PART III, OPERATING UNIT 3 UNIT-SPECIFIC CONDITIONS

Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility

The Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility (LERF and 200 Area ETF) consists of an aqueous waste treatment system that provides storage and treatment for a variety of aqueous mixed waste located in the 200 East Area.

This document sets forth the operating conditions for the LERF and 200 Area ETF.

III.3.A COMPLIANCE WITH PERMIT CONDITIONS

The Permittees shall comply with all requirements set forth in the Hanford Facility RCRA Permit (Permit) as specified in Permit Attachment 3, Permit Applicability Matrix, including all approved modifications. All chapters, subsections, figures, tables, and appendices included in the following unit-specific Permit Conditions are enforceable in their entirety.

In the event that the Part III-Unit-Specific Conditions for Operating Unit 3, LERF and 200 Area ETF conflict with the Part I-Standard Conditions and/or Part II-General Facility Conditions of the Permit, the unit-specific conditions for Operating Unit 3, LERF and 200 Area ETF prevail.

OPERATING UNIT 3:

Chapter 1.0	Part A Form, Revision 0, dated May 2005
Chapter 2.0, §2.1	Topographic Map (refer to Chapter 1.0)
Chapter 3.0	Waste Analysis Plan, dated June 30, 2007
Chapter 4.0	Process Information, dated June 30, 2007
Chapter 5.0	Groundwater Monitoring (PNNL-11620 & WHC-SD-EN-AP-024), dated October 2006
Chapter 6.0	Procedures to Prevent Hazards, dated June 30, 2007 (also refer to Permit Attachment 33, §6.1)
Chapter 7.0	Contingency Plan, dated June 30, 2007
Chapter 8.0	Personnel Training, dated October 2006
Chapter 11.0	Closure and Postclosure Requirements, dated October 2006
Chapter 12.0	Reporting and Recordkeeping (refer to Permit Attachment 33, Table 12.1)

III.3.B UNIT-SPECIFIC CONDITIONS FOR LERF AND 200 AREA ETF

III.3.B.1 Portions of Permit Attachment 4, *Hanford Emergency Management Plan*, (DOE/RL-94-02) that are not made enforceable by inclusion in the applicability matrix for that document are not made enforceable by reference in this document.

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Chapter 1.0 Part A Form

1.0 PART A FORM 1.i

1.0 PART A, DANGEROUS WASTE PERMIT

The following is a chronology of the regulatory history of the Liquid Effluent Retention Facility (LERF) and 200 Area Effluent Treatment Facility (ETF).

LERF:

- February 26, 1990, submitted Hanford Facility Dangerous Waste Part A Permit Application (Part A), Form 3, Revision 0, to the Washington State Department of Ecology (Ecology).
- June 26, 1991, Part A, Form 3, Revision 1, added nonspecific source Dangerous Waste (DW) Number F005 to corresponded with the DW numbers from the Double-Shell Tank (DST) System and 242-A Evaporator.
- May 17, 1993, Part A, Form 3, Revision 2, added nonspecific source DW Numbers F001, F002, and F004 to corresponded with the DW numbers from the DST System and 242-A Evaporator.
- November 4, 1994, Part A, Form 3, Revision 3, added nonspecific source DW Number F003 to correspond with the DW numbers from the DST System and 242-A Evaporator.
- February 9, 1996, Part A, Form 3, Revision 4, added treatment capability (for treatment of dilute aqueous waste streams from other Hanford Facility generators) pursuant to treatment surface impoundment exemption located in Title 40 Code of Federal Regulations Part 268.4
- October 1, 1996, Part A, Form 3, Revision 5, supported transition of this treatment, storage, and/or disposal (TSD) unit to the new Project Hanford Management Contractor (PHMC).
- May 22, 1998, Part A, Form 3, Revision 6, was submitted to increase the waste management capacity from 24,605,000 liters per basin to 29,500,000 liters per basin.

200 Area ETF:

- June 26, 1991, submitted Part A, Form 3, Revision 0, to Ecology.
- August 25, 1993, Part A, Form 3, Revision 1, added three 2,536,000-liter verification tanks for greater-than-90 day storage and a greater-than-90 day container storage area. Added six new DW numbers to reflect waste that could be stored in the verification tanks and 32 new DW numbers that could be stored in the container storage area.
- October 1, 1996, Part A, Form 3, Revision 2, supported transition of this TSD unit to the new (PHMC). Added DW Number F039 (multi-source leachate). DW Number F039 added to support Low-Level Burial Grounds efforts to treat, store, and/or dispose of multi-source leachate from the mixed waste trenches and from other potential sources of leachate.
- May, 22, 1998, Part A, Form 3, Revision 3, added treatment of waste in containers as a new process. This process addressed sludge that accumulates in the bottoms of the ETF process tanks. This waste is periodically removed and placed into containers. The waste is solidified by decanting the supernate from the container and the remainder of the waste evaporates or absorbents are added as necessary to address remaining liquids. Following treatment, this waste is stored at the ETF or transferred to another TSD unit.

LERF/200 Area ETF:

- May 2005, Part A, Revision 0, adopted the new Ecology Part A Form [ECY 030-31 Hanford (Rev. 3/5/04)], and combined the LERF and 200 Area ETF Part A Forms on one Part A.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Dangerous Waste Permit Application Part A Form

Date Received	Reviewed by: Kathy Conaway	Date: 07/25/2005
Month Day Year	Approved by: Greg P. Davis	Date: 08/10/2005
07/11/2005	**Please refer to instructions for completing this form.**	

I. This form is submitted to: (place an "X" in the appropriate box)

☒	**Request modification to a final status permit (commonly called a "Part B" permit)**
☐	**Request a change under interim status**
☐	**Apply for a final status permit. This includes the application for the initial final status permit for a site or for a permit renewal (i.e., a new permit to replace an expiring permit).**
☐	**Establish interim status because of the wastes newly regulated on:** (Date)
	List waste codes:

II. EPA/State ID Number

WA7890008967

III. Name of Facility

US Department of Energy – Hanford Facility

IV. Facility Location (Physical address not P.O. Box or Route Number)

A. Street

825 Jadwin

City or Town	State	ZIP Code
Richland	WA	99352

County Code (if known)	County Name
005	Benton

B. Land Type	C. Geographic Location Latitude (degrees, mins, secs)	Longitude (degrees, mins, secs)	D. Facility Existence Date Month Day Year
F	SEE TOPO	MAP	03/22/1943

V. Facility Mailing Address

Street or P.O. Box

P.O. Box 550

City or Town	State	ZIP Code
Richland	WA	99352

VI. Facility contact (Person to be contacted regarding waste activities at facility)		
Name (last)	**(first)**	
Klein	Keith	
Job Title	**Phone Number (area code and number)**	
Manager	(509) 376-7395*	
Contact Address		
Street or P.O. Box		
P.O. Box 550		
City or Town	**State**	**ZIP Code**
Richland	WA	99352

VII. Facility Operator Information		
A. Name	**Phone Number (area code and number)**	
Department of Energy * Owner/Operator Fluor Hanford** Co-Operator for 200 Area ETF	(509) 376-7395* (509) 375-3576 **	
Street or P.O. Box		
P.O. Box 550 * P.O. Box 1000 **		
City or Town	**State**	**ZIP Code**
Richland	WA	99352
B. Operator Type F		
C. Does the name in VII.A reflect a proposed change in operator?	☐ Yes ☒ No	
If yes, provide the scheduled date for the change:	**Month**	**Day** / **Year**
D. Is the name listed in VII.A. also the owner? If yes, skip to Section VIII.C.	☐ Yes ☒ No	

VIII. Facility Owner Information		
A. Name	**Phone Number (area code and number)**	
Keith A. Klein, Operator/Facility-Property Owner	(509) 376-7395*	
Street or P.O. Box		
P.O. Box 550		
City or Town	**State**	**ZIP Code**
Richland	WA	99352
B. Operator Type F		
C. Does the name in VII.A reflect a proposed change in operator?	☐ Yes ☒ No	
If yes, provide the scheduled date for the change:	**Month**	**Day** / **Year**

IX. NAICS Codes (5/6 digit codes)													
A. First							**B. Second**						
5	6	2	2	1		Waste Treatment & Disposal	9	2	4	1	1	0	Administration of Air & Water Resource & Solid Waste Management Programs
C. Third							**D. Fourth**						
5	4	1	7	1	0	Research & Development in the Physical, Engineering, & Life Sciences	9	9	9	9	9	9	Unclassified Establishments

X. Other Environmental Permits (see instructions)

A. Permit Type	B. Permit Number	C. Description
E	TSCA03-1 0-22	TSCA approval, 40 CFR 761
E	WCM-27	40 CFR 761.61(c), TSCA risk-based approval 2003-10-22
E	NOC-93-3	WAC 173-400, General Regulations for Air Pollution Sources/WAC 173-460, Controls for New Sources of Toxic Air Pollutants
E	NOC-96NW-1-301	WAC 173-400, General Regulations for Air Pollution Sources/ WAC 173-460, Controls for New Sources of Toxic Air Pollutants
E	AIR-04-1 01	WAC 246-247, Radiation Protection -- Air Emissions
U	ST 4500	WAC 173-216, State Waste Discharge Permit Program, Sitewide Permit for miscellaneous streams
U	ST 4511	WAC 173-216, State Waste Discharge Permit Program, Sitewide Permit for miscellaneous streams

XI. Nature of Business (provide a brief description that includes both dangerous waste and non-dangerous waste areas and activities)

Construction of the Liquid Effluent Retention Facility (LERF) began in 1990. Waste management operations began at LERF in April 1994. Construction of the 200 Area Effluent Treatment Facility (ETF) began in 1992. Waste management operations began at ETF in November of 1995.

The LERF and ETF comprise an aqueous waste treatment system located in the 200 East Area that provides storage and treatment for a variety of aqueous mixed waste. This aqueous waste includes process condensate from the 242-A Evaporator and other aqueous waste generated from onsite remediation and waste management activities.

The LERF consists of three lined surface impoundments, or basins. Aqueous waste from LERF is pumped to the ETF for treatment in a series of process units, or systems, that remove or destroy dangerous waste constituents. The treated effluent is discharged to a State-Approved Land Disposal Site (SALDS) north of the 200 West Area, under the authority of a Washington State Waste Discharge Permit (ST4500) and the Final Delisting (40 CFR 261, Appendix IX, Table 2)

Sludge that accumulates in the bottoms of ETF process tanks is removed periodically and placed into containers. The waste is solidified by decanting the supernate from the container and the remainder of the liquid is allowed to evaporate, or absorbents are added, as necessary, to address the residual liquid. The process design capacity for treatment of waste in containers (T04) is 18,927 liters per day.

EXAMPLE FOR COMPLETING ITEMS XII and XIII (shown in lines numbered X-1, X-2, and X-3 below): A facility has two storage tanks that hold 1200 gallons and 400 gallons respectively. There is also treatment in tanks at 20 gallons/hr. Finally, a one-quarter acre area that is two meters deep will undergo *in situ vitrification.*

Section XII. Process Codes and Design Capacities								Section XIII. Other Process Codes								
Line Number		A. Process Codes (enter code)			B. Process Design Capacity		C. Process Total Number of Units	Line Number		A. Process Codes (enter code)			B. Process Design Capacity		C. Process Total Number of Units	D. Process Description
					1. Amount	2. Unit of Measure (enter code)							1. Amount	2. Unit of Measure (enter code)		
X	1	S	0	2	1,600	G	002	X	1	T	0	4	700	C	001	In situ vitrification
X	2	T	0	3	20	E	001									
X	3	T	0	4	700	C	001									
	1	S	0	4	88,500,000	L	003		1	T	0	4	18,927	V	001	container treatment
	2	T	0	2	88,500,000	V	003		2							
	3	S	0	2	7,608,654	L	017		3							
	4	T	0	1	817,646	V	017		4							
	5	S	0	1	147,630	L	003		5							
	6	T	0	4	18,927	V	001		6							
	7								7							
	8								8							
	9								9							
1	0							1	0							
1	1							1	1							
1	2							1	2							
1	3							1	3							
1	4							1	4							
1	5							1	5							
1	6							1	6							
1	7							1	7							
1	8							1	8							
1	9							1	9							
2	0							2	0							
2	1							2	1							
2	2							2	2							
2	3							2	3							
2	4							2	4							
2	5							2	5							

XIV. Description of Dangerous Wastes

Example for completing this section: A facility will receive three non-listed wastes, then store and treat them on-site. Two wastes are corrosive only, with the facility receiving and storing the wastes in containers. There will be about 200 pounds per year of each of these two wastes, which will be neutralized in a tank. The other waste is corrosive and ignitable and will be neutralized then blended into hazardous waste fuel. There will be about 100 pounds per year of that waste, which will be received in bulk and put into tanks.

Line Number			A. Dangerous Waste No. (enter code)				B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)	D. Processes									
									(1) Process Codes (enter)									(2) Process Description [If a code is not entered in D (1)]
X	1		D	0	0	2	400	P	S	0	1	T	0	1				
X	2		D	0	0	1	100	P	S	0	2	T	0	1				
X	3		D	0	0	2												Included with above
		1	D	0	0	1	88,497,000	K	S	0	4	T	0	2				
		2	D	0	0	2		K	S	0	4	T	0	2				
		3	D	0	0	3		K	S	0	4	T	0	2				
		4	D	0	0	4		K	S	0	4	T	0	2				
		5	D	0	0	5		K	S	0	4	T	0	2				
		6	D	0	0	6		K	S	0	4	T	0	2				
		7	D	0	0	7		K	S	0	4	T	0	2				
		8	D	0	0	8		K	S	0	4	T	0	2				
		9	D	0	0	9		K	S	0	4	T	0	2				
	1	0	D	0	1	0		K	S	0	4	T	0	2				
	1	1	D	0	1	1		K	S	0	4	T	0	2				
	1	2	D	0	1	8		K	S	0	4	T	0	2				
	1	3	D	0	1	9		K	S	0	4	T	0	2				
	1	4	D	0	2	2		K	S	0	4	T	0	2				
	1	5	D	0	2	8		K	S	0	4	T	0	2				
	1	6	D	0	2	9		K	S	0	4	T	0	2				
	1	7	D	0	3	0		K	S	0	4	T	0	2				
	1	8	D	0	3	3		K	S	0	4	T	0	2				
	1	9	D	0	3	4		K	S	0	4	T	0	2				
	2	0	D	0	3	5		K	S	0	4	T	0	2				
	2	1	D	0	3	6		K	S	0	4	T	0	2				
	2	2	D	0	3	8		K	S	0	4	T	0	2				
	2	3	D	0	3	9		K	S	0	4	T	0	2				
	2	4	D	0	4	0		K	S	0	4	T	0	2				
	2	5	D	0	4	1		K	S	0	4	T	0	2				

EPA/State ID Number	W	A	7	8	9	0	0	0	8	9	6	7

Continuation of Section XIV. Description of Dangerous Waste

Line Number	A. Dangerous Waste No. (enter code)	B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)	D. Process (1) Process Codes (enter)									D. Process (2) Process Description [If a code is not entered in D (1)]
26	D043		K	S04	T02								
27	F001		K	S04	T02								
28	F002		K	S04	T02								
29	F003		K	S04	T02								
30	F004		K	S04	T02								
31	F005		K	S04	T02								
32	F039		K	S04	T02								
33	WT01		K	S04	T02								
34	WT02		K	S04	T02								
35	D001	298,434,296	K	T01									
36	D002		K	T01									
37	D003		K	T01									
38	D004		K	T01									
39	D005		K	T01									
40	D006		K	T01									
41	D007		K	T01									
42	D008		K	T01									
43	D009		K	T01									
44	D010		K	T01									
45	D011		K	T01									
46	D018		K	T01									
47	D019		K	T01									
48	D022		K	T01									
49	D028		K	T01									
50	D029		K	T01									
51	D030		K	T01									
52	D033		K	T01									
53	D034		K	T01									
54	D035		K	T01									
55	D036		K	T01									
56	D038		K	T01									
57	D039		K	T01									

EPA/State ID Number	W	A	7	8	9	0	0	0	8	9	6	7

Continuation of Section XIV. Description of Dangerous Waste

Line Number	A. Dangerous Waste No. (enter code)	B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)	D. Process (1) Process Codes (enter)									D. Process (2) Process Description [If a code is not entered in D (1)]
58	D040		K	T01									
59	D041		K	T01									
60	D043		K	T01									
61	F001		K	T01									
62	F002		K	T01									
63	F003		K	T01									
64	F004		K	T01									
65	F005		K	T01									
66	F039		K	T01									
67	WT01		K	T01									
68	WT02		K	T01									
69	D001	30,433,326	K	S02									
70	D002		K	S02									
71	D003		K	S02									
72	D004		K	S02									
73	D005		K	S02									
74	D006		K	S02									
75	D007		K	S02									
76	D008		K	S02									
77	D009		K	S02									
78	D010		K	S02									
79	D011		K	S02									
80	D018		K	S02									
81	D019		K	S02									
82	D022		K	S02									
83	D028		K	S02									
84	D029		K	S02									
85	D030		K	S02									
86	D033		K	S02									
87	D034		K	S02									
88	D035		K	S02									
89	D036		K	S02									

