill (i.e., double-lined trench with leachate drainage system). One of the IDF disposal cells will be permitted by the Washington State Department of Ecology for the disposal of MLLW. The second IDF disposal cell will be utilized for the disposal of LLW. The ILAW packages and other MLLW will be disposed in the permitted MLLW cell. Following the completion of all disposal activities an engineered barrier will be installed as a closure cap over the IDF. The final IDF closure cap shall be designed to minimize maintenance and ensure long-term stability to isolate the disposed waste.

This document is a preliminary closure plan that addresses the closure activities for the IDF. It is a companion document to the facility's performance assessment (PA) (Mann et al. 2001) which provides critical design features and future conditions needed to conduct the PA and the RCRA Part B Permit Application (DOE/RL 2003-12). An update to the PA is expected to be issued in 2005. The PA provides the DOE with a reasonable expectation that the MLLW and LLW disposal will meet the radiological performance objectives established in DOE M 435.1-1. The Part B Permit Application provides closure and post-closure performance standards as well as pre-closure operations and maintenance requirements. The final RCRA Part B Permit is expected to be issued in late 2004.

This closure plan is written in accordance with the *Format and Content Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Closure Plans*, dated November 10, 1999 (DOE 1999c). It is a living document that will be updated throughout the operational life of the disposal site with specific information about the disposal of MLLW and LLW and partial closure of cells (e.g., covering waste packages with fill material) within the disposal unit, and other activities necessary to achieve the facility's final closed state. The Closure Plan was initially prepared because the disposal authorization statement (DAS) required it to be issued within a year of issuance of the DAS (i.e., before October 25, 2000). This update

reflects the change of mission from the ILAW-only disposal facility into the Integrated Disposal Facility for disposal of Hanford LLW and MLLW, including ILAW, and potentially off-site waste.

The major advantages of the IDF are low cost and flexible capacity. The IDF is similar in concept to the existing Hanford Site Radioactive Mixed Waste Burial Trench and the Environmental Restoration Disposal Facility. The disposal site is projected to consist of one expandable trench that is divided into two cells. The IDF will consist of a lined landfill, approximately 442 m (1450 ft) wide by approximately 555 m (1820 ft) in length by up to 13.2 m (43.3 ft) deep. The IDF will contain four layers of ILAW packages separated vertically by 1 m of soil. Other waste types may have different layering strategies to accommodate varying sizes.

The *Integrated Disposal Facility Critical Systems Design Report,* (Comstock 2003), was published May 24, 2003, using the IDF concept. Construction activities began in September of 2004 with scheduled construction completion in October of 2005. IDF operations is scheduled to begin in March of 2006. The IDF trench will be expanded as additional disposal capacity is needed. Each expansion will be filled with MLLW and LLW, in the proper cells, and an interim cover installed. The IDF final closure cap will be installed after the end of waste disposal in the IDF. The last IDF expansion is expected to be closed in 2032.

Post-closure monitoring of the IDF will continue to ensure that the waste is isolated and contamination is prevented from reaching the public and the environment in excess of limits. The duration of monitoring will be assessed at each permit review and renewal. Post-closure monitoring of the IDF will continue for at least 30 years as required by both state and federal regulation. The duration of post-closure monitoring could be shortened or extended as appropriate based on the adequacy of the closure process [WAC 173-303-610 (7) and 40 CFR 264.310].

The Hanford Site burial ground design and operating practices are a historically proven, cost-effective, and regulatory-compliant approach to solid-mixed-waste and low-level waste disposal. The IDF disposal architecture based on these practices should possess equally attractive attributes.

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TERMS

BV	bulk vitrification
CA	composite analysis
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1981*
CFR	*Code of Federal Regulations*
DAS	disposal authorization statement
DOE	U.S. Department of Energy
DQO	data quality objectives
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FFS	focused feasibility study
HLW	high-level waste
HMS	Hanford Meteorological Station
IDF	Integrated Disposal Facility
IHLW	immobilized high-level waste
ILAW	immobilized low-activity waste
LAW	low-activity waste
LLBG	low level burial grounds
LLW	low-level waste
MLLW	mixed low-level waste
MTG	minimum technology guidance
NEPA	*National Environmental Policy Act of 1969*
NRC	U.S. Nuclear Regulatory Commission
OEA	Office of External Affairs
ORP	U.S. Department of Energy, Office of River Protection
OSHA	Occupational Safety and Health Administration
PA	performance assessment
PNNL	Pacific Northwest National Laboratory
QAPP	Quality Assurance Program Plan
RCRA	*Resource Conservation and Recovery Act of 1976*
RHW	remote-handled waste
RMW	radioactive mixed waste
ROD	Record of Decision
RPP	River Protection Project
SST	single-shell tank
SWIFT	solid waste integrated forecast technical
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic
TWRS	Tank Waste Remediation System
WAC	*Washington Administrative Code*
WHC	Westinghouse Hanford Company
WTP	Waste Treatment and Immobilization Plant

DEFINITIONS

NOTE: Some definitions are adapted from the U.S. Nuclear Regulatory Commission (NRC) (10 *Code of Federal Regulations* [CFR] 61) and the U. S. Department of Energy (DOE) requirements.

Active maintenance. Any significant remedial activity needed during the period of institutional control to maintain a reasonable assurance that the performance objectives in 40 CFR 61.41 and 40 CFR 61.42 are met. Such active maintenance includes ongoing activities such as the pumping and treatment of water from a disposal unit or one-time measures such as replacement of a disposal unit cover. Active maintenance does not include custodial activities such as repair of fencing, repair or replacement of monitoring equipment, revegetation, minor additions to soil cover, minor repair of disposal unit covers, and general disposal site upkeep such as mowing grass.

Becquerel (Bq). The International System (SI) unit for activity of radioactive material. One Becquerel is that quantity of radioactive material in which one atom is transformed per second or undergoes one disintegration per second (d/s).

Buffer zone. A portion of the disposal site that is controlled by the licensee and lies around the disposal units and between the disposal units and the Site boundary.

Closure. See site closure and stabilization.

Closure plans. Indicate how each DOE storage, treatment, and disposal facility will be closed on termination of operations to ensure that the public and environment will be protected. Closure plans shall be reviewed and approved (DOE O 435.1).

Composite analysis. An analysis of all sources of radioactive material that may interact with the disposal facility. The composite analysis provides a reasonable expectation that long-term impacts from the disposal facility and other sources will be acceptable. Composite analyses shall be prepared and submitted to DOE Headquarters for review and approval (DOE O 435.1).

Curie. A unit of radioactivity. The amount of any radionuclide that undergoes exactly 3.7×10^{10} disintegrations per second.

Dangerous Waste. Those solid wastes designated in WAC 173-303-070 through 173-303-100 as dangerous or extremely hazardous waste.

Disposal. Placement in or on the land, except in a corrective action management unit or staging pile, and includes, but is not limited to, placement in a landfill.

Disposal site. That portion of a land disposal facility used to dispose of waste. It consists of disposal units and a buffer zone.

Disposal unit. A discrete portion of the disposal site into which waste is placed for disposal. For the Integrated Disposal Facility the disposal unit, is divided into two expandable cells.

Engineered barrier. A constructed structure or device intended to improve the land disposal facility's ability to meet the performance objective set forth in 10 CFR 61, Subpart C.

Gray (Gy). SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (100 rads).

Hazardous waste. That waste designated as hazardous by U.S. Environmental Protection Agency regulations in 40 CFR Part 261.

Inadvertent intruder. Any person who might occupy the disposal site after closure and engage in normal activities, such as farming, constructing dwellings, or other pursuits in which the person might unknowingly be exposed to radiation from the waste.

Intruder barrier. A depth of cover over the waste sufficient to inhibit contact with waste and help ensure that radiation exposures to an inadvertent intruder will meet the performance objectives set forth in 10 CFR 61, Subpart C, or engineered structures that provide equivalent protection to the inadvertent intruder.

Land disposal facility. The land, buildings, structures, and equipment intended to be used for the disposal of radioactive waste.

Low-activity waste. That secondary waste stream derived from the contents of the high-level waste tanks after separation of most of the radionuclides. Low-activity waste is the portion classified by the U.S. Nuclear Regulatory Commission (NRC) as waste incidental to reprocessing. The onsite disposal facility for low-activity waste shall meet the low-level waste requirements for disposal in accordance with DOE M 435.1-1.

Low-level waste. Radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in Section 11e.(2) of the *Atomic Energy Act of 1954*, as amended), or naturally occurring radioactive material.

Mixed waste. Dangerous, extremely hazardous, or acutely hazardous waste that contains both a nonradioactive hazardous component and, as defined by 10 CFR 120.1003, source, special nuclear, or by-product material subject to the *Atomic Energy Act of 1954*.

Monitoring. Observing and making measurements to provide data to evaluate the performance and characteristics of the disposal site.

Near-surface disposal facility. A land disposal facility in which radioactive waste is disposed of in or within the upper 30 meters of the surface of the earth.

Package. An immobilized low-activity waste (ILAW) metal container 2.3-m high, 1.22-m diameter with a volume of 2.55 m^3 that is filled on the average with 6.0 MT of waste glass (at a density of 2.66 MT/m^3) and filler materials and having minimal void space. Other waste containers of unspecified size and shape are also defined as packages.

Performance Assessment. A site-specific low-level waste disposal facility radiological performance assessment that provides a reasonable expectation of compliance with the performance objectives in Section 3.C.(4) that is prepared and submitted to Headquarters for review and approval. (DOE O 435.1)

Rad. A unit of absorbed radiation dose. One rad is equal to an absorbed dose of 100 ergs per gram or 0.01 joule per kilogram (0.01 gray).

Rem. A unit of dose equivalent. Dose equivalent in rem is numerically equal to the absorbed dose in rad multiplied by a quality factor, a distribution factor, and any other necessary modifying factor (1 rem = 0.01 sievert).

Sievert (Sv). SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rems).

Site closure and stabilization. Those actions taken on completion of operations that prepare the disposal site for custodial care and that ensure that the disposal site will remain stable and will not need ongoing active maintenance.

Surveillance. Observation of the disposal site for purposes of visually detecting the need for maintenance or custodial care, evidence of intrusion, and compliance with other license and regulatory requirements.

Waste Acceptance Criteria. Ensure that the design and operating bases of each treatment, storage, and disposal facility are met. Waste acceptance criteria shall be prepared and submitted to ORP for review and approval (DOE O 435.1).

Waste Treatment and Immobilization Plant (WTP). The WTP is a responsible for design, construction, and operation of the waste immobilization facility.

PRELIMINARY CLOSURE PLAN FOR THE INTEGRATED DISPOSAL FACILITY

1.0 INTRODUCTION

The Hanford Site consists of 1450 km^2 of shrub steppe, sand, and sagebrush located near the Columbia River in southeastern Washington State. The Hanford Site is managed by the U.S. Department of Energy (DOE), the successor agency to the U.S. Atomic Energy Commission. As a plutonium production complex, the Hanford Site played a pivotal role in the nation's defense for more than 50 years beginning in the 1940's with the construction of the Site as part of the Manhattan Project. Much of the byproduct nuclear materials created by the operations at the Hanford Site have been contained in underground waste storage tanks.

The DOE, through the U.S. Department of Energy, Office of River Protection (ORP), created the River Protection Project (RPP) (formerly the Tank Waste Remediation System [TWRS] Project) as part of the program for environmental remediation of the Hanford Site. The RPP mission (Acree 1998) is retrieval, pretreatment, immobilization, interim storage, and disposal of the high-level radioactive tank waste and associated incidental low-activity waste (LAW) disposal at the Hanford Site, followed by tank closure.

Some treatment of tank waste will be performed by the Waste Treatment Plant and Immobilization Plant (WTP) or supplemental technology such as bulk vitrification. The Tank Farm Contractor will be responsible for work scope that includes receipt of immobilized low-activity waste (ILAW) from the WTP, safe transportation of the waste to the onsite disposal facility, and final disposal and closure monitoring. Other low-level waste (LLW) and mixed low-level waste (MLLW) generated as part of DOE cleanup activities at Hanford and possibly from other sites will be disposed of in the IDF.

Radioactive waste management for the IDF is implemented in accordance with DOE O 435.1, *Radioactive Waste Management*, and DOE M 435.1-1, *Radioactive Waste Management Manual*. The DOE manual requires that a "preliminary closure plan shall be developed, and submitted to Headquarters for review with the performance assessment and composite analysis." The layout of this closure plan follows the *Format and Content Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Closure Plans*, dated November 10, 1999 (DOE 1999c).

The DOE, in response to a Defense Nuclear Facilities Safety Board review (Napolitano et al. 1994) of its radioactive waste management policy, has outlined a more strategic role for closure planning and performance assessment (PA) work in concert with the disposal facility's design work. For example, the format guide for DOE M 435.1-1 states that a conceptual design for final closure should be presented in the preliminary closure plan.

1.1 PURPOSE AND SCOPE

The purpose of this document is to provide the technical basis for defining critical closure design features and future conditions needed to conduct the PA. This document also satisfies the DOE M 435.1-1 requirement that a preliminary closure plan shall be submitted to Headquarters for review. The PA provides the DOE with a reasonable expectation that the waste disposal will meet the radiological performance objectives established in DOE M 435.1-1.

The current classification of ILAW as a mixed waste makes it subject to the requirements of 40 CFR 264.112(a) and *Washington Administrative Code* (WAC) 173-303-610 (3) requiring a written closure plan. Because the requirement for closure plans in DOE M 435.1-1 is identical to the RCRA/WAC requirement, this document and its updates will meet the RCRA requirement for the written closure plan.

This closure plan describes the disposal facility characteristics and the technical approach that will be employed to ensure the long-term stability of the waste and minimize the need for active maintenance following closure. It is a living document that is updated throughout the operational life of the facility with specific information about the waste being disposed of, partial closure of disposal units, and other information necessary to achieve the facility's final closed state.

1.2 BACKGROUND

During the 1980's the planned method for treating LAW from underground tanks at the Hanford Site was a grouted waste form. Five vaults were designed and built during the period from 1983 to 1989 for grouted LAW disposal. Only one vault was used for this purpose. In the early 1990's, as a result of concerns with the adequacy of disposal of LAW using grout to immobilize the waste, the grout project was terminated, leaving unused vaults.

The concerns about the adequacy of grout disposal involved the large projected volume, the ability of grout to adequately inhibit contaminants from leaching out of the grouted waste and the ability to safely retrieve the waste from the grout vaults in the future, if retrieval became necessary for some unforeseen reason. After LLW treatment options were reevaluated, a vitrified waste form was adopted as the proposed approach. The DOE issued a record of decision documenting the selection of the vitrification alternative for retrieving and immobilizing the high-level tank waste stored at the Hanford Site.

Different waste treatment scenarios have been modeled using current data on tank waste compositions and quantities. The results of these analyses, documented in *Tank Farm Contractor Operation and Utilization Plan* (Kirkbride et al. 2000), provides increased assurance that a credible plan, with a reasonable chance of success, has been devised and can be implemented for tank waste retrieval, treatment, immobilization, and disposal. The following subsections describe the waste generation path, an estimation of the quantity of waste that will be generated, and the disposal authorization statement for the IDF.

1.2.1 Low-Activity Waste Treatment and Immobilization

Figure 1-1 provides a program logic flow diagram for the ILAW processing. LAW will be generated in the pretreatment processing of the high-level waste (HLW) currently in the underground tanks. The waste from selected tanks will be retrieved following a staging plan, and subsequently separated into LAW and HLW fractions. The LAW feed (the tank waste to be fed to the WTP) will be treated in the WTP to remove nearly all of the cesium and much of the strontium, which will be processed separately into immobilized high-level waste (IHLW). Separations requirements for these radionuclides have not been specified. Instead, separations

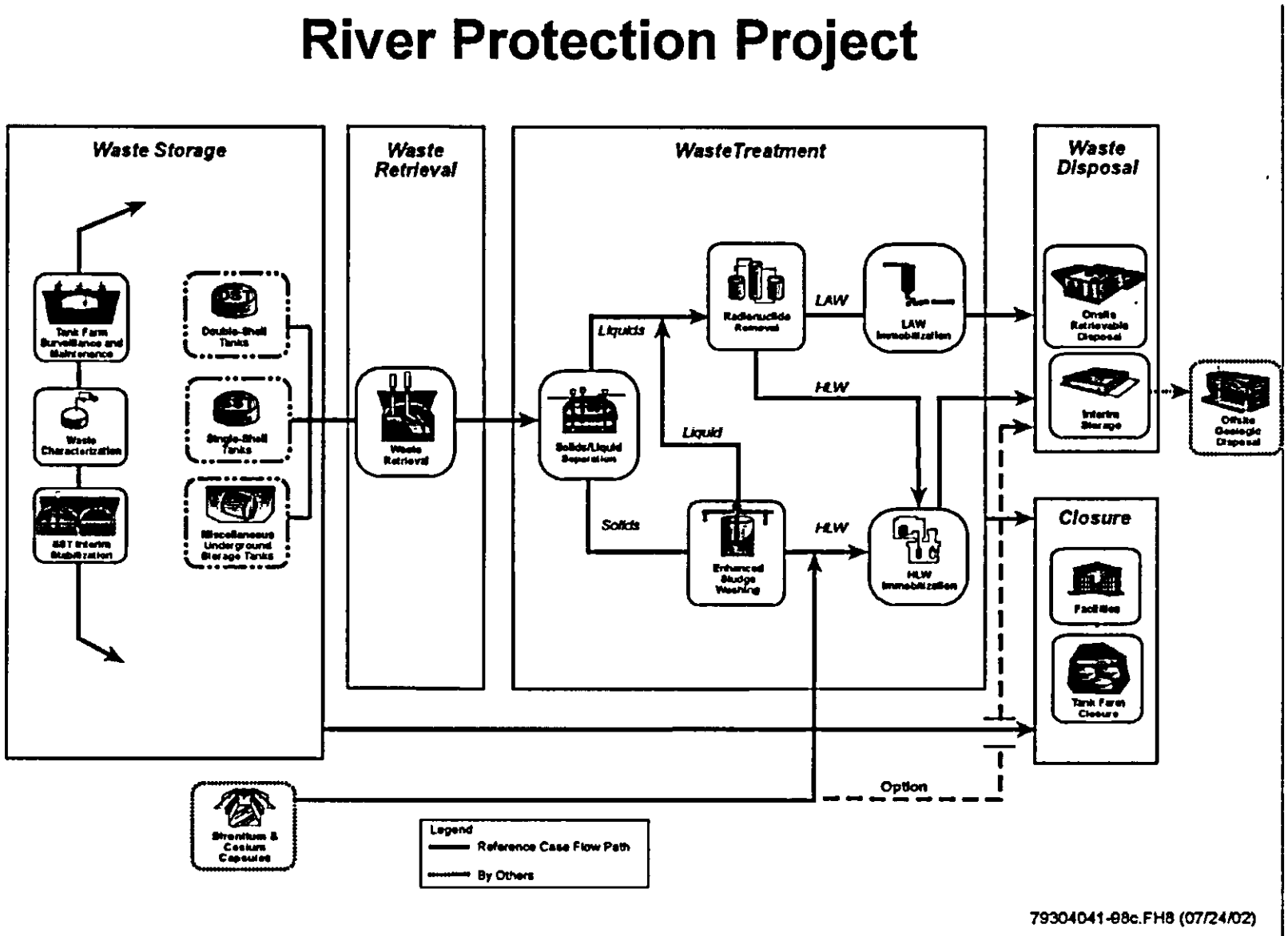
requirements have been translated into objective product requirements more stringent than NRC Class C waste (10 CFR 61).

The WTP also will remove the transuranic (TRU) elements to meet the requirements for burial of NRC Class C waste (10 CFR 61). The LAW waste remaining after separations will be mixed with glass formers and vitrified in a glass melter. When the mixture cools, the resulting ILAW is highly effective in inhibiting the leaching of contaminants and is suitable for onsite disposal.

Some low-activity Hanford tank waste will be used in the bulk vitrification (BV) process to produce ILAW. The BV process is under development and potentially may not proceed beyond demonstration tests. During processing, liquid waste will be mixed with appropriate glass formers and excess water will be removed from the mixture. The mixture will be transported and placed in a waste container, where electrodes, penetrating the waste, will vitrify the waste via joule heating (Leonard 2004).

Both the WTP vitrification and the BV process will generate secondary waste streams. These waste streams will be analyzed against the requirements of the Waste Acceptance Criteria and the Performance Assessment for disposal in the IDF.

Figure 1-1. Immobilized Low-Activity Waste Disposal Program Flow Diagram



1.2.2 Expected Waste Volumes

MLLW and LLW are expected in approximately equal quantities of 450,000 m^3, the full IDF build out capacity is 900,000m^3. Approximately 70-80% of the MLLW will be vitrified waste and the remaining 20-30% other MLLW from cleanup activities. The LLW is expected to be roughly 80% Category 1 (waste is grouped based on radionuclide concentrations), and 20% greater than Category 1 by volume. Initial construction of the IDF will accommodate 38,000 m^3 ILAW containers, 44,000 m^3 MLLW, and 81,000 m^3 LLW. The IDF total phase 1 capacity is 163,000 m^3. Waste volumes will be updated in future revisions to the closure plan.

1.2.3 WTP LAW Glass Waste Package Design

The physical, chemical, and radiological properties of the waste at the time of disposal have not been completely determined. The WTP ILAW glass waste form is expected to be contained in right circular, steel cylinder containers (1.22 m diameter by 2.29 m tall). The waste package volume is 2.55 m^3 (90.0 ft^3). Given the geometry of the WTP ILAW glass container that necks near the top, the corresponding LAW glass height in the container is estimated to be 2.0 m. The estimated WTP ILAW glass volume held by each WTP ILAW glass waste package is 0.90*2.55 m^3 = 2.30 m^3. The WTP ILAW glass density is 2.6 MT/m^3 (Kirkbride et al. 2003). The number of WTP ILAW glass waste packages disposed in the IDF will depend on the amount of WTP ILAW glass produced. The ILAW package will contain 90 % (minimum) by volume of ILAW glass.

1.2.4 WTP Spent Melter Package Designs

The HLW and LAW melter radiological and physical characteristics have not been finalized. The following assumptions have been made concerning the quantity of waste material remaining in the spent melters, their dimensions and overpack design.

The HLW melter overpacks are currently designed as carbon steel containers that provide the necessary shielding, contamination control, and structural rigidity to allow direct burial of the spent melters as MLLW (Zuberi and Lowe 2003). Table 1-1 summarizes the current melter overpack design envelopes.

A preliminary shielding assessment for the HLW melter indicates a steel shielding thickness of 8 inches for the overpack is necessary. Planning for the disposal of the melters is still under development.

Table 1-1. Melter and Melter Overpack Characteristics

Melter Type	Height [1]	Length [1]	Width [1]	Surface to Volume Ratio	Melter Weight [2,3]	Overpack Weight [3]
HLW	4.38-m (172-in)	5.29-m (208-in)	5.29-m (208-in)	1.215 m^{-1}	100.8 MT (222,200 lbs)	226.8 MT (500,000 lbs)
LAW	4.86-m (190-in)	6.79-m (262-in)	9.38-m (367-in)	0.9295 m^{-1}	329.3 (MT) (726,000 lbs)	Under development [4]

1 The LAW and HLW melter dimensions include the melter overpack.

2 Melter weight includes melter filled with glass.

3 All Weights in table include a 10% contingency due to status of design, as design progresses these values will be revised

4 The recommended Land Disposal Restriction (LDR) compliance strategy for the LAW melter is to transport the melter to the disposal trench and treat the melter in-trench (encapsulate melter in grout), however, it is recognized that this path forward may include regulatory hurdles and life-cycle cost impacts greater than originally anticipated. Therefore, a backup approach was recommended by BNI that includes macro-encapsulation of the LAW melter in a sealed stainless steel box. This would be the limiting case relative to transportation limits (e.g., road load bearing limits).

1.2.5 Low-Level and Mixed Low-Level Waste Package Designs

The waste package designs that will be used to dispose LLW and MLLW in the IDF are generally known, as defined in the waste acceptance criteria (Girres 2004 and Burbank 2002), but specific package information is not known until waste is placed in package and shipped to IDF. The waste acceptance criteria is currently under revision to integrate the waste acceptance criteria into a single document and is expected to be available in 2006. The Hanford Solid Waste Burial Grounds has had experience with the disposal of many different waste package geometries during its operation. Two waste package designs, 55-gallon drums and waste burial boxes, have been used extensively at the Hanford Solid Waste Burial Grounds. Waste package designs are also discussed in the RCRA Part B Application (DOE/RL 2003-12).

The 55-gallon drum waste package has nominal dimensions of 0.60 m diameter by 0.884 m in height. It is typically fabricated from steel and may be either painted or galvanized. The waste volume contained in a standard 55-gallon drum is nominally 0.208 m^3.

The waste burial box has nominal dimensions of 1.22 m [L] x 2.44 m [W] x 1.22 m [H] (4 ft [L] x 8 ft [W] x 4 ft [H]). It is typically fabricated from steel. The waste volume contained in this waste package is nominally 3.62 m^3.

The waste packages accepted into the Hanford Solid Waste Burial Grounds have been categorized within the SWIFT report (Barcot 2003) into the following package sizes: small boxes (volume less than 3.95 m^3), medium boxes (volume between 3.95 m^3 and 15 m^3), large boxes (volumes between 15 and 28.3 m^3), extra large boxes (volumes greater than 28.3 m^3) and SWBs with volumes = 2.1 m^3. The void fraction for the LLW and MLLW loaded into these waste package geometries is required to be less than 10% (Girres 2004).