EPA/State ID Number	W	A	7	8	9	0	0	0	8	9	6	7

Continuation of Section XIV. Description of Dangerous Waste

Line Number	A. Dangerous Waste No. (enter code)	B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)	D. Process (1) Process Codes (enter)									D. Process (2) Process Description [If a code is not entered in D (1)]
90	D038		K	S02									
91	D039		K	S02									
92	D040		K	S02									
93	D041		K	S02									
94	D043		K	S02									
95	F001		K	S02									
96	F002		K	S02									
97	F003		K	S02									
98	F004		K	S02									
99	F005		K	S02									
100	F039		K	S02									
101	WT01		K	S02									
102	WT02		K	S02									
103	D001	1,986,735	K	S01									Includes Debris
104	D002		K	S01									Includes Debris
105	D003		K	S01									Includes Debris
106	D004		K	S01									Includes Debris
107	D005		K	S01									Includes Debris
108	D006		K	S01									Includes Debris
109	D007		K	S01									Includes Debris
110	D008		K	S01									Includes Debris
111	D009		K	S01									Includes Debris
112	D010		K	S01									Includes Debris
113	D011		K	S01									Includes Debris
114	D018		K	S01									Includes Debris
115	D019		K	S01									Includes Debris
116	D022		K	S01									Includes Debris
117	D028		K	S01									Includes Debris
118	D029		K	S01									Includes Debris
119	D030		K	S01									Includes Debris
120	D033		K	S01									Includes Debris
121	D034		K	S01									Includes Debris
122	D035		K	S01									Includes Debris

EPA/State ID Number	W	A	7	8	9	0	0	0	8	9	6	7

Continuation of Section XIV. Description of Dangerous Waste

Line Number	A. Dangerous Waste No. (enter code)	B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)	D. Process (1) Process Codes (enter)									D. Process (2) Process Description [If a code is not entered in D (1)]
123	D036		K	S01									Includes Debris
124	D038		K	S01									Includes Debris
125	D039		K	S01									Includes Debris
126	D040		K	S01									Includes Debris
127	D041		K	S01									Includes Debris
128	D043		K	S01									Includes Debris
129	F001		K	S01									Includes Debris
130	F002		K	S01									Includes Debris
131	F003		K	S01									Includes Debris
132	F004		K	S01									Includes Debris
133	F005		K	S01									Includes Debris
134	F039		K	S01									Includes Debris
135	WT01		K	S01									Includes Debris
136	WT02		K	S01									Includes Debris
137	D001	81,310	K	T04									Includes Debris
138	D002		K	T04									Includes Debris
139	D003		K	T04									Includes Debris
140	D004		K	T04									Includes Debris
141	D005		K	T04									Includes Debris
142	D006		K	T04									Includes Debris
143	D007		K	T04									Includes Debris
144	D008		K	T04									Includes Debris
145	D009		K	T04									Includes Debris
146	D010		K	T04									Includes Debris
147	D011		K	T04									Includes Debris
148	D018		K	T04									Includes Debris
149	D019		K	T04									Includes Debris
150	D022		K	T04									Includes Debris
151	D028		K	T04									Includes Debris
152	D029		K	T04									Includes Debris
153	D030		K	T04									Includes Debris
154	D033		K	T04									Includes Debris
155	D034		K	T04									Includes Debris

EPA/State ID Number	W	A	7	8	9	0	0	0	8	9	6	7

Continuation of Section XIV. Description of Dangerous Waste

Line Number	A. Dangerous Waste No. (enter code)	B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)	D. Process (1) Process Codes (enter)	D. Process (2) Process Description [If a code is not entered in D (1)]
156	D035		K	T04	Includes Debris
157	D036		K	T04	Includes Debris
158	D038		K	T04	Includes Debris
159	D039		K	T04	Includes Debris
160	D040		K	T04	Includes Debris
161	D041		K	T04	Includes Debris
162	D043		K	T04	Includes Debris
163	F001		K	T04	Includes Debris
164	F002		K	T04	Includes Debris
165	F003		K	T04	Includes Debris
166	F004		K	T04	Includes Debris
167	F005		K	T04	Includes Debris
168	F039		K	T04	Includes Debris
169	WT01		K	T04	Includes Debris
170	WT02		K	T04	Includes Debris

XV. Map

Attach to this application a topographic map of the area extending to at least one (1) mile beyond property boundaries. The map must show the outline of the facility; the location of each of its existing and proposed intake and discharge structures; each of its dangerous waste treatment, storage, recycling, or disposal units; and each well where fluids are injected underground. Include all springs, rivers, and other surface water bodies in this map area, plus drinking water wells listed in public records or otherwise known to the applicant within ¼ mile of the facility property boundary. The instructions provide additional information on meeting these requirements.

XVI. Facility Drawing

All existing facilities must include a scale drawing of the facility (refer to Instructions for more detail).

XVII. Photographs

All existing facilities must include photographs (aerial or ground-level) that clearly delineate all existing structures; existing storage, treatment, recycling, and disposal areas; and sites of future storage, treatment, recycling, or disposal areas (refer to Instructions for more detail).

XVIII. Certifications

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Operator* Name and Official Title (type or print) Keith A. Klein, Manager U.S. Department of Energy Richland Operations Office	**Signature**	**Date Signed** 7/11/05
Co-Operator** Name and Official Title (type or print) Ronald G. Gallagher President and Chief Executive Officer Fluor Hanford	**Signature**	**Date Signed** 6/16/05
Co-Operator** – Address and Telephone Number 2420 Stevens Center P.O. Box 1000 Richland, WA 99352 (509) 376-3576		
Facility-Property Owner* Name and Official Title (type or print) Keith A. Klein, Manager U.S. Department of Energy Richland Operations Office	**Signature**	**Date Signed** 7/11/05

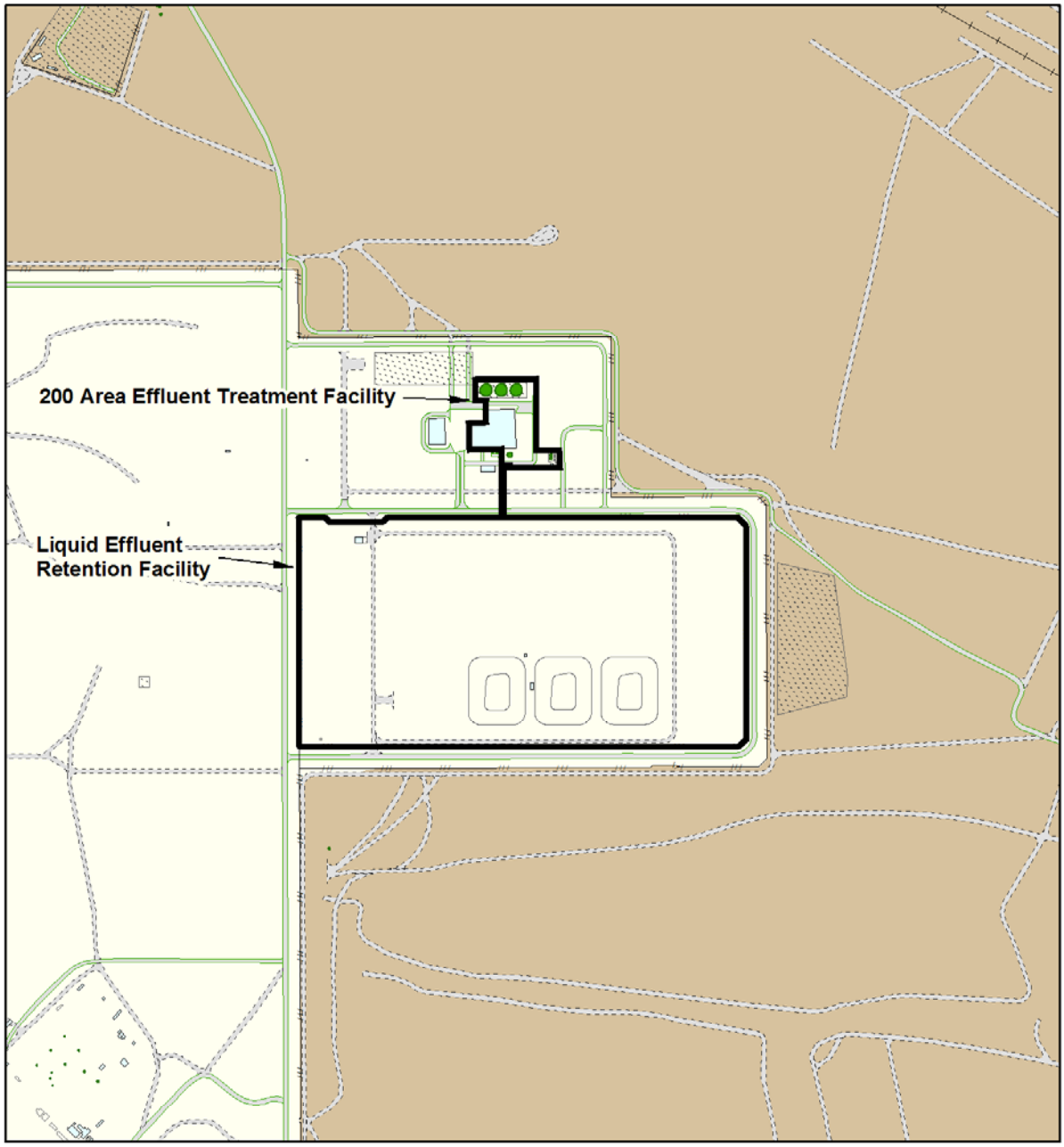
Comments

Liquid Effluent Retention Facility

TYPICAL BASIN (PHOTO TAKEN 1992)

200 Area Effluent Treatment Facility

(PHOTO TAKEN 2005)



Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility

Prepared for:
US DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE

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TSD Unit Boundary
DOE Operating Areas
Hanford Facility
Structures
Concrete
Tanks

Buildings and Mobiles
Major Hanford Routes
Local Hanford Roads
Minor Roads
Railroads
Fences

Meters: 0 100 200 300
Feet: 0 200 400 600 800 1,000

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3.0 WASTE ANALYSIS [C]

METRIC CONVERSION CHART

Into metric units			Out of metric units		
If you know	Multiply by	To get	If you know	Multiply by	To get
Length			Length		
inches	25.40	millimeters	millimeters	0.0393	inches
inches	2.54	centimeters	centimeters	0.393	inches
feet	0.3048	meters	meters	3.2808	feet
yards	0.914	meters	meters	1.09	yards
miles	1.609	kilometers	kilometers	0.62	miles
Area			Area		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092	square meters	square meters	10.7639	square feet
square yards	0.836	square meters	square meters	1.20	square yards
square miles	2.59	square kilometers	square kilometers	0.39	square miles
acres	0.404	hectares	hectares	2.471	acres
Mass (weight)			Mass (weight)		
ounces	28.35	grams	grams	0.0352	ounces
pounds	0.453	kilograms	kilograms	2.2046	pounds
short ton	0.907	metric ton	metric ton	1.10	short ton
Volume			Volume		
fluid ounces	29.57	milliliters	milliliters	0.03	fluid ounces
quarts	0.95	liters	liters	1.057	quarts
gallons	3.79	liters	liters	0.26	gallons
cubic feet	0.03	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.76456	cubic meters	cubic meters	1.308	cubic yards
Temperature			Temperature		
Fahrenheit	subtract 32 then multiply by 5/9ths	Celsius	Celsius	multiply by 9/5ths, then add 32	Fahrenheit
Force			Force		
pounds per square inch	6.895	kilopascals	kilopascals	1.4504×10^{-4}	pounds per square inch

Source: *Engineering Unit Conversions*, M. R. Lindeburg, P.E., Second Ed., 1990, Professional Publications, Inc., Belmont, California.

3.1 INTRODUCTION

In accordance with the federal and state regulations set forth in 40 Code of Federal Regulations (CFR) 264.13 and in Washington State Department of Ecology (Ecology) *Dangerous Waste Regulations*, Washington Administrative Code (WAC) 173-303-300, this waste analysis plan (WAP) has been prepared for operation of the Liquid Effluent Retention Facility (LERF) and the 200 Area Effluent Treatment Facility (200 Area ETF) located in the 200 East Area on the Hanford Site, Richland, Washington.

The Permittees shall comply with all the requirements, subsections, figures, tables, and appendices, included this Waste Analysis Plan for Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility.

The purpose of this WAP is to document the sampling and analytical methods, and describe the procedures used for all dangerous waste managed in the specific treatment storage, and disposal (TSD) units identified in Chapter 1.0 (Part A Form). This WAP also documents the requirements for generators sending aqueous waste to the LERF or 200 Area ETF for treatment. Throughout this WAP, the term generator includes any Hanford Site unit, including TSD units, whose process produces an aqueous waste.

The TSD units include a surface impoundment (LERF), which provides treatment and storage, a tank system at 200 Area ETF, which provides treatment and storage, and a container management area at 200 Area ETF, which provides drum storage and treatment. Additionally, this WAP discusses the sampling and analytical methods for the treated effluent (treated aqueous waste) that is discharged from 200 Area ETF as a non-dangerous, delisted waste to the State-Approved Land Disposal Site (SALDS). Specifically, the WAP delineates the following:

- Influent Waste Acceptance Process - determines the acceptability of a particular aqueous waste at the LERF or 200 Area ETF pursuant to applicable Permit conditions, regulatory requirements, and operating capabilities prior to acceptance of the waste at the LERF or 200 Area ETF for treatment or storage. Refer to Section 3.2.
- Special Management Requirements - identifies the special management requirements for aqueous wastes managed in the LERF or 200 Area ETF. Refer to Section 3.3.
- Influent Aqueous Waste Sampling and Analysis - describes influent sampling and analyses used to characterize an influent aqueous waste to ensure proper management of the waste and for compliance with the special management requirements. Also includes rationale for analyses. Refer to Section 3.4.
- Treated Effluent Sampling and Analysis - describes sampling and analyses of treated effluent (i.e., treated aqueous waste) for compliance with State Waste Discharge Permit (Ecology 2000) and Final Delisting [40 CFR 261, Appendix IX, Table 2, 70 FR 44496 (EPA, 2005)] limits. Also includes rationale for analyses. Refer to Section 3.5.
- 200 Area ETF Generated Waste Sampling and Analysis - describes the sampling and analyses used to characterize the secondary waste streams generated from the treatment process and to characterize waste generated from maintenance and operations activities. Also includes rationale for analyses. Refer to Section 3.6.
- Quality Assurance and Quality Control - ensures the accuracy and precision of sampling and analysis activities. Refer to Section 3.7.

This WAP meets the specific requirements of the following:

- Land Disposal Restrictions Treatment Exemption for the LERF under 40 CFR 268.4, U.S. Environmental Protection Agency, December 6, 1994 (EPA 1994)
- Final Delisting for 200 Area ETF, 40 CFR 261, Appendix IX, Table 2,70 FR 44496 (EPA 2005)
- Washington State Waste Discharge Permit, No. ST 4500, as amended, (Ecology 2000)
- Hanford Facility RCRA Permit WA7890008967 (Permit)
- This plan also includes the specific elements of a WAP, as identified in the *Dangerous Waste Permit Application Requirements* (Ecology 1996a).
- Chapter 5.0, Groundwater Monitoring addresses groundwater monitoring.

The conditions of the Washington State Discharge Permit, Number ST 4500 (Discharge Permit) are included in this WAP for completeness, although they are not within the scope of RCRA or WAC 173-303. Therefore, revisions of this WAP that are not governed by the requirements of WAC 173-303 will not be considered as a modification subject to review or approval by Ecology.

3.1.1 Liquid Effluent Retention Facility and Effluent Treatment Facility Description

The LERF and 200 Area ETF comprise an aqueous waste treatment system located in the 200 East Area . Both LERF and 200 Area ETF may receive aqueous waste through several inlets. 200 Area ETF can receive aqueous waste through three inlets. First, 200 Area ETF can receive aqueous waste directly from the LERF. Second, aqueous waste can be transferred from the Load-In Station to 200 Area ETF. Third, aqueous waste can be transferred from containers (e.g., carboys, drums) to the 200 Area ETF through either the Secondary Waste Receiving Tanks or the Concentrate Tanks. The Load-In Station is located just east of 200 Area ETF and currently consists of two 37,854-liter storage tanks and a pipeline that connects to either LERF or 200 Area ETF through fiberglass pipelines with secondary containment.