The typical process for treatment of hazardous materials to meet Land Disposal Restrictions (LDR) is to grout the associated MLLW prior to disposal. Also, LLW may be grouted if the activity is above Category 1 levels.

1.2.6 Non-WTP Supplemental Technology Waste Package Design

The waste form for the supplemental technology waste stream is not known. It is expected that all the supplemental technology waste is processed by the BV process. The BV waste package geometry has not been finalized. The preliminary waste package design assumes a rectangular box having dimensions of 2.4 m (H) x 7.5 m (L) x 3.0 m (W) (8 x 24' x 10') (Leonard 2004) for a maximum volume of 54 m^3.

1.2.7 Disposal Authorization

Before construction of the IDF, DOE M 435.1-1 requires that a disposal authorization statement (DAS) be obtained. A DAS is documentation authorizing operation of a low-level waste disposal facility resulting from the DOE Headquarters review and acceptance of the facility's performance assessment, composite analysis, and other information and evaluations. The DAS constitutes approval of the performance assessment and composite analysis, authorizes operation of the facility, and includes the conditions the disposal facility must meet.

The DAS for ILAW at the Hanford Site, supported by Mann et al. (1998) was issued by DOE-Headquarters, Environmental Management Office (EM-35), in October 1999. The DAS supported by Mann et al. (2001) was issued by DOE-Headquarters, Office of Program Integration (EM-43). DOE Headquarters reviewed the final 2001 ILAW PA, which incorporated the IDF concept, and concluded that no changes to the DAS were necessary (DOE 2003). The DAS conditions for construction and operation may be modified by DOE Headquarters based on the results of the review of the forthcoming 2005 IDF PA (planned to be submitted in 2005).

1.3 GENERAL FACILITY DESCRIPTION

This description applies to the IDF that has been adopted for disposal of MLLW and LLW waste. The location chosen for the IDF is in the 200 East Area of the Hanford Site. The Hanford Site is owned by the U.S. Government, and its use currently is controlled by the DOE. Land surrounding the Hanford Site is primarily used for agriculture. The present land use in the facilities on Site is "Industrial-Exclusive" (DOE, 1999b). More descriptive information on the disposal facility is given in Section 2.1.

The IDF is a RCRA-compliant landfill that includes a double-lined trench with a leachate drainage and collection system. The planned disposal site will consist of a single expandable trench. The trench will be divided into two disposal cells, one RCRA permitted for the disposal of MLLW and the non-permitted cell for the disposal of LLW. The layout of the IDF is shown in Figure 1-2.

Figure 1-2. Layout of the IDF within the Disposal Site

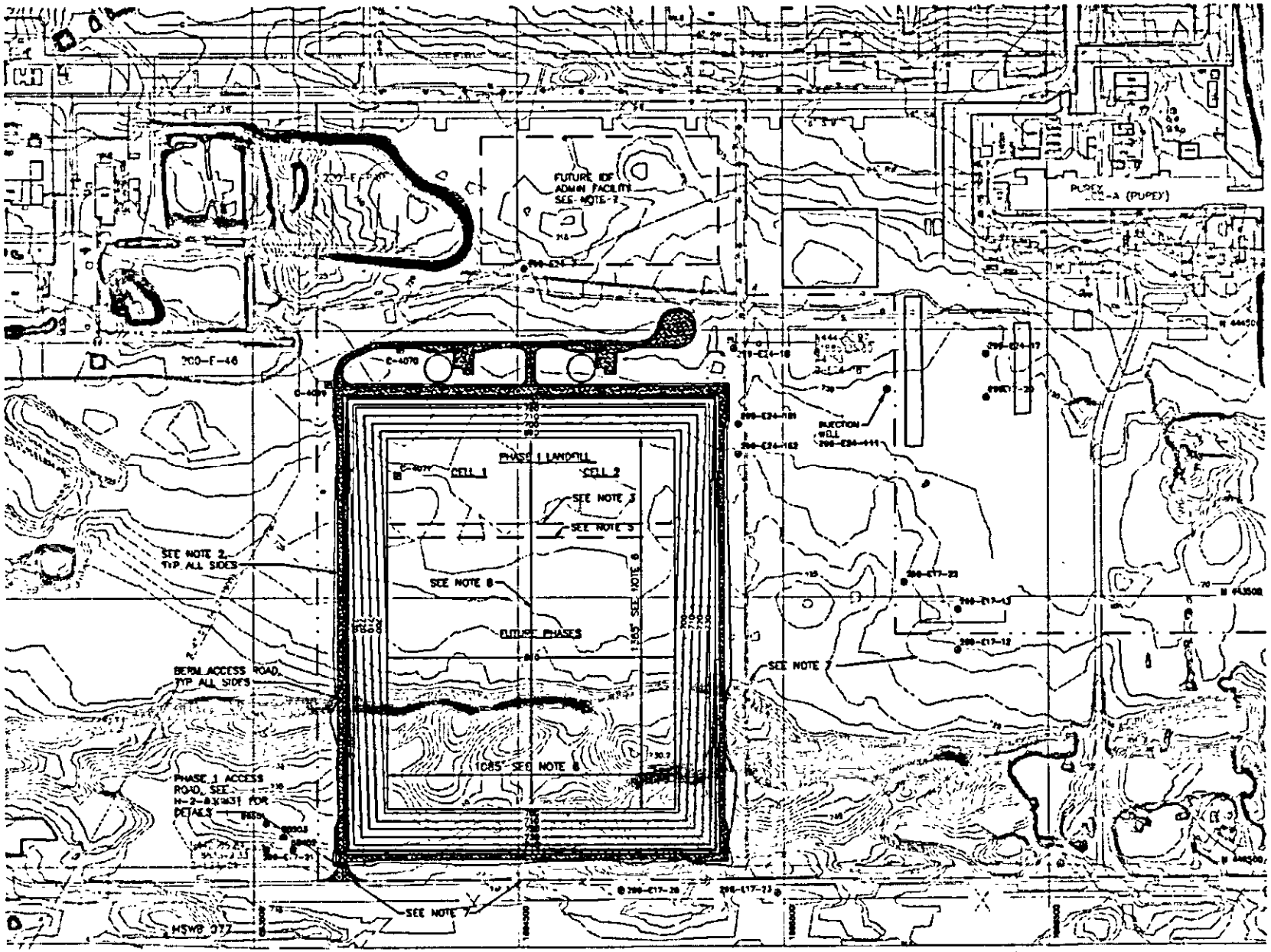
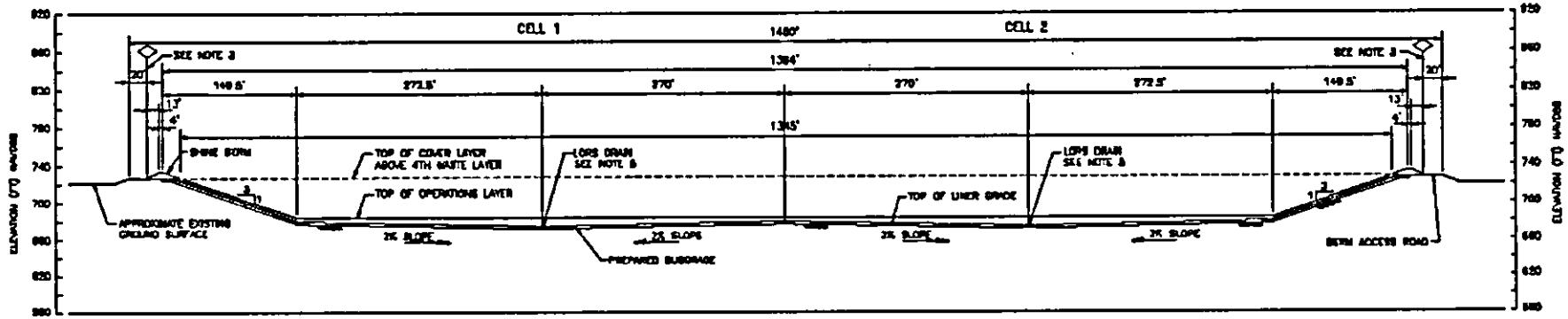
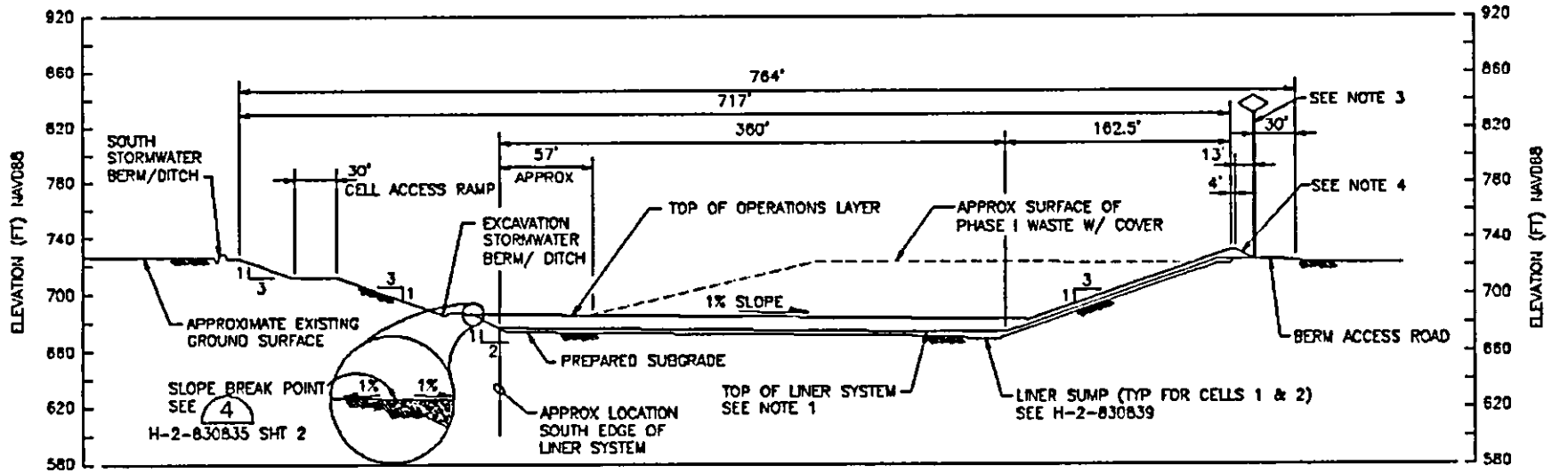


Figure 1-3. IDF Cross-Section Dimensions



East – West Cross-Section



North – South Cross Section (IDF Initial Construction)

Figure 1-4. IDF Leachate Collection and Recovery System

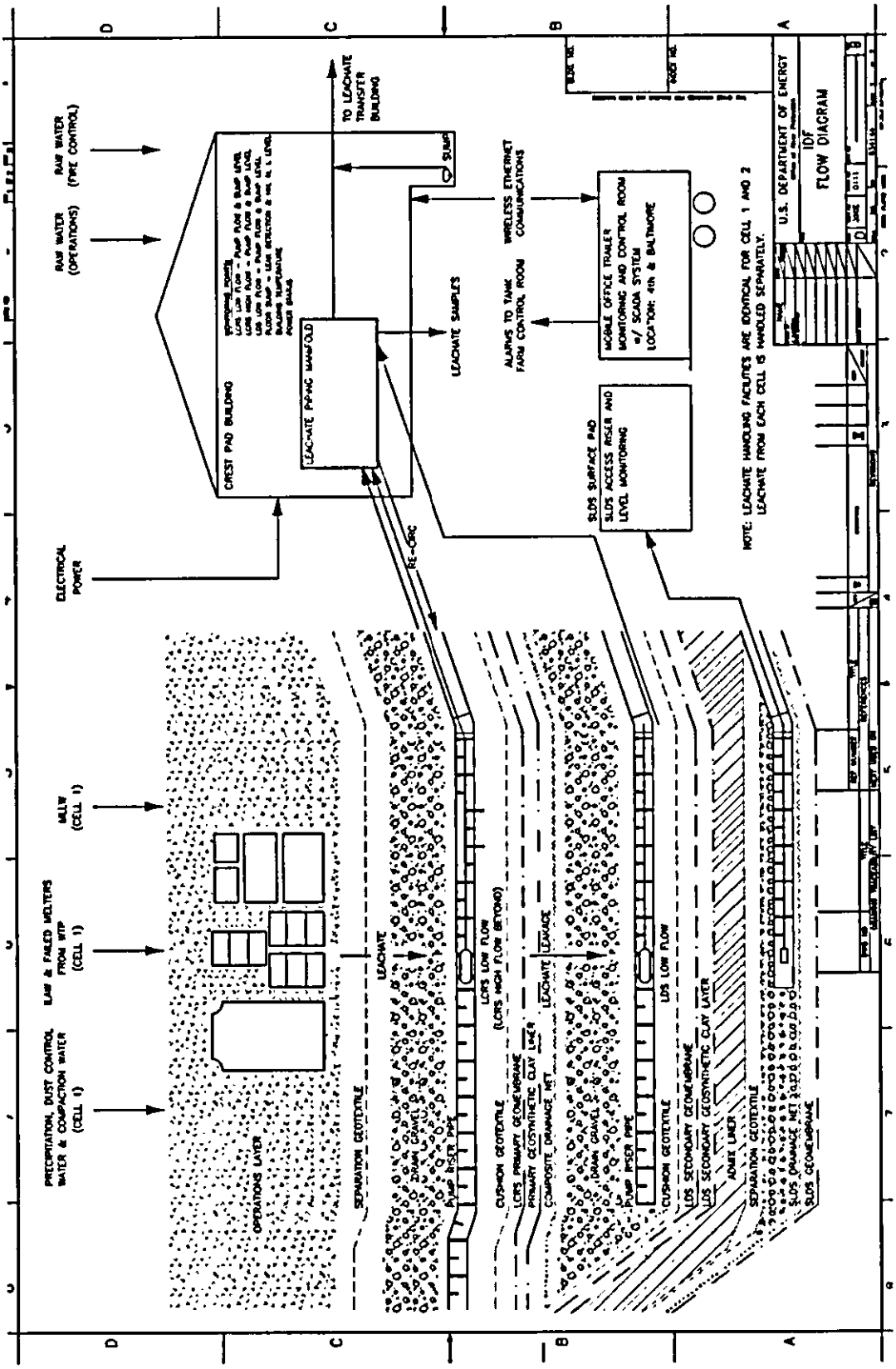


Figure 1-4. IDF Leachate Collection and Recovery System, Cont.

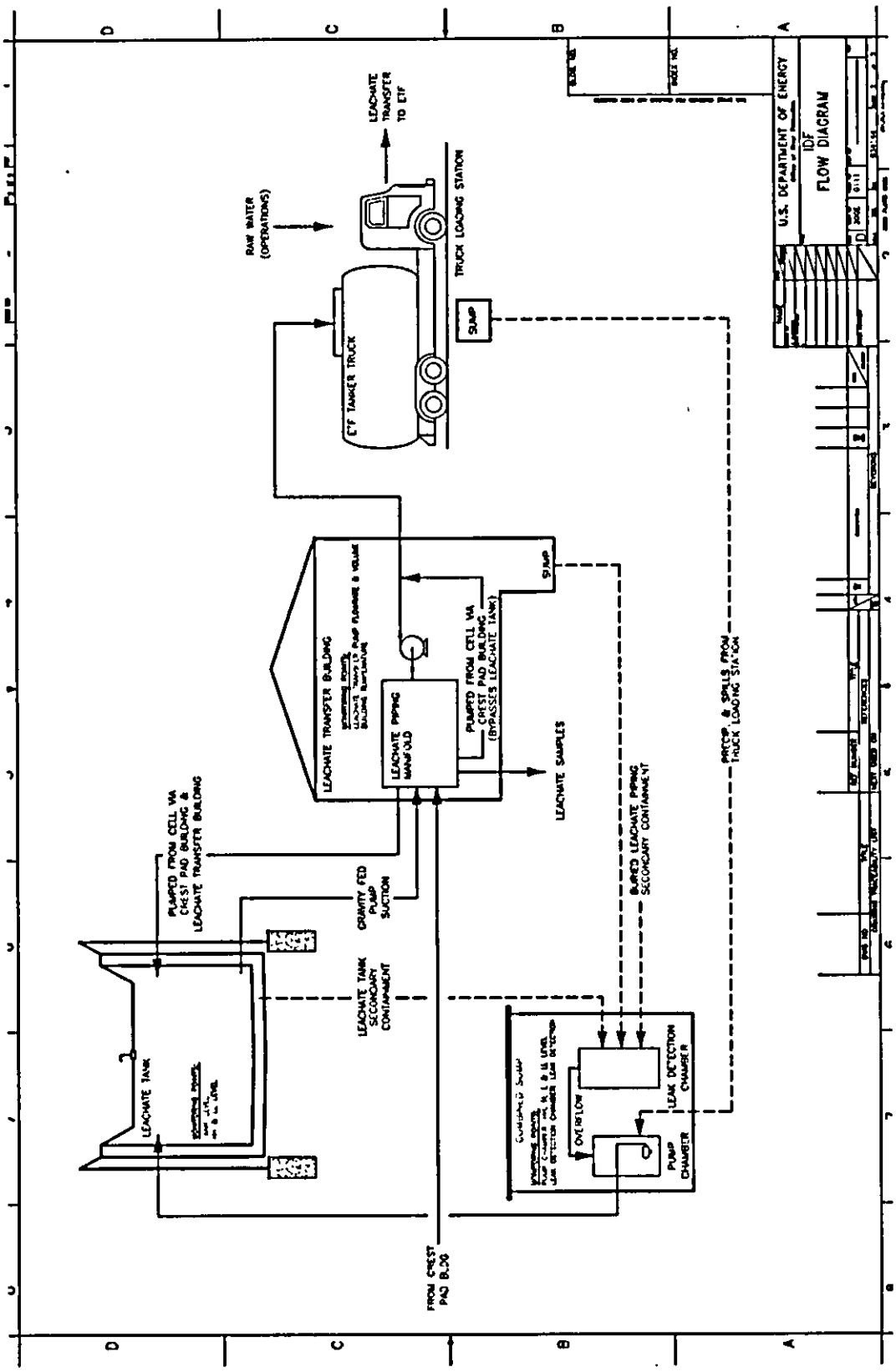
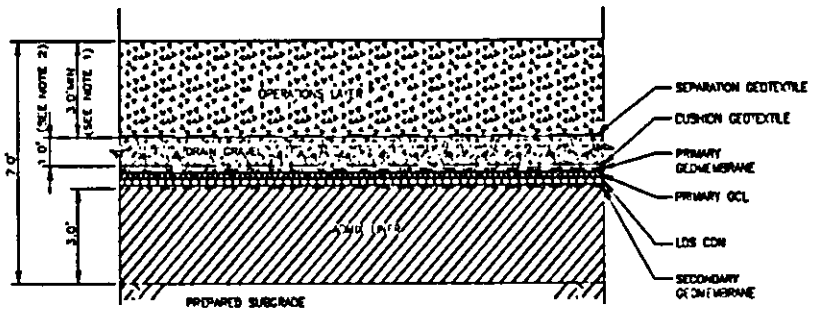
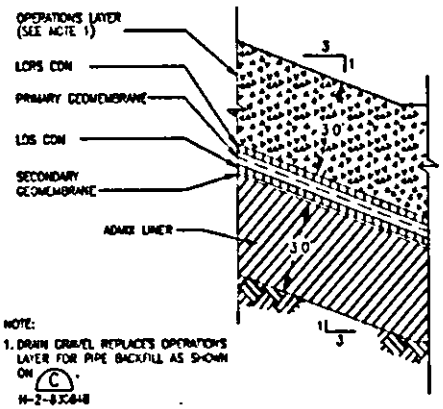


Figure 1-5. IDF RCRA Compliant Liner Details



NOTES:
1. OPERATIONS LAYER THICKNESS VARIES ACROSS CELL BOTTOM WITH A 3-FOOT MIN. THICKNESS.
2. INCREASE DRAIN GRAVEL THICKNESS IN VICINITY OF LEACHATE COLLECTION AND RISER PIPES IN LDS SUMP AS SHOWN ON (B) AND (D) H-2-830848 H-2-830845

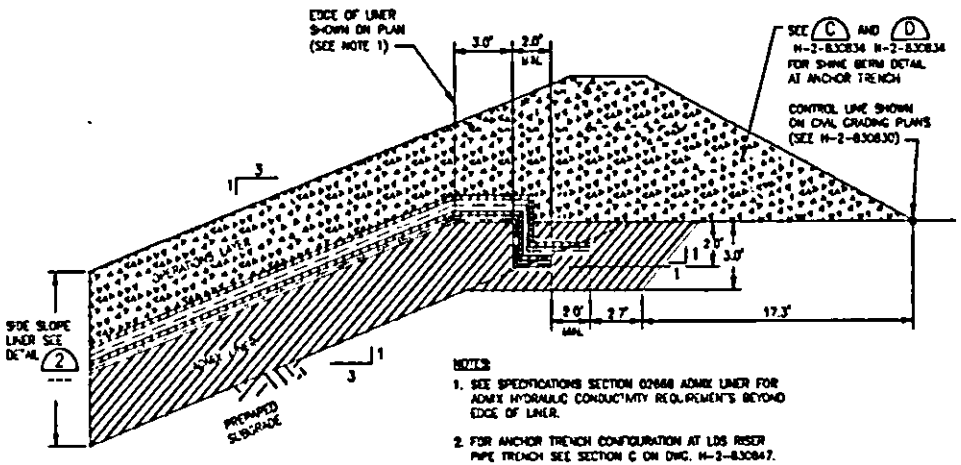
BOTTOM LINER DETAIL (1) N.T.S. H-2-830838, H-2-830839 H-2-830840



NOTE:
1. DRAIN GRAVEL REPLACES OPERATIONS LAYER FOR PIPE BACKFILL AS SHOWN ON (C) H-2-830848

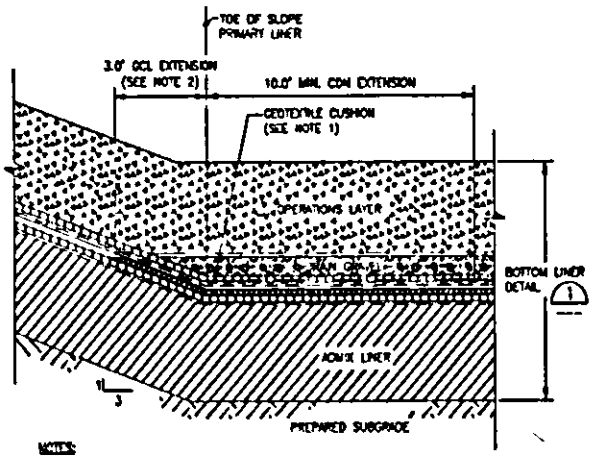
GENERAL NOTE (H-2-830838 THROUGH 830840): SPACING BETWEEN GEOSYNTHETIC LAYERS IS EXAGGERATED FOR CLARITY.

SIDE SLOPE LINER DETAIL (2) N.T.S. H-2-830838, H-2-830839, H-2-830840, H-2-830848



NOTES:
1. SEE SPECIFICATIONS SECTION 02668 ADMIX LINER FOR ADMIX HYDRAULIC CONDUCTIVITY REQUIREMENTS BEYOND EDGE OF LINER.
2. FOR ANCHOR TRENCH CONFIGURATION AT LDS RISER PIPE TRENCH SEE SECTION C ON DWG. H-2-830847.

LINER ANCHOR TRENCH DETAIL (3) N.T.S. H-2-830834, H-2-830838



NOTES:
1. GEOTEXTILE CUSHION ENDS AT TOE OF SLOPE
2. EXTEND GCL 3.0' UP SLOPE (HORIZONTAL LENGTH) TO TOP OF DRAIN GRAVEL

TOE OF SLOPE LINER DETAIL (4) N.T.S. H-2-830836, H-2-830839

1.3.1 IDF Description

The IDF will consist of a lined landfill, approximately 442 m (1450 ft) wide by approximately 555 m (1820 ft) in length by up to 13.2 m (43.3 ft) deep as illustrated in Figure 1-3. The landfill is separated into two separate cells that are each 205 m wide by approximately 501 m in length. One cell is RCRA permitted to receive MLLW. The trench floor will have a gradual 1% slope down to the north and the trench sides have a slope of 1 m rise for every 3 m run as shown in Figure 1-4. Each successive layer can be increased in length and width and can accommodate more packages than the layer below it. The 13.2 m depth excludes the liner system, the cover cap thickness, and the 2 % slope of the final cover grade. The detailed design for the Integrated Disposal Facility liner is shown in Figure 1-5.

The permitted and the non-permitted cells are identical in design. The RCRA permitted cell is designed to accommodate four layers of ILAW waste packages separated vertically by 1 m of soil. Each cell contains multiple arrays of like packages spanning the length of the trench. The IDF cell design assumes a waste volume loading of 40% into the available trench volume (soil to waste ratio of 1.5 to 1) (Dehner 2004). The loading of waste into each IDF Cell is assumed to be in layers, called lifts. The planning lift thickness corresponds to the waste stack height (typically 2.3 m) and cover soil layer (typically 1 m). Waste packages with heights less than to slightly greater than 2.3 m (i.e., 2.4 m) would be accommodated into one lift. For example, WTP ILAW, Bulk Vitrification, and some solid waste packages (such as 208 L drums and typical waste boxes) can be accommodated in one lift. Spent melters and large solid waste packages would be accommodated in several lifts. The current planning is to locate spent melters in the buffer area of the cells. The waste loading plan for the IDF has not been finalized.

WAC (173-303-665) and EPA regulations (40 CFR 264) involve requirements for installing two or more liners and a leachate collection and removal system for a disposal trench (WAC, NRC and EPA 1987). Using the RMW burial trench design as an example, the bottom of the IDF will contain a primary and secondary flexible membrane liner (FML) made of a 60 mil nominal thick high-density polyethylene (HDPE) sheet (Figure 1-5).

The primary and secondary drainage gravel layers shown in Figure 1-5 are for the two drainage collection systems associated with the RCRA-compliant disposal facilities. A perforated collection pipe located under the primary gravel layer allows collected liquids to drain to a sump at either end of the trench for sampling and removal. Both the primary and secondary liners lie atop an admix layer. The admix layers are 0.5 m and 1 m thick, respectively. Admix consists of bentonite-enriched soil that is mixed, moisture conditioned, placed, compacted, and trimmed to form the soil liner before placing the FML. The secondary admix layer offers backup containment of contaminants in the unlikely event that the secondary liner fails catastrophically. The topmost layer at the bottom of each trench consists of an operations layer whose composition can be tailored to meet special needs. For example, the operations layer could contain soil mixed with crushed concrete to sequester uranium ions that might be released from the disposed-of waste. The first layer of waste packages is placed directly on the operations layer.

The tops of the packages must be at least 5 m below the surface of the trench (DOE/RL 1996). The liner, as depicted in Figure 1-4, extends well past the last package. A berm will be formed around the perimeter of the trench as part of the trench liner anchor system to prevent storm water from surrounding areas running into the trench. The berm will also provide shielding for above-trench operations.

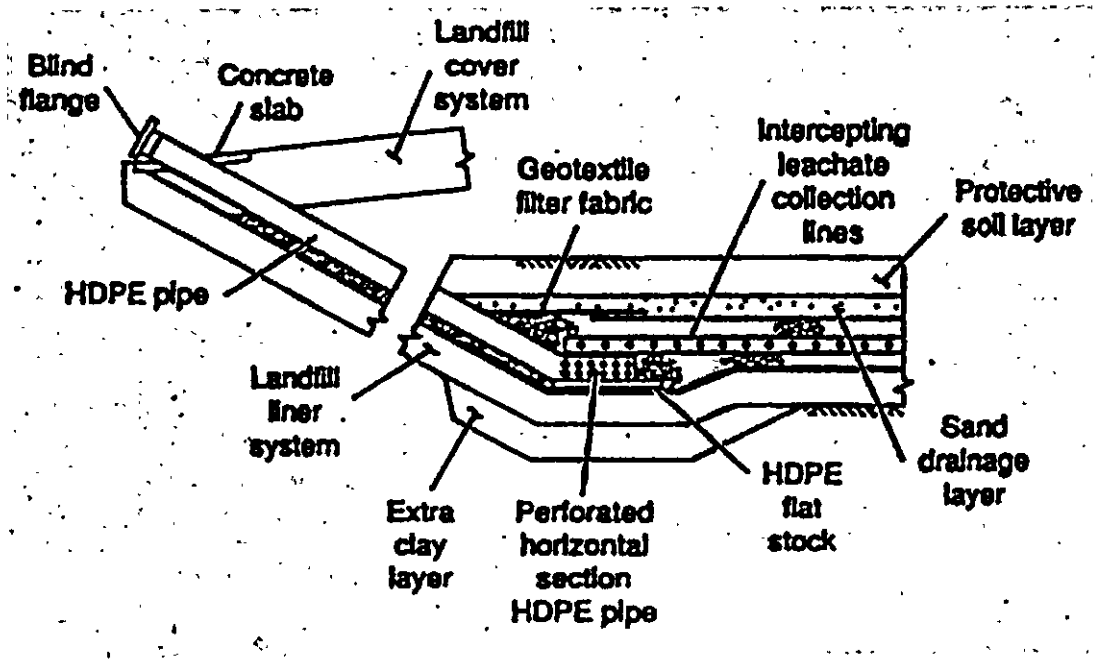
1.3.1.1 Leachate Collection System

Any water that might transgress the RCRA barrier either vertically or laterally will be trapped in the trench liner and leachate collection system. This system will ensure that water does not collect in the trench and create a "bathtub" effect, thus helping to prevent corrosion of the waste packages.

Figure 1-6 illustrates a typical leachate collection and removal system used in hazardous waste landfills (Kreith 1994). Perforated pipe, placed in each leachate collection channel, is used to convey the collected leachate to a sump located at the edge of the trench. The method shown for the removal of leachate from the sump involves using an inclined riser pipe located within the landfill. This method and other options will be evaluated thoroughly and appropriate design features incorporated during development of the IDF trench liner and barrier cover design.

Liquids entering the IDF sump will be detected by instrumentation. Leachate samples can be removed by lowering a sample collection device down the leachate riser. Leachate could be removed using a portable pump with a hose lowered down the riser pipe. The leachate will be pumped into a holding tank then transferred to the Effluent Treatment Facility for treatment and disposal. The leachate collection and removal system will continue to be operated until leachate is no longer detected (WAC 173-303-665, WAC 173-303-610, 40 CFR 264.310).

Figure 1-6. A Typical Leachate Collection System



1.3.2 Ancillary Facilities

The ancillary facilities will consist of groundwater monitoring wells. Operations support facilities may be determined to be necessary during the operations phase but are not planned at this time.

1.3.2.1 Groundwater Monitoring Wells

Groundwater monitoring wells for the IDF disposal site will be located around the IDF disposal site and will be integrated with the Hanford Groundwater Monitoring Network. The groundwater monitoring network will have six wells: one upgradient and five downgradient (Horton et al. 2000). The downgradient wells will be placed so as to sample groundwater passing the point of compliance. The point of compliance at the IDF site is a plane connecting the groundwater monitoring wells along the southern and eastern sides of the site in accordance with WAC 173-303-645 and the groundwater monitoring plan contained in the RCRA Part B Permit Application (DOE/RL 2003-12). The downgradient wells will be installed in a sequence coordinated with the construction of the IDF. The wells will be protected from tampering or damage by installing steel guard posts and a padlock and providing access control by Site Security.

1.3.2.2 Support Facility

If required, the support/operations facility is expected to be a single-story modular building. The support facility will contain office areas, a control room, a conference and training room, restrooms, and a lunchroom with kitchen facilities.

1.4 GENERAL CLOSURE APPROACH

The IDF will be closed as a landfill with the waste remaining in place. Site closure will include constructing a closure cover to minimize long-term intrusion or infiltration of water. The closure cover is a Modified RCRA Subtitle C barrier (DOE/RL 1996). The closure cover consists of a topsoil layer, a lateral drainage area, and a barrier layer. The closure cover provides a minimum of 5 m of soil cover above the surface of the top of the uppermost layer of packages and extends at least 6 m beyond the surface edge of the secondary trench liner. The modified RCRA barrier has a requirement to design the low-permeability layer of the cover to have a permeability less than or equal to any natural subsoils present. Additionally, it is required that "for frost protection, the lateral drainage layer and the low-permeability asphalt layer must be located at least 75 cm below final grade."

Groundwater samples will be taken regularly to verify that no radioactive or hazardous waste is leaching from the packages. All wells will be inspected regularly to ensure proper operation. The overall condition of each well will be checked during each groundwater sampling event. Items inspected include padlocks, well casing, guard posts, and pumps. A detailed well condition evaluation was performed in accordance with the Hanford Site Environmental Monitoring Plan (DOE/RL 1997). The evaluation concluded that the pre-existing wells were of no use to the project.

Leachate collection, sampling, and disposal activities will be initiated at the start of disposal in the landfill in accordance with RCRA requirements. The time allotted for post-closure care will vary depending on the findings during post-closure monitoring. The duration of monitoring will be assessed at each permit review and renewal.

1.5 CLOSURE SCHEDULE

The IDF Project encompasses the design and construction of the initial section (north end) of the IDF. This landfill will be available for waste disposal in 2006. Production of ILAW packages is expected at the rate of 30 MTG/day with a nominal production of 5 ILAW packages per day. Rate of receipt for other waste packages is not known at this time. Shipment of the WTP ILAW is scheduled to begin in 2010. Production of the ILAW is scheduled to be completed by 2028.

Design and construction of the second section of the IDF landfill is expected to begin in 2014; this expansion will be ready to accept waste in October 2016. Up to three expansions of the same size are expected to be needed to accommodate all waste designated for disposal in the IDF. The expandable landfill is expected to be closed and the closure cap installed after the completion of all waste disposal.

Disposal operations are expected to last for 30 years or more. Operations are contingent upon waste production from sources including WTP ILAW, Hanford cleanup activities (such as tank farms) and decontamination and decommissioning of the WTP. Operations are also contingent upon space availability in the IDF. Operations are tentatively expected to continue until 2030 when the retrieval of all tank waste and production of the last ILAW package is expected to be completed.

Closure activities will begin following receipt of the last waste in 2030. Post closure monitoring will be initiated when closure activities are complete, approximately 2032. Schedule dates are subject to change depending on waste receipts. Revised schedule information will be included in closure plan updates.

1.6 RELATED ACTIVITIES

This section discusses Site-specific regulatory context and documentation required for waste disposal. It also presents information on other programs, plans, and tasks being undertaken at Hanford that have a relationship with this closure plan. Studies regarding integration of the IDF closure activities with other 200 Area burial grounds have not been performed as of this closure plan revision but may be performed in the future. If so, the results from such studies will be incorporated in a future closure plan update.

Phase I Feasibility Study for the Canyon Disposition Initiative (221-U Facility) (DOE/RL-97-11), examined six alternatives for final disposition of the Hanford Site canyon buildings (the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, U Plant, the Reduction-Oxidation (REDOX) Plant, and T Plant). The alternatives, especially entombment, presented in the study were evaluated for potential impacts on the IDF and none were noted. The only plant of any concern was PUREX because of its proximity to the IDF site. However, the PUREX plant is far enough from the IDF site that even the largest potential burial mound presented in the study would not interfere with the IDF.

1.6.1 Regulatory Requirements

In the early 1990's the DOE petitioned the NRC for a ruling on the classification for the ILAW prepared from the RPP tank waste. The NRC has conditionally approved that the proposed RPP ILAW can be disposed of as incidental waste (Paperiello 1997) subject to the following conditions:

- The "waste has been processed (or will be further processed) to remove key radionuclides to the maximum extent technically and economically practical."
- The "waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C LLW as set out in 10 CFR [*Code of Federal Regulations*] Part 61."
- The solid, immobilized waste will be managed, pursuant to the *Atomic Energy Act of 1954*. This requirement ensures that the performance objectives equivalent to those set out in 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," are satisfied.

This NRC waste classification decision means that the disposal of the ILAW, as prepared from double-shell tanks and single-shell tanks (SST), would not be controlled by the HLW disposal licensing authority of the NRC. This classification also enables the RPP to plan to dispose of this ILAW in shallow land disposal facilities in accordance with DOE O 435.1, *Radioactive Waste Management.*

The federal and state regulations and requirements governing the handling, storage, and disposal of toxic or hazardous waste also must be followed. Because ILAW is classified as a hazardous waste, RCRA permitting must be obtained for the portion of the IDF in which the ILAW and MLLW is disposed (RCRA 1976). The IDF Part B permit application was submitted to the Washington State Department of Ecology (Ecology) in 2003 (*Hanford Federal Facility Agreement and Consent Order* [Tri-Party Agreement] milestone M-20-57). A final status RCRA Part B permit is expected in late calendar year 2004. There are no current plans for obtaining exemptions from RCRA for the permitted cell of the IDF. An exemption is not required for the non-RCRA permitted cell as it will not receive waste regulated under RCRA purview. Other LLW and MLLW are governed by DOE O 435.1. MLLW with hazardous constituents is regulated by RCRA requirements.

DOE facilities are not subject to NRC regulations and the NRC is not expected to have regulatory authority over the IDF at the Hanford Site in the future.

1.6.2 Performance Assessment, Composite Analysis, and Preliminary Monitoring Plan

The regulatory guidance and requirements strongly advocate an early start and an ongoing and thorough integration of the closure cap system design with that of the rest of the disposal facility system (Napolitano et al. 1994, DOE 1999a). The guidance and requirements also recommend that similar integration be performed between the overall disposal system design and the performance assessment (PA) work.

Design concepts and preliminary evaluations have been conducted to support selection of a reference concept for the closure cap system design in support of the PA work for the proposed disposal facility. The selected closure cap system uses a defense-in-depth design approach, yielding a multilayered barrier stacking system (see Section 2.2.4).

1.6.2.1 Performance Assessment

The PA examines the long-term environmental and human effects of the planned Hanford Site waste disposal to support DOE issuance of a disposal authorization statement as required by DOE O 435.1 and to support the RCRA Part B permit as required by Ecology. The 1998 version of the ILAW PA (Mann et al. 1998) was written using available data. DOE conditionally approved the ILAW PA (DOE 1999a) and issued a disposal authorization statement (Fiore and Frei 1999). As required by DOE (DOE O 435.1 and Mann 2000), the ILAW PA is being maintained. The first iteration (Mann et al. 2001) updates the 1998 ILAW PA by using site-, waste-form-, and facility-specific data (Mann and Puigh 2000). Important changes are the analysis of the IDF, improved groundwater calculations, and deterministic simulations of the degradation of the expected waste form. Section 3.1 compares the expected impacts with the performance objectives. The 2001 ILAW PA was unconditionally approved and a revised disposal authorization statement was issued (DOE 2001). The next full revision of the PA (which will include all wastes expected in the IDF) is expected in 2005. A less detailed risk assessment for the IDF (Mann et al 2003a) was part of the 2003 Annual Summary (Mann 2003b), which was approved by DOE (Frei 2003).

The IDF risk assessment (Mann 2003a) investigated the long-term impacts from the disposal of ILAW, associated melters, as well as other radioactive and mixed waste currently planed for the Hanford Site Solid Waste Burial Grounds. The impacts were less than the established performance objectives for the inventories projected for the IDF (Mann 2003b).

The ILAW trench concept design analyzed in Mann et al. (2001) was determined to be adequate to meet the overall performance needs of the proposed disposal facility. Mann et al. (2001) also determined that the performance of the ILAW trench is superior to the concrete vault concept of ILAW disposal. Both the remote-handled waste trench and the concrete vaults would meet the performance objectives of the ILAW performance assessment. However, degraded concrete will significantly increase the pH of the water in contact with the glass waste forms, resulting in a faster contaminant release rate (Mann et al. 2000). The vault scenario increases the waste concentration, producing larger contaminant concentrations in groundwater.

The 1998 ILAW PA modeled the effects of the naturally occurring recharge rate into the disposal facility at 3 mm per year. Work at the Hanford Site supported by field lysimeter tests (Fayer et al. 1999) shows that a Modified RCRA Subtitle C barrier or one of similar design would meet the performance needs of the proposed disposal facility. Because the cover systems evaluated performed much better than the design goal of 0.5 mm/year, a recharge rate of 0.1 mm/year was proposed in Fayer et al. (1999) and utilized for the 2001 update of the PA. The PA also concluded that a sand-gravel capillary break-barrier, which currently is part of the planned closure design, would provide significantly improved disposal system performance at a low cost.

The capillary break-barrier consists of a layer of sand on top of a layer of gravel. In an unsaturated system, the capillary pressures are much less than atmospheric pressure. For significant quantities of water to flow into and through the coarser sublayers, the water pressure must be raised to nearly atmospheric pressure. Thus, the overlying fine soils must become nearly saturated for water pressure to approach atmospheric pressure and allow water to flow into the sublayers. Keeping the water in the fine-texture layer provides time for evaporation and transpiration to remove it. (Wing 1994).

The sloping sides of the IDF are lined with geotextile fabric that will impede lateral flow of moisture into the trench. The barrier cap extends a few meters beyond the outer edges of the trench, further hindering moisture migration. Potential modifications to layer dimensions and barrier components will be evaluated by the ongoing PA work (Mann et al. 2001).

1.6.2.2 Composite Analysis

The *Composite Analysis for the Low-Level Waste Disposal in the 200 Areas of the Hanford Site* (Kincaid et al. 1998) deals with the environmental impact from all waste that will be disposed of in the Central Plateau of the Hanford Site at the time of site closure. The composite analysis (CA) was approved (Fiore and Frei 1999). It is a companion analysis to PAs for active and planned waste disposal and remedial investigations and feasibility studies for remediation sites. Subject to some limitations of available waste inventory data, this was a preliminary analysis to discover the long-term effects to an offsite individual from all waste present at the Hanford Site at the time of site closure. Plans are for the CA to be updated and submitted to DOE in the summer of 2005.

For the CA, the offsite individual resided outside the exclusive waste management area and buffer zone as defined by the Hanford Future Site Uses Working Group (HFSUWG 1992). This buffer zone is about 1 km from the present 200 Area fences. The analysis considered a 1,500-year period and reached the following conclusions:

- Significant releases from the liquid discharge sites, tank leaks, losses from tanks during tank waste recovery operations, and pre-1988 solid waste burial grounds have occurred or could occur before site closure and would be significantly separated in time from any releases from the active or planned disposal. That is, contaminants from active and planned disposal should not contact groundwater for at least 1,000 years, whereas the releases from operations already have reached groundwater or will reach groundwater in the next few hundred years.

- Peak all-pathways dose to the maximally exposed individual outside the buffer zone after site closure (assumed in 2050) was less than 6 mrem in a year. Despite high uncertainty in the inventories of past liquid discharges, tank leaks, tank losses, and pre-1988 burial grounds, this analysis indicated dose outside the buffer zone would not exceed the dose limit of 30 mrem in a year.

- Peak dose rates are highest now and will decline with time. The dose rates are still associated with remnants of the existing plumes at the time of site closure. Releases from liquid discharges, tank leaks, tank losses, and pre-1988 burial grounds will

continue to enter the aquifer over the next few decades, but in general, the rate of nuclide mass releasing to the aquifer will decline from now until site closure and continue to decline.

- No releases from the RPP ILAW disposal facility are seen during the DOE regulatory period of 1,000 years or the full 1,500 years analyzed.

Future iterations of the CA (the next one being planned for 2005) will be based on a more fully consistent inventory for all post-closure waste sites including canyon buildings and associated facilities including permanent filters and the PUREX tunnels.

1.6.2.3 Preliminary Monitoring Plan

Section IV.R(3) of the manual for DOE O 435.1 requires that an environmental monitoring plan be prepared. Currently, a Sitewide monitoring plan (DOE/RL 1997) exists for the Hanford Site, a preoperational monitoring plan was approved for ILAW RH facility, and a preoperational monitoring plan is being drafted specifically for the IDF site. The IDF project will use the results of the Sitewide monitoring program and the forthcoming IDF preoperational monitoring plan to determine the adequacy of groundwater models. In addition, the IDF preoperational monitoring plan provides a program to characterize and establish an environmental baseline for the IDF site. The plan will focus on characterizing the surface and near surface vadose zone, and on data collection supporting the development of the preoperational baseline.

1.6.3 RCRA Requirements Including Permit Conditions

The RPP tank waste contains listed hazardous waste and falls under the jurisdiction of RCRA. Unless such waste is treated to the point where it no longer is considered hazardous and is "delisted" (formally removed from regulation), the RCRA requirements (40 CFR 260-268) apply. In Washington State, these federal regulations regarding waste handling and disposal are administered by Ecology under *Washington Administrative Code* (WAC) 173-303.

Compliance with final status permit conditions that regulate operational activities such as groundwater monitoring and waste disposal inventory control is required to proceed with certification of closure and obtaining post closure permits. Future revisions of this closure plan will present detailed discussion of the interface between the closure plan and the other permitting requirements (including a WAC 246-247 Washington State issued air quality permit).

1.6.4 Relevant Agreements

The Tri-Party Agreement (Ecology et al. 1996) is an agreement between DOE, the EPA, and Ecology concerning the cleanup of the Hanford Site. Tri-Party Agreement milestones M-90-08 through M-90-10 and M-20-57 all are legally enforceable and pertain to the ILAW program. The following are the Tri-Party Agreement milestones for IDF and the ILAW program:

Table 1-2. Tri-Party Agreement milestones for IDF and the ILAW program

Milestone	Milestone Description	Milestone Status
M-20-57	Submit ILAW Disposal Facility Certified Part B Permit Application to Ecology – 6/30/03.	Completed
M-90-08	Initiate ILAW Disposal Facility Construction. Initiation of Construction Occurs When DOE or Its Contractor (as Authorized) Issues an Approval to Start Construction and the Contractor Commences Excavation of Non-Critical Systems Within the RCRA Disposal Facility – 2/28/05.	Completed
M-90-09-T01	Complete Detailed Design of ILAW Disposal Facility Critical Systems to 80 %. Detailed Design of Critical Systems Includes the a) Liner, b) Leachate Collection System and c) Leak Detection System – 5/30/03.	Completed
M-90-10	Ready to Accept Placement of ILAW Waste in ILAW Disposal Facility. (Low Activity Waste Packages Placed Within These Facilities Will Be Retrievable) – 8/31/08.	On Schedule

1.6.5 Planned or Completed National Environmental Policy Act of 1969 Documentation

The IDF trench is a concept for a near-surface disposal unit. Existing *National Environmental Policy Act of 1969* (NEPA) documentation provides a Record of Decision (ROD) for the *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement* (DOE 2004) to allow storage, treatment, and disposal of LLW and MLLW generated at Hanford and other sites and disposal of vitrified immobilized low-activity waste and melters from the vitrification project. The ROD also specifies DOE will construct and operate a lined, combined-use disposal facility.

1.6.6 Safety Analysis Report

Effective quality and environmental safety and health protection programs will be established and maintained to ensure compliance with DOE requirements in all areas of onsite supplemental technology, melter and ILAW transportation and IDF trench design, construction, and operation.

The documented safety analysis, when completed, may impose various requirements on the operation of the facility. If these requirements also affect closure, they will be covered in a future closure plan revision.

1.6.7 Groundwater Protection Management Plan

Pacific Northwest National Laboratory (PNNL) has prepared an *Integrated Monitoring Plan for the Hanford Groundwater Monitoring Project* (Hartman et al. 1999) for the DOE. The IDF monitoring wells (Horton et al. 2000) will become a part of the 200 East Area groundwater monitoring effort and, as such, will be monitored under the Hanford Site monitoring plan.

The Central Plateau Remediation Project contractor is responsible for integrating sitewide groundwater and vadose zone evaluations, so environmental restoration is an essential component to this plan as it relates to vadose zone issues. In conjunction with the Office of External Affairs (OEA), the Central Plateau Remediation Project contractor is responsible for managing all communications regarding Site projects and public involvement activities that affect the vadose zone or groundwater. OEA in turn will involve the ORP Public Involvement Manager and ORP contractor support staff when their participation on vadose zone-groundwater public involvement activities is required.

The overriding theme of the RPP is that treatment and disposal of the Hanford Site's tank waste will provide the greatest protection for human health and the environment (DOE and Ecology 1996). In addition, recent confirmatory evidence (Hartman et al. 2003) of past tank leakage affecting the groundwater reinforces the need to remove pumpable liquids from SSTs as soon as possible and retrieve waste from the tanks and convert it to a form that will not pose further threats to human health and the environment. This waste removal effort, known as interim stabilization, was completed in 2004.

1.7 SUMMARY OF KEY ASSUMPTIONS

The assumptions listed in this section relate in part to the provisional status of the classification of Hanford Site tank waste by the NRC and the ILAW regulation by RCRA. Other assumptions are based on tank waste inventory determination and characterization, and ILAW specifications including waste loading.

1.7.1 Regulatory Classification Status of Hanford Tank Wastes

It is assumed that the NRC will continue to classify the ILAW as incidental waste. This is based on a conditional agreement that the LAW portion of the Hanford Site tank waste will not be subject to NRC licensing authority (NRC 1997), as discussed in Section 1.6.1.

Under the current EPA "mixture" and "derived-from" rules, the ILAW would continue to be managed as a RCRA-regulated mixed (hazardous and radioactive) waste because it is derived from tank waste that contains listed and other hazardous constituents. The vitrification process results in a product that complies with the land disposal restrictions. The IDF meets the requirements of a RCRA Class I hazardous waste landfill, including double liners, leachate collection systems, leak detection, and closure and post-closure monitoring systems. This is reflected in Tri-Party Agreement milestone M-20-57, "Submit ILAW Disposal Facility Part B Application to Ecology by June 30, 2003", which has been completed.

1.7.2 Waste Volumes

MLLW and LLW are expected in approximately equal quantities of 450,000 m^3, the full IDF build out capacity is 900,000m^3. Approximately 70-80% of the MLLW will be vitrified, and the remaining 20-30% other MLLW from cleanup activities. The LLW is expected to be roughly 80% category 1, and 20% greater than category 1 by volume. Initial construction of the IDF will accommodate 38,250 m^3 ILAW containers, 44,000 m^3 MLLW, and 81,000 m^3 LLW. The IDF total phase 1 capacity is 163,000 m^3. Waste volumes will be updated in future revisions to the closure plan.