The LERF can receive aqueous waste through four inlets. First, aqueous waste can be transferred to LERF through a dedicated pipeline from the 200 West Area. Second, aqueous waste can be transferred through a pipeline that connects LERF with the 242-A Evaporator. Third, aqueous waste also can be transferred to LERF from a pipeline that connects LERF to the Load-In Station at 200 Area ETF. Finally, aqueous waste can be transferred into LERF through a series of sample ports located at each basin.

The LERF consists of three lined surface impoundments with a nominal capacity of 29.5 million liters each. Aqueous waste from LERF is pumped to 200 Area ETF through a double-walled fiberglass pipeline. The pipeline is equipped with leak detection located in the annulus between the inner and outer pipes. Each basin is equipped with six available sample risers constructed of 6-inch-perforated pipe. A seventh sample riser in each basin is dedicated to influent waste receipt piping, and an eighth riser in each basin contains liquid level instrumentation. Each riser extends along the sides of each basin from the top to the bottom of the basin. Detailed information on the construction and operation of the LERF is provided in Chapter 4.0.

200 Area ETF is designed to treat the contaminants anticipated in process condensate (PC) from the 242-A Evaporator and other aqueous wastes from the Hanford Site. Section 3.1.2 provides more information on the sources of these wastes.

The capabilities of 200 Area ETF were confirmed through pilot plant testing. A pilot plant was used to test surrogate solutions that contained constituents of concern anticipated in aqueous wastes on the Hanford Site. The pilot plant testing served as the basis for a demonstration of the treatment capabilities of 200 Area ETF in the *200 Area Effluent Treatment Facility Delisting Petition* (DOE/RL-92-72).

200 Area ETF consists of a primary and a secondary treatment train (Figure 3.1). The primary treatment train removes or destroys dangerous and mixed waste components from the aqueous waste. In the secondary treatment train, the waste components are concentrated and dried into a powder. This waste is containerized, and transferred to a waste TSD unit.

Each treatment train consists of a series of operations. The primary treatment train includes the following:

- Surge tank
- Rough filter
- Ultraviolet light oxidation (UV/OX)
- pH adjustment
- Hydrogen peroxide decomposer
- Fine filter
- Degasification
- Reverse osmosis (RO)
- Polisher [ion exchange (IX) column]
- Final pH adjustment and verification

The secondary treatment train uses the following systems:

- Secondary waste receiving tanks
- Evaporator (mechanical vapor recompression)
- Concentrate tank
- Thin film dryer
- Container handling
- Supporting systems

A dry powder waste is generated from the secondary treatment train, from the treatment of an aqueous waste. The secondary waste treatment system typically receives and processes by-products generated from the primary treatment train. However, in an alternate operating scenario, some aqueous wastes may be fed to the secondary treatment train before the primary treatment train. Detailed information on the treatment trains and the unit operations is provided in Chapter 4.0.

The treated effluent is contained in verification tanks where the effluent is sampled to confirm that the effluent meets the 'delisting' criteria. Under 40 CFR 261, Appendix IX, Table 2, 70 FR 44496, the treated effluent from 200 Area ETF is considered a delisted waste; that is, the treated effluent is no longer a dangerous or hazardous waste subject to the hazardous waste management requirements of RCRA. The treated effluent is discharged under the Discharge Permit as a nondangerous, delisted waste to the SALDS, located in the 600 Area, north of the 200 West Area. Treated wastewater from the Verification Tanks is recycled throughout the facility; for example, it is used to dilute bulk acid and caustic to meet processing needs reducing the demand for process water.

3.1.2 Sources of Aqueous Waste

200 Area ETF was intended and designed to treat a variety of mixed wastes. However, PC from the 242-A Evaporator was the only mixed waste identified for storage and treatment in the LERF and 200 Area ETF. As cleanup activities at Hanford progress, many of the aqueous wastes generated from site remediation and waste management activities are sent to the LERF and 200 Area ETF for treatment and storage.

The PC is a dangerous waste because it is derived from a listed, dangerous waste stored in the Double-Shell Tank (DST) System. The DST waste is transferred to the 242-A Evaporator where the waste is concentrated through an evaporation process. The concentrated slurry waste is returned to the DST System, and the evaporated portion of the waste is recondensed, collected, and transferred as PC to the LERF.

Other aqueous wastes that are treated and stored at the LERF and 200 Area ETF include, but are not limited to the following Hanford wastes: contaminated groundwater from pump-and-treat remediation activities, such as groundwater from the 200-UP-1 Operable Unit; purgewater from groundwater monitoring activities; water from deactivation activities, such as water from the spent fuel storage basins at deactivated reactors (e.g., N Reactor); laboratory aqueous waste from unused samples and sample analyses; and leachate from landfills, such as the Environmental Restoration Disposal Facility.

Most of these aqueous wastes are accumulated in batches in a LERF basin for interim storage and treatment through pH and flow equalization before final treatment in 200 Area ETF. However, some aqueous wastes, such as 200-UP-1 Groundwater, may flow through LERF en route to 200 Area ETF for final treatment. The constituents in these aqueous wastes are common to the Hanford Site and were considered in pilot plant testing or vendor tests, either as a constituent or as a family of constituents.

3.2 INFLUENT WASTE ACCEPTANCE PROCESS

Throughout the acceptance process, there are specific criteria required for an influent waste (i.e., aqueous waste) to be accepted at the LERF and/or 200 Area ETF. These criteria are identified in the following sections and summarized in Table 3.2. If an aqueous waste initially does not meet these criteria, it is not necessarily rejected. In many instances, ETF process or the LERF and 200 Area ETF unit-specific Permit Conditions can be modified to accommodate the treatment and storage of that waste. A discussion of the reevaluation process is provided in Section 3.2.3.

The first step in the waste acceptance process is for the generator to provide information on the influent waste stream. At this stage, the generator will work with LERF/200 Area ETF personnel to define what information must be provided to determine the acceptability of an aqueous waste for the treatment, storage, or disposal at the LERF and 200 Area ETF. At a minimum, the information required by WAC 173-303-300(2) will be obtained, which includes sampling and analysis of the aqueous waste stream. The LERF/200 Area ETF management will evaluate, on a case-by-case basis, whether the aqueous waste stream is acceptable for storage and treatment. The waste acceptance process contains the following steps.

Acceptance Process is performed as follows.

- Waste information--the generator of an aqueous waste works with LERF/200 Area ETF personnel to provide detailed information on the waste stream, i.e., a waste characterization.
- Waste management decision process--LERF/200 Area ETF management decision is based on a case-by-case evaluation of whether an aqueous waste stream is acceptable for treatment or storage, or whether to reject a stream. In addition, any special management practices required for an accepted stream may be specified at this time. The evaluation is divided into two categories.
  - Regulatory acceptability--a review to determine if there are any regulatory concerns that would prohibit the storage or treatment of an aqueous waste in the LERF or 200 Area ETF; e.g., treatment would meet permit conditions that would comply with applicable regulations.
  - Operational acceptability--an evaluation to determine if there are any operational concerns that would prohibit the storage or treatment of an aqueous waste in the LERF or 200 Area ETF; e.g., determine treatability and compatibility or safety considerations.

  Specific waste acceptance criteria are defined within the individual discussions on regulatory and operational acceptability.

Re-evaluation Process is performed to ensure the characterization is accurate and current. This process also provides a mechanism for re-evaluating an aqueous waste stream that does not meet the waste acceptance criteria.

Record Information/Decision Process provides that information used in the decision. The evaluation and the decision are documented as part of LERF & 200 Area ETF Operating Record.

3.2.1 Acceptance Process

When an aqueous waste stream is identified for treatment or storage in the LERF or 200 Area ETF, the generator is required to characterize the waste and document the characterization on an aqueous waste profile sheet (WPS). This requirement is the first waste acceptance criterion. The LERF and 200 Area ETF personnel work with the generators to ensure that the necessary information is collected for the characterization of a waste stream (i.e., the appropriate analyses or adequate process knowledge), and that the information provided on the WPS is complete. The completed WPS is maintained at 200 Area ETF.

3.2.1.1 Waste Characterization

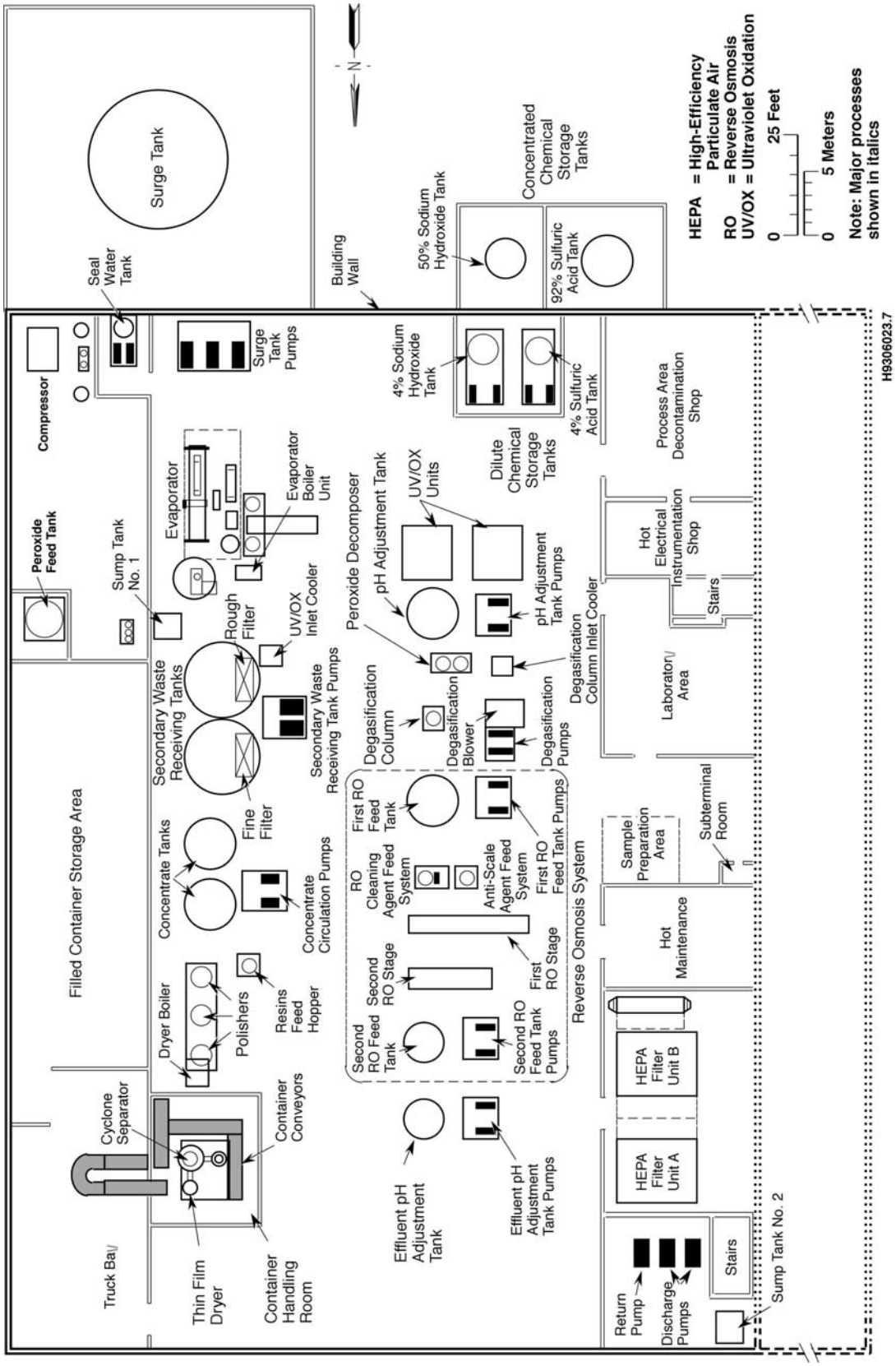
Because the constituents in the individual aqueous waste streams vary, each stream is characterized and evaluated for acceptability on a case-by-case basis. The generator is required to designate an aqueous waste, which generally will be backed up by analytical data. However, a generator may use process knowledge to substantiate the waste designation, or for general characterization information. Examples of acceptable process knowledge include the following:

- Documented data or information on processes similar to that which generated the aqueous waste stream
- Information/documentation that dangerous waste constituents are from specific, well documented processes, e.g., F-listed wastes
- Information/documentation that sampling/analyzing a waste stream would pose health and safety risks to personnel
- Information/documentation that the waste does not lend itself to collecting a laboratory sample, for example, wastewater collected (e.g., sump, tank) where the source water characterization is documented.

When a generator submits process knowledge for the characterization of a dangerous and/or mixed waste stream, LERF and 200 Area ETF personnel review the process knowledge as part of the waste acceptance process. Specifically, LERF and 200 Area ETF personnel review the generator's processes to verify the integrity of the process knowledge, and determine whether the process knowledge is current and consistent with current regulations. LERF/200 Area ETF management or their designee determines the final decision on the adequacy of the process knowledge. The persons reviewing generator process knowledge and those making decisions on the adequacy of process knowledge are trained according to the requirements of the Dangerous Waste Training Plan (Chapter 8.0).

The generator is also responsible for identifying Land Disposal Restrictions (LDRs) that would be applicable to the influent aqueous waste as part of the characterization, as required under 40 CFR 268.40 and WAC 173-303-140. Because the 200 Area ETF is a Clean Water Act - equivalent TSD unit (40 CFR 268.37(a)), the generator is not required to identify the underlying hazardous constituents (40 CFR 286.48).

Figure 3.1. 200 Area Effluent Treatment Facility Floor Plan



When analyzing an aqueous waste stream for characterization, a generator is required to use the target list of parameters identified in Table 3.3. Refer to Section 3.9 for the corresponding analytical methods. The generator may use process knowledge in lieu of some analyses, as determined by LERF/200 Area ETF management or their designee, if the process knowledge is adequate (as described above). For example, if a generator provides information that, the process generating an aqueous waste does not include or involve organic chemicals; analyses for organic compounds likely would not be required. Additional analyses could be required if historical information and/or process knowledge indicate that an aqueous waste contains constituents not included in the target list of parameters.

The LERF and 200 Area ETF personnel will work with the generator to determine which analyses are appropriate for the characterization. This approach ensures that the waste analyses adequately characterize the aqueous waste and defines the constituents of concern in a cost effective manner. The characterization and historical information are documented in the WPS, which is discussed in the following section.

3.2.1.2 Aqueous Waste Profile Sheet

The WPS documents the characterization of each new aqueous waste stream. The profile includes a detailed description of the volume, source, waste designation, and the chemical and physical nature of the aqueous waste. For an aqueous waste to be accepted for treatment or storage in the LERF or 200 Area ETF, each new waste stream generator is required to complete and provide this form to LERF and 200 Area ETF management. Each generator also is required to provide the analytical data and process knowledge used to designate the aqueous waste stream, and to determine the chemical and physical nature of the waste. The LERF and 200 Area ETF management determine whether the information on the WPS is sufficient. The LERF and 200 Area ETF management use this information to evaluate the acceptability of the aqueous waste for storage and treatment in the LERF and 200 Area ETF, and to determine if the aqueous waste can be handled properly.

3.2.2 Waste Management Decision Process

All aqueous waste under consideration for acceptance must be characterized using analytical data, and process knowledge. This information is used to determine the acceptability of an aqueous waste stream. The LERF and 200 Area ETF Facility Manager or their designee is responsible for making the decision to accept or reject an aqueous waste stream. The management decision to accept any aqueous waste stream is based on an evaluation of regulatory acceptability and operational acceptability. Each evaluation uses acceptance criteria, which were developed to ensure that an aqueous waste is managed in a safe, environmentally sound, and compliant manner. The following sections provide detail on the acceptance evaluation and the acceptance criteria.

In many instances, an aqueous waste that does not meet one of the waste acceptance criteria is not necessarily rejected. Section 3.2.3 discusses the process for re-evaluating an aqueous waste that does not initially meet the waste acceptance criteria. However, the final decision to reject an aqueous waste is made by LERF and 200 Area ETF management. An aqueous waste stream could be rejected for one of the following reasons:

- The paperwork and/or laboratory analyses from the generator are insufficient
- Discrepancies with the regulatory and operational acceptance criteria cannot be reconciled, including:
  - An aqueous waste is not allowed under the current Discharge Permit or Final Delisting, and LERF/200 Area ETF management elect not to pursue an amendment, or the Permit and Delisting cannot be amended (Section 3.2.2.1)
  - An aqueous waste is incompatible with LERF liner materials or with other aqueous waste in LERF and no other management method is available (Section 3.2.2.2).

- Adequate storage or treatment capacity is not available.

3.2.2.1 Regulatory Acceptability

Each aqueous waste stream is evaluated on a case-by-case basis to determine if there are any regulatory concerns that would preclude the storage or treatment of a waste in the LERF or 200 Area ETF. Before an aqueous waste can be stored or treated in either the LERF or 200 Area ETF, the waste designation must be determined. Information on the waste designation of an aqueous waste is documented in the WPS. This information is used to confirm that treating or storing the aqueous waste in the LERF or 200 Area ETF is allowed under and in compliance with WAC 173-303, RCRA Permit, Final Delisting for 200 Area ETF, and the Discharge Permit for 200 Area ETF.

3.2.2.1.1 Dangerous Waste Regulations/Permits

Before an aqueous waste stream is sent to the LERF or 200 Area ETF, the generator will characterize and designate the stream with the appropriate dangerous/hazardous waste numbers according to WAC 173-303-070. The LERF and 200 Area ETF Part A Form, and the Final Delisting for 200 Area ETF identify the specific waste numbers for dangerous/mixed waste that can be managed in the LERF and 200 Area ETF. Dangerous waste designated with waste numbers not specified in Chapter 1.0 (Part A Form) cannot be treated or stored in the LERF or 200 Area ETF, unless the Permit is modified.

Additionally, aqueous wastes designated with listed waste numbers identified in the Final Delisting will be managed in accordance with the conditions of the delisting, or an amended delisting. Accordingly, the acceptance criteria in this evaluation are satisfied through compliance with the Chapter 1.0, (Part A Form), and the Final Delisting.

3.2.2.1.2 State Waste Permit Regulations/Permit

Compliance with the Discharge Permit constitutes another waste acceptance criterion. In accordance with the conditions of the Discharge Permit, the constituents of concern in each new aqueous waste stream must be identified. The waste designation and characterization data provided by the generator are used to identify these constituents. A constituent of concern, under the conditions of the Discharge Permit, in an aqueous waste stream is defined as any contaminant with a maximum concentration greater than one of the following:

- Any limit in the Discharge Permit (Ecology 2000)
- Groundwater Quality Criteria (WAC 173-200)
- Final Delisting levels (EPA 2005)
- Background groundwater concentrations as measured at 200 Area ETF disposal site. The practical quantification limit (PQL) is used for the groundwater background concentration for constituents not analyzed or not detected in the SALDs background data.

The conditions of the Discharge Permit also require a demonstration that 200 Area ETF can treat the constituents of concern to below discharge limits.

3.2.2.2 Operational Acceptability

Because the operating configuration or operating parameters at the LERF and 200 Area ETF can be adjusted or modified, most aqueous waste streams generated on the Hanford Site can be effectively treated to below Delisting and Discharge Permit limits. Because of this flexibility, it would be impractical to define numerical acceptance or decision limits. Such limits would constrain the acceptance of appropriate aqueous waste streams for treatment at the LERF and 200 Area ETF. The versatility of the LERF and 200 Area ETF is better explained in the following examples:

- The typical operating configuration of 200 Area ETF is to process an aqueous waste through the UV/OX unit first, followed by the RO unit. However, high concentrations of nitrates may interfere

with the performance of the UV/OX. In this case, 200 Area ETF could be configured to process the waste in the RO unit prior to the UV/OX unit.

- For a small volume aqueous waste with high concentrations of some anions and metals, the approach may be to first process the waste stream in the secondary treatment train. This approach would prevent premature fouling or scaling of the RO unit. The liquid portion (i.e., untreated overheads from 200 Area ETF evaporator and thin-film dryer) would be sent to the primary treatment train.
- An aqueous waste with high concentrations of chlorides and fluorides may cause corrosion problems when concentrated in the secondary treatment train. One approach is to adjust the corrosion control measures in the secondary treatment train. An alternative may be to blend this aqueous waste in a LERF basin with another aqueous waste, which has sufficient dissolved solids, such that the concentration of the chlorides in the secondary treatment train would not pose a corrosion concern.
- Some metal salts (e.g., barium sulfate) tend to scale the RO membranes. In this situation, descalants used in the treatment process may be increased.
- Any effluent that does not meet these limits in one pass through 200 Area ETF treatment process is recycled to 200 Area ETF for re-processing.

There are some aqueous wastes whose chemical and physical properties preclude that waste from being treated or stored at the LERF or 200 Area ETF. Accordingly, an aqueous waste is evaluated to determine if it is treatable, if it would impair the efficiency or integrity of the LERF or 200 Area ETF, and if it is compatible with materials in these units. This evaluation also determines if the aqueous waste is compatible with other aqueous wastes managed in the LERF.

The waste acceptance criteria in this category focus on determining treatability of an aqueous waste stream, and on determining any operational concerns that would prohibit the storage or treatment of an aqueous waste stream in the LERF or 200 Area ETF. The chemical and physical properties of an aqueous waste stream are determined as part of the waste characterization, and are documented on the WPS and compared to the design of the units to determine whether an aqueous waste stream is appropriate for storage and treatment in the LERF and 200 Area ETF.

3.2.2.1.3 Treatability

The process of determining treatability involves two steps. The first step is to establish the treatment efficiencies for the constituents of concern in an influent aqueous waste. The treatment efficiencies must be sufficient such that the treated effluent will meet the Discharge Permit and Delisting limits. The pilot plant testing provided destruction and removal (i.e., treatment) efficiencies for most of the anticipated constituents in aqueous waste streams at the Hanford Site, and are documented in the *200 Area Effluent Treatment Facility Delisting Petition* (DOE/RL-92-72). Information or studies from the vendors of the individual treatment units' studies may also be used on a case-by-case basis to develop treatment efficiencies for 200 Area ETF or for the individual treatment units. Chapter 4.0 provides a detailed discussion of the individual treatment units. Treatment efficiencies also may be determined or confirmed by 200 Area ETF operating data.

The second step in determining treatability is to identify those physical and chemical properties in an aqueous waste that would interfere with, or foul 200 Area ETF treatment process. This step focuses on the potential of a waste stream to interfere with the destruction efficiency of organic compounds in the UV/OX system, rejection rates of the RO membranes, or foul the filtration systems. Generally, the operating parameters or operating configuration at the LERF or 200 Area ETF can be adjusted or modified to accommodate these properties. However, in those cases where a treatment process or operating configuration cannot be modified, the aqueous waste stream will be excluded from treatment or storage at the LERF or 200 Area ETF.

Additionally, an aqueous waste stream is evaluated for the potential to deposit solids in a LERF basin (i.e., an aqueous waste that contains sludge). This evaluation will also consider whether the blending or mixing of two or more aqueous waste streams will result in the formation of a precipitate. However, because the waste streams managed in the LERF and 200 Area ETF are generally dilute, the potential for mixing waste streams and forming a precipitate is low; no specific compatibility tests are performed. If necessary, filtration at the waste source could be required before acceptance into LERF based on total suspended solids analysis or process knowledge of the waste.

To determine if an aqueous waste meets the criterion of treatability, specific information is required. Treatment efficiencies will be developed from characterization data provided by the generator. Generators will also provide characterization data to identify those physical and chemical properties that would interfere with, or foul 200 Area ETF treatment process. In some instances, process knowledge may be adequate to identify a chemical or physical property that would be of concern. For example, the generator could provide process knowledge that the stream has two phases (an oily phase and an aqueous phase). In this case, if the generator could not physically separate the two phases, the aqueous waste stream would be rejected because the oily phase could compromise some of the treatment equipment. Typically, analyses for the following parameters are required to evaluate treatability and operational concerns:

- total dissolved solids
- total organic carbon
- total suspended solids
- specific conductivity
- pH
- alkalinity
- ammonia
- barium
- calcium
- chloride
- fluoride
- iron
- magnesium
- nitrate
- nitrite
- phosphate
- potassium
- silicon
- sodium
- sulfate

These constituents are identified in Table 3.2.

3.2.2.1.4 Compatibility

Corrosion Control. Because of the materials of construction used in 200 Area ETF, corrosion is generally not a concern with new aqueous waste streams. Additionally, these waste streams are managed in a manner that minimizes corrosion. To ensure that a waste will not compromise the integrity of 200 Area ETF tanks and process equipment, each waste stream is assessed for its corrosion potential as part of the compatibility evaluation. This assessment usually focuses on chloride and fluoride concentrations; however, the chemistry of each new waste also is evaluated for other parameters that could cause corrosion.

Compatibility with Liquid Effluent Retention Facility Liner and Piping. As part of the acceptance process, the criteria of compatibility with the LERF liner materials are evaluated for each aqueous waste stream. The evaluation for liner compatibility is documented as part of the waste acceptance process. The chemical parameters or constituents considered for liner compatibility are identified in Table 3.1. The analytical methods for these parameters and constituents are provided in Section 3.9.

The high-density polyethylene liners in the LERF basins potentially are vulnerable to the presence of certain constituents that might be present in some aqueous waste. Using EPA SW-846 Method 9090, the liner materials were tested to evaluate compatibility between aqueous waste stored in the LERF and synthetic liner components. Based on the data from the compatibility test and vendor data on the liner materials, several constituents and parameters were identified as potentially harmful (at high concentrations) to the integrity of the liners. From these data and the application of safety factors, concentration limits in Table 3.1 were established.

The strategy for protecting the integrity of a LERF liner is to establish upfront that an aqueous waste is compatible before the waste is accepted into LERF. Characterization data on each new aqueous waste

stream are compared to the limits outlined in Table 3.1 to ensure compatibility with the LERF liner material before acceptance into the LERF.

Before a waste stream is processed at the 242-A Evaporator, the generator reviews DST analytical data and a PC profile is developed to ensure that PC is compatible with the LERF liner. For flow-through aqueous wastes like the 200-UP-1 Groundwater, characterization data will be reviewed quarterly to ensure that liner compatibility is maintained.

In some instances, process knowledge may be adequate to determine that an aqueous waste is compatible with the LERF liner. In those instances where process knowledge is adequate, the waste characterization would likely not require analysis for these parameters and constituents. Stormwater is an example where process knowledge is adequate to determine that this aqueous waste is compatible with the LERF liner.

Compatibility with Other Waste. Some aqueous wastes, especially small volumes, are accumulated in the LERF with other aqueous waste. Before acceptance into the LERF, the aqueous waste stream is evaluated for its compatibility with the resident aqueous waste(s). The evaluation focuses on the potential for an aqueous waste to react with another waste (40 CFR 264, Appendix V, *Examples of Potentially Incompatible Wastes*). However, the potential for problems associated with commingling aqueous wastes is very low due to the dilute nature of the wastes; this evaluation confirms the compatibility of two or more aqueous wastes from different sources. Compatibility is determined by evaluating parameters such as pH, ammonia, and chloride. No specific analytical test for compatibility is performed.

If it is determined that an aqueous waste stream is incompatible with other aqueous waste streams, alternate management scenarios are available. For example, another LERF basin that contains a compatible aqueous waste(s) might be used, or the aqueous waste stream might be fed directly into 200 Area ETF for treatment. In any case, potentially incompatible waste streams are not mixed, and all aqueous waste is managed in a way that precludes a reaction, degradation of the liner, or interference with 200 Area ETF treatment process.

3.2.3 Re-Evaluation Process

In accordance with 40 CFR 264.13 and WAC 173-303-300(4)(a), an influent aqueous waste will be re-evaluated as necessary to ensure that the characterization is accurate and current. At a minimum, an aqueous waste stream will be re-evaluated in the following situations.

- The LERF and 200 Area ETF management have been notified, or have reason to believe that the process generating the waste has changed.
- The LERF and 200 Area ETF management note an increase or decrease in the concentration of a constituent in an aqueous waste stream, beyond the range of concentrations that was described or predicted in the waste characterization.

In these situations, LERF and 200 Area ETF management will review the available information. If existing analytical information is not sufficient, the generator may be asked to review and update the current waste characterization, to supply a new WPS, or re-sample and re-analyze the aqueous waste, as necessary. Other situations that might require a re-evaluation of a waste stream are discussed in the following sections.

3.2.3.1 Re-Evaluation for Aqueous Wastes not Meeting Waste Acceptance Criteria

An aqueous waste that does not meet one of the acceptance criteria is not necessarily rejected. Several options are available in the event that an aqueous waste is not acceptable following an initial evaluation. For example, a more extensive evaluation could be required to determine if the 200 Area ETF process can be modified to treat an aqueous waste to required discharge levels. Additionally, a more extensive

evaluation might be required to determine if a modification of the Discharge Permit or the Final Delisting is required and is feasible (e.g., to treat waste with new listed waste numbers).

3.2.3.2 Re-Evaluation for Treated Effluent not Meeting 200 Area Effluent Treatment Facility Permit Limits

If the treated effluent does not meet the Discharge Permit and Delisting limits in one pass through 200 Area ETF treatment process, the acceptability of the influent aqueous waste would be re-evaluated. This situation generally would apply to large volumes of aqueous waste (such as 200-UP-1 Groundwater) or to aqueous waste that is sent to the LERF or 200 Area ETF in batches on some frequency (such as monthly transfers of an aqueous waste). Small volumes of aqueous waste generally would be reprocessed until permit limits are met.

3.2.3.3 Re-Evaluation Requirements for Flow-Through Aqueous Waste

Aqueous waste like the 200-UP-1 Groundwater is unique because of the constant-flow source, and because the waste is pumped into a LERF basin throughout the lifetime of the pump-and-treat remediation activity. Also, rather than being accumulated in the LERF in a batch mode, this aqueous waste will generally flow through the LERF to 200 Area ETF for final treatment. Though this aqueous waste has been characterized upfront for acceptability, special sampling and analysis requirements must be met during the pump-and-treat operation to ensure that it continues to meet acceptance criteria.

Accordingly, flow-through wastes like the 200-UP-1 Groundwater are, and will be sampled quarterly to update the initial characterization. The LERF and 200 Area ETF personnel monitor this on-going characterization. If the data from a sampling event suggest that contaminant concentrations have increased beyond that described in the initial characterization, the acceptability of the waste stream will be re-evaluated. Details on the sampling and analysis of flow-through aqueous waste, like the 200-UP-1 Groundwater, are provided in Section 3.4.

3.2.4 Record/Information and Decision

The information and data collected throughout the acceptance process, and the evaluation and decision on whether to accept an influent aqueous waste stream for treatment or storage in the LERF or 200 Area ETF are documented as part of LERF and 200 Area ETF Operating Record, which is maintained at 200 Area ETF. Specifically, the Operating Record contains the following components on a new influent aqueous waste stream:

- The signed WPS for each aqueous waste stream and analytical data
- Process knowledge used to characterize a dangerous/mixed waste (under WAC 173-303), and information supporting the adequacy of the process knowledge
- The evaluation on whether an aqueous waste stream meets the waste acceptance criteria, including:
  - The evaluation for regulatory acceptability including appropriate regulator approvals
  - The evaluation for liner compatibility and for compatibility with other aqueous waste

Table 3.1. General Limits for Liner Compatibility

Chemical Family	Constituent(s) or Parameter(s)[1]	Limit (mg/L)[2] (sum of constituent concentrations)
Alcohol/glycol	1-butanol	500,000
Alkanone[3]	acetone,	200,000
Alkenone[4]	none targeted	NA
Aromatic/cyclic hydrocarbon	acetophenone, benzene, carbozole, chrysene, cresol, di-n-octyl phthalate, diphenylamine, isophorone, pyridine, tetrahydrofuran,	2000
Halogenated hydrocarbon	arochlors, carbon tetrachloride, chloroform,hexachlorobenzene, lindane (gamma-BHC), hexachlorocyclopentadiene, methylene chloride, p-chloroaniline, tetrachloroethylene, 2,4,6-trichlorophenol	2000
Aliphatic hydrocarbon	none targeted	500,000
Ether	dichloroisopropyl ether	2000
Other hydrocarbons	acetontrile, carbon disulfide, n-nitrosodimethylamine, tributyl phosphate	2000
Oxidizers	none targeted	NA
Acids, Bases, Salts	ammonia, cyanide, anions, cations	100,000
pH	pH	0.5 < pH < 13.0

[1] Analytical methods for the parameters and constituents are provided in Section 3.9.