2.0 DISPOSAL FACILITY CHARACTERISTICS

This section presents information on the Hanford Site, especially the area surrounding the IDF. For additional information on site characteristics the reader should refer to the *Geologic Data Package for 2005 Integrated Disposal Facility Waste Performance Assessment* (Reidel 2004) where this topic is discussed in greater detail. The facility characteristics section includes a detailed description of the cover barrier selected for the IDF trench and emphasizes those features important for the long-term performance of the disposal system. Section 2.3 describes the waste characteristics, provides data on their inventory, and helps to form a basis for understanding the approach to closure of the disposal facility.

2.1 SITE CHARACTERISTICS

This section describes the regional and local environment in which the IDF will be located. The following sections describe the disposal site, along with the climatological, geological, and geographical conditions of the 200 Area plateau.

2.1.1 Geography and Demography

Extensive research has been done on the Hanford Site geography. However, this section will cover only the characteristics that will be used to model the IDF's long-term performance. More complete descriptions will be referenced whenever applicable.

2.1.1.1 Disposal Site Location

The Hanford Site is an area of approximately 1450 km^2 located in south-central Washington State. The site for the IDF is located on the Hanford Central Plateau in the 200 East Area within the Hanford Site boundary shown in Figure 2-1. The location of the disposal site relative to the 200 East Area is shown in Figure 2-2.

The Hanford Central Plateau is approximately 198 m to 229 m above mean sea level. The major features of regional geography are the nearby rivers (Columbia and Yakima) and mountains (Saddle Mountains and Umtanum to the north, Cascade Mountains to the west, Yakima Ridge to the southwest, and Rattlesnake Ridge to the south). The Columbia River, which forms the eastern boundary of the developed areas of the Hanford Site, is an important source of water and hydroelectric power for the region. Other important rivers near the Hanford Site are the Yakima River to the southwest and the Snake River to the east. The Cascade Mountains, which are about 160 km (100 mi.) to the west, have an important influence on the climate of the area in their rain shadow, which includes the Hanford Site.

Figure 2-1. 200 East Area Relative to the Hanford Site and Washington State.

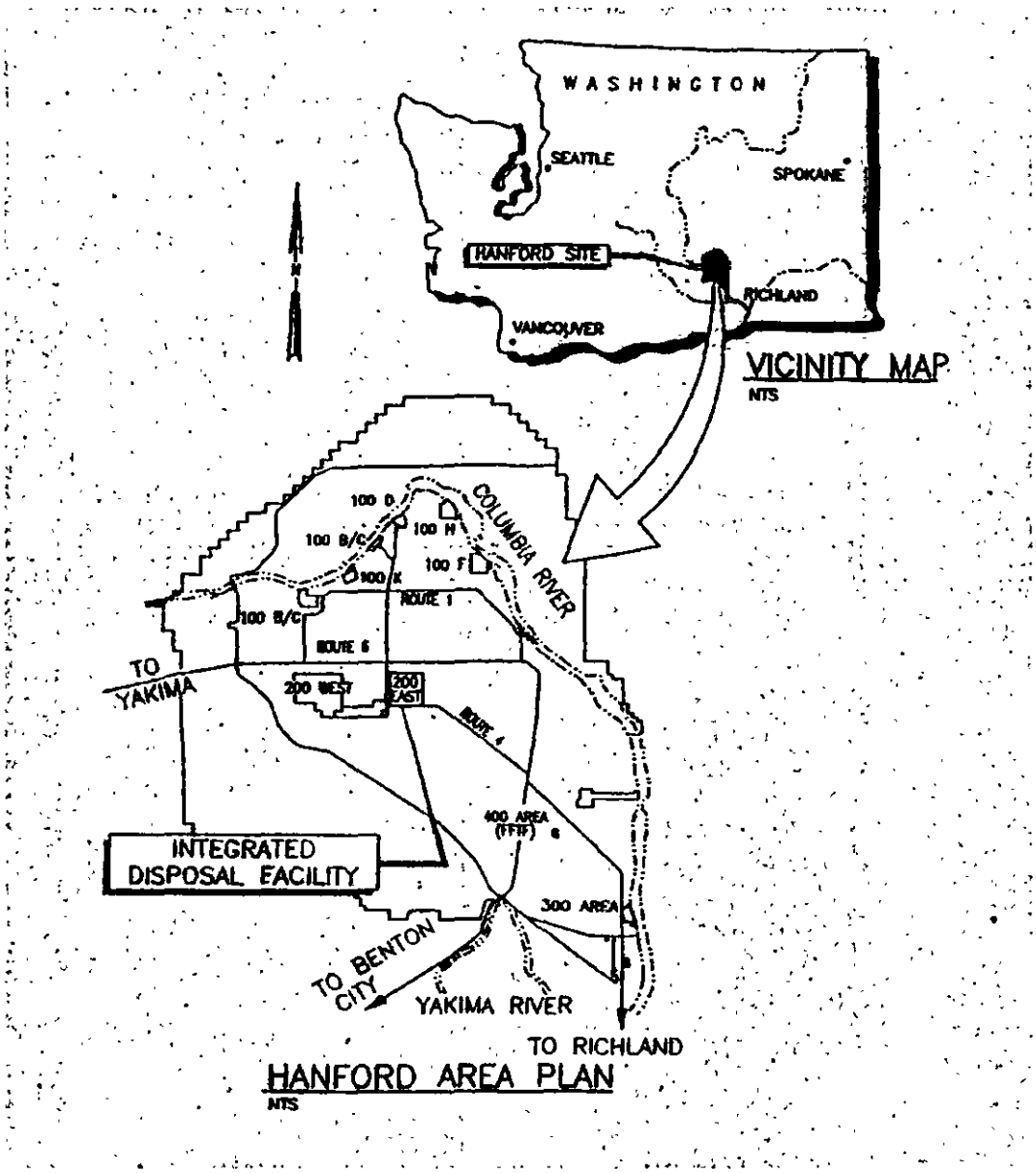
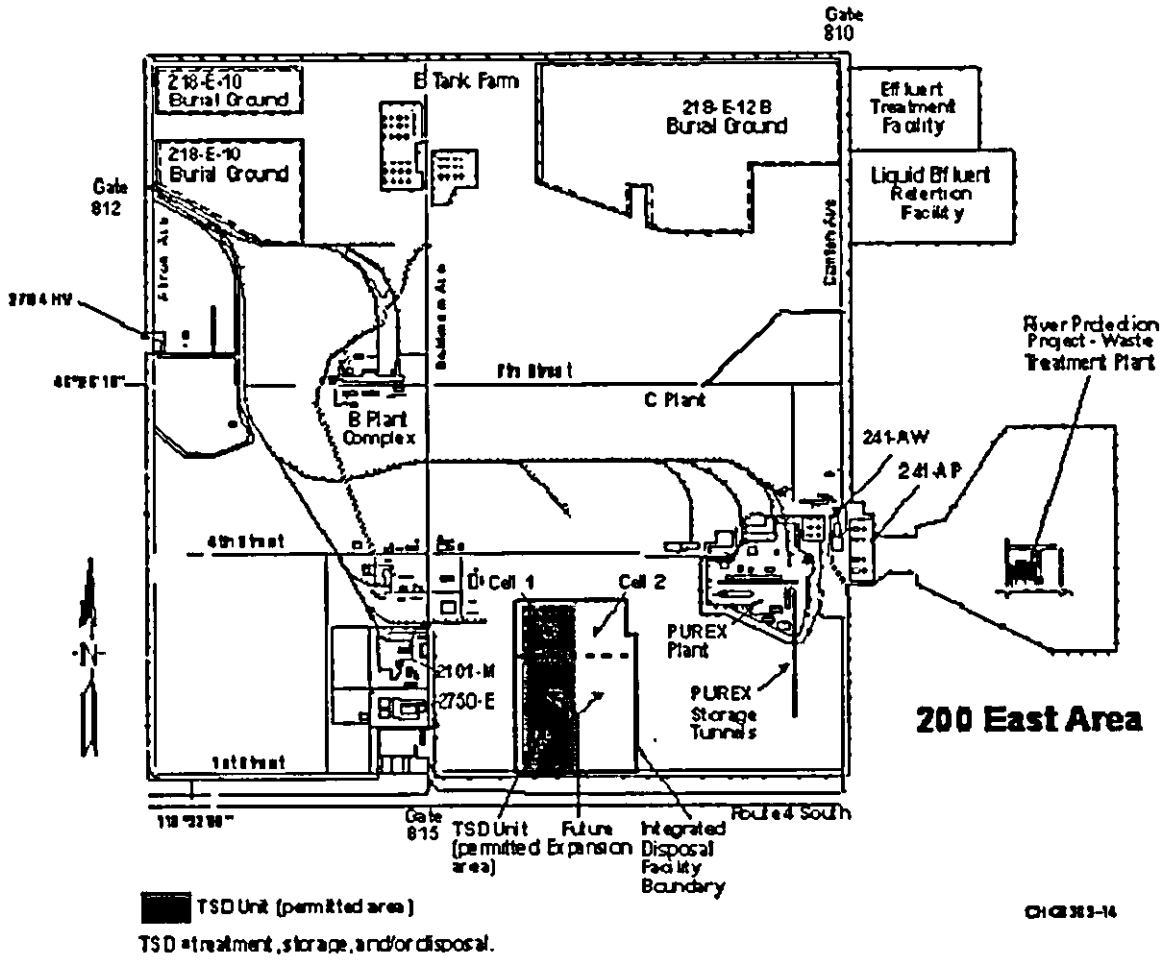


Figure 2-2. IDF Location within the 200 East Area.



2.1.1.2 Disposal Site Description

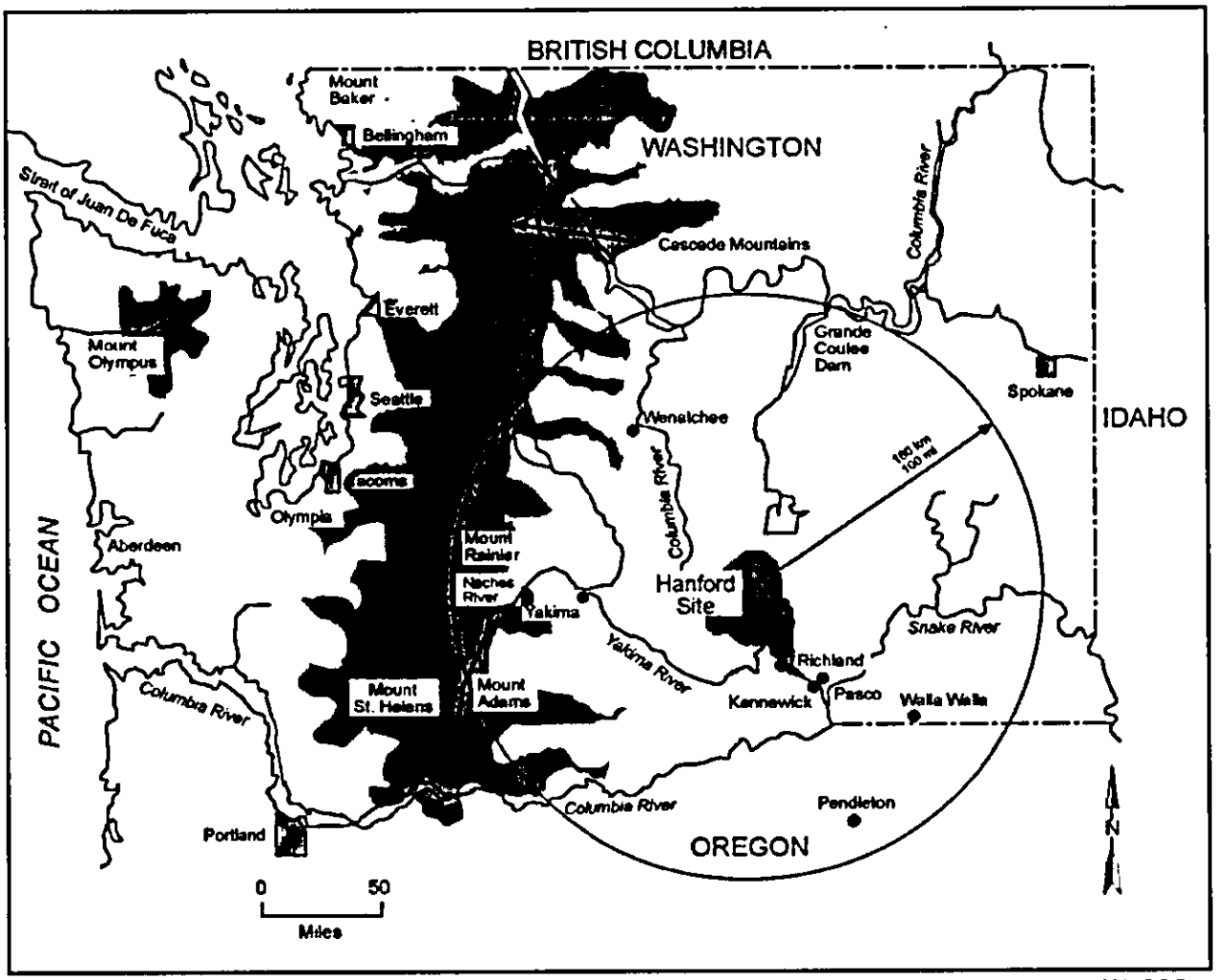
The site selected for the IDF is on a plateau in the southeastern quadrant of the 200 East Area and is shown in Figure 2-2. The DOE has approved the choice of this site for ILAW disposal (Rutherford 1997). The Solid Waste Program Environmental Impact Statement (DOE/EIS-0286D, 2003) identified IDF as the preferred alternative and was approved in the ROD (DOE 2004). The selected disposal site consists of approximately 36.4 ha of vacant and uncontaminated land located just southwest of the PUREX facility (Shord 1995 and Reidel 1997). The IDF will provide an expandable disposal trench for MLLW and LLW. The shaded area (cell 1) indicates the TSD area is for the disposal of MLLW. The bold perimeter indicates the IDF Boundary. The rectangular area on the east half of the expandable trench (cell 2) will be used for LLW disposal.

2.1.1.3 Demography

Figure 2-3 shows the Hanford Site location within Washington State and its relationship to the northern border region of Oregon State. It also identifies the major cities in the region; Seattle, Portland, and Spokane, each of which is over 160 km from the Hanford Site.

In general, the Hanford Site is more than 160 km from any major city (e.g., a city with more than 100,000 inhabitants). The Site is surrounded by a rural-type population distribution associated mostly with agricultural activities. The Tri-Cities (Kennewick, Pasco, and Richland), less than 40 km from the Site, are the nearest communities of significant size (e.g., more than 20,000 inhabitants). These three cities are grouped together along the Columbia River a few miles downstream of the Site to the southeast of the Site boundary. Several smaller communities lie within 80 km of the Site though none constitute more than 20,000 inhabitants.

Figure 2-3. Major Population Centers Surrounding the Hanford Site.



2.1.1.4 Uses of Adjacent Lands

In 1992, the Hanford Future Site Uses Working Group (HFSUWG) was charged with determining potential future uses of the various parts of the Hanford Site. This group consisted of local, state, and federal officials, representatives of affected Indian tribes and agricultural and labor organizations, as well as members of environmental and other special interest groups. The efforts of the HFSUWG form the basis of the Hanford Site Comprehensive Land-Use Plan Environmental Impact Statements (DOE 1999b).

The 200 East Area is presently classified as "Industrial-Exclusive" (DOE 1999b). This land-use designation would preserve DOE control of the existing compatible infrastructure required to support activities such as dangerous waste, radioactive waste, and waste treatment, storage, and disposal facilities. If the Industrial-Exclusive use designation is maintained, records of past activities (particularly the disposal of nuclear materials) are likely to be kept. In addition, in an industrial area, liquid discharges to the ground would be highly regulated and kept small.

The Central Plateau and the Horse Heaven Hills, south of the Hanford Site, are near, but at a significantly higher elevation than the Columbia River. Although the amount of irrigation is increasing at certain locations, comparatively little irrigation occurs in the Horse Heaven Hills because of the relatively high energy cost of bringing water to the surface. Dry-land farming continues to be the main use for the land in the Horse Heaven Hills.

East of the Central Plateau, across the Columbia River, irrigated farming is extremely common. The water, however, does not come from the nearby stretches of the Columbia River. The water comes from the Columbia Basin Project, which derives its water from the Grand Coulee Dam, over 322 km (200 mi.) upstream of the Hanford Site. The water is gravity-fed to the farms. The regional geography makes such a water delivery system unlikely for the Central Plateau.

The area south of the Central Plateau is a combination of residential, commercial, and industrial zones. Agriculture is practiced on the north side of the Waluke Slope. Finally, west of the Plateau is the Fitzner/Eberhardt Arid Lands Ecology Reserve, a nature preserve.

2.1.1.4.1 Hanford Reach National Monument

The Hanford Reach National Monument is located in south-central Washington State along the Columbia River. It encompasses approximately 81,000 ha (200,000 acres) of public land within the borders of DOE's Hanford Site. The monument, whose lands have been or are being cleaned up to meet EPA and State requirements, acts as a buffer around a portion of the Hanford Site.

Because the 200 East Area is located outside the area which a portion has been designated a national monument, and because the IDF is located within the 200 East Area, the national monument designation has no effect on the IDF.

2.1.1.5 Socioeconomics

The major employers in the Tri-Cities area since 1970 have been the DOE and the Hanford Site contractors; Energy Northwest (formerly the Washington Public Power Supply System), which operates a nuclear power plant; farms; and a large food processing industry; plus several smaller industrial operations. Other than DOE activities, agriculture and food processing are the dominant industries. The socioeconomics of the area surrounding the Hanford Site are described more fully in Nietzel (2000-2).

The land use around the Hanford Site varies from urban to rural. Most of the land south of the Site is urban, including the Tri-Cities, while much of the land to the north and east is irrigated cropland. Most of the irrigation water comes from the Bureau of Reclamation's Columbia Basin Project, which uses the water behind Grand Coulee Dam as the primary water source. The land to the west of the Hanford Site is used for irrigated agriculture near the Yakima River and dry-land farming at the higher elevations.

The area rivers are used primarily as sources of irrigation and drinking water, as major sources of power production for the western United States, as primary salmon spawning grounds as well as for recreation. Recent designation of a portion of the Hanford Site as a national monument will have no effect on the proposed IDF.

2.1.2 Meteorology and Climatology

The following paragraphs briefly describe this topic. Detailed information on the Hanford Site's climate is available in *Hanford Site National Environmental Policy Act (NEPA) Characterization,* PNNL-64415, Rev. 12, Section 4.1 (Neitzel 2000-1). The IDF design requirements mandate that the disposal facility design must be capable of operating at or near the temperatures and conditions provided by the Hanford Meteorological Station (HMS).

Long-term stability of the disposed-of waste could be affected by wind or water erosion of the IDF trench barriers. Regional precipitation, temperatures, wind, and relative humidity conditions that will need to be considered in the closure design are described in Sections 2.1.2.1 through 2.1.2.4.

2.1.2.1 Precipitation

Precipitation is one of the most important weather characteristics that must be recognized in siting and designing the IDF. The Hanford Site sits within the Pasco Basin, which is characterized as a semi-arid region because of its low annual precipitation levels. Between 1946 and 1998, annual precipitation at the HMS averaged 16 cm (6.3 in.) and varied between 7.6 cm and 31.3 cm. The wettest season on record was the winter of 1996-1997 with 141 mm (5.4 in.) of precipitation; the driest season was the summer of 1973 when only 1 mm (0.03 in.) of precipitation was measured. Most precipitation occurs during the winter, with more than half of the annual amount occurring from November through February. Days with more than 13 mm (0.5 in.) precipitation occur on average less than once each year. Rainfall intensities of 13 mm/h (0.5 in./hr) persisting for 1 hour are expected once every 10 years. Rainfall intensities of 25 mm/h (1 in./hr) for 1 hour are expected only once every 500 years.

About 38 % of the precipitation during December through February falls as snow. Winter monthly average snowfall ranges from 0.8 cm (0.3 in.) in March to 13.5 cm (5.3 in.) in January. Only one winter in four is expected to accumulate as much as 15 cm (5.9 in.) of snow on the ground. During these winters, four days, on average, have 15.2 cm (6.0 in.) or more of snow on the ground. However, the 1964-1965 winter had 35 days with snow on the ground, 32 of which were consecutive. That winter also provided one of the deepest accumulations, with 31 cm (12 in.) of snow occurring in December 1964. The record accumulation of snow is 62.2 cm (24.5 in.) in February 1916.

2.1.2.2 Temperature

Temperature is another important weather characteristic that must be recognized in designing and closing the IDF. Atmospheric temperature directly affects evapotranspiration that is a factor in determining the amount of precipitation that infiltrates into the IDF barrier layers. The temperature conditions for the Hanford Site and the 200 Area Plateau range from extremely cold during the winter months to extremely warm during the summer months. This can result in local temperatures of below -18°C (0°F), during some winter months, especially at night. During some summer months, the temperature during the day can exceed 40°C (104°F). Characterization of the HMS temperature records are as follows (Ashworth and Burbank 1998):

> "The mean surface air temperature averages approximately 12°C (53°F) at the HMS. July tends to be the warmest month of the year with temperatures averaging 25 and 33 °C (61 and 92 °F) respectively. The highest temperature ever recorded on the Site is 46 °C (115 °F). January is the coolest month of the year with an average temperature of -2 °C (29 °F). The lowest temperature ever recorded on the Site was -33 °C (-27 °F)."

2.1.2.3 Wind

The wind conditions are another Site weather characteristic that must be considered in designing and closing the IDF. The wind conditions can vary considerably on the 200 Area Plateau throughout the year. The monthly average is about 10 km/h (6 mi/h) during the winter and 15 km/h (9 mi/h) during the summer. Wind speeds at specific times, especially during summer storm activity, can reach many times this average level. The greatest peak gust was 130 km/h (81 mi/h), recorded at 15 m above ground at the Hanford Meteorological Station. Extrapolations based on 35 years of observation indicate a return period of about 200 years for a peak gust in excess of 145 km/h (90 mi/h) at 15 m above ground level (Mann et al. 2001). Erosion by wind action also is a potential degradation that the disposal facility design work must address.

2.1.2.4 Relative Humidity

The seasonal variation in the relative humidity is considerable according to the records of the HMS. This weather characteristic is one that must be recognized in designing the barrier system for the IDF. Like temperature, humidity has a direct effect on the evapotranspiration rate and therefore indirectly has a bearing on the moisture-recharge rate. The Ashworth and Burbank (1998) characterization of these relative humidity records as follows:

"The annual mean relative humidity recorded at the HMS is approximately 54 % with the highest monthly average relative humidity (80 %) occurring in December and lowest average monthly relative humidity (32 %) occurring in July. Daily relative humidity can change 20 to 30 % between early morning and late afternoon, except in the winter months when the changes are less pronounced."

2.1.3 Ecology

This section summarizes the ecology of the Hanford Site, emphasizing plant and animal activities that may affect exposure pathways. The primary impact would be through roots penetrating and animals burrowing through barriers into a disposal facility. Secondarily, the types of plants and animals and their density can affect net groundwater recharge, which is greatly influenced by surface vegetation and burrowing. Neitzel (2000-2) details both the terrestrial and aquatic ecology of the Hanford Site and presents extensive listings of plant and animal species. This section considers only terrestrial ecological effects because the proposed immobilized low-activity tank waste disposal facility sites are not located near significant aquatic ecological systems.

The Hanford Site consists of mostly undeveloped land. Only about 6 % of the Site is occupied by chemical processing facilities, shut-down nuclear reactors, and supporting facilities. Most of the Hanford Site has not experienced tillage or agricultural grazing since the early 1940's.

The Hanford Site is characterized as a shrub-steppe environment. This environment contains numerous plant and animal species adapted to the region's semiarid climate. Because of the aridity and low water-holding capacity of the soils, the productivity of both plants and animals is relatively low.

2.1.3.1 Flora

The dominant plants on the Hanford Site have changed over time. In the early 1800's, before settlement and agricultural activities, the dominant plants were big sagebrush and an understory consisting of perennial Sandberg's bluegrass and bluebunch wheatgrass. Agriculture opened the area to invasion by alien plants, predominantly cheatgrass. The plant community at the IDF site is shrub-steppe dominated by big sagebrush, Sandberg's bluegrass, and cheatgrass. Root penetration to depths of over 3 m has not been demonstrated in the 200 Areas. Rabbit brush roots have been found only at a depth of 2.4 m (8 ft) near the 200 Areas.

2.1.3.2 Fauna

A variety of birds and mammals inhabit the Hanford Site. Wildlife species observed at the IDF site include mule deer, black-tailed jackrabbits, cottontail rabbits, coyotes, side-blotched lizards, gopher snakes, sage sparrows, shrikes, meadowlarks, and horned larks.

2.1.4 Geology

The physical geology of the 200 East Area, along with much of the Hanford Site, is a layered structure. The geologic structure is composed of multiple layers of sediments, which range from sand, silt, volcanic ash, and clay to coarse gravels and cobbles and conglomerates that overlay

thick layers of basaltic lava. The layers of sediments often are heterogeneous in their composition and discontinuous in their physical structure. Some of these sediment layers were deposited during glacier-age floods thousands of years ago. The geology of the near-surface region typically has been modified by the weather, especially the wind; dune and sheet sands cover much of the area.

2.1.4.1 Regional and Site-Specific Geology and Topography

The IDF is on the Hanford Central Plateau, a Pleistocene flood bar most commonly referred to as the 200 Areas Plateau, near the center of the Hanford Site. The Hanford Central Plateau is approximately 198 m (650 ft) to 229 m (750 ft) above mean sea level. The plateau decreases in elevation to the north, northwest, and east toward the Columbia River. It also decreases to the south, although not as abruptly as it does to the east. The plateau escarpments have elevation changes of 15 to 30 m (50 to 100 ft).