[2] Analytical data are evaluated using the following 'sum of the fraction' technique. The individual constituent concentration is evaluated against the compatibility limit for its chemical family. The sum of the evaluations must be less than 1. pH is not part of this evaluation.

$$\sum_{n=1}^{i}\left(\frac{\mathrm{Conc}_n}{\mathrm{LIMIT}_n}\right) \le 1$$

[3] Ketone containing saturated alkyl group(s)

[4] Ketone containing unsaturated alkyl group(s)

Where 'i' is the number of organic constituents detected

mg/L = milligrams per liter

NA = not applicable

Table 3.2. Waste Acceptance Criteria

General criteria category	Criteria description
1. Characterization	A. Each generator must provide an aqueous waste profile.
	B. Each generator must designate the aqueous waste stream.
	C. Each generator must provide analytical data and/or process knowledge.
2. Regulatory acceptability	A. The LERF and 200 Area ETF can store and treat influent aqueous wastes with waste numbers identified in Chapter 1.0 (Part A Form) for the LERF and 200 Area ETF, and the Final Delisting for 200 Area ETF.
	B. The aqueous waste must comply with conditions of the Discharge Permit.
3. Operational acceptability	A. Determine whether an aqueous waste stream is treatable, considering: 1. Whether the removal and destruction efficiencies on the constituents of concern will be adequate to meet the Discharge Permit and Delisting levels 2. Other treatability concerns; analyses for this evaluation may include: total dissolved solids — iron total organic carbon — magnesium total suspended solids — nitrate specific conductivity — nitrite alkalinity — phosphate ammonia — potassium barium — silicon calcium — sodium chloride — sulfate fluoride — pH
	B. Determine whether an aqueous waste stream is compatible, considering: 1. Whether an aqueous waste stream presents corrosion concerns; analysis may include chloride and fluoride 2. Whether an aqueous waste stream is compatible with LERF liner materials, compare characterization data to the liner compatibility limits (Table 3.1). 3. Whether an aqueous waste stream is compatible with other aqueous waste(s). (A 40 CFR 264 Appendix V type of comparison will be employed).

200 Area ETF = 200 Area Effluent Treatment Facility
LERF = Liquid Effluent Retention Facility

3.3 SPECIAL MANAGEMENT REQUIREMENTS

Special management requirements for aqueous wastes that are managed in the LERF or 200 Area ETF are discussed in the following sections.

3.3.1 Conditions on Process Condensate for Newly Identified Waste Numbers

In January 1995, the U.S. Department of Energy, Richland Operations Office (DOE-RL) notified Ecology and the U.S. Environmental Protection Agency that small amounts of listed waste might have been introduced to the DST System, upstream of the LERF and 200 Area ETF. This listed waste previously had not been identified in the Part A Form for the DST System, LERF, or 200 Area ETF. In a March 7, 1995 letter from Ecology to DOE-RL (Ecology 1995b), Ecology exercised its enforcement discretion with respect to the designation of this waste so long as several conditions are met. As long as these conditions are met, the waste numbers will not be included in Chapter 1.0 (Part A Form), for the LERF and 200 Area 200 Area ETF. These conditions only apply to PC. The constituents vanadium, formate, and cyanide will be analyzed in the PC to meet these conditions.

3.3.2 Land Disposal Restriction Compliance at Liquid Effluent Retention Facility

Because LERF provides treatment through flow and pH equalization, a surface impoundment treatment exemption from the land disposal restrictions was granted in accordance with 40 CFR 268.4 (EPA 1994 and Ecology 1996b). This treatment exemption is subject to several conditions, including a requirement that the WAP address the sampling and analysis of the treatment 'residue' [40 CFR 268.4(a)(2)(i) and WAC 173-303-300(5)(h)(i) and (ii)] to ensure the 'residue' meets applicable treatment standards. Though the term 'residue' is not specifically defined, this condition further requires that sampling must be designed to represent the "sludge and the supernatant" indicating that a residue may have a sludge (solid) and supernatant (liquid) component.

Solid residue is not anticipated to accumulate in a LERF basin for the following reasons:

- Aqueous waste streams containing sludge would not be accepted into LERF under the acceptance criteria of treatability (Section 3.2.2.2.1)
- No solid residue was reported from PC discharged to LERF in 1995
- The LERF basins are covered and all incoming air first passes through a breather filter
- No precipitating or flocculating chemicals are used in flow and pH equalization.

Therefore, the residue component subject to this condition is the supernatant (liquid component). As indicated above, solids are not anticipated to accumulate in a LERF basin. Additionally, an aqueous waste stream is evaluated for the potential to deposit solids in a LERF basin (i.e., an aqueous waste that contains sludge). If necessary, filtration at the waste source could be required before acceptance into LERF. The contingency for removal of solids will be addressed during closure [as indicated in Chapter 11.0, Closure Plan.

The conditions of the treatment exemption also require that treatment residues (i.e., aqueous wastes), which do not meet the LDR treatment standards "must be removed at least annually" [40 CFR 268.4(a)(2)(ii)]. To address the conditions of this exemption, an influent aqueous waste is sampled and analyzed and the LDR status of the aqueous waste is established as part of the acceptance process. The LERF basins are then managed such that any aqueous waste(s), which exceeds an LDR standard, is removed annually from a LERF basin, except for a heel of approximately 1 meter. A heel is required to stabilize the LERF liner. The volume of the heel is approximately 1.9 million liters.

3.4 INFLUENT AQUEOUS WASTE SAMPLING AND ANALYSIS

The following sections provide a summary of the sampling procedures, frequencies, and analytical parameters that will be used in the characterization of influent aqueous waste (Section 3.2) and in support of the special management requirements for aqueous waste in the LERF (Section 3.3).

3.4.1 Sampling Procedures

With a few exceptions, generators are responsible for the characterization, including sampling and analysis, of an influent aqueous waste. PC is either sampled at the 242-A Evaporator or accumulated in a LERF basin following a 242-A Evaporator campaign and sampled. Flow-through aqueous wastes, such as the 200-UP-1 Groundwater, will be characterized before acceptance; however, these aqueous wastes will also be sampled at LERF quarterly. Other exceptions will be handled on a case-by-case basis and the operating record will be maintained at the unit for inspection by Ecology. The following section discusses the sampling locations, methodologies, and frequencies for these aqueous wastes. Aqueous waste generators are referred to WAC 173-303-110(2) (40 CFR 261, Appendix I) for the sampling procedures that are applicable to their waste. For samples collected at the LERF and 200 Area ETF, unit-specific sampling protocol is followed. The sample containers, preservation materials, and holding times for each analysis are listed in Section 3.10.

3.4.1.1 Batch Samples

In those cases where an aqueous waste is sampled in a LERF basin, samples are collected from four of the six available sample risers located in each basin, i.e., four separate samples. When LERF levels are low, fewer than four samples can be taken provided that the sampling approach is still representative. Though there are eight sample risers at each basin, one is dedicated to liquid level instrumentation and another is dedicated as an influent port. Operating experience indicates that four samples adequately capture the variability of an aqueous waste stream. Specifically, sections of stainless steel (or other compatible material) tubing are inserted into the sample riser to an appropriate depth. Using a portable pump, the sample line is flushed with the aqueous waste and the sample collected. The grab sample containers typically are filled for volatile organic compounds (VOC) first, followed by the remainder of the containers for the other parameters.

Several sample ports are also located at 200 Area ETF, including a valve on the recirculation line at 200 Area ETF surge tank, and a sample valve on a tank discharge pump line at 200 Area ETF Load-In Station. All samples are obtained at the LERF or 200 Area ETF are collected in a manner consistent with SW-846 procedures (EPA as amended).

3.4.1.2 Flow-Through Samples at the Liquid Effluent Retention Facility

Flow-through samples are collected from a valve located at a transfer pipeline connection to the LERF. Samples of flow-through aqueous wastes, such as 200-UP-1 Groundwater, are collected quarterly or more frequently if there is change in the source (e.g., a change in the well-head), or if it is determined that there is an increase in the concentration of contaminants beyond the range described in the initial characterization. For flow-through grab samples, VOC sample containers are typically filled first, followed by the remainder of the containers for the other parameters.

3.4.2 Analytical Rationale

As stated previously, each generator is responsible for designating and characterizing its aqueous waste stream. Accordingly, each generator samples and analyzes an influent waste stream using the target list of parameters (Table 3.3) for the waste acceptance process. At the discretion of the LERF and 200 Area ETF management, a generator may provide process knowledge in lieu of some analyses as discussed in Section 3.2.1.1. The LERF and 200 Area ETF personnel will work with the generator to determine which parameters are appropriate for the characterization.

The analytical methods for these parameters are provided in Section 3.9. All methods are EPA methods. Additional analyses may be required if historical information and process knowledge indicate that an influent aqueous waste contains constituents not included in the target list of parameters. For example, if process knowledge indicates that an aqueous waste contains a parameter that is regulated by the Groundwater Quality Criteria (WAC 173-200), that parameter(s) would be added to the suite of analyses required for that aqueous waste stream.

The analytical data for the parameters presented in Table 3.3, including VOC, SVOC, metals, anions, and general chemistry parameters are used to define the physical and chemical properties of the aqueous waste to:

- Set operating conditions in the LERF and 200 Area ETF (e.g., to determine operating configuration - refer to Section 3.2.2.2)
- Identify concentrations of some constituents which may also interfere with, or foul 200 Area ETF treatment process (e.g., fouling of the RO membranes - refer to Section 3.2.2.2)
- Evaluate LERF liner and piping material compatibility
- Determine treatability to evaluate if applicable constituents in the treated effluent will meet Discharge Permit and Delisting limits

- Estimate concentrations of some constituents in the waste generated in the secondary treatment train (i.e., dry powder waste).

Some analyses also are performed to address special conditions (Section 3.3) or for other specific purposes as indicated below:

- Formate, cyanide, and vanadium analysis is required for compliance with special conditions for PC (refer to Section 3.3.2).
- Total dissolved solids analysis to predict volume of powder waste from the secondary treatment train.

Table 3.3. Target Parameters for Influent Aqueous Waste Analyses

VOLATILE ORGANIC COMPOUNDS		SEMIVOLATILE ORGANIC COMPOUNDS
Acetone Acetonitrile Benzene 1-Butanol Carbon disulfide Carbon tetrachlorideChloroform Methylenechloride Tetrachloroethylene Tetrahydrofuran		Acetophenone Cresol (o, p, m) Dichloroisopropyl ether (bis(2-chloropropyl)ether) Di-n-octyl phthalate Diphenylamine Hexachlorobenzene Hexachlorocyclopentadiene Iosophorone Lindane (gamma-BHC) N-nitrosodimethylamine Pyridine Tributyl phosphate 2,4,6-Trichlorophenol
TOTAL METALS		**ANIONS**
Arsenic Barium Beryllium Cadmium Calcium Chromium Copper Iron Lead	Magnesium Mercury Nickel Potassium Selenium Silicon Silver Sodium Vanadium Zinc	Chloride Fluoride Formate[1] Nitrate Nitrite Phosphate Sulfate
		GENERAL CHEMISTRY PARAMETERS
		Ammonia Total Kjeldahl nitrogen Cyanide pH Total suspended solids Total dissolved solids Total organic carbon Specific conductivity

[1] Parameter only required for 242-A Evaporator process condensate (refer to Section 3.3.2)

3.5 TREATED EFFLUENT SAMPLING AND ANALYSIS

The treated aqueous waste, or effluent, from 200 Area ETF is collected in three 2,540,000-liter verification tanks before discharge to the SALDS. To determine whether the Discharge Permit early warning values, enforcement limits, and the Delisting criteria are met, the effluent routinely is sampled at the verification tanks. The sampling and analyses performed are described in the following sections.

3.5.1 Rationale for Effluent Analysis Parameter Selection

The parameters measured in the treated effluent are required by the following regulatory documents:

- Delisting criteria from the Final Delisting (EPA 2005)
- Effluent limits from the State Waste Discharge Permit (Ecology 2000)

- Early warning values from the State Waste Discharge Permit (Ecology 2000).

The Final Delisting provides two testing regimes for the treated effluent. Initial verification-testing is performed when a new influent wastestream is processed through the 200 Area ETF. For each 200 Area ETF influent, the first generated verification tank must be sampled and analyzed for all delisting constituents and conductivity. Subsequent verification sampling and analysis of all delisting parameters is performed on every 15th tank of that 200 Area ETF influent type. If the concentration of any analyte is found to exceed a Discharge Permit enforcement limit or a Delisting criterion, the contents of the verification tank are reprocessed and/or re-analyzed. The next verification tank generated is also sampled for all delisting constituents. If the concentration of any analyte exceeds an early warning value an early warning value report is prepared and submitted to Ecology.

3.5.2 Effluent Sampling Strategy: Methods, Location, Analyses, and Frequency

Effluent sampling methods and locations, the analyses performed, and frequency of sampling are discussed in the following sections.

3.5.2.1 Effluent Sampling Method and Location

Samples of treated effluent are collected and analyzed to verify the treatment process using 200 Area ETF-specific sampling protocol. These verification samples are collected at a sampling port on the verification tank recirculation line. Section 3.9 presents the sample containers, preservatives, and holding times for each parameter monitored in the effluent.

3.5.2.2 Analyses of Effluent

The parameters required by the current Discharge Permit and Delisting conditions are presented in Table 3.4. The analytical methods and PQLs associated with each parameter are provided in Section 3.9. The methods and PQLs are equivalent to those used in the analysis of influent aqueous waste. With the exception of formic acid (analyzed as formate), analyses for the constituents associated with the newly listed waste numbers (Section 3.3.2) already are required analyses for the effluent. An analysis for formate is not required unless this constituent is identified in the influent aqueous waste.

3.5.2.3 Frequency of Sampling

Treated effluent is tested for all parameters listed in Table 3.4 on a frequency consistent with the conditions of the Discharge Permit and the Final Delisting. This effluent must meet the Discharge Permit and Delisting limits associated with these parameters. Grab samples are collected from each verification tank.

During operation of 200 Area ETF, if one or more of the constituents exceeds a Delisting criterion, the Delisting conditions require the analysis of samples from the following verification tank volume before effluent can be discharged. Treated effluent that does not meet Delisting criteria and Discharge Permit is not discharged to the SALDS until the tank has been retreated and/or analyzed.

3.6 EFFLUENT TREATMENT FACILITY GENERATED WASTE SAMPLING AND ANALYSIS

The wastes discussed in this section include the wastes generated at 200 Area ETF and are managed in the container storage areas of 200 Area ETF. This section describes the characterization of the following secondary waste streams generated within 200 Area ETF:

- Secondary waste generated from the treatment process, including the following waste forms:
  - dry powder waste
  - concentrate tanks slurry

  - sludge removed from process tanks
- Waste generated by operations and maintenance activities
- Miscellaneous waste generated within 200 Area ETF

For each waste stream, the waste is described, a characterization methodology and rationale are provided, and sampling requirements are addressed.

3.6.1 Secondary Waste Generated from Treatment Processes

The following terms used in this Section, including powder, dry powder, waste powder, and dry waste powder, are equivalent to the term 'dry powder waste'.

A dry powder waste is generated from the secondary treatment train, from the treatment of an aqueous waste. Waste is received in the secondary treatment train in waste receiving tanks where it is fed into an evaporator. Concentrate waste from the evaporator is then fed to a concentrate tank. From these tanks, the waste is fed to a thin film dryer and dried into a powder, and collected into containers. The containers are filled via a remotely controlled system. The condensed overheads from the evaporator and thin film dryer are returned to the surge tank to be fed to the primary treatment train.

Occasionally, salts from the treatment process (e.g., calcium sulfate and magnesium hydroxide) accumulate in process tanks as sludge. Because processing these salts could cause fouling in the thin film dryer, and to allow uninterrupted operation of the treatment process, the sludge is removed and placed in containers. The sludge is dewatered and the supernate is pumped back to 200 Area ETF for treatment.

The secondary treatment system typically receives and processes the following by-products generated from the primary treatment train:

- Concentrate from the first RO stage
- Backwash from the rough and fine filters
- Regeneration waste from the ion exchange system
- Spillage or overflow collected in the process sumps.

In an alternate operating scenario, some aqueous wastes may be fed to the secondary treatment train before the primary treatment train. A more complete description of these processes can be found in Chapter 4.0.

3.6.1.1 Rationale for Selection of Parameters for Analysis

200 Area ETF secondary waste is anticipated to consist primarily of sulfate salts with minor amounts of metals. The designation of 200 Area ETF secondary waste is based on influent characterization data. These data are used to assign applicable listed waste numbers to the secondary waste and to determine if the secondary waste would designate as a characteristic waste because of toxic metals.

Concentrations of metals in the secondary waste are projected by comparing the influent metals data to the removal efficiencies of 200 Area ETF treatment process. When the influent data indicate that the secondary waste will not designate as a characteristic waste, the secondary waste, as slurry, sludge, or dry powder, is not sampled and analyzed for metals.

The influent data, in conjunction with knowledge of 200 Area ETF treatment processes, also are used to determine the LDR status of 200 Area ETF secondary waste. Knowledge of the treatment process indicates that VOCs and SVOCs (i.e., listed waste constituents) are not expected in the secondary waste because of the organic destruction capability of the UV/OX and the temperatures of the thin film dryer. Accordingly, when the influent data indicate that the secondary waste meets the LDR treatment standards, the secondary waste, as slurry, sludge, or dry powder, is not sampled and analyzed for VOCs or SVOCs.

The parameters for analysis of 200 Area ETF secondary waste are provided in Table 3.5. The specific analytical methods for these analyses are provided in Section 3.9. Additionally, samples of slurry or sludge undergo a total solids analysis to convert the analytical data on other parameters to dry weight concentrations.

3.6.1.2 Sampling Methods

The dry powder waste and containerized sludge are sampled from containers using the principles presented in SW-846 (EPA as amended) and ASTM Methods (American Society for Testing Materials), as referenced in WAC 173-303-110(2). The sample container requirements, sample preservation requirements, and maximum holding times for each of the parameters analyzed in either matrix are presented in Section 3.9.

Concentrate tank waste samples are collected from recirculation lines, which provide mixing in the tank during pH adjustment and prevent caking. The protocol for concentrate tank sampling prescribes opening a sample port in the recirculation line to collect samples directly into sample containers. The sample port line is flushed before collecting a grab sample. The VOC sampling typically is performed first for grab samples. Each VOC sample container will be filled such that cavitation at the sample valve is minimized and the container has no headspace. The remainder of the containers for the other parameters will be filled next.

Table 3.4. Rationale for Parameters to Be Monitored in Treated Effluent

Parameter	(Cas No.)	Final Delisting[1]	Discharge Permit[2]	
			Enforcement Limit	Early Warning Value
VOLATILE ORGANIC COMPOUNDS				
Acetone	(67-64-1)	X		
Acetonitrile	(75-05-8)	X		
Benzene	(71-43-2)	X		X
1-Butanol	(71-36-3)	X		
Carbon disulfide	(75-15-0)	X		
Carbon tetrachloride	(56-23-5)	X	X	
Chloroform	(67-66-3)			X
Methylene Chloride	(75-09-2)		M	
Tetrachloroethylene	(127-18-4)		X	
Tetrahydrofuran	(109-99-9)	X		X
SEMIVOLATILE ORGANIC COMPOUNDS				
Acetophenone	(98-86-2)		X	
Carbazole	(86-74-8)	X		
p-Chloroaniline	(106-47-8)	X		
Chrysene	(218-01-9)	X		
Cresol (total)	(1319-77-3)	X		
Dichloroisopropyl ether (bis(2-chloroisopropyl)ether)	(108-60-1)	X		
Di-n-octyl phthalate	(117-84-0)	X		
Diphenylamine	(122-39-4)	X		
Hexachlorobenzene	(118-74-1)	X		
Hexachlorocyclopentadiene	(77-47-4)	X		
Isophorone	(78-59-1)	X		
Lindane (gamma-BHC)	(58-89-9)	X		
N-nitrosodimethylamine	(62-75-9)	X	X	
Pyridine	(110-86-1)	X		
Tributyl phosphate	(126-73-8)	X		
2,4,6-Trichlorophenol	(88-06-2)	X		
PCBs				
Aroclor 1016	(12674-11-2)	X		
Aroclor 1221	(11104-28-2)	X		
Aroclor 1232	(11141-16-5)	X		
Aroclor 1242	(53469-21-9)	X		
Aroclor 1248	(12672-29-6)	X		
Aroclor 1254	(11097-69-1)	X		
Aroclor 1260	(11096-82-5)	X		
TOTAL METALS[3]				
Arsenic	(7440-38-2)	X	X	
Barium	(7440-39-3)	X		
Beryllium	(7740-41-7)	X	X	
Cadmium	(7440-43-9)	X		X
Chromium	(7440-47-3)	X	X	
Copper	(7440-50-8)			X
Lead	(7439-92-1)	X		X
Mercury	(7439-97-6)	X		X
Nickel	(7440-02-0)	X		
Selenium	(7782-49-2)	X		

Table 3.4. Rationale for Parameters to Be Monitored in Treated Effluent

Parameter	(Cas No.)	Final Delisting[1]	Discharge Permit[2]	
			Enforcement Limit	Early Warning Value
Silver	(7440-22-4)	X		
Vanadium	(7440-62-2)	X		
Zinc	(7440-66-6)	X		
ANIONS				
Chloride	(16887-00-6)		X	
Fluoride	(16984-48-8)	X		
Nitrate (as N)	(14797-55-8)		X	
Nitrite (as N)	(1479765-0)		X	
Sulfate	(14808-79-8)		X	
OTHER ANALYSES				
Ammonia	(7664-41-7)	X	X	
Cyanide	(57-12-5)	X		
Total dissolved solids				X
Total organic carbon			X	
Total suspended solids			X	
Specific conductivity			M	

[1] Parameters required by the current conditions of the Final Delisting, 40 CFR 261, Appendix IX, Table 2,70 FR 44496 (EPA 2005)

[2] Parameters required by the current conditions of the State Waste Discharge Permit, No. ST 4500 (Ecology 2000)

[3] Metals reported as total concentrations

X Rationale for measuring this parameter in treated effluent

M Monitor only; no limit defined

PCBs = polychlorinated biphenyls

3.6.1.3 Sampling Frequency

200 Area ETF secondary waste is sampled on a batch basis. A batch is defined as any volume of aqueous waste that is being treated under consistent and constant process conditions. The secondary waste will be resampled under the following changes in process conditions:

- Change in an influent source
- Change in process chemistry, as indicated by in-line monitoring of conductivity and pH.

One representative sample will be collected from the concentrate tank, if waste from the concentrate tank is used for characterization of a batch of influent waste. The sample will be analyzed for the appropriate parameters identified in Table 3.5 based on the needs identified from evaluating influent sampling and analysis data. When personnel exposures are of concern, analytical results from concentrate tank samples or influent data will be used to represent the powder waste generated from the treatment of that aqueous waste(s). The dry powder, solidified waste block, or concentrate tanks will be re-sampled in the following situations:

- The LERF and 200 Area ETF management have been notified, or have reason to believe that the process generating the waste has changed (for example, a source change such as a change in the well-head for groundwater that significantly changes the aqueous waste characterization).

- The LERF and 200 Area ETF management note an increase or decrease in the concentration of a constituent in an aqueous waste stream, beyond the range of concentrations that was described or predicted in the waste characterization.

3.6.1.4 Special Requirements Pertaining to Land Disposal Restrictions

Containers of 200 Area ETF secondary waste are transferred to a storage or final disposal unit, as appropriate (e.g., the Central Waste Complex or to the Environmental Restoration Disposal Facility). 200 Area ETF personnel provide the analytical characterization data and necessary process knowledge for the waste to be tracked by the receiving staff, and for the appropriate LDR documentation.

The following information on the secondary waste is included on the LDR documentation provided to the receiving unit:

- Dangerous waste numbers (as applicable)
- Determination on whether the waste is restricted from land disposal according to the requirements of 40 CFR 268/WAC 173-303-140 (i.e., the LDR status of the waste)
- The waste tracking information associated with the transfer of waste
- Waste analysis results.

3.6.2 Operations and Maintenance Waste Generated at the 200 Area Effluent Treatment Facility

Operation and maintenance of process and ancillary equipment generates additional routine waste. These waste materials are segregated to ensure proper handling and disposition, and to minimize the commingling of potentially dangerous waste with nondangerous waste. The following waste streams are anticipated to be generated during routine operation and maintenance of 200 Area ETF. This waste might or might not be dangerous waste, depending on the nature of the material and its exposure to a dangerous waste.

- Spent lubricating oils and paint waste from pumps, the dryer rotor, compressors, blowers, and general maintenance activities
- Spent filter media and process filters
- Spent ion exchange resin

- HEPA filters
- UV light tubes
- RO membranes
- Equipment that cannot be returned to service
- Other miscellaneous waste that might contact a dangerous waste (e.g., plastic sheeting, glass, rags, paper, waste solvent, or aerosol cans).

These waste streams are stored at 200 Area ETF before being transferred for final treatment, storage, or disposal as appropriate. This waste is characterized and designated using process knowledge (from previously determined influent aqueous waste composition information); analytical data; and material safety data sheets (MSDS) of the chemical products present in the waste or used (the data sheets are maintained at 200 Area ETF). Sampling of these waste streams is not anticipated; however, if an unidentified or unlabeled waste is discovered, that waste is sampled. This 'unknown' waste is sampled and analyzed for the parameters in Table 3.5 as appropriate, and will be designated according to Washington state regulatory requirements. The specific analytical methods for these analyses are provided in Section 3.9.

3.6.3 Other Waste Generated at the 200 Area Effluent Treatment Facility

There are two other potential sources of waste at 200 Area ETF: spills and/or overflows, and discarded chemical products. Spilled material that potentially might be dangerous waste generally is routed to 200 Area ETF sumps where the material is transferred either to the surge tank for treatment or to the secondary treatment train. A spilled material also could be containerized and transferred to another TSD unit. In most cases, process knowledge and the use of MSDSs are sufficient to designate the waste material. If the source of the spilled material is unknown and the material cannot be routed to 200 Area ETF sumps, a sample of the waste is collected and analyzed according to Table 3.5, as necessary, for appropriate characterization of the waste. Unknown wastes will be designated according to Washington State regulatory requirements. The specific analytical methods for these analyses are provided in Section 3.9.

A discarded chemical product waste stream could be generated if process chemicals, cleaning agents, or maintenance products become contaminated or are otherwise rendered unusable. In all cases, these materials are appropriately containerized and designated. Sampling is performed, as appropriate, for waste designation.

Table 3.5. 200 Area Effluent Treatment Facility Generated Waste - Sampling and Analysis

Parameter[1]	Rationale
• Total solids or percent water[2]	• Calculate dry weight concentrations
• Volatile organic compounds[3]	• LDR - verify treatment standards
• Semivolatile organic compounds[3]	• LDR - verify treatment standards
• Metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver)	• Waste designation • LDR - verify treatment standards
• Cation and anions of concern	• Address receiving TSD unit waste acceptance requirements
• pH	• Waste designation

[1] For influent and concentrate tank samples, the total sample (solid plus liquid) is analyzed and the analytical result is expressed on a dry weight basis. The result for toxicity characteristic metal and organic is divided by a factor of 20 and compared to the toxicity characteristic (TC) constituent limits [WAC 173-303-090(8)]. If the TC limit is met or exceeded, the waste is designated accordingly. All measured parameters are compared against the corresponding treatment standards.

[2] Total solids or percent water are not determined for unknown waste and dry powder waste samples and are analyzed in maintenance waste and sludge samples, as appropriate (i.e., percent water might not be required for such routine maintenance waste as aerosol cans, fluorescent tubes, waste oils, batteries, etc., or sludge that has dried).

[3] VOC and/or SVOC analysis of secondary waste is required unless influent characterization data and process knowledge indicate that the constituent will not be in the final secondary waste at or above the LDR.

LDR = land disposal restrictions

TSD = treatment, storage, and/or disposal

3.7 QUALITY ASSURANCE/QUALITY CONTROL

The following quality assurance/quality control (QA/QC) information for LERF and 200 Area ETF is provided as required by WAC 173-303-810(6). The sampling and analysis activities at LERF and 200 Area ETF conform to the requirements of an LERF and 200 Area ETF-specific quality assurance project plan and are in accordance with the following EPA guidance documents:

- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition, as amended, U.S. Environmental Protection Agency, Washington, DC, as amended, as referenced in WAC 173-303-110.

- *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79/020, U.S. Environmental Protection Agency, National Exposure Research Laboratory, Cincinnati, Ohio, March 1983.

3.7.1 Sampling Program

Typically, generators are responsible for the sampling and analysis of an influent aqueous waste. However, samples of influent aqueous waste can be collected at the LERF or the Load-In Station. Samples of treated effluent are collected at the verification tanks. Secondary waste generated from the treatment process is typically sampled in the dry powder form; however, the secondary waste also could be characterized based on influent data or by sampling while in slurry form. Sampling of influent aqueous waste, treated effluent, and secondary waste is discussed in Sections 3.4, 3.5, and 3.6, respectively, of the WAP.

Specific information on sample holding times, preservatives, and sample containers is provided in Section 3.9. The selection of the sample collection device depends on the type of sample, the sample container, the sampling location, and the nature and distribution of the waste components. In general, the

methodologies used for specific materials correspond to those referenced to WAC 173-303-110(2). The selection and use of the sampling device is supervised or performed by a person thoroughly familiar with the sampling requirements. Samples are collected according to LERF and 200 Area ETF-specific sampling protocol.

Sampling equipment is constructed of nonreactive materials such as glass, plastic, aluminum, or stainless steel, as indicated by the nature and matrix of the waste. Care is taken in the selection of the sampling device to prevent contamination of the sample and to ensure compatibility of materials. For example, plastic bottles are not used to collect some organic wastes.

3.7.2 Analytical Program

The onsite laboratory employed by LERF and 200 Area ETF organization is required to have a program of quality control practices and procedures to ensure that precision and accuracy are maintained. The QA/QC program for sampling complies with the applicable requirements in the Tri-Party Agreement Action Plan, Section 6.5 (TPA) and the regulations. All analytical data are defensible and traceable to specific, related QC samples and calibrations. Offsite laboratories employed by LERF and 200 Area ETF must meet the same QA/QC requirements as onsite laboratories and must demonstrate quality control practices that are comparable to the onsite laboratory's program. A review of an offsite laboratory may be conducted to ensure that the quality control of LERF and 200 Area ETF data is maintained. The SW-846 and EPA-600 analytical methods are followed (as indicated in Section 3.9). However, other methods may be substituted for a parameter if the PQL can be met.

The chemical parameters and associated analytical methods identified in Section 3.9 are used to characterize an influent aqueous waste, effluent waste, and 200 Area ETF secondary waste. The analytical data on these parameters are also used to establish that key decision limits pertinent to proper waste management are met. These key decision limits are numerical thresholds, which include:

- liner compatibility limits for an influent aqueous waste as managed in LERF (may include blending a waste with other wastes to meet these limits)
- the LDR status of 200 Area ETF secondary waste
- delisting limits for treated effluent

Where analytical data are used in key decision-making, the PQL of an analytical parameter (or sum of the PQLs, as indicated by the decision) must be at or below the key decision limit. In cases where the decision limit is below the PQL, the method detection limit (MDL) is used in the key decision-making process.

Good laboratory practices, which encompass sampling, sample handling, housekeeping, and safety, are maintained at all laboratories. The following section describe the specific practices which are implemented at the onsite laboratory to maintain the precision and accuracy goals in Section 3.9for quality control samples which include method blank, quality control check, matrix spike, and duplicate samples.

The decision to re-analyze if the stated precision and accuracy goals are not met will depend on the use of the analytical results. Generally, only analytical results used in key decisions would require re-analysis if precision and accuracy goals were not met. For example, if the precision and accuracy goals are not met in a liner compatibility analysis, the sample would generally be re-analyzed if the results were close to a compatibility limit. However, if the analytical results suggested that concentrations were an order of magnitude below a liner compatibility limit, generally re-analysis would not be required. The decision to re-analyze a waste in a key decision situation will be made on a case-by-case basis.

3.7.2.1 Contamination Evaluation

Method blank samples are prepared with each batch of samples (at least 1 in a batch of 20) and analyzed to ensure sample contamination has not occurred.

3.7.2.2 Quality Control Check Sample

A quality control check sample is analyzed with each batch (at least 1 in a batch of 20) for each analytical parameter determined. The results show that analytical procedures are properly performed and that calibration and standardization of instrumentation are within acceptable limits per the method.

3.7.2.3 Matrix Spike Analyses

Matrix spike samples are employed to monitor recoveries and demonstrate accuracy. Matrix spike samples are periodically analyzed to provide information about the effect of the sample matrix on the analyte in question. Typically, a ratio of one spike for each analytical batch of samples, or 1 in 20, is maintained.

3.7.2.4 Duplicate Analyses

A laboratory sample duplicate or a matrix spike duplicate is analyzed to assess analytical precision in the laboratory. Typically, a ratio of one duplicate sample for each analytical batch of samples, or 1 in 20, is maintained.

3.7.3 Conclusion

The aforementioned sampling and analytical quality practices help ensure that the data obtained are precise and accurate for the waste stream being sampled. The analytical results are used by LERF and 200 Area ETF management to decide whether to accept a particular waste stream and, upon acceptance, to determine the appropriate method of treatment, storage, and disposal. Results are also important to ensure that wastes are managed properly by LERF and 200 Area ETF and those incompatible wastes are not inadvertently combined. Just as these results are important, so is the quality of these results. Thus, the quality of the analytical data, the thoroughness and care with which the sampling and analyses are performed and reported, provides an important basis for day-to-day operational decisions.