2.1.4.1.1 Site Geologic History

The Hanford Site is situated within the Pasco Basin of south-central Washington State. The Pasco Basin is one of many topographic depressions located within the Columbia Intermontane Province, a broad basin located between the Cascade Range and the Rocky Mountains. The sediment package of the Pasco Basin consists of a relatively thick sequence of fluvial, lacustrine, and glacio-fluvial sediments over the past several million years. The Columbia Intermontane Province is the product of Miocene continental flood, basalt volcanism, and regional deformation that occurred over the past 17.5 million years. The Pasco Basin is bounded on the north by the Saddle Mountains; on the west by the Hog Ranch-Nanen Ridge anticline; on the south by Rattlesnake Mountain and the Horse Heaven Hills; and on the east by the Palouse Slope.

The physical geography of the Hanford Site is dominated by the low-relief plains of the Pasco Basin and anticlinal ridges of the Yakima Folds physiographic region. The surface topography of the Hanford Site is the result of the following events:

- Uplift of anticlinal ridges
- Pleistocene cataclysmic flooding
- Holocene eolian activity.

Uplift of the ridges began in the Miocene epoch (starting about 17 million years ago) and continues to the present. This uplift is occurring on geologic time scales (i.e., over tens of millions of years). The uplift is not incorporated into the conceptual model of the IDF, which addresses a time scale of tens of thousands of years (Mann et al. 2001).

2.1.4.1.2 Flooding

Glacier-related flooding has had a major impact on the physical geography of the region. Cataclysmic flooding occurred when ice dams in western Montana and northern Idaho were breached, allowing large volumes of water to spill across eastern and central Washington. The last major flood occurred about 13,000 years ago, during the late Pleistocene epoch. Interconnected flood channels, giant current ripples, and giant floor bars are among the landforms created by the floods. These formations resulted in heterogeneous and discontinuous

characteristics for sediments ranging in size from silts to coarse gravels. These sediments yield a wide range of vadose zone hydraulic properties.

2.1.4.1.3 Landslides

Landslides have had a limited effect on the Hanford Site's geography. Previous landslide activity in the area is generally limited to the White Bluffs area east of the Hanford Site and the Rattlesnake Hills south of the Site. No landslide activity is observed in the Hanford Central Plateau.

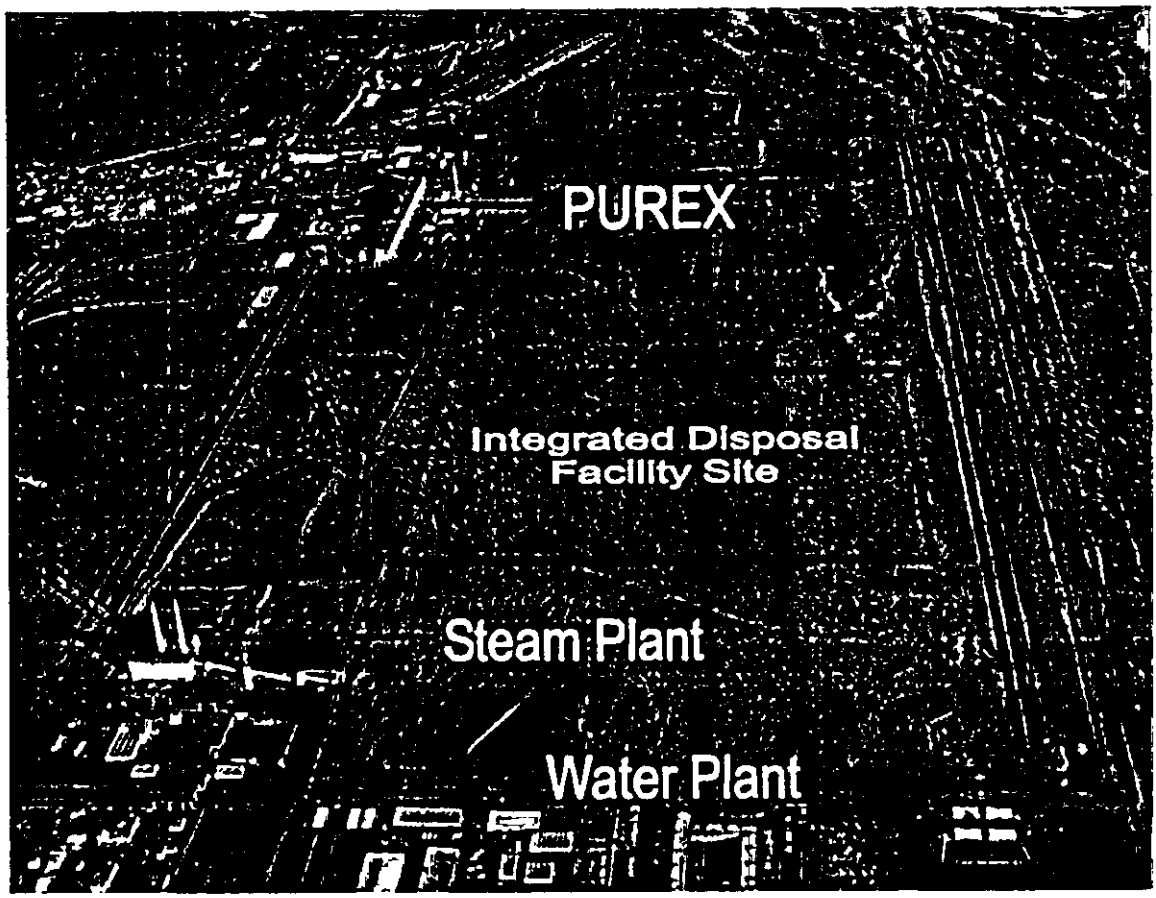
2.1.4.1.4 Sand Dune Activity

The location of the Hanford Site in an intermontane basin helps maintain a semiarid climate with low recharge. Eolian activity at the Hanford Site is relevant in evaluating the disposal facility because winds can cause erosion and create sand dunes and indirectly affect the rate of percolation of water into the IDF trench (Fayer et al. 1999).

The IDF lies along the northern margin of a giant dune field. The existence and characteristics of the dune field appear to be controlled by wind moving from west to east, down the adjacent Dry Creek and Cold Creek valleys and across the expansive Hanford Site plains toward the Columbia River. A long, stabilized dune lying in an east-west direction can be seen along the southern border of the IDF Site north of Route 4S (Figure 2-4).

The history of sand dune development in this area dates back to the last cataclysmic flood (approximately 13,000 years ago). During the Holocene Epoch (the last 11,000 years), winds have locally reworked the flood sediments. It has been estimated that sand transport was most active earlier than 4,400 years ago and the dunes stabilized thereafter. Most sand dunes on the Hanford Site are located southeast of the 200 East Area and are stabilized by vegetation. However, they have been reactivated where vegetation has been disturbed, by fire or other activity.

Figure 2-4. Aerial View of the Integrated Disposal Facility Site.



(The viewing direction is east. The 200 East Area Coal Power Plant and Water Purification Plant are in the left foreground).

The closest point of active dune formation to the IDF Site is approximately 3 km south of this area. Its location approximately downwind of the new disposal site, coupled with the planned closure cap vegetation layer, suggests that wind will have an insignificant effect on the percolation of water into the IDF in the future.

2.1.4.2 Seismology

The disposal site is in a relatively quiet seismic region. The past seismic history of the Hanford Site and surrounding area has been quite extensively characterized as part of previous Hanford Site program activities. The DOE has had a seismic monitoring network operating in and around the Site since 1969. The design basis ground motion used for design will be obtained from the latest revision of TFC-ENG-STD-06, "*Design Loads for Tank Farm Facilities*".

2.1.4.3 Volcanic Activity

The Cascade Mountain range contains the only volcanoes in the region. The nearest of these is Mount Adams, approximately 160 km (100 mi.) away. The most active of these nearby volcanoes in recent times has been Mount St. Helens, located approximately 220 km (136 mi.) from the Site. Volcanic flows are not expected from these mountains because of their locations. The only expected effect of an eruption would be ashfall. The impacts of any such ash fall are not expected to have any long-term significance to contaminant movement.

2.1.4.4 Other Natural Occurrences for the Site

The following paragraphs briefly describe other natural occurrences and their frequency at the Hanford Site.

2.1.4.4.1 Tornadoes

The regional weather records do not support a major concern about tornadoes being a significant occurrence and hence a threat to this disposal facility. However, the design requirements for this disposal facility require that they be designed to survive specified tornado conditions.

2.1.4.4.2 Range Fires

Fire is an event that could disrupt the performance capabilities of certain features of the disposal facility. Fire protection and prevention design must recognize this potential and account for its effects. The Hanford Site has a historical record of experiencing fires that damage or even destroy relatively large tracts of vegetation. Occasionally even some buildings have been endangered. Such fires have occurred from either lightening strikes or human activities; most commonly along the public highway that runs northwest to southeast across the southwestern edge of the Hanford Site. Such fires could pose a threat to certain engineered features of the disposal facility, particularly during the operations period. In particular, fires could pose a threat to engineered vegetation features incorporated into the outermost layer of the closure cap barrier system. Such vegetation destruction could increase the risk of wind and/or water erosion. The design needs to ensure that the barrier performance would not be unacceptably degraded by fire.

2.1.5 Hydrology

The following paragraphs briefly describe the known hydrology conditions for the Hanford Site and most specifically the 200 Area Plateau.

2.1.5.1 Surface Water

Although large rivers are near the Hanford Site, no significant long-term surface water features are near the disposal site. Several disposal ponds, used during past fuel reprocessing activities at the Hanford Site for cooling water discharge, are near enough to the proposed disposal site that they could have an artificial influence on net contributions to the water table. However, these disposal ponds are not expected to exist when current operations end, thereby negating any effect that they may currently have.

Except for catastrophic glacial flooding, which is not expected for tens of thousands of years, no floods are expected to affect the 200 Area Plateau.

2.1.5.2 Groundwater

An unconfined aquifer exists in the lower part of the sedimentary sequence overlying the uppermost basalt flow. This relatively thin aquifer is considered the primary contaminant pathway for evaluating exposure scenarios. The aquifer intercepts infiltration from the vadose (unsaturated) zone above it, providing a pathway for water and contaminant transport to the Columbia River. The aquifer under the proposed disposal site is approximately 95 to 102 m below the surface grade (Reidel et al. 2001; Walker and Wright 2002).

The groundwater pathway is considered the most likely pathway for contaminants released from an IDF for the following reasons:

- Low precipitation in the Pasco Basin
- Lack of surface transport pathways near the disposal facility
- Subsurface location of the disposal facility
- Near-surface lysimeter measurements showing downward movement of water
- Samples showing the existence of radioactive contamination plumes in the groundwater because of past Hanford Site operations.

2.1.5.3 Recharge

Recharge is the amount of total precipitation that infiltrates into the unsaturated zone (vadose zone) after runoff, evaporation, and transpiration by plants have occurred. Recharge from rain and snow melt is a major hydrologic variable affecting contaminant transport from an immobilized low-activity tank waste disposal facility. For the sites of interest to the IDF, surface soils are dominated by Rupert Sands and Burbank Loamy Sand. Fayer and Szecsody (2004), summarized in Section 3.4.6 along with the human influences on recharge, estimates that the natural recharge rate through the two types of soils are 0.9 mm/y. See Section 2.1.2.1 for further information about precipitation levels and Section 2.2.1 for more information regarding water infiltration.

2.1.6 Geochemistry

Hanford scientists have been studying the geochemistry of the Hanford Site vadose zone and groundwater for a long time. Little work has been done with surface water however because geochemistry plays a small role there.

The strategy has been to identify waste contaminants, pertinent geochemical conceptual release and sorption models, and available data that quantify the environment; calculate the range of sorption, solubility, and release rate variables; collect data; simulate the contaminant transport; then determine if the disposal action is acceptable given the data uncertainties.

The Hanford Site has a long history of conducting laboratory experiments to determine geochemical retardation. The results of the first experiment were reported in 1966. These experiments (see Kaplan and Serne [1995] for a summary of the experiments) are normally performed by passing a solution, typical of the contaminant leachant, through relevant sediments from Hanford Site soils.

The data used in the 1998 PA (Mann et al. 1998) are based primarily on Kaplan and Serne (1995) and Kaplan et al. (1995). Subsequent research was documented in Kaplan et al. (1996). A review of this research suggests that moisture dependency may be more complex than previously thought (Kaplan et al. 1996) and that colloidal transport will not be a concern at the Hanford Site (McGraw and Kaplan 1997). The most recent geochemical data are presented in Kaplan and Serne (2000), the source of data for the 2001 PA (Mann et al. 2001). In this data package the solubility of contaminants is approximated as a simplified parameter known as "solution concentration limits." The distribution coefficient (K_d) and the solution concentration limit for each contaminant will be fed into subsurface flow and transport codes for the 2001 PA.

2.1.7 Natural Resources

The Central Plateau of the Hanford Site has no important natural resources except industrial minerals. No major mining operations exist in the area of the Hanford Site. Oil and gas exploration have occurred in the region; however, no economically viable accumulations of either were found. Some local gravel processing is being performed in the area.

2.2 FACILITY CHARACTERISTICS

This section provides information on the engineered features of the disposal facility and their effectiveness in meeting performance standards. The topics covered are the integrity and design of the closure cap for protecting and safeguarding the waste against water infiltration and inadvertent intruders.

2.2.1 Water Infiltration

Water flow in the near-surface unsaturated zone at the Hanford Site is transient because of intermittent precipitation events. Transient water flow begins when water enters at the ground surface and infiltrates downward into the soil column. At some distance from the ground surface, transient effects will dampen out, and the downward-flowing water will reach a steady rate. The distance at which steady infiltration occurs is sometimes referred to as the penetration depth. Thus, the unsaturated zone essentially consists of two regions: an unsteady-flow region between the ground surface and penetration depth, and a steady flux in the lower unsaturated region is equal to the annual rate of groundwater recharge and therefore is composed of contributions not only from the most recent pulse, but from previous precipitation events as well.

The IDF is situated below the penetration depth in the region of steady flow. The natural rate of moisture infiltration is approximately 0.9 mm/year (Fayer 2004). However, the natural rate of moisture infiltration will change because construction of the disposal system will destroy the natural soil-sediment profile and remove surface vegetation. To prevent or minimize infiltration, a protective surface barrier will be engineered with sediment layers and one or more capillary barriers. The closure cover proposed is a Modified RCRA Subtitle C barrier. The current best

estimate through such a barrier is 0.1 mm/year (Fayer 2004). Infiltration beyond the root zone depends on the soil-atmosphere interface where surface soils and sediments and vegetation interact with the climate. The frequency, duration, and magnitude of precipitation and runoff events in part determine the infiltration rate into the disposal facility. Other parameters are the unsaturated hydraulic properties of the surface and subsurface infiltration barriers and the surrounding soil.

2.2.2 Disposal Unit Cover Integrity

The IDF trench closure cap forms an essential part of the disposal facility. This section identifies the design features used to ensure its long-term integrity and effectiveness. As noted earlier, the WAC, NRC, EPA, and DOE each have provided guidance and/or requirements that are applicable to the IDF onsite disposal planning and implementation. The regulatory requirements and guidance offer considerable flexibility in configuring the barriers and barrier components for an acceptable closure cap design. The closure cap system design can be tailored with respect to the characteristics of the disposal facility and the specific nature of the waste to ensure that the defined PA objectives of the disposal system are met. Closure cap design and construction for the IDF will require approval from Ecology in accordance with WAC 173-303-806 and 173-303-665.

2.2.2.1 Major Topical Concerns of Regulations and Guidance

The applicable regulations and guidance provide several major topical requirements for ensuring the stability and integrity of the closure cap system. The following are the major topical concerns that are the basis for the requirements:

- Failure of engineered barriers of the closure cap and the rest of disposal facility barrier system (i.e., seismic or slope stability)
- Subsidence of emplaced disposal product (waste) and other engineered barriers of the disposal system
- Surface erosion by wind and water
- Excess water infiltration (i.e., through the closure cap and/or underlying barrier system of the waste emplacement assemblage) causing percolating water to contact and interact with the waste
- Intrusion into emplaced waste by humans, plants, or animals.

Tables 5-1, 5-2, and 5-3 in the EPA (1989) guidance document on closure cover systems provide informative examples of recommended design specifications for categories of recommended barrier types to consider in designing closure cover systems.

2.2.2.1.1 Specific Regulations and Guidance Concerning Water and Leachate Control

Specific emphasis regarding how the design will deal with water and leachate diversion and/or collection are suggested by the NRC (10 CFR 61) and prescribed by the EPA (40 CFR 264,

40 CFR 265), and other related regulations and guidance (NRC and EPA 1987, WAC 173-303). The topical considerations of particular concern here can be summarized as follows:

- [10 CFR 61.7(b)(2)] (NRC) - The long-term stability of the waste and disposal site requires minimization of the access by water.
- [10 CFR 61.51(a)(6)] (NRC) - The disposal site should be designed to minimize to the extent practicable the contact of water with waste during storage and the contact of standing water with waste after disposal.

  NOTE: This NRC guidance is particularly directed at avoiding a design/performance development of a "bathtub" effect in which the waste could become immersed in liquid within a disposal unit located below grade with a low-permeability bottom surface. This applies to the closure cover system design, as far as its performance could help avoid or mitigate such performance problems.
- DOE M 435.1-1 IV (M)(3)(d) – Low-level waste disposal facilities shall be designed to minimize to the extent practical, the contact of waste with water during and after disposal.
- WAC 173-303-600 through WAC 173-303-806 – The facility permitting, design, closure, and post closure requirements to minimize impacts to human health and the environment.

Tables 5-1 through 5-3 in the EPA (1989) guidance document on closure cover systems provide further guidance on closure cover design regarding concerns about water drainage and diversion.

2.2.2.2 Barrier Design Selection

The principal design objective of a disposal facility for waste is to effectively contribute to protection of the public and the environment through effective long-term isolation of the waste material. The principal design objective for the closure system is to ensure that it transforms the facility from operational status to inactive status in a manner that ensures the disposal site's integrity and ability to continue isolating the waste. The design of a disposal site and closure system requires integration with closure plan requirements.

Detailed assessments of four surface barrier designs that constitute potential generic remedial alternatives for 200 Area waste sites were performed in a focused feasibility study (FFS) (DOE/RL 1996). The designs presented in this study are as follows:

- **Hanford Barrier.** Designed to provide 1,000-year isolation of waste sites containing Greater than Class C LLW, Greater than Class C mixed waste, and significant inventories of transuranic (TRU) constituents.

- **Modified RCRA Subtitle C Barrier.** Designed to provide 500-year isolation of waste sites with dangerous waste, Category 3 LLW, Category 3 low-level mixed waste, and Category 1 low-level mixed waste as defined by the *Hanford Site Solid Waste Acceptance Criteria*, (McDowell 2002).

- **Standard RCRA Subtitle C Barrier.** Designed to provide 30-year isolation of dangerous waste sites.

- **Modified RCRA Subtitle D Barrier.** Designed to provide 100-year isolation of waste sites with Category 1 LLW and nonhazardous-nonradioactive solid waste.

The generic design from the FFS (DOE/RL 1996) reflects a barrier that meets potential design criteria and can be simplified or reduced if not all the design criteria are needed for the specific site. During the site-specific evaluation, the cover design can be tailored to factor in specific location, contaminants, risk levels, etc. Figure 2-5 represents the graded approach in DOE/RL (1996) for selecting a suitable barrier design for the Hanford Site's IDF. Decision gates numbered in the figure correspond to the following questions.

1. Does the disposal facility contain significant inventories of TRU constituents?

2. Does the disposal facility contain LLW with greater-than-Class C activity (i.e., does waste activity exceed Category 3 limits)?

3. Does the disposal facility contain waste regulated as dangerous waste?

4. Does the disposal facility contain LLW with Category 3 activity?

5. Does the disposal facility contain LLW with Category 1 activity?

6. Is only nonradiological, nonhazardous solid waste present?

The following decisions show the logic path through Figure 2-5 used for this closure system.

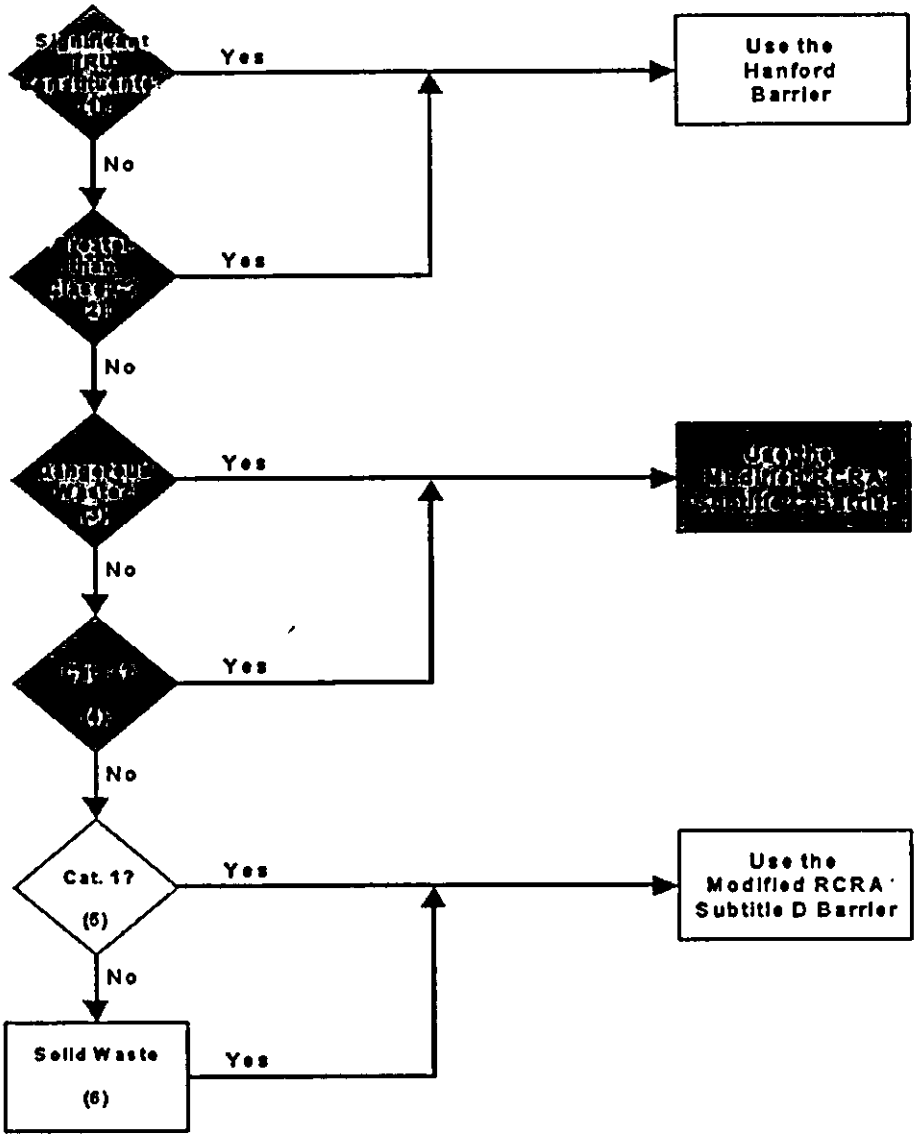
- The ILAW disposal facility will not contain significant quantities of TRU constituents nor LLW with greater-than-Class C activity.

- The proposed disposal facility may contain waste regulated as dangerous waste, but this may not apply if the waste is delisted.

- However, the ILAW disposal facility will contain LLW with Category 3 activity.

Based on this information, the Modified RCRA Subtitle C Barrier is identified as the appropriate surface barrier design for the IDF.

Figure 2-5. Barrier Decision Logic.



2.2.2.3 Design Criteria

Lists of design criteria for various barrier systems were assembled in DOE/RL (1996). The set of design criteria for the Modified RCRA Subtitle C Barrier is summarized as follows:

1. Minimize moisture infiltration through the cover.
2. Design a multilayer cover of materials that are resistant to natural degradation processes.
3. Design a durable cover that needs minimal maintenance during its design life.
4. Design a cover with a functional life of 500 years.
5. Prevent plants from accessing and mobilizing contamination (i.e., prevent root penetration into the waste zone).
6. Prevent burrowing animals from accessing and mobilizing contamination.
7. Ensure that the top of the waste is at least 5 m below final grade or include appropriate design provisions to limit inadvertent human intrusion.
8. Facilitate drainage and minimize surface erosion by wind and water.
9. Design the low-permeability layer of the cover to have a permeability less than or equal to any natural subsoils present.
10. Design the cover to prevent the migration and accumulation of topsoil material within the lateral drainage layer (i.e., clogging of the lateral drainage layer).
11. For frost protection, the lateral drainage layer and the low-permeability asphalt layer must be located at least 0.75 m below final grade.

2.2.2.4 Barrier Configuration and Sizing

The IDF closure cap barrier system will be composed of a layered assemblage of different engineered barriers. Figure 2-6 is a cross-sectional elevation view of this closure cap barrier system concept. Each layer within the closure cap will be sloped with a 2 % grade to allow runoff and minimize erosion. A barrier overhang will be used to control potential water infiltration problems at the edges of the barrier. "Barrier overhang" is the term used to describe the projection of the functional barrier surface beyond the perimeter of the waste zone. The barrier overhang will extend 2 m beyond the edge of the disposal trench. Beyond the barrier overhang, the barrier layers above the low-permeability layers will extend farther, but at a steeper slope of 3:1 (horizontal:vertical) until they reach the existing ground elevation. The grading fill layer of the barrier located underneath the low-permeability layers will extend beyond the barrier overhang as well. This layer will support the 3:1 sloped layers extending beyond the barrier overhang.

2.2.3 Structural Stability

DOE guidance (DOE 1992, DOE 1999a) on stabilization and closure of disposal facilities provides listings of characteristics needed by an acceptable disposal site. The NRC, Ecology, EPA, and DOE regulations and guidance all impose similar requirements regarding the need for such disposal facilities to have adequate physical stability. The NRC guidance and DOE requirements are primarily performance based, while the EPA hazardous waste regulations include specific design requirements. Key concerns addressed by such requirements will be met as described in the following paragraphs.

The waste package is the single most important building block in ensuring the structural stability of the disposal facility. All waste generators must provide waste packages that confirm to waste acceptance criteria which conform to minimum fill volume percentage, subsidence, and void space requirements. Information on the exact contents of a package, including filler material, will be documented by the waste generator and provided to the DOE.

The slope stability of the disposal system will not be compromised in case of subsidence, thus ensuring continued effectiveness of the Modified RCRA Subtitle C barrier (see Section 2.2.4). Water infiltration can be the single most destructive element in waste degradation and release of contaminants. Water infiltration is reduced considerably by the barrier and additionally, the IDF trench is located sufficiently above the water table that groundwater contact will not occur directly.

The operational and interim closure activities (Section 3.2.1) and final closure (Section 3.2.2) minimize the potential ingress of water into the disposal facility during all phases of the disposal program. The Modified RCRA Subtitle C barrier design also provides appropriate deterrence to intrusion into the disposal facility by plants, animals, and humans and minimizes surface erosion of the engineered barrier system, including the closure system.

2.2.4 Inadvertent Intruder and RCRA Barrier Description

The primary purpose of the combination of engineered barriers of a LLW disposal facility is to support the waste isolation function of the disposal facility. The barriers support the waste isolation function primarily by preventing and/or impeding the ingress of intruders that could degrade the waste and result in release of waste constituents.

The Modified RCRA Subtitle C barrier design is the baseline design for waste containing not only dangerous waste, but also Category 3 LLW. The barrier is designed to provide hydrologic protection and containment for a performance period of 500 years (DOE/RL 1996). The term "Modified" designates that this design differs in certain key aspects from the EPA's minimum technology guidance (MTG) for RCRA covers. The MTG design has a 30-year design life.

The Modified RCRA Subtitle C barrier as proposed in the FFS (DOE/RL 1996) would include multiple layers of variable thickness. Table 2-1 provides a comprehensive summary of the essential functions and characteristics of each proposed barrier layer for that particular concept. For waste disposal at the Hanford Site, the initial choice of barrier materials, barrier thickness, and degree of capping barrier slope are presented in Figure 2-6, but are subject to change during

closure cap detailed design. They will be tailored to the function and performance requirements for these uppermost layers.

The Modified RCRA Subtitle C barrier shown in Figure 2-6 differs from the FFS. A second capillary break has been added. This, or a similar barrier layer system, will be built over the trench following completion of waste emplacement, backfilling, and then temporary closure of each trench.

The structure of the closure cover acts as a barrier against infiltration and intruders. The conceptual closure cover has been designed as described in the following paragraphs:

The Modified RCRA Subtitle C barrier is constructed over the waste packages to ensure a total depth below the surface of at least 5 m and a 2 % slope for the upper layers of the barrier, as measured from the center to the longer edge of each trench.

Various design guidance documents recommend that the minimum slope of the internal drainage layer of the cover be no less than 3 % after any settlement that may occur over the life of the trench. To ensure that the 3 % post-settlement slope is maintained, a layer of common structural fill is built up to provide a 5 % grade for the internal drainage layer. A 15 cm thick gravel filter layer is placed over the common structural fill. This layer provides a capillary break for any water reaching this depth. The next layer consists of 1.0 m sandy soil. The sand layer will be smoothed to establish a planar base surface for accurate and controlled placement of the overlying layers. A 10 cm thick asphalt base course will provide a stable base for placing the overlying low-permeability asphalt layer (the water infiltration barrier). This is the uppermost layer of the Modified RCRA Subtitle C barrier to be built at a 5 % grade. The asphaltic concrete mixture will be specially formulated to minimize hydraulic conductivity and will be applied 15 cm thick. A spray-applied asphalt then will be applied over the layer to seal any voids or defects in the surface. This layer will function as a low-permeability barrier as well as a human-intrusion barrier. The asphalt layer also is expected to serve as a highly effective deterrent to intrusion by plant roots and burrowing animals. The 5 % slope will carry infiltrated water to the layer edges where it will enter the surrounding soil.

Next, a 15 cm-to-1.65 m thick layer of drainage gravel will be laid down. The function of this layer will be to allow moisture that reaches this layer to laterally migrate to the barrier edge and to reduce the slope of the upper layers of the barrier to 2 % for erosion control.

The next task will be installing the second two-part graded filter layer (labeled Capillary Break #1). The lower layer will be a 15 cm thick sand filter layer. The gravel in this layer will be sized to be compatible with the lateral drainage gravel layer below and the sand filter layer above to prevent fine-textured sand from moving downward. Once the gravel filter layer is installed, a 15 cm thick sand filter layer will be installed. The purpose of these two layers is to prevent topsoil particles from moving downward and clogging the lateral drainage layer. They also serve as another capillary break to divert infiltration.

After the filter layers are installed, a 50 cm thick layer of compacted topsoil will be installed. This layer (Layer 2 in Figure 2-6) will supplement the moisture storage capacity of the layer to be installed above it. The material used for the topsoil will be McGee Ranch silt loam without pea gravel. This layer of topsoil will be compacted, to at least 85 % of optimum dry density.

Another 50 cm thick layer of topsoil will be installed next. This layer will contain McGee Ranch silt loam, along with 15-wt. % pea gravel, 2.4 mm to 9.5 mm in diameter, mixed uniformly. The topsoil mixture will be placed at a bulk density of approximately 1.46 g/cm^3, which would be conducive to plant growth. The pea gravel is designed to minimize wind erosion of the silt loam without significantly affecting its moisture retention capabilities. Construction quality control will be conducted throughout installation of each layer to ensure that the appropriate slopes are maintained and that the desired compaction is attained. Appropriate quality assurance records will be kept during construction and will be made part of the permanent facility logbook.

Next, the ground will be prepared for planting and fertilization. Once this is complete, the ground will be seeded with mixed perennial grasses and planted with shrubs and sagebrush.

A fence will surround the perimeter of the IDF. This fence will prevent medium to large animals from accessing the cover. The cover will be inspected quarterly for signs of burrowing animals. Small animals are not expected to penetrate the low-permeability components of the cover. Typical small-animal species living on the Hanford Site tend to live in the upper 1.2 m of earth.

2.2.4.1 Conformance To Design Criteria

This section shows how the Modified RCRA Subtitle C Barrier conforms to the design criteria listed in Section 2.2.2.3 and the PA. In Table 2-1, each design criterion has been addressed individually; the criteria and corresponding conformance attributes are listed in adjacent columns. Layer numbers referenced in the table refer to the corresponding cover layers shown in Figure 2-6 and Table 2-1.

Figure 2-6. Modified RCRA Subtitle C Barrier, Cross-Sectional Elevation View.

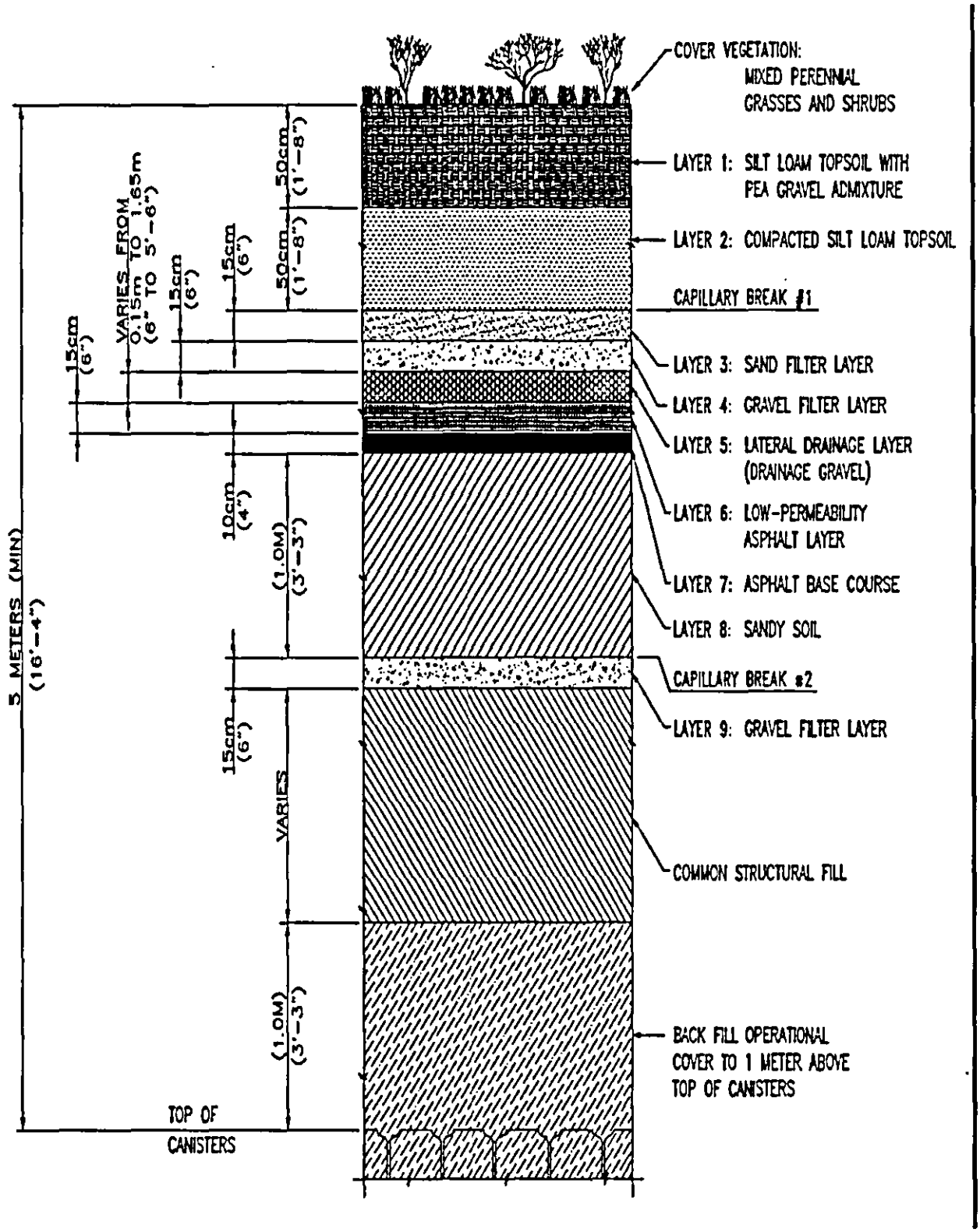


Table 2-1. Conformance Assessment of Modified RCRA Subtitle C Barrier to Design Criteria. (3 Sheets)

	Design Criteria	Assessment of Conformance
1.	Minimize moisture infiltration through the cover.	Design facilitates moisture retention in the topsoil layers for removal by evaporation and plant transpiration. Capillary barrier interface at the base of the topsoil will restrict drainage and increase moisture storage capacity in the topsoil layers. A high-saturated hydraulic conductivity value (1 cm/second) is specified for the lateral drainage layer to prevent significant hydraulic head buildup within the layer. The low-permeability (approximately 10^{-8} cm/s) asphalt layer will be highly impervious to water penetration. Numerical performance assessments predict that infiltration through the barrier will be negligible (i.e., less than 0.2 % of precipitation).
2.	Design a multilayer cover of materials that are resistant to natural degradation processes.	Long-term durability of asphalt is being evaluated through natural analog studies. Preliminary results indicate that asphalt offers adequate durability over periods in excess of 5,000 years. Except for the asphalt layer, the Modified RCRA Subtitle C barrier is designed entirely of natural soil and rock that will provide appropriate long-term resistance to chemical and physical weathering.
3.	Design a durable cover that will need minimal maintenance during its design life.	Perennial vegetation will be cultivated on the cover surface to minimize susceptibility to wind and water erosion. The topsoil in Layer 1 will contain 15-wt. % pea gravel. As silt particles are removed from the surface by erosion, pea gravel will form a lag deposit that will tend to protect the surface from further erosion. The surface slope has been limited to 2 % to limit wind erosion.
4.	Design a cover with a functional life of 500 years.	The thickness of topsoil in the Modified RCRA Subtitle C barrier is sufficient to accommodate soil losses at a rate of 2 tons per acre per year for 500 years with no significant adverse effect on performance. (Note: The PA takes no credit for engineered features.) The Modified RCRA Subtitle C barrier can accommodate substantial increases in annual precipitation (up to twice ambient) with no significant adverse effect on performance. The 500-year, 24-hour storm has been evaluated. Although the design storm delivers 6.2 cm (2.47 in.) of precipitation, runoff during the 24-hr period is less than 2.5 cm (1 in.) (i.e., runoff is not excessive, and the design storm is unlikely to cause severe erosion of the cover surface).

Table 2-1. Conformance Assessment of Modified RCRA Subtitle C Barrier to Design Criteria. (3 Sheets)

	Design Criteria	Assessment of Conformance
5.	Prevent plants from accessing and mobilizing contamination (i.e., prevent root penetration into the waste zone).	Extremely low soil moisture conditions are expected to be maintained in the coarse-textured soil layer (i.e., Layer 5) below the capillary barrier interface. These conditions are expected to deter root zone development below the topsoil layers. The low-permeability asphalt in Layer 6 is expected to present an impenetrable barrier to plant roots.
6.	Prevent burrowing animals from accessing and mobilizing contamination.	The low-permeability asphalt in Layer 6 is expected to present an impenetrable barrier to burrowing animals.
7.	Ensure that the top of the waste zone is at least 5 m (16.4 ft) below final grade or include appropriate design provisions for limiting inadvertent human intrusion.	Human habitation of the site surface is considered the most potentially adverse human intrusion scenario for LLW sites. Many radiological waste sites in the 200 Areas have already been stabilized with coarse fill that would approach or exceed these criteria. At other sites, the criteria could be met by placing additional grading fill. Layer 6 represents a substantial barrier to inadvertent human intrusion. Layer 6 could be excavated, but only with the aid of mechanized equipment.
8.	Facilitate drainage and minimize surface erosion by wind and water.	The surface slope is specified at 2 % to provide for coherent drainage off the barrier surface while limiting wind erosion potential. Perennial vegetation will be cultivated on the cover surface to minimize susceptibility to wind and water erosion. The topsoil in Layer 1 will contain 15-wt. % pea gravel. As silt particles are eroded from the surface, pea gravel will form a lag deposit that will tend to protect the surface from further erosion.
9.	Design the low-permeability layer of the cover to have a permeability less than or equal to any natural subsoils present.	The low-permeability asphalt layer is expected to demonstrate an in-field saturated hydraulic conductivity value on the order of 10^{-9} cm/s. This value is several orders of magnitude lower than the conductivity values of natural subsoils in the 200 Areas.

Table 2-1. Conformance Assessment of Modified RCRA Subtitle C Barrier to Design Criteria. (3 Sheets)

	Design Criteria	Assessment of Conformance
10.	Design the cover to prevent the migration and accumulation of topsoil material within the lateral drainage layer (i.e., clogging of the lateral drainage layer).	A two-layer graded filter (Layers 3 and 4) separates the topsoil layers from the underlying layers of coarse-textured aggregate materials that will perform the biointrusion prevention and drainage functions. Design specifications for the two graded filter layers conform to standard filter criteria.
11.	For frost protection, the lateral drainage layer and the low-permeability asphalt layer are to be located at least 0.6 m, 15 cm (2 ft, 6 in.) below final grade.	The top of the lateral drainage layer will be situated approximately 1.3 m (4.33 ft.) below final grade.

DOE/RL, 1996, *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas*, DOE/RL-93-33, Rev. 1, August, 1996, prepared by Bechtel Hanford, Inc., for U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Richland Operations Office, Richland, Washington.

2.3 WASTE CHARACTERISTICS

This section provides a detailed description of important characteristics of the waste that may be disposed of at the IDF. This description is based mainly on the contents of the *Integrated Disposal Facility Risk Assessment* (Mann 2003a). The waste to be disposed of at IDF can be classified into four (4) categories:

- **Low-level waste (LLW)** – waste that contains man-made radionuclides but which is not classified as high-level waste or transuranic waste. This waste could have been generated on the Hanford Site or could have been imported from offsite. Category 1 (unstabilized) waste has the lowest level of radionuclides. Category 3 (stabilized) waste has higher concentrations and/or amounts and is grouted before disposal.

- **Mixed low-level waste (MLLW)** – waste that contains man-made radionuclides but which is not classified as high-level waste or transuranic waste and which contains materials that are regulated under RCRA or the corresponding dangerous waste management laws of the State of Washington.

- **Immobilized Low-Activity Waste (ILAW)** – Hanford tank waste that has undergone separations treatment to remove the bulk of the radionuclides and then solidified at the Hanford Waste Treatment and Immobilization Plant (WTP). Presently, the only DOE-approved solidification process is WTP vitrification.

- **Failed or Decommissioned Melters** – High-level and low-activity waste melters used to treat tank waste in the WTP.

The source of ILAW will be the vitrification of the low-activity fraction of the Hanford tank waste after suitable separations. The source of low-level waste and mixed low-level waste will be from both onsite operations and remediation and offsite shipments from other DOE sites. The source of melters will be from the operation of the WTP.

2.3.1 Low-Level Waste /Mixed Low Level Waste

The baseline inventory and associated volume estimates come from the same source, the 2002 SWIFT forecast. In this forecast for waste to be disposed in 2007 and beyond, the LLW volume is 111,000 m^3 and the MLLW volume is 53,500 m^3, for a grand total of 164,500 m^3 (Barcot 2002). The LLW volume estimate does not include the small amount of waste projected for disposal between 2003 and 2006. The upper bound inventory and volume estimates are taken from the Solid Waste Program Environmental Impact Statement (DOE/EIS-0286D, 2003). The inventory estimate is based primarily on average concentrations of radionuclides in disposed and stored mixed and low level waste at Hanford from 1996 through 1997. To generate inventory estimates, these concentrations were multiplied by volume estimates based on forecasted waste volumes. The volumes were derived from the 1999 Solid Waste Integrated Forecast Technical (SWIFT) report (Barcot 1999) plus the DOE complex evaluation (DOE/EIS-0286D, 2003) that attempts to encompass offsite generators who currently do not ship to Hanford but may if Hanford becomes a complex-wide disposal facility for LLW and MLLW. The upper bound volume associated with the upper bound inventory (see Table 3-2 in Section 3.1.2) is 306,000 m^3 for LLW and 188,000 m^3 for MLLW, a grand total of 494,000 m^3.

2.3.2 Immobilized Low-Activity Waste

The TWRS record of decision (DOE 1997) states that the waste will be retrieved from the tanks, and then chemically separated to form the high-level and low-activity radioactive waste fractions. The high-level radioactive waste fraction will contain most of the radionuclides. This waste fraction will be vitrified, and the product stored until it can be transferred to a licensed high-level waste repository. The low-activity radioactive waste fraction contains the bulk of the nonradioactive chemicals and is predominantly the soluble components of the tank waste. This waste fraction will be solidified in a glass or other form that meets the DOE specifications.

It is proposed to dispose of the immobilized low-activity waste form onsite in a manner that allows the waste to be retrievable for at least 50 years, although this time period has not been adopted officially.

After waste-type separation, the low-activity waste will be immobilized into glass. Current plans involve vitrification in a joule-heated ceramic DuraMelter. The DuraMelter vitrification system imposes certain operational and process requirements on the glass formulations that include:

- Viscosity limits of 1 to 15 Pa·s at 1100°C
- Electrical conductivity limits of 0.2 to 0.7 S/cm at 1100 to 1200°C
- Liquidus temperature below 950°C.

Other factors affecting melter operations that are also important include:

- Ability to retain sulfur in the glass matrix without the formation of molten salt phases during processing; these phases are more corrosive, electrically conductive, and fluid than the glass melt, and have lower melting points.
- Compatibility of the glass melts with the projected glass contact refractory (primarily Monofrax K-3) and the metallic components of the melter (e.g., electrodes, bubblers, thermowells, etc.).
- In addition to these processing constraints, the DOE imposes additional product acceptance constraints. Detailed specifications regarding waste package size, compressive strength, crystallinity, etc., have been developed.

A large number of LAW glasses have been formulated by staff at the Vitreous State Laboratory (VSL) in Washington D.C. that meet these processing and product acceptance requirements while achieving waste loadings ranging from 6 to 31 mass%. Supplemental to the VSL work, a set of 77 glasses was formulated and tested under a project funded by DOE headquarters (EM-50) (Vienna et al. 2000). The combined set of these glasses covers a very wide-ranging, multidimensional compositional space.

The LAWABP1 glass was used to represent the ILAW glass performance in the 2001 ILAW PA (Mann et al. 2001). The risk assessment utilizes the performance of LAWABP1 glass to represent the performance of ILAW in the proposed IDF disposal action. Although LAWABP1

glass composition is not the same as the glass compositions selected by the WTP contractor, it is chosen to represent the glass composition because it was the glass composition analyzed in the base analysis of the 2001 ILAW PA and because it is now known that LAWABP1 glasses perform slightly more poorly than the WTP selected glass. See the 2001 ILAW PA (Mann et al. 2001), the 2002/2003 ILAW PA annual summary (Mann 2002 and Mann 2003b), and McGrail et al. (2001) for additional details on the performance of LAW glass waste form.

The physical, chemical, and radiological properties of the waste at the time of disposal have not been completely determined. At the time of the start of this analysis, the ILAW waste form is expected to be contained in the form of right circular, steel cylinder containers (1.22 m diameter by 2.29 m tall) based on modification 12 of the BNFL contract (see DOE/BNFL 1998). The containers are assumed to be filled to 85% by volume waste glass. Given the geometry of the ILAW glass container, the corresponding glass height in the container is estimated to be 2.0 m.

Based on Case 3 of the TWRSO&UP (Kirkbride et al. 1999), 158,105 m^3 of ILAW glass will be produced for Phase 1 and Phase 2 operations of the WTP. Also, 15,021 m^3 of HLW glass will be produced. The ILAW glass density is approximately 2.6 kg/L. Table 2-2 summarizes the ILAW volume, mass, and number of packages for the reference case (Case 3 of the TWRSO&UP) (Kirkbride 1999).

Table 2-2. Summary of ILAW and HLW Glass Production.

	Total MT glass	Total m^3 glass
ILAW	411,073	158,105
HLW	39,055	15,021

The Office of River Protection is also investigating the use of bulk vitrification to supplement the WTP production of low-activity glass waste. Bulk vitrification is a modification to the in situ vitrification process developed for remediation of buried wastes and contaminant plumes in soils (Tixier 1991, Luey 1995). An in-container vitrification process has been designed in which LAW, soil, and glass forming chemicals are mixed, dried, and then melted at about 1500°C by electrical resistance heating (Kim 2003). Graphite flakes are added to the mix to form a conductive path for melt initiation. Current is supplied by two graphite electrodes imbedded in the batch. The high-temperature glass melt is kept insulated from the steel container by lining the container walls with a 15 cm (6 in) of Lane Mountain #16 quartz sand. Gases generated during the process are vented to an off-gas treatment system.