3.8 REFERENCES

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EPA, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846* (Third Edition, as amended), U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1994, *Liquid Effluent Retention Facility (LERF) Land Disposal Restrictions Treatment Exemption-Regulatory Interpretation EPA/Ecology ID No: WA7890008967*, letter from U.S. Environmental Protection Agency, Region 10 to J. Hennig, U.S. Department of Energy, December 6, 1994.

EPA, 2005, Final Delisting [Exclusion], issued to U.S. Department of Energy, 40 CFR 261, Appendix IX, Table 2 (70 FR 44496, August 3, 2005), U.S. Environmental Protection Agency, Washington, D.C

3.9 ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATIVE METHODS, AND HOLDING TIMES

Table 3.6. Sample and Analysis Criteria for Influent Aqueous Waste and Treated Effluent

Parameter	Analytical Method[a]	Method PQL[b] Sensitivity[2]	Accuracy/ Precision for Method[3] (percent)	Sample container[4]/ Preservative[4]/ Holding time[5]
VOLATILE ORGANIC COMPOUNDS				
Acetone	SW-846 8260	40	60-120	Sample container 3 x 40-mL amber glass with septum Preservative HCl to pH<2; 4EC Holding time 14 days
Acetonitrile		820	60-120	
Benzene		5	60-120	
1-Butanol		1600	60-120	
Carbon Disulfide		1500	60-120	
Carbon tetrachloride		5	60-120	
Chloroform		5	50-130	
Methylene chloride		5	50-150	
Tetrachloroethylene		5	65-140	
Tetrahydrofuran		100	60-120	
SEMIVOLATILE ORGANIC COMPOUNDS				
Acetophenone	SW-846 8270	10	70-110	Sample container 4 x 1-liter amber glass Preservative 4EC Holding time 7 days for extraction; 40 days for analysis after extraction
Carbazole		110	50-120	
p-Chloroaniline		76	50-120	
Chrysene		350	50-120	
Cresol (o, p, m)		760	50-120	
Di-n-octyl phthalate		300	50-120	
Diphenylamine		350	50-120	
Hexachlorobenzene		2	50-120	
Hexachlorocyclopentadiene		110	50-120	
Isophorone		2600	50-120	
Lindane (gamma-BHC)		1.9	50-120	
N-nitrosodimethylamine		10	50-120	
Pyridine		15	50-120	
Tributyl phosphate		76	50-120	
2.4.6-Trichlorophenol		230	50-120	
POLYCHLORINATED BIPHENYLs (PCBs)				
Aroclor-1016	SW-846 8082	0.4	50-110	Sample container 4 x 1-liter amber glass Preservative 4EC Holding time 7 days for extraction; 40 days for analysis after extraction
Aroclor-1221		0.4	50-110	
Aroclor-1232		0.4	50-110	
Aroclor-1242		0.4	50-110	
Aroclor-1248		0.4	50-110	
Aroclor-1254		0.4	50-110	
Aroclor-1260		0.4	50-110	

Table 3.6. Sample and Analysis Criteria for Influent Aqueous Waste and Treated Effluent

Parameter	Analytical Method[a]	Method PQL[b] Sensitivity[2]	Accuracy/ Precision for Method[3] (percent)	Sample container[4]/ Preservative[4]/ Holding time[5]
TOTAL METALS				
Arsenic	EPA-600 200.8	11	70-130	Sample container 1 x 0.5-liter plastic/glass Preservative 1:1 HNO_3 to pH<2 Holding time 180 days; mercury 28 days
Cadmium		5	70-130	
Chromium		20	70-130–	
Copper		70	70-130–	
Lead		10	70-130–	
Mercury		2	70-130–	
Selenium		20	70-130	
Barium	6010A/EPA-600 200.7	1200	75 - 125	
Beryllium		34	75 - 125	
Calcium		200	75 - 125	
Iron		100	75 - 125	
Magnesium		400	75 - 125	
Nickel		340	75 - 125	
Potassium		10,000	75 - 125	
Silicon		580	75 - 125	
Silver		83	75 - 125	
Sodium		2500	75 - 125	
Vanadium		120	75 - 125	
Zinc		5100	75 - 125	
GENERAL CHEMISTRY				
Chloride	EPA-600 300.0	1000	70-130	Sample container 1 x 1-liter glass Preservative 4EC Holding time 28 days
Fluoride		880	70-130	
Formate[6]		1250	70-130	
Nitrate (as N)		100	70-130	
Nitrite (as N)		100	70-130	
Phosphate		1500	70-130	
Sulfate		10,000	70-130	
Ammonia	EPA-600	40	70-130	Sample container 1 x 50- mL glass or plastic Preservative H_2SO_4 to pH<2; 4EC Holding time 28 days
Cyanide	EPA-600 335.2/335.3	350	70-130	Sample container 1 x 250- mL glass or plastic Preservative NaOH to pH>12; 4EC Holding time 14 days
Alkalinity	EPA-600 310.1/310.2	ND	ND	Sample container 1 x 50- mL glass or plastic Preservative 4EC Holding time 14 days

Table 3.6. Sample and Analysis Criteria for Influent Aqueous Waste and Treated Effluent

Parameter	Analytical Method[a]	Method PQL[b] Sensitivity [2]	Accuracy/ Precision for Method[3] (percent)	Sample container[4]/ Preservative[4]/ Holding time[5]
Total dissolved solids	EPA-600 160.1	ND	ND	Sample container 1 x 500-mL glass or plastic Preservative 4EC Holding time 7 days
Total suspended solids	EPA-600 160.2	ND	ND	Sample container 1 x 1-L glass or plastic Preservative 4EC Holding time 7 days
Specific conductivity	EPA-600 120.1 (in lab)	ND	ND	Sample container 1 x 100-mL glass or plastic Preservative 4EC Holding time 28 days
Ph[7]	EPA-600 150.1	ND	ND	Sample container 1 x 25-mL glass or plastic Preservative None Holding time Analyze immediately
Total organic carbon	SW-846 9060	ND	ND	Sample container 1 x 250-mL glass Preservative H_2SO_4 to pH<2; 4EC Holding time 28 days

[1] SW-846 or EPA-600 methods are presented unless otherwise noted. Other methods might be substituted if the applicable PQL can be met.
[2] ST4500 required method PQL or Delisting Exclusion targeted method sensitivity/detection limit, which ever is lower.Units are parts per billion unless otherwise noted.
[3] Accuracy/precision used to confirm or re-establish MDL
[4] Sample bottle and preservatives could be adjusted, as applicable, to minimize sample volume.
[5] Holding time = time between sampling and analysis.
[6] Analysis for formate only required if detected in the influent aqueous waste.
[7] pH monitored in influent aqueous waste only

L = liter
mL = milliliter
NA = not applicable
ND = not determined
MDL = method detection level
PQL = practical quantitation limit
RL = reporting limit

Table 3.7. Sample Containers, Preservative Methods, and Holding Times for 200 Area ETF Generated Waste

Parameter	Analytical Method	Method PQL	Accuracy/ Precision for Method (percent)	Sample container[1]/ Preservative[1]/ Holding time[2]
Liquid Matrix				
For methods other than total solids, analyze using the methods and QA/QC in Table 3.6. For each method, analyze the target compound list				
Total solids	EPA-600 160.3	ND	ND	Sample container 1 x 500-mL glass or plastic Preservative – 4EC Holding time –7 days
Solid Matrix				
Volatile organic compounds (combined method target compound lists)	SW-846 8260	Refer to Table 3.6	Refer to Table 3.6	Sample container 3 x 40-mL amber glass with septum Preservative –4EC Holding time –14 days
Semivolatile organic compounds (method target compound list)	SW-846 8270	Refer to Table 3.6	Refer to Table 3.6	Sample container glass – 50 g of sample Preservative –4EC Holding time –14 days for extraction; 40 days for analysis after extraction
PCBs (method target compound list)	SW-846 8082	Refer to Table 3.6	Refer to Table 3.6	Sample container glass – 50 g of sample Preservative –4EC Holding time –14 days for extraction; 40 days for analysis after extraction
RCRA Metals (method target compound list)	EPA-600 200.8	Refer to Table 3.6	Refer to Table 3.6	Sample container glass or plastic – 10 g of sample Preservative –none, mercury 4EC Holding time –180 days; mercury 28 days
Total Metals (method target compound list)	SW-846 6010	Refer to Table 3.6	Refer to Table 3.6	
Anions (method target compound list)	EPA-600 300.0	Refer to Table 3.6	Refer to Table 3.6	Sample container glass or plastic – 10 g of sample Preservative –none Holding time –6 months for extraction; 28 days for analysis after extraction, nitrate and nitrite 48 hours for analysis after extraction
Ammonia	EPA-600 300.7	Refer to Table 3.6	Refer to Table 3.6	Sample container glass or plastic – 100 g of sample Preservative –none Holding time –6 months for extraction; 28 days for analysis after extraction
pH	SW-846 9045	ND	ND	Sample container glass or plastic – 100 g of sample Preservative –none Holding time –none

Parameter	Analytical Method	Method PQL	Accuracy/ Precision for Method (percent)	Sample container[1]/ Preservative[1]/ Holding time[2]
Toxicity Characteristic Leaching Procedure[3]	SW-846 1311	NA	NA	Sample container Refer to specific method being performed after TCLP – 125 g of sample Preservative –None (after TCLP, preserve extract per method being performed) Holding time –Metals: 180 days for TCLP extraction, mercury 28 days for TCLP extraction SVOA: 14 days for TCLP extraction (after TCLP, refer to specific methods for time for analysis after extraction)

[1] Sample bottle and preservatives could be changed as directed by the laboratory, or as required by the analytical method.
[2] Holding time equals time between sampling and analysis.
[3] Extraction procedure, as applicable; extract analyzed by referenced methods [WAC 173-303-110(3)(c)]

g = grams NA = not applicable PQL = practical quantitation limit
mL = milliliter ND = not determined TCLP = toxicity characteristic leaching procedure

Chapter 4.0 Process Information

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4.0 PROCESS INFORMATION

This chapter provides a detailed discussion of the LERF and ETF processes and equipment. The LERF and ETF comprise an aqueous waste treatment system located in the 200 East Area that provides storage and treatment for a variety of aqueous mixed waste. This aqueous waste includes process condensate from the 242-A Evaporator and other aqueous waste generated from onsite remediation and waste management activities.

The LERF consists of three lined surface impoundments, or basins. Aqueous waste from LERF is pumped to the ETF for treatment in a series of process units, or systems, that remove or destroy essentially all of the dangerous waste constituents. The treated effluent is discharged to a State-Approved Land Disposal Site (SALDS) north of the 200 West Area, under the authority of a Washington State Waste Discharge Permit (Ecology 2000) and the Final Delisting (40 CFR 261, Appendix IX, Table 2).

4.1 LIQUID EFFLUENT RETENTION FACILITY PROCESS DESCRIPTION

Each of the three LERF basins has an operating capacity of 29.5-million liters. The LERF receives aqueous waste through several inlets including the following:

- A pipeline that connects LERF with the 242-A Evaporator
- A pipeline from the 200 West Area
- A pipeline that connects LERF to the Load-In Station at the ETF
- A series of sample ports located at each basin.

Figure 4.1 presents a general layout of LERF and associated pipelines. Aqueous waste from LERF is pumped to the ETF through one of two double-walled fiberglass transfer pipelines. Effluent from the ETF also can be transferred back to the LERF through one of these transfer pipelines. These pipelines are equipped with leak detection located in the annulus between the inner and outer pipes. In the event that these leak detectors are not in service, the pipelines are visually inspected during transfers for leakage by opening the secondary containment drain lines at the ETF end of the transfer pipelines.

Each basin is equipped with six available sample risers constructed of 6-inch perforated pipe. A seventh sample riser in each basin is dedicated to influent aqueous waste receipt piping (except for aqueous waste received from the 242-A Evaporator), and an eighth riser in each basin contains liquid level instrumentation. Each riser extends along the sides of each basin from the top to the bottom of the basin and allows samples to be collected from any depth. Personnel access to these sample ports is from the perimeter area of the basins.

A catch basin is provided at the northwest corner of each LERF basin for aboveground piping and manifolds for transfer pumps. Aqueous waste from the 242-A Evaporator is transferred through piping which ties into piping at the catch basins. Under routine operations, a submersible pump is used to transfer aqueous waste from a LERF basin to the ETF for processing or for basin-to-basin transfers. This pump is connected to a fixed manifold on one of four available risers.

Each basin consists of a multilayer liner system supported by a concrete anchor wall around the basin perimeter and a soil-bentonite clay underlayment. The multilayer liner system consists of a primary liner in contact with the aqueous waste, a layer of bentonite carpet, a geonet, a geotextile, a gravel layer, and a secondary liner that rests on the bentonite underlayment. Any aqueous waste leakage through the primary liner flows through the geonet to a leachate collection system. The leachate flows to a sump at the northwest corner of each basin, where the leachate is pumped up the side slope and back into the basin above the primary liner. Each liner is constructed of high-density polyethylene. A floating cover made of very low-density polyethylene is stretched over each basin above the primary liner. These covers serve to keep unwanted material from entering the basins, and to minimize evaporation of the liquid contents.

4.2 EFFLUENT TREATMENT FACILITY PROCESS DESCRIPTION

The ETF is designed as a flexible treatment system that provides treatment for contaminants anticipated in process condensate and other onsite aqueous waste. The design influent flow rate into the ETF is approximately 570 liters per minute, with planned outages for activities such as maintenance on the ETF systems. Maintenance outages typically are scheduled between treating a batch of aqueous waste, referred to as treatment campaigns. The effluent flow (or volume) is equivalent to the influent flow (or volume).

The ETF generally receives aqueous waste directly from the LERF. However, aqueous waste also can be transferred from tanker trucks at the Load-In Station to the ETF and from containers (e.g., carboys, drums) directly to ETF. Aqueous waste is treated and stored in the ETF process area in a series of tank systems, referred to as process units. Within the ETF, waste also is managed in containers through treatment and/or storage. Figure 4.2 provides the relative locations of the process and container storage areas within the ETF.

The process units are grouped in either the primary or the secondary treatment train. The primary treatment train provides for the removal or destruction of contaminants. Typically, the secondary treatment train processes the waste by-products from the primary treatment train by reducing the volume of waste. In the secondary treatment train, contaminants are concentrated and dried to a powder. The liquid fraction is routed to the primary treatment train. Figure 4.3 provides an overview of the layout of the ETF, 2025E Building). Figure 4.4 presents the ETF floor plan, the relative locations of the individual process units and associated tanks within the ETF, and the location of the Load-In Station.

The dry powder waste and maintenance and operations waste are containerized and stored or treated in the container storage areas or in collection or treatment areas within the Process Area. Secondary containment is provided for all containers and tank systems (including ancillary equipment) housed within the ETF. The trenches and floor of the ETF comprise the secondary containment system. The floor includes approximately a 15.2-centimeter rise (berm) along the containing walls of the process and container storage areas. Any spilled or leaked material from within the process area or container storage area is collected into trenches that feed into either sump tank 1 or sump tank 2. From these sump tanks, the spilled or leaked material (i.e., waste) is fed to either the surge tank and processed in the primary treatment train or the secondary waste receiving tanks and processed in the secondary treatment train. All tank systems outside of the ETF are provided with a secondary containment system.

In the following sections, several figures are provided that present general illustrations of the treatment units and the relation to the process.

4.2.1 Load-In Station

The ETF receives aqueous waste from LERF or the Load-In Station. The ETF Load-In Station, located due east of the surge tank and outside of the perimeter fence (Figure 4.4), was designed and constructed to provide the capability to unload, store, and transfer aqueous waste to the ETF or LERF from tanker trucks and other containers (such as drums). The Load-In Station consists of two truck bays equipped with load-in tanks, transfer pumps, filtration system, level instrumentation for tanker trucks, leak detection capabilities for the containment basin and transfer line, and an underground transfer line that connects to lines in the surge tank berm, allowing transfers to either the ETF surge tank or LERF. The Load-In Station is covered with a steel building for weather protection. Tanker trucks and other containers are used to unload aqueous waste at the Load-In Station. To perform unloading, the tanker truck is positioned on a truck pad, a 'load-in' transfer line is connected to the truck, and the tanker contents are pumped into one of the Load-In Station tanks, the surge tank, or directly to the LERF. For container unloading, the container is placed on the truck pad and the container contents are pumped into one of the Load-In Station tanks, the surge tank, or directly to the LERF.

During unloading operations, solids may be removed from the waste by pumping the contents of the tanker truck or container through a filtration system. If solids removal is not needed, the filtration system is not used and the solution is transferred directly to the Load-In Station tanks, surge tank, or to LERF.

Any leaks at the Load-In Station drain to the sump. A leak detector in the sump alarms locally and in the ETF control room. Alternatively, leaks can be visually detected.

4.2.2 Effluent Treatment Facility Operating Configuration

Because the operating configuration of the ETF can be adjusted or modified, most aqueous waste streams can be effectively treated to below Delisting and Discharge Permit limits. The operating configuration of the ETF depends on the unique chemistry of an aqueous waste stream(s). Before an aqueous waste stream is accepted for treatment, the waste is characterized and evaluated. Information from the characterization is used to adjust the treatment process or change the configuration of the ETF process units, as necessary, to optimize the treatment process for a particular aqueous waste stream.

Typically, an aqueous waste is processed first in the primary treatment train, where the ETF is configured to process an aqueous waste through the UV/OX unit first, followed by the RO unit. However, under an alternate configuration, an aqueous waste could be processed in the RO unit first. For example, high concentrations of nitrates in an aqueous waste might interfere with the performance of the UV/OX. In this case, the ETF could be configured to process the waste in the RO unit before the UV/OX unit.

The flexibility of the ETF also allows some aqueous waste to be processed in the secondary treatment train first. For example, for small volume aqueous waste with high concentrations of some anions and metals, the approach could be to first process the waste stream in the secondary treatment train. This approach would prevent premature fouling or scaling of the RO unit. The liquid portion (i.e., untreated overheads from the ETF evaporator and thin film dryer) would be sent to the primary treatment train.

Figures 4.5 and 4.6 provide example process flow diagrams for two different operating configurations.

4.2.3 Primary Treatment Train

The primary treatment train consists of the following processes:

- Influent Receipt/Surge tank - inlet, surge capacity
- Filtration - for suspended solids removal
- UV/OX - organic destruction
- pH adjustment - waste neutralization
- Hydrogen peroxide decomposition - removal of excess hydrogen peroxide
- Degasification - removal of carbon dioxide
- RO - removal of dissolved solids
- IX - removal of dissolved solids
- Verification - holding tanks during verification

Reverse Osmosis. The RO system (Figure 4.9) uses pressure to force clean water molecules through semi-permeable membranes while keeping the larger molecule contaminants such as dissolved solids and large molecular weight organic materials, in the membrane. The RO process uses a staged configuration to maximize water recovery. The process produces two separate streams, including a clean 'permeate' and a concentrate (or retentate), which are concentrated as much as possible to minimize the amount of secondary waste produced.

Influent Receipt/Surge Tank. Depending on the configuration of the ETF, the surge tank is one inlet used to feed an aqueous waste into the ETF for treatment. In Configuration 1 (Figure 4.5), the surge tank is the first component downstream of the LERF. The surge tank provides a storage/surge volume for chemical pretreatment and controls feed flow rates from the LERF to the ETF. However, in Configuration 2 (Figure 4.6), aqueous waste from LERF is fed directly into the treatment units. In this configuration, the surge tank receives aqueous waste that has been processed in the RO units and provides the feed stream to the remaining downstream process units. In yet another configuration, some small volume aqueous waste could be received into the secondary treatment train first for processing. In this case, the aqueous waste would be received directly into the secondary waste receiving tanks. Finally,

the surge tank also receives waste extracted from various systems within the primary and secondary treatment train while in operation.

The surge tank is located outside the ETF on the south side. In the surge tank (Figure 4.7), the pH of an aqueous waste is adjusted using the metered addition of sulfuric acid and sodium hydroxide, as necessary, to prepare the waste for treatment in downstream processes. In addition, hydrogen peroxide or biocides could be added to control biological growth in the surge tank. A pump recirculates the contents in the surge tank, mixing the chemical reagents with the waste to a uniform pH.

Filtration. Two primary filter systems remove suspended particles in an aqueous waste: a rough filter removes the larger particulates, while a fine filter removes the smaller particulates. The location of these filters depends on the configuration of the primary treatment train. However, the filters normally are located upstream of the RO units.

The solids accumulating on these filter elements are backwashed to the secondary waste receiving tanks with pulses of compressed air and water, forcing water back through the filter. The backwash operation is initiated either automatically by a rise in differential pressure across the filter or manually by an operator. The filters are cleaned chemically when the backwashing process does not facilitate acceptable filter performance.

Auxiliary fine and rough filters (e.g., disposable filters) have been installed to provide additional filtration capabilities. Depending on the configuration of the ETF, the auxiliary filters are operated either in series with the primary filters to provide additional filtration or in parallel, instead of the primary fine and rough filters, to allow cleaning of the primary fine and rough filters while the primary treatment train is in operation.

Ultraviolet Light/Oxidation. Organic compounds contained in an aqueous waste stream are destroyed in the UV/OX system (Figure 4.8). Hydrogen peroxide is mixed with the waste. The UV/OX system uses the photochemical reaction of UV light on hydrogen peroxide to form hydroxyl radicals and other reactive species that oxidize the organic compounds. The final products of the complete reaction are carbon dioxide, water, and inorganic ions.

Organic destruction is accomplished in two UV/OX units operating in parallel. During the UV/OX process, the aqueous waste passes through reaction chambers where hydrogen peroxide is added. While in the UV/OX system, the temperature of an aqueous waste is monitored. Heat exchangers are used to reduce the temperature of the waste should the temperature of the waste exceed the upper limits for the UV/OX or RO systems.

pH Adjustment. The pH of a waste stream is monitored and controlled at different points throughout the treatment process. Within the primary treatment train, the pH of a waste can be adjusted with sulfuric acid or sodium hydroxide to optimize operation of downstream treatment processes or adjusted before final discharge. For example, the pH of an aqueous waste would be adjusted in the pH adjustment tank after the UV/OX process and before the RO process. In this example, pH is adjusted to cause certain chemical species such as ammonia to form ammonium sulfate, thereby increasing the rejection rate of the RO.

Hydrogen Peroxide Decomposition. Typically, hydrogen peroxide added into the UV/OX system is not consumed completely by the system. Because hydrogen peroxide is a strong oxidizer, the residual hydrogen peroxide from the UV/OX system is removed to protect the downstream equipment. The hydrogen peroxide decomposer uses activated carbon to break down the hydrogen peroxide that is not consumed completely in the process of organic destruction. The aqueous waste is sent through a column of fluidized activated carbon that breaks down the hydrogen peroxide into water and oxygen. The gas generated by the decomposition of the hydrogen peroxide is vented to the vessel off gas system.

Degasification. The degasification column is used to purge dissolved carbon dioxide from the aqueous waste to reduce the carbonate loading to downstream dissolved solids removal processes within the ETF primary treatment train. The purged carbon dioxide is vented to the vessel off gas system.

Reverse Osmosis. The RO system (Figure 4.9) uses pressure to force clean water molecules through semi-permeable membranes while keeping the larger molecule contaminants, such as dissolved solids, and large molecular weight organic materials, in the membrane. The RO process uses a staged configuration to maximize water recovery. The process produces two separate streams, including a clean 'permeate' and a concentrate (or retentate), which are concentrated as much as possible to minimize the amount of secondary waste produced.

The RO process is divided into first and second stages. Aqueous waste is fed to the first RO stage from the RO feed tank. The secondary waste receiving tanks of the secondary treatment train receive the retentate removed from the first RO stage, while the second RO stage receives the permeate (i.e., 'treated' aqueous waste from the first RO stage). In the second RO stage, the retentate is sent to the first stage RO feed tank while the permeate is sent to the IX system or to the surge tank, depending on the configuration of the ETF.

Two support systems facilitate this process. An anti-scale system injects scale inhibitors as needed into the feed waste to prevent scale from forming on the membrane surface. A clean-in-place system using cleaning agents, such as descalants and surfactants, cleans the membrane pores of surface and subsurface deposits that have fouled the membranes.

Ion Exchange. Because the RO process removes most of the dissolved solids in an aqueous waste, the IX process (Figure 4.10) act as a polishing unit. The IX system consists of three columns containing beds of cation and/or anion resins. This system is designed to allow for regeneration of resins and maintenance of one column while the other two are in operation. Though the two columns generally are operated in series, the two columns also can be operated in parallel or individually.

Typically, the two columns in operation are arranged in a primary/secondary (lead/lag) configuration, and the third (regenerated) column is maintained in standby. When dissolved solids breakthrough the first IX column and are detected by a conductivity sensor, this column is removed from service for regeneration, and the second column replaces the first column and the third column is placed into service. The column normally is regenerated using sulfuric acid and sodium hydroxide. The resulting regeneration waste is collected in the secondary waste receiving tanks.

Spent resins are transferred into a disposal container should regeneration of the IX resins become inefficient. The container is designed to provide dewatering with remote monitoring of the resin and water levels within the container. Displaced air from the vessels is exhausted through an entrainment separator (to remove water drops) and a high-efficiency particulate air filter and into the vessel off gas system. Free water is removed from the container and returned to the surge tank. Dewatered resins are transferred to a final storage/disposal point.

Verification. The three verification tanks (Figure 4.11) are used to hold the treated effluent while a determination is made that the effluent meets discharge limits. The effluent can be returned to the primary treatment train for additional treatment, or to the LERF should a treated effluent not meet Discharge Permit or Final Delisting requirements.

The three verification tanks alternate between three operating modes: receiving treated effluent, holding treated effluent during laboratory analysis and verification, or discharging verified effluent. Treated effluent may also be returned to the ETF to provide 'clean' service water for operational and maintenance functions, e.g., for boiler water and for backwashing the filters. This recycling keeps the quantity of fresh water used to a minimum.

4.2.4 Secondary Treatment Train

The secondary treatment system typically receives and processes the following by-products generated from the primary treatment train: concentrate from the first RO stage, filter backwash, regeneration waste from the ion exchange system, and spillage or overflow received into the process sumps. Depending on the operating configuration, however, some aqueous waste could be processed in the secondary treatment

train before the primary treatment train (refer to Figures 4.5 and 4.6 for example operating configurations).

The secondary treatment train provides the following processes:

- Secondary waste receiving - tank receiving and chemical addition
- Evaporation - concentrates secondary waste streams
- Concentrate staging - concentrate receipt, pH adjustment, and chemical addition
- Thin film drying - dewatering of secondary waste streams
- Container handling - packaging of dewatered secondary waste

Secondary Waste Receiving. Waste to be processed in the secondary treatment train is received into two secondary waste receiving tanks, where the pH can be adjusted with sulfuric acid or sodium hydroxide for optimum evaporator performance. Chemicals, such as reducing agents, may be added to waste in the secondary waste receiving tanks to reduce the toxicity or mobility of constituents in the powder.

Evaporation. The ETF evaporator is fed alternately by the two secondary waste receiving tanks. One tank serves as a waste receiver while the other tank is operated as the feed tank. The ETF evaporator vessel (also referred to as the vapor body) is the principal component of the evaporation process (Figure 4.12).

Feed from the secondary waste receiving tanks is pumped through a heater to the recirculation loop of the ETF evaporator. In this loop, concentrated waste is recirculated from the ETF evaporator, to a heater, and back into the evaporator where vaporization occurs. As water leaves the evaporator system in the vapor phase, the concentration of the waste in the evaporator increases. When the concentration of the waste reaches the appropriate density, a portion of the concentrate is pumped to one of the concentrate tanks.

The vapor that is released from the ETF evaporator is routed to the entrainment separator, where water droplets and/or particulates are separated from the vapor. The 'cleaned' vapor is routed to the vapor compressor and heater. The steam from the vapor compressor/heater is used to heat the recirculating concentrate in the ETF evaporator. From the vapor compressor/heater, the steam is condensed and fed to the distillate flash tank, where the saturated condensate received from the heater drops to atmospheric pressure and cools to the normal boiling point through partial flashing (rapid vaporization caused by a pressure reduction). The resulting distillate is routed to the surge tank. A vacuum blower to the vessel off gas system exhausts noncondensible vapors, such as air.

Concentrate Staging. The concentrate tanks make up the head end of the thin film drying process. From the ETF evaporator, concentrate is pumped into two concentrate tanks, and pH adjusted chemicals, such as reducing agents, may be added to reduce the toxicity or mobility of constituents when converted to powder. Waste is transferred from the concentrate tanks to the thin film dryer for conversion to a powder. The concentrate tanks function alternately between concentrate receiver and feed tank for the thin film dryer.

Because low solubility solids (i.e., calcium and magnesium sulfate) tend to settle in the concentrate tanks, these solids must be removed to prevent fouling and to protect the thin film dryer, and to maintain concentrate tank capacity.

Thin Film Drying. From the concentrate tanks, feed is pumped through a preheater to the thin film dryer (Figure 4.13) that is heated by steam. As the concentrated waste flows down the length of the dryer, the waste is dried. The dried film, or powder, is scraped off the dryer cylinder by blades attached to a rotating shaft. The powder is funneled through a cone-shaped powder hopper at the bottom of the dryer and into the Container Handling System.

Overhead vapor released by the drying of the concentrate is condensed in the distillate condenser. Excess heat is removed from the distillate by a water-cooled heat exchanger. Part of the distillate is circulated back to the condenser spray nozzles. The remaining distillate is pumped to the surge tank. Any

noncondensible vapors and particulates from the spray condenser are exhausted to the vessel off gas system.

Container Handling. Before an empty container is moved into the Container Handling System (Figure 4.14), the lids are loosely placed on the containers and the container is placed on a conveyor. After the lid is removed, the containers are moved into the container filling area after passing through an air lock. The empty container is located under the thin film dryer, and raised into position. The container is sealed to the thin film dryer and a rotary valve begins the transfer of powder to the empty container. Air displaced from the container is vented to the entrainment separator attached to the ETF evaporator that exhausts to the vessel off gas system.

The container is filled to a predetermined level, recapped, and moved along the conveyor to the smear station airlock. At the smear station airlock, the container is moved onto the conveyor by remote control. The airlock is opened, the smear sample (surface wipe) is taken, and the contamination level counted. A 'C' ring is installed to secure the container lid. If the container has contaminated material on the outside, the container is moved to the wash down station and washed. The container wash water drains to sump tank 1. The washed container is air-dried and retested. Filled containers that pass the smear test are labeled, placed on pallets, and moved by forklift to the filled container storage area. Section 4.3 provides a more detailed discussion of container handling.

4.2.5 Other Effluent Treatment Facility Systems

The ETF is provided with support systems that facilitate treatment in the primary and secondary treatment trains and that provide for worker safety and environmental protection. An overview of the following systems is provided:

- Monitor and control system
- Vessel off gas system
- Sump collection system
- Chemical injection feed system
- Verification tank recycle system
- Utilities

4.2.5.1 Monitor and Control System

The operation of the ETF is monitored and controlled by a centralized computer system (i.e., monitor and control system or MCS). The MCS continuously monitors data from various field indicators, such as pH, flow, tank level, temperature, pressure, conductivity, alarm status, and valve switch positions. Data gathered by the MCS enable operations and engineering personnel to document and adjust the operation of the ETF.

4.2.5.2 Vessel Off gas System

Ventilation for various tanks and vessels is provided through the vessel off gas system. The system includes a moisture separator, duct heater, pre-filter, high-efficiency particulate air filters, carbon absorber (when required to reduce organic emissions), exhaust fans, and ductwork. Gasses ventilated from the tanks and vessels enter the exhaust system through the connected ductwork. The vessel off gas system draws vapors and gasses off the following tanks and treatment systems:

- Surge tank
- ETF evaporator
- pH adjustment tank
- Concentrate tanks
- Degasification system
- First and second RO stages
- Dry powder hopper
- Effluent pH adjustment tank

- Drum capping station
- Secondary waste receiving tanks
- Resin dewatering system
- Distillate condenser (off the thin film dryer)
- Sump tanks 1 and 2

The vessel off gas system maintains a negative pressure with respect to the atmosphere, which produces a slight vacuum within tanks, vessels, and ancillary equipment for the containment of gas vapor. This system also provides for the collection, monitoring, and treatment of confined airborne in-vessel contaminants to preclude over-pressurization. The high-efficiency particulate air filters remove particulates and condensate from the air stream before these are discharged to the heating, ventilation, and air conditioning system.

4.2.5.3 Sump Collection System

Sump tanks 1 and 2 compose the sump collection system that provides containment of waste streams and liquid overflow associated with the ETF processes. The process area floor is sloped to two separate trenches that each drain to a sump tank located under the floor of the ETF (Figure 4.15). One trench runs the length of the primary treatment train and drains to Sump Tank 2, located underneath the verification tank pump floor. The second trench collects spillage primarily from the secondary treatment train and flows to Sump Tank 1, located near the ETF evaporator. Sump tanks 1 and 2 are located below floor level (Figure 4.15). An eductor in these tanks prevents sludge from accumulating.

4.2.5.4 Chemical Injection Feed System

At several points within the primary and secondary treatment trains, sulfuric acid and sodium hydroxide