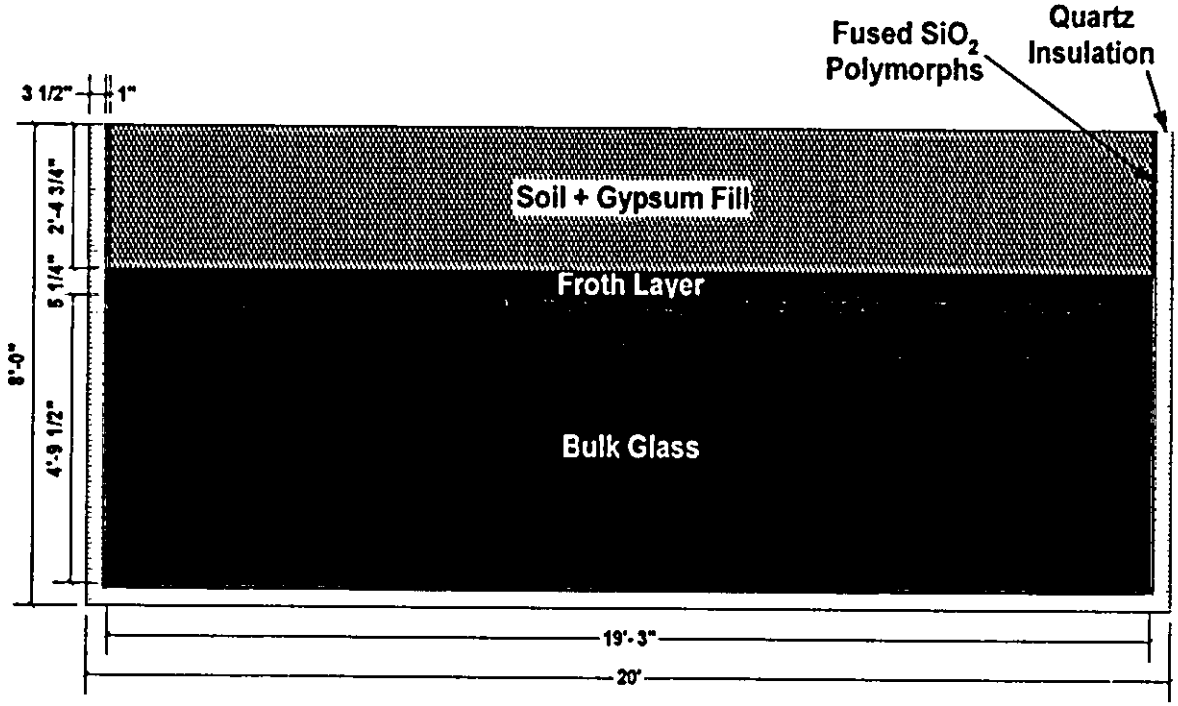
The target BV glass is quite similar to WTP glass. Major differences are that it is lower in B_2O_3 and considerably higher in ZrO_2. During the vitrification process, partial dissolution of the insulating layer of quartz sand occurs into the BV melt. This tends to raise the SiO_2 content of the final product glass from the target. Heating into the temperature range of the BV melt (≈1500°C) also causes phase changes in the quartz sand; high-temperature, low-pressure SiO_2 polymorphs identified in samples taken from large-scale tests of the process include several

forms of tridymite and cristobalite. Consequently, five sides of the BV box contain a sequence of layers that generally progress from the outer edge towards the melt as follows:

$$\alpha\text{-quartz} \rightarrow \text{Tridymite} \rightarrow \text{cristobalite} \rightarrow \text{glass melt} \qquad (1)$$

The final overall geometry and lithological units assigned to the BV waste package are shown in Figure 2-7. The void space in the box after vitrification is filled with a mixture of 90% backfill soil and 10% gypsum removed from the off-gas treatment system.

Figure 2-7. Geometry of BV Waste Package and Lithological Units Used in Modeling.



The long dimension is shown here but the 2-D simulations were conducted on the end-view plane (8 ft × 8 ft) cross-section.

2.3.3 WTP Failed Melters

The number of melters requiring disposal for the balance of the WTP mission is estimated to be 18 melters, including 8 HLW melters, 8 LAW melters, and 2 contingency melters (Zuberi and Lowe 2003). The HLW and LAW melter radiological and physical characteristics have not been finalized. The following assumptions have been made concerning the quantity of waste material remaining in the failed melters and overpack design.

The final maximum glass volume remaining in a HLW melter is 4498 L or 1.17×10^4 kg. The glass density (cold) is 2.6 kg/L. The LAW cold glass density is 2.6kg/L,and the final maximum glass volume remaining in a LAW melter is 26,048 L or 6.77×10^4 kg.

The melter overpacks are currently designed as carbon steel containers that provide the necessary shielding, contamination control, and structural rigidity to allow direct burial of the spent/failed melters as MLLW (Zuberi and Lowe 2003). Table 1-1 summarizes the current melter overpack design envelopes.

Current planning has each HLW melter encapsulated in an 8-inch thick carbon steel rectangular overpack. Planning for the disposal of the LAW melters is still under development. For this risk assessment, we have assumed that a 1-inch thick steel rectangular overpack is used for the LAW melters. Both the LAW and HLW melters are assumed to be grouted into their respective overpacks.

2.3.4 Inventory

Inventory estimates are needed to assess the estimated impacts of the proposed disposal action against performance objectives established to protect human health and the environment. These estimates are from the Integrated Disposal Facility Risk Assessment (Mann 2003a). The 2001 ILAW PA inventory is assumed for the ILAW waste form. A preliminary estimate for the LLW/MLLW inventory is taken from the most recent Solid Waste Integrated Forecast Technical (SWIFT) report (Barcot 2002) and bounding estimates developed for the Hanford Site SWEIS (DOE/EIS-0286D, 2003). The inventory contained in the disposed melters is taken from information provided for the tank inventory and ILAW inventory used for the 2001 ILAW PA.

These inventory estimates are being revisited in preparation of the 2005 version of the Integrated Disposal Facility Performance Assessment. Actual verses forecast inventory values will continue to be evaluated through the life of the project.

2.3.4.1 Immobilized Low-Activity Waste

The ILAW inventory assumed in the risk assessment is provided by Wootan (1999) and is equivalent to the inventory used in the 2001 ILAW PA.

The contaminant concentration in bulk vitrification packages should be similar to that of WTP ILAW. However, until the split between WTP ILAW and supplement bulk vitrification waste forms is decided, the inventory in bulk vitrification is not known. However, the total inventory (WTP glass and bulk vitrification) should stay relatively constant, independent of the split.

2.3.4.2 Low-Level and Mixed Low-Level Waste

Inventory estimates for key contaminants of solid wastes that could be disposed in the Integrated Disposal Facility (IDF) in the 200 East Area just west of the PUREX facility are based on the annual waste forecast (referred to as the Solid Waste Integrated Forecast Technical (SWIFT) Report that is derived each year by the waste management group for the currently operating Low Level Waste Burial Gounds (LLBG). In this forecast, known generators of wastes that are being disposed of in the LLBG are requested to provide life cycle forecasts of future waste to be disposed in the LLBG. Radionuclide inventory estimates are generated from two sources (the latest annual waste forecast and input from the Solid Waste Environmental Impact Statement)

Using the volume estimates for the LLW and MLLW baseline and upper bound inventories average contaminant concentrations in the waste were estimated by combining the LLW and MLLW inventories and dividing by the sum of the LLW and MLLW volumes for the baseline and upper bound estimates, respectively.

2.3.4.3 WTP Melters

The inventories associated with the HLW and LAW melters scheduled for disposal in the IDF are not known. It is assumed that each melter has the maximum amount of waste. Specifically, each HLW melter contains 1.2×10^4 kg of HLW and each LAW melter contains 6.8×10^4 kg of LAW.

For the LAW melters we have assumed the contaminant concentrations in the waste material remaining in the melter are the same as the ILAW glass contaminant concentrations. Note that this relatively small amount of waste is double counted as it is also placed in the ILAW containers.

For the HLW melters we have assumed the inventory remaining in the melter is based on the tank and ILAW inventories and the total HLW glass volume produced. The total HLW inventory is estimated by subtracting the ILAW inventory from the Tank inventories. These HLW inventories are conservative because they neglect any losses of contaminants to secondary waste streams. The HLW contaminant concentration is then estimated by dividing the HLW inventory for each contaminant by the total amount of HLW glass produced (15,021 m^3). Estimated inventory values can be found in Mann 2003a.

2.3.4.4 Packaged Waste Form

The planned waste form is low-activity radioactive glass poured into stainless-steel right circular cylindrical containers that will be managed and disposed of as RCRA mixed waste.

A matrix of 55 glass formulations was developed and tested and a data package (McGrail et al. 2001) issued in accordance with the Disposal Authorization Statement. Testing results of all 55 glasses are reported in detail in PNNL-13101 (Vienna et al. 2000). Tentative conclusions reached in the data package indicate that the glass formulation LAWABP1 is the best performer to date on all of the tests. A large number of experiments with LAWABP1 (and four other glass compositions) are under way.

2.3.4.5 ILAW Specifications

The DOE specified in the contract the required ILAW characteristics, properties, and associated limiting values that would be met by the WTP. The requirements of particular interest for the onsite disposal and closure tasks are as follows (DOE 1998 as amended):

- The waste package is defined as a sealed stainless steel container enclosing a vitrified waste form.
- The package will be fully sealed and its exterior surface cleaned of smearable radioactive contamination.

- Package configuration: The package will be a stainless-steel right circular cylinder. The as-fabricated package dimensions will be constant and have a dimensional tolerance of ±0.01 m. The external dimensions of the right-cylindrical package, including all appurtenances, will be 1.22 m (diameter) by 2.3 m (height). At the time of acceptance, the ILAW package will stand without support on a flat, horizontal surface and will fit completely and without forcing when lowered vertically into a right circular cylindrical cavity with internal dimensions of 1.27 m (diameter) by 2.4 m (height).

- Package mass will not be greater than 10,000 kg.

- The chemical and radiological composition of the ILAW packages will be documented.

- The radionuclide concentration of the ILAW will be less than Class C limits (see section 1.2.1)

- The external surface dose rate of the package will not exceed 200 mrem/hr (24590-LAW-ZOC-W13T-00002).

- The package will have a welded head identification number on the shoulder and side of the package.

- The temperature of the accessible external surfaces of the package will not exceed 465°F.

- The package will contain no detectable free liquids.

- The package contents will not be pyrophoric, ignitable, or reactive.

- The waste form will have a sodium leachability index greater than 6.0.

- The ILAW will be acceptable for land disposal under WAC 173-303 and 40 CFR 268.

- The package will be able to withstand a compression load of 50,000 kg.

- The package will be compatible with crane lifting and movement.

2.3.4.6 ILAW Package Description

The ILAW containers, used to store radioactive glass, are right cylindrical stainless-steel containers, 1.22 m (diameter) by 2.3 m (height) (48 in. by 90 in.). After filling to specified levels with glass, the void space remaining in the container will be filled with inert material. After the filler material is added, the container will contain less than 10 % void space. The container will be closed and sealed to prevent the dispersal of ILAW glass. Each package will have a label welded on the shoulder and side in a readily accessible location. The label will contain unique

identification (e.g., serial number) that will be assigned to each package and the corresponding documentation.

2.3.4.7 ILAW Package Dose Rate

After decontamination has been completed and surface smears taken, the surface dose rate is determined to ensure that the package meets contract requirements (The loaded shipping package will not exceed 200 mrem/hr at contact and 10 mrem/hr at 2m).

3.0 TECHNICAL APPROACH TO CLOSURE

The DOE provides requirements and guidance through its system of orders, manuals, and guides. The primary driver for this closure plan is DOE O 435.1. The objective of this order is to ensure that radioactive waste is managed in a manner that protects workers, public health and safety, and the environment.

This section of the IDF Closure Plan describes the conceptual technical approach for specific activities that will be conducted to close the facility in a manner that will meet the requirements of DOE O 435.1 and DOE M 435.1-1, DOE Order 5400.5, and applicable EPA and Washington State requirements and NRC guidance.

3.1 COMPLIANCE WITH PERFORMANCE OBJECTIVES AND OTHER REQUIREMENTS

This section summarizes the results from the ILAW PA under various radiation exposure scenarios and pathways and shows compliance by comparing them to the performance objective values. Because the PA has not taken credit of any reduction in the natural water infiltration rate by thesubsurface capillary barrier underneath the Modified RCRA Subtitle C barrier, the PA evaluation is conservative for ILAW. With the barrier in place, the rate of contaminant release caused by the leachate will drop and actual dose impacts are expected to be much lower.

Two additions risk assessments, *Integrated Disposal Facility Risk Assessment* (Mann 2003a) and *Risk Assessment Supporting the Decision on the Initial Selection of Supplemental ILAW Technologies* (Mann 2003c), have been created to investigate the estimated impacts from non-WTP ILAW. All of these results will be updated in the 2005 version of the Integrated Disposal Facility Performance Assessment.

3.1.1 All-Pathways Dose

Table 3-1 summarizes the performance objectives from the CA (Kincaid 1998) and from the latest ILAW PA analysis (Mann 2001) along with the estimated impacts from those studies. The CA shows that the disposal of ILAW has no impact for the compliance time studied (1,000 years). According to the latest ILAW PA analysis, at the DOE compliance time of 1,000 years, the estimated all-pathways dose in mrem/year is over 30,000 times less than the performance objective. Even at 10,000 years, this dose is a factor of approximately 350 lower than the performance objective.

In past Hanford Site PAs and environmental impact statements, the dominant pathway for contaminants was through groundwater. Moisture from precipitation can enter the engineered barrier system and cause contaminants (e.g., in a water-glass interaction) to be released, or might simply carry away already-released contaminants. The contaminated leachate can travel downward through the vadose zone until the contaminants reach the unconfined aquifer where humans can encounter the radioisotopes when recovering the groundwater resource for residential and agricultural uses. Previous ILAW analyses (Mann et al. 1998, Mann et al. 2001) also conclude that this is the dominant pathway for contaminant release from ILAW.

Table 3-1. Comparison of Estimated Impacts with Performance Objectives from the ILAW PA Analyses and from the CA.

Performance Measure	Performance Objective	Estimated Impact at 1,000 years	Estimated Impact at 10,000 years	
			1998 ILAW PA (a)	2001 ILAW PA (b)
All Pathways – CA (c)				
All-pathways [mrem in a year]	100	6	---	---
All Pathways – ILAW PA				
All-pathways [mrem in a year]	25	0.000078	6.4	0.070
Groundwater Pathway – ILAW PA				
Beta/photon emitters in groundwater [mrem in a year]	4.0	0.000021	2.0	0.010
Alpha emitters in groundwater [pCi/L]	15.0	1.0×10^{-16}	1.7	0.034
Radium in groundwater [pCi/L]	5.0	0.0	<0.001	< 0.001
Surface Water Pathway – ILAW PA				
Beta/photon emitters in surface waters [mrem in a year]	1.0	2.0×10^{-6}	0.07	0.00095
Alpha emitters in surface waters [pCi/L]	15.0	1.0×10^{-17}	0.058	0.0032
Radium in surface waters [pCi/L]	0.3	0.0	<0.001	< 0.001
Air pathway – ILAW PA				
Performance Measure	**Performance Objective**	**Estimated Impact at 1,000 years**		
		1998 ILAW PA (a)	2001 ILAW PA (b)	
Radon [pCi m^{-2} s^{-1}]	20.0	<0.001	< 0.96	
Other Radionuclides [mrem in a year]	10.0	$<10^{-8}$	< 0.006	
Inadvertent Intruder – ILAW PA(a)				
Performance Measure	**Performance Objective**	**Estimated Impact at 500 years**		
		1998 ILAW PA (a)	2001 ILAW PA (b)	
Acute (drilling) Exposure [mrem]	500.0	5.5	0.76	
Continuous (residential farming) exposure [mrem in a year]	100.0	27.5	10.2	

(a) Mann et al. 1998 (b) Mann et al.2001 (c) Kincaid et al. 1998

The most restrictive performance objective is protecting groundwater from beta/photon radionuclides where the objective is 4.0 mrem/year and the estimate at 10,000 years is 0.010 mrem/year. The point of compliance is a well 100 m downgradient from the facility. The 1998 ILAW PA had higher estimates (e.g., a beta/photon groundwater dose of 2.0 mrem/year) because it used more conservative inputs based on a poorer knowledge base. The 2001 ILAW

PA required that the disposal facility be designed so that the infiltration rate is no more than 4 mm/year, the natural infiltration rate.

Because the CA found no impact from ILAW, the CA has no impact on ILAW requirements. The IDF site closure will include construction of a final closure cover for each trench to minimize long-term intrusion or infiltration of water. The final closure cover, a Modified RCRA Subtitle C barrier (See Section 2.2.4), incorporates a drainage pathway to route any infiltrating water away from the waste.

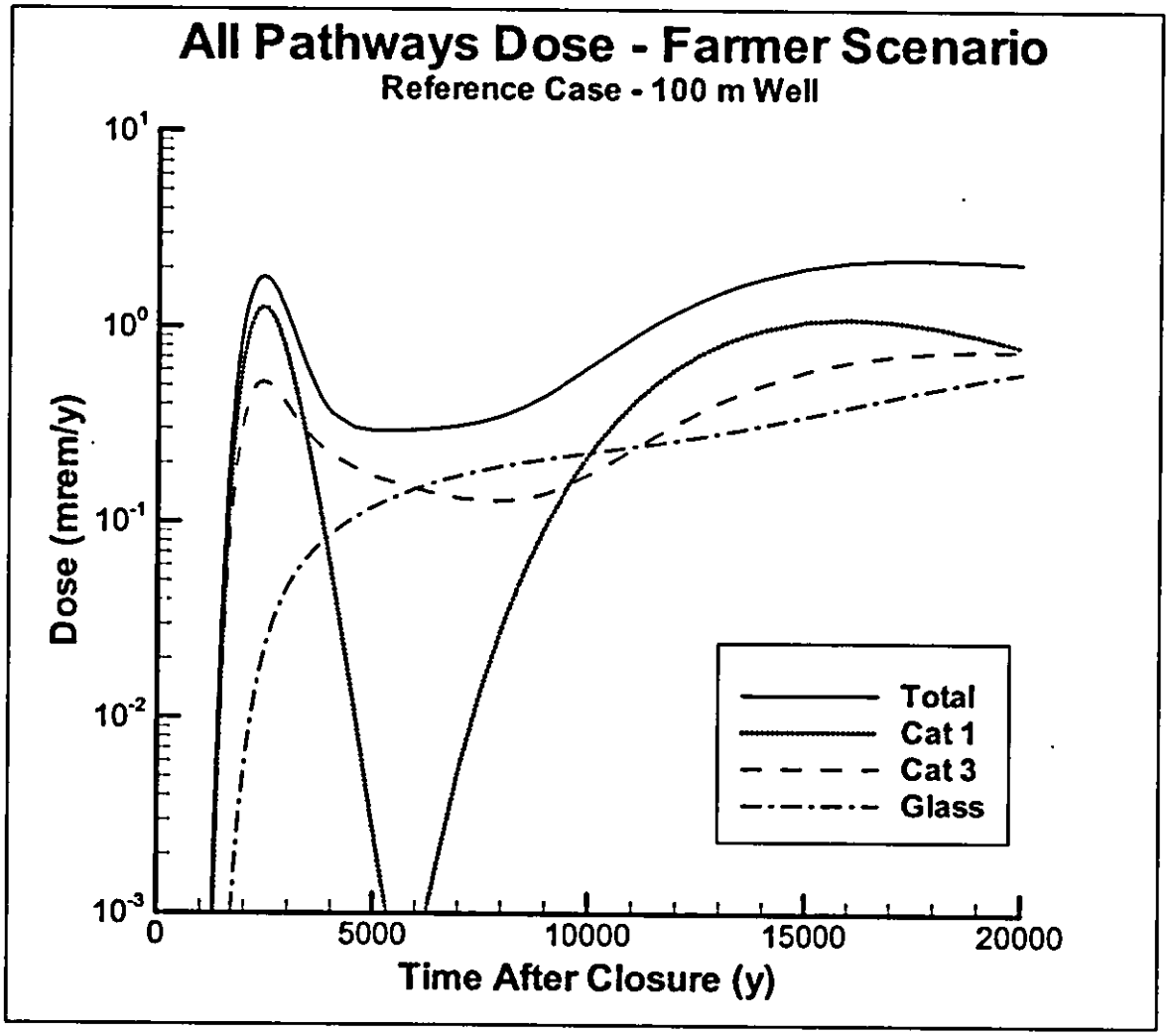
The *Integrated Disposal Facility Risk Assessment* (Mann 2003a) investigated the all-pathways impacts from all of the waste expected at IDF. Figure 3-1 displays the all-pathways estimated impacts as a function of time.

The peak groundwater impacts contained in the *Integrated Disposal Facility Risk Assessment* (Mann 2003a) are due to Category 1 waste. The impacts from Category 1, Category 3 and glass wastes are comparable at 10,000 years. Because only a relatively few Category 1 packages are expected to drive the results (i.e., those packages with high technetium/iodine content), the amount of Category 1 waste accepted is manageable (e.g., these wastes can be disposed as Category 3 waste, if necessary). Impacts from melter disposal are not significant relative to impacts from other wastes.

The contaminant breakthrough impacts for the groundwater for ILAW-glass disposal are about five times higher than those presented in the base analysis case of the *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version*, but still far below performance objectives. The key drivers are increased Tc-99 inventory due to the removal of the technetium separations process from WTP, decreased groundwater dilution due to the placement of the disposal trenches further towards the southern end of the disposal site, and the decrease in contaminant release due to the size of the containers. Additional analyses and assumptions that could reduce the estimated impacts (such as the estimated impacts from a two-dimensional modeling of the near-field (compared to one-dimensional modeling) and better waste form performance) have not been included in this analysis.

The *Risk Assessment Supporting the Decision on the Initial Selection of Supplemental ILAW Technologies* (Mann 2003c) provides estimated impacts if bulk vitrification is used. This document also updates the impacts estimated from secondary waste produced by the WTP and by bulk vitrification. Mann 2003c shows that the impacts from secondary waste are larger than from the ILAW, due to the large inventory of ^{129}I in the secondary waste and the poorer performance of the secondary waste form.

Figure 3-1. Time Dependence of the Estimated Farmer Scenario All-Pathways Dose at a Well 100 m Downgradient from the Disposal Facility.



3.1.2 Air Pathway Dose

The air pathway consists of diffusion of radioactive and hazardous gases from the disposal facility to the surface where individuals or groups are potentially at risk of exposure. Gases and vapors will travel upward through the soil to the ground surface. This pathway is maximized with minimum downward water movement. No water flow is considered in the PA calculations for the protection of air resources. The vitrification of LAW removes volatile constituents present in the waste. An insignificant inventory of volatile radionuclides remains in the ILAW.

As the latest analyses, documented in the approved ILAW PA (Mann et al. 2001) indicated, the dose from the ILAW placed in the IDF trench is not expected to be significant (see Table 3-1). As long as 5 meters of material with standard earth fill density lie between the waste and the surface, no special design feature is needed to meet the performance objective.

3.1.2.1 Radon Flux

Radon is a naturally occurring radioactive gas produced by the radioactive decay of uranium. The concentration of radon and its progeny in air is affected by a number of environmental factors including temperature, humidity, atmospheric pressure, and soil constituency. Temperature inversions commonly produce elevated radon concentrations, as do dry soils. A significant increase in radon emissions is not expected to occur as a result of ILAW disposal. The estimated impact from radon is <0.001 pCi m^{-2} s^{-1}, which is insignificant compared to the performance objective of 20.0 pCi m^{-2} s^{-1} (see Table 3-1).

3.1.3 Inadvertent Intruder

It is possible that an inadvertent intruder could drill a hole through the disposal facility to obtain groundwater. The contaminated cuttings from such an intrusion could then irradiate the intruder through direct radiation, through inhalation, or through ingestion. The latest ILAW PA (Mann et al. 2001) analyzed exposure to such an inadvertent intruder (see Table 3-1). Using present inventory estimates and packing densities, this intruder would be exposed to minor exposure during drilling and more significant exposure while living a residential farming lifestyle. However, both estimates are below performance objectives. At the time of compliance for this scenario (500 years) the combined exposure is a factor of 10 lower than the performance objective with ^{126}Sn contributing over 70 % of the dose.

The main limits imposed by the 2001 ILAW PA are the amount of ^{126}Sn disposed of in a vertical column, as well as some easily met limits on some other radionuclides.

3.1.4 Other Requirements

This section briefly describes the requirements imposed by the PA, RCRA regulations, and DOE Order 5400.5.

3.1.4.1 Requirements from Performance Assessment

The ILAW disposal PA imposes certain constraints on the configuration of the closed disposal facility. These constraints are described in Section 7.6 of the ILAW PA (Mann et al. 2001). The constraints are a function of the radionuclide concentrations in the waste and the physical properties of the waste form. The primary constraints are the following:

1. Facility orientation with respect to groundwater flow direction
2. Maximum stacking height of ILAW packages with high concentrations of certain radionuclides
3. Maximum allowable rate of infiltration of water through the closure cover.

3.1.4.2 RCRA-Based Requirements

The proposed IDF will have to be RCRA permitted in accordance with the present EPA classification of the RPP tank wastes (i.e., these wastes are classified as including listed and other hazardous wastes). The requirements are taken primarily from Title 40 of the CFR.

3.1.4.3 DOE Order 5400.5 Requirements

Institutional control shall continue until the facility can be released (DOE O 435.1) pursuant to DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

3.1.4.4 CERCLA Remedial Action and RCRA Corrective Action

This section is not applicable at this time.

3.1.4.5 Long-Term Site Stewardship

After trench loading and backfilling are completed, the top of the trench will receive a Modified RCRA Subtitle C barrier to provide appropriate protection from the weather and other types of intrusion. The IDF will be closed as a landfill with waste remaining in place. Post-closure activities will be initiated on completion of closure cap construction. The length of time required for post-closure care will depend on the results of post-closure monitoring. The need and duration of monitoring will be assessed at each permit review and renewal.

3.2 DETAILED CLOSURE ACTIVITIES

This section describes the various closure activities that will occur in stages. Preliminary trench closure, consisting primarily of backfilling activities, begins soon after placement of the first few packages of waste in the IDF. These operational/interim closure activities continue until the IDF is filled to capacity with waste packages. The final closure stage of the IDF trench begins after the last waste package is placed and backfilled.

An engineered barrier cover as described in Section 2.2.4 will be installed in accordance with RCRA regulatory requirements to minimize infiltration of precipitation into the trench and hinder the inadvertent intruder from accessing the waste packages. Once the IDF is closed, operations are reduced to the continuance of monitoring and maintenance of security systems for this facility; the waste is safeguarded and monitored by institutional control.

3.2.1 Operational/Interim Closure

The first major step in the operation of the disposal facility will be the receipt of waste packages at the IDF. Waste packages will be delivered by a transport vehicle likely consisting of a tractor-truck and trailer. Transportation studies are ongoing at this time. A mobile crane system will be used to remove the ILAW packages from the trailer-mounted shipping container and place them for disposal over a gabion shielding wall. Other waste package types may be contact handled. Each waste package placement will be closely monitored for future package retrievability.

As an array of ILAW and other waste packages advances, the space between the packages is backfilled with previously excavated soil. Soil also is added around the packages that are exposed in the outer column of the arrays. Loaders, dump trucks, bulldozers, and compactors are used to place a backfill layer of soil up to 1 m thick above the top of the waste packages. These steps during operations help to minimize the exposed surface area of waste packages. A temporary rain curtain may be used to control the amount of clean stormwater runoff that enters the leachate collection system. The rain curtain can be used in areas where no waste has been placed or in the areas where waste packages and the full operations layer have been placed. Because the collected water will not have contacted waste packages, it can be discharged as stormwater and reduce the amount of precipitation that ends up as leachate.

3.2.2 Final Disposal Site Closure

Final disposal site closure consists of installing the Modified RCRA Subtitle C barrier on the IDF, decontaminating and decommissioning no-longer-needed ancillary facilities, compiling a final inventory of the waste disposed in the facility, placing permanent facility location markers, preparing the disposal site for post-closure monitoring and maintenance, and submitting the required certifications that the IDF has been closed to the regulatory authority. A description of the Modified RCRA Subtitle C barrier, which is an important part of final site closure, is located in Section 2.2.4 and is illustrated in Figure 2-6. Equipment decontamination will comply with DOE/RL-96-109, the *Hanford Site Radiological Control Manual* (DOE/RL 1994).

3.2.2.1 Closure Cover Installation

The waste packages will be backfilled during the interim closure as described in Section 3.2.1. The first step will be to augment the backfill layer with a grading fill layer that will be of variable thickness because of a 2 % slope requirement for the closure cover. The closure cover installation process is described in detail in Section 2.2.4.

3.2.2.2 Records Management Plan for Documents and Records Generated During Final Closure

Records concerning the disposal-product receipt acceptance and the total inventory of waste placed in the facility will be maintained as a part of the permanent closure documentation (DOE O 435.1 and WAC 246-247), in accordance with TFC-BSM-IRM_DC-C-02, *Records Management Programs Standards*. Records must also include 40 CFR 268 and WAC 173-303-380 land disposal restriction certification and records supporting waste verification and confirmation through the operating life of the IDF.

Before final closure of the disposal facility, records of the final inventory of waste placed in the facility will be made available for additional updating of the PA and the closure plan.

3.2.2.2.1 Inventory

At the time of final closure of the disposal facility, the PA (DOE O 435.1) will be updated to include the final inventory of waste placed in the facility. The total volume of wastes currently stored in the 177 underground storage tanks is estimated at 204,000 m^3 in the form of liquids, sludges, and saltcakes. IDF total phase 1 capacity is 163,000 m^3. The full build out capacity of IDF is 900,000 m^3.

3.2.2.2.2 Records

Records concerning the disposal-product receipt acceptance and the total inventory of waste placed in the facility will be maintained as a part of closure (DOE O 435.1 and WAC 246-247).

3.2.3 Institutional Control

Institutional control shall continue until the facility can be released (DOE O 435.1) pursuant to DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

3.2.4 Unrestricted Release of Site

For the site to be released, it must meet all pertinent requirements of *The Hanford Site Radiological Control Manual* (DOE/RL 1994); 10 CFR 835, *Occupational Radiation Protection*; and WAC 173-303, *Dangerous Waste Regulations*. Figure 3-2 shows the estimated timetable for the various stages of facility stabilization and control.

The DOE, along with the U.S. Department of Interior, local governments, and affected tribal nations, has issued a comprehensive land use plan for the Hanford Site for at least the next 50 years (DOE 1999b). The plan indicates that the 200 Areas (or Central Plateau) would be used exclusively for the management of Hanford Site waste.

The long-term use of the Hanford Site has been the subject of some concern. In 1992, the HFSUWG (consisting of local, state, and federal officials, representatives of tribal nations, people from agriculture and labor, as well as members of environmental and special interest groups) was charged to determine potential future uses of the various parts of the Hanford Site. Their summary report (HFSUWG 1992) makes the following statement:

> "In general, the Working Group desires that the overall cleanup criteria for the Central Plateau should enable general usage of the land and groundwater for other than waste management activities in the horizon of 100 years from the decommissioning of waste management facilities and closure of disposal areas."

However, except for the inadvertent intruder scenario, the scenarios described here assume that some controls remain in place to prevent public intrusion into the disposal site (i.e., the barriers and markers that have been left are effective in preventing open use of the land directly above the disposal site).

3.2.4.1 Authorized Limits for Residual Radioactive Material

Limits for residual radioactive material will comply with the current version of DOE/RL-96-109, Rev. 2, *Hanford Site Radiological Control Manual* (DOE/RL 1994); 10 CFR 835, "Occupational Radiation Protection." The closed site will be posted as an Underground Radioactive Material Area. The closed site is not expected to be a contamination area or a radiation area.

3.2.4.2 Identification of Other Requirements Applicable to Release of Property

No other requirements have been identified for this revision; but should other requirements be identified, they will be added to future versions of this closure plan.

3.2.4.3 Comparison of Existing Site Conditions to Requirements for Unrestricted Release

Because the closed site will be posted as an Underground Radioactive Material Area, it is not expected to meet requirements for unrestricted release.

3.3 MONITORING

Following disposal operations, the IDF will be closed by placing an engineered barrier (cover) over the waste. Final closure follows completion of operations to prepare the disposal site for post-closure monitoring and maintenance. Implementation of monitoring activities for the IDF disposal systems will begin with the operations phase and will continue in some form throughout the subsequent phases of a disposal facility's lifetime. To assist the reader in relating to these defined phases of a disposal facility's lifetime, Figure 3-2 offers a perspective on the approximate duration of these phases. These definitions appear in a guidance document on LLW disposal (DOE 1992). The monitoring activities for the disposal facility will be tailored to the information needs during these respective phases.

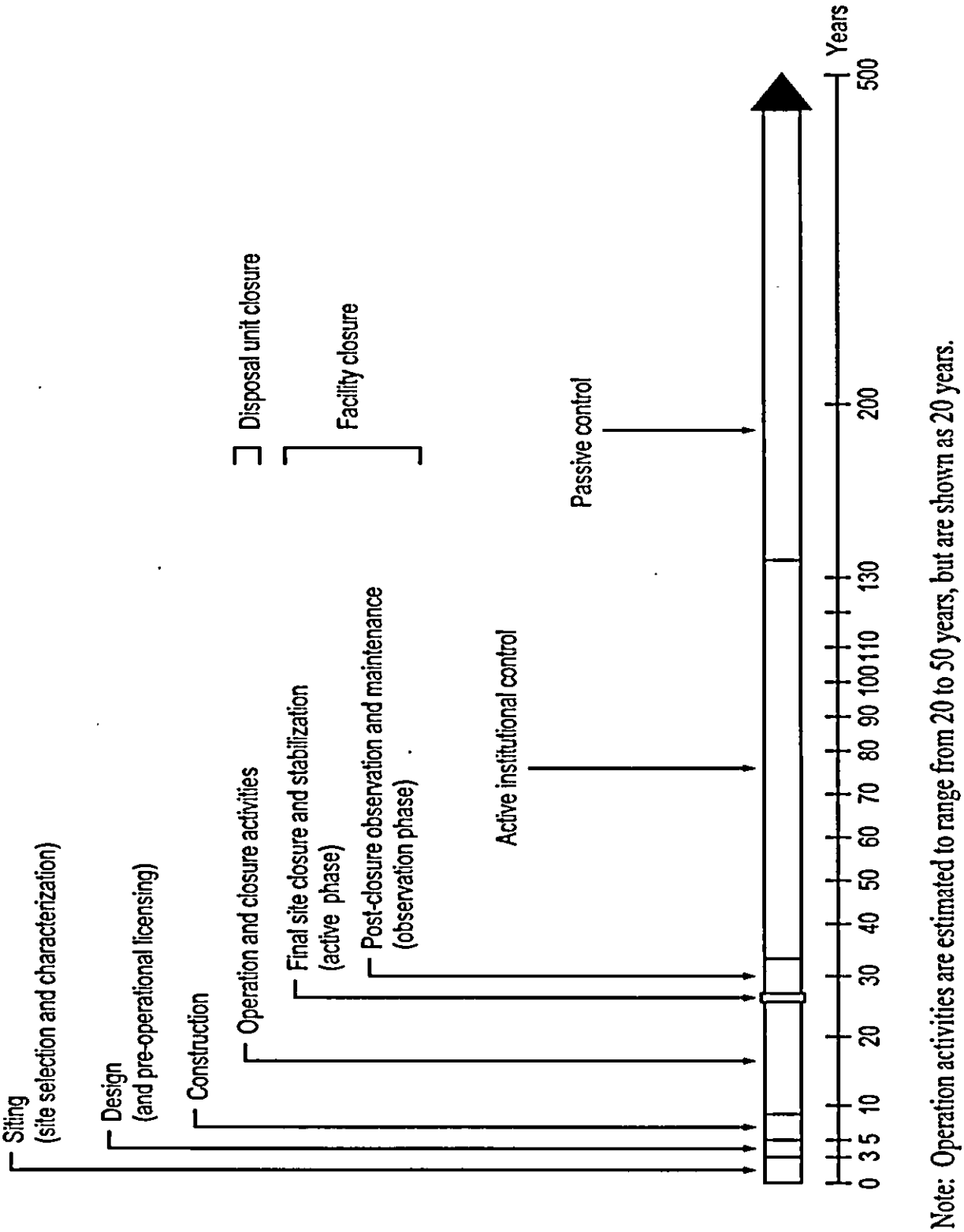
3.3.1 Operational/Interim Closure

This section describes monitoring activities that will be implemented during operations to monitor the performance of interim closure measures. During the operational/interim closure activities, the volume of leachate collected, along with any radionuclides, will be monitored. Groundwater also will be monitored in accordance with Hartman et al. (1999). The IDF groundwater monitoring network will be integrated with the Hanford Groundwater Monitoring Network, and will have six wells: one upgradient and five downgradient (Horton et al. 2000). The downgradient wells will be placed so as to sample groundwater passing the point of compliance. The point of compliance at the IDF site is a plane connecting the groundwater monitoring wells along the southern and eastern sides of the site in accordance with WAC 173-303-645 and as described in the RCRA Part B Permit Application (DOE/RL 2003-12).

3.3.1.1 Application of the Data Quality Objectives (DQO) Process

The DQO process will be applied to identify the specific data that should be collected during monitoring and will be reported in a later version of this closure plan.

Figure 3-2. Approximate Integrated Disposal Facility Site Activity Duration. (DOE 1992)



Note: Operation activities are estimated to range from 20 to 50 years, but are shown as 20 years.

3.3.1.2 Summary of Quality Assurance/Quality Control Procedures

Effective quality and environmental safety and health protection programs will be established and maintained to ensure the requisite level of quality, safety, and environmental compliance in all areas of onsite waste transportation and disposal facility design, construction, test evaluation, and maintenance of waste-form qualification.

The IDF will implement the quality requirements to ensure that systems, structures, and components (design features) needed to ensure and document product quality are provided and available for use by individuals during the operations phase of the facility life-cycle. The DOE can influence the quality of the immobilized waste by confirming, documenting, and enforcing the continued quality of the WTP's product.

Integrated Disposal Facility Project Quality Assurance Program Plan, TFC-PLN-20, requirements are derived from 10 CFR 830.120, *Quality Assurance for Nuclear Facilities* and DOE O 414.1, *Quality Assurance*. Public safety, onsite worker safety, environmental protection, and maintenance of waste form qualification are overriding considerations for the project. The commitment to safety by the ORP dictates that management and verification activities to ensure safety and environmental considerations be reflected in the design, procurement, construction, and operation of the project. These management controls and verification activities are described in the referenced Quality Assurance Program Plan. Audits, surveillance activities, and/or assessments will be conducted periodically by the RPP Quality Assurance organizations to verify that quality requirements are being met.

3.3.2 Final Closure/Institutional Care

Within 60 days of post-closure care completion, the DOE will submit by registered mail or an equivalent delivery service to the regulatory authority both a self-certification and a certification by an independent registered professional engineer that the IDF has been closed in accordance with the specifications of the approved post-closure plan.

3.3.2.1 Owner/Operator Post-closure Certification

The DOE will self-certify using the following statement or a statement similar to it.

> "I, (name), an authorized representative of the U.S. Department of Energy, Office of River Protection, located at 2440 Stevens Center, Richland, Washington, hereby state and certify that the Integrated Disposal Facility at the 200 East Area, to the best of my knowledge and belief, has been closed in accordance with the attached approved post-closure plan, and that the post-closure period was completed on (date). (Signature and date.)"

3.3.2.2 Professional Engineer Post-closure Certification

The DOE will engage an independent professional engineer to certify that the IDF has been closed in accordance with the approved post-closure plan. The DOE will require the engineer to sign the following statement or a statement similar to it.

> "I, (name), a certified professional engineer, hereby certify, to the best of my knowledge and belief, that I have made visual inspection(s) of the Integrated Disposal Facility at the 200 East Area and that post-closure activities of the aforementioned facility have been performed in accordance with the attached approved post-closure plan. (Signature, date, state professional engineer license number, business address, and phone number.)"

3.3.2.3 Application of the Data Quality Objectives (DQO) Process

The DQO process will be applied to identify the specific data that should be collected during monitoring and will be reported on in a later version of this closure plan.

3.3.2.4 Summary of Quality Assurance/Quality Control Procedures

Effective quality and environmental safety and health protection programs will be established and maintained to ensure a requisite level of quality, safety, and environmental compliance in all areas of onsite waste transportation and disposal facility design, construction, test evaluation, and maintenance of waste form qualification.

The IDF Project will implement the quality requirements to ensure that systems, structures, and components (design features) needed to ensure and document product quality are provided and available for use by individuals during the operations phase of the facility life cycle.

The Quality Assurance Program Plan (QAPP) requirements are derived from 10 CFR 830.120, *Quality Assurance for Nuclear Facilities* and DOE O 414.1, *Quality Assurance*. Public safety, onsite worker safety, environmental protection, and maintenance of waste form qualification are overriding considerations for the project. The commitment to safety by the ORP dictates management and verification activities to ensure safety and environmental considerations are reflected in the design, procurement, construction, and operation of the project. These management controls and verification activities are described in the referenced QAPP. Audits, surveillance activities, and/or assessments will be conducted periodically by the RPP Quality Assurance organizations to verify that quality requirements are being met.

3.3.3 Monitoring Parameters Of Closure Cap System

The IDF project will use the results of the Sitewide monitoring program and the ILAW preoperational monitoring plan (Horton et al. 2000) discussed in Section 1.6.2 to determine the adequacy of groundwater models. In addition to monitoring to ensure that the IDF site remains physically undisturbed, it is important to monitor the hydraulic characteristics of the IDF, such as water penetration and drainage requirements. The concept of a leachate collection system and groundwater monitoring wells has been discussed in Section 1.3.1.1. At this stage of the IDF, it is difficult to determine exactly the types and frequency of monitoring.

This section provides information on the monitoring parameters for degradation mechanisms pertaining to the closure cap system. Examples of parameters that could be used to monitor the post-closure physical integrity of the various layers of the closure cap system appear in Tables 3-2, through 3-5. These parameters were derived from the DOE (1992) guidance document on closure of the IDF. For a detailed listing of inspection activities to consider regarding closure cover barriers, see Table 5-4 in DOE (1992).

Table 3-2. Candidate Monitoring Parameters for the Degradation Mechanisms Relevant to the Sand/Gravel Layer and Drainage Backfill.

Mechanism	Definition	Measurable Parameters
Sedimentation	Mechanical or hydraulic transport of finer grained particles in pore spaces	Bulk density/porosity Infiltration
Differential settlement	Mechanical settling from changing weight and compaction of host materials, waste, and cover	Change in cover elevation Horizontal continuity and thickness

DOE, 1992, *Considerations for Closure of Low-Level Radioactive Waste Engineered Disposal Facilities*, DOE/LLW--133, January 1992, National Low-Level Waste Management Program, Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho.

Table 3-3. Candidate Monitoring Parameters for Degradation Mechanisms Relevant to the Surface Layers of the Closure Cap System.

- Meteorologic conditions
  - Rainstorm intensity and duration
  - Wind velocity
- Drainage characteristics
  - Drainage patterns
  - Rill and gully characteristics
  - Hydraulic roughness
  - Surface runoff rates
- Soil properties
  - Particle size and shape distribution
  - Particle cohesion
  - Soil bulk density
  - Soil structure and aggregation
  - Organic matter content
  - Chemical properties
  - Aggregate strength and stability
- Microtopography
  - Elevation
  - Slope aspect, length, and shape
- Vegetation canopy
  - Canopy type
  - Average canopy height
  - Percent canopy cover
- Vegetation root system
  - Extent and length
  - Soil stabilization potential
  - Water extraction potential
- Vegetation habitat characteristics
  - Succession species
  - Seasonal changes
  - Species hardiness
- Animal habitat characteristics
  - Succession species
  - Burrow extent and depth

DOE, 1992, *Considerations for Closure of Low-Level Radioactive Waste Engineered Disposal Facilities*, DOE/LLW--133, January 1992, National Low-Level Waste Management Program, Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho.

Table 3-4. Candidate Monitoring Parameters for Degradation Mechanisms Relevant to the Low-Permeability Layers.

Mechanism	Definition	Measurable Parameters
Biological intrusion	Animal or plant intrusion into the cover	Animal or insect burrow depth Plant root depth
Differential settlement	Mechanical settling from changing weight and compaction of host materials, waste and cover	Horizontal continuity and thickness
Freeze/thaw	Alternate freezing and thawing of low-permeability layers resulting in cracking	Soil temperature/frost depth

DOE, 1992, *Considerations for Closure of Low-Level Radioactive Waste Engineered Disposal Facilities*, DOE/LLW--133, January 1992, National Low-Level Waste Management Program, Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho.

Table 3-5. Candidate Monitoring Parameters for Degradation Mechanisms Relevant to the Vegetative Cover Layer of the Closure Cap System

Mechanism	Definition	Measurable Parameters
Water erosion	Movement of cover material from normally occurring site precipitation	Precipitation characteristics Soil loss or movement Change in cover elevation
Wind erosion	Movement of cover material from normal occurring site winds	Wind characteristics Soil loss or movement Change in cover elevation
Denudation	Vegetation stress leading to plant death without new plant growth	Vegetation characteristics Climatic conditions Brush fires.
Human activities	Cover disturbance by primarily equipment operation and sample collection	Soil loss or movement Miscellaneous disturbance
Biological intrusion	Animal or plant intrusion into the cover	Animal or insect burrow depth Plant root depth
Freeze/thaw	Alternate freezing and thawing of near-surface soil moisture	Soil temperature Soil cracking or heaving Water ponding or excessive mud
Differential settlement	Mechanical settling from changing weight and compaction of host materials, waste and cover	Change in cover elevation Cover movement

DOE, 1992, *Considerations for Closure of Low-Level Radioactive Waste Engineered Disposal Facilities*, DOE/LLW--133, January 1992, National Low-Level Waste Management Program, Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho.

3.3.4 Washington State Requirements for Air Monitoring

Air monitoring will be required at the IDF. The New Source Review confirmed a Notice of Construction was not required but an Air Permit issued by the Washington State Department of Health will be required for operations. The IDF has been classified as a "diffuse source." Current plans for air monitoring include 3 air sampling stations, one upwind and two downwind. In addition, TLDs will be placed at each air sampler location. Additional information on air monitoring will be included in updates to this closure plan.

3.3.5 Security

A Sitewide security program is in place at the Hanford Site that fully complies with DOE O 470.1, *Safeguards and Security Program* and with DOE O 472.1B, *Personnel Security Activities*. This program will encompass the IDF. IDF security shall also comply with WAC 173-303-310 and security requirements defined in the RCRA Part B Permit Application (DOE/RL 2003-12).

Security will be a part of the activities associated with establishing and implementing the disposal of waste on the Hanford Site. The IDF is located within the Hanford Facility controlled-access area. Roadways within the controlled area are restricted to authorized personnel and are not accessible by the general public. The IDF will be patrolled by the Hanford Patrol. The Modified RCRA Subtitle C barrier that will be placed over the disposal facility will serve as an inadvertent intruder prevention barrier if only by virtue of the minimum 5 meter thickness.

Both non-radiological and radiological safety issues will be addressed by the application of certain security measures. Selected combinations of active and passive types of security systems likely will be used during most phases of the disposal facility lifetime. Examples of active security systems include such measures as full-time security personnel at the facility site, visits to the site and facility at intervals by security staff, and active sensor systems. Passive security systems would include such options as fencing, signs, and access controls.

Security at the disposal site, for general safety purposes, would begin well before waste was brought into the site for disposal. Both road access and land access presently are controlled with respect to public access.

Before the disposal site begins receiving waste, the security system will need to be enhanced to fulfill the added obligation for the radiological safety and control of the sites and facilities. Both active and passive types of security measures will be employed during waste-receiving, facility-closure, site-closure, and post-closure phases. Once closure work has been completed security personnel might no longer be needed as part of any active security component of these security systems.

3.3.5.1 Security Control Devices

A locking hasp is welded to the cap and casing of each groundwater monitoring well used for monitoring for the IDF. The wells are protected from tampering or damage by the installation of steel guard posts and a padlock. The overall condition of each well will be inspected and its condition noted in the logbook during each groundwater sampling event. Items inspected include padlocks, well casing, guard posts, and pumps. All accessible metallic components will be inspected for excessive corrosion.

4.0 CLOSURE SCHEDULE

Disposal operations are expected to last for 30 years or more. A single trench will be built and expanded as required for additional waste capacity. Closure activities will be instituted when the IDF is at final capacity, approximately 2032. Please see section 1.5.

The project dates may change as a result of renegotiation of the Tri-Party Agreement (Ecology et al. 1996), which sets the cleanup schedule for the Hanford Site, and as a result of contract renegotiation related to the extension of the treatment contract. Figure 3-2 illustrates the duration of closure activities at the disposal site.

5.0 SAFETY CONSIDERATIONS DURING DISPOSAL FACILITY CLOSURE

The closure task must be conducted in a manner that protects the health and safety of both the facility personnel and the general public. The following sections discuss topical aspects of such safety considerations during closure.

5.1 REGULATORY REQUIREMENTS

The U.S. Occupational Safety and Health Administration (OSHA), NRC, Ecology, EPA, and DOE have issued operational safety requirements relevant to the closure tasks associated with disposal facilities.

The OSHA administers the requirements of the *Occupational Safety and Health Act of 1970*, as amended. The closure and post-closure maintenance operations of the IDF will comply with the occupational safety requirements of 29 CFR 1910.120 (29 CFR 1910).

The applicable Ecology and EPA health and safety regulations for mixed waste disposal facilities focus primarily on hazards associated with the handling operations for hazardous waste (WAC 173-303, 40 CFR 270). The operations, closure, and post-closure monitoring stages of the ILAW disposal facility will meet these regulations.

For further information regarding the NRC and EPA safety related guidance and requirements, see DOE (1992). The DOE Order 5820.2A and its replacement, DOE O 435.1 impose general requirements on safety at such facilities. These orders also cross-link with other DOE orders.

5.1.1 Analyses

In planning and implementing the safety program supporting the disposal facility, the potential safety hazards, risks, and consequences will be assessed in a series of analyses. These analyses will address the closure task and its activities. The safety basis and associated criticality safety evaluation report are drafted but not finalized at this time. Additional information on the safety basis will be presented in an update of this closure plan.

5.1.2 Planning

Safe and timely closure of the disposal facility will require careful planning and management. In addition to an operations plan, a detailed health and safety plan is critical to the successful stabilization and closure of a disposal site. This plan should be prepared, reviewed, and approved before stabilization and closure operations begin (DOE 1992).

5.2 IMPLEMENTATION

Closure activities related to safety will be covered by a combination of the parts of the safety program created for the operational phase and supplemental planning and training to address activities unique to the closure task, e.g., decontamination/decommissioning of excess buildings and equipment, construction of the closure barrier system.

5.2.1 Training

During closure, the new-employee orientations, radiation protection training, safety meetings, and training in the operations of equipment that began during the operational phase of the facility will continue. Supplemental training tailored to closure operations will address task-specific areas such as equipment rigging or dismantling and decontamination of the support buildings. A more detailed example of a recommended personnel-training matrix is presented in Table 8-1 of DOE 1992. Training information is also provided in chapter 8 of the RCRA Part B Permit Application (DOE/RL 2003-12).

5.2.2 Inspections and Reviews

Safety inspections and reviews of ongoing activities will be part of the safety program. The closure task will involve a variety of non-routine construction tasks that will present potential challenges to safe operations. Both routine and non-routine tasks will be addressed by the safety program.

5.2.3 Emergency Response

A link with the overall emergency response program for the proposed disposal facility will need to be maintained to handle events outside the bounds of normal operational safety. The appropriate responses to emergency situations will be incorporated into the training matrix, and drills will be conducted as appropriate to familiarize personnel with emergency scenarios and suitable responses.

6.0 REFERENCES

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations*, as amended.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*, as amended.

29 CFR 1910, "Occupational Safety and Health Standards," *Code of Federal Regulations*, as amended.

40 CFR 260, "Hazardous Waste Management System," *Code of Federal Regulations*, as amended.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, as amended.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, as amended.

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations*, as amended.

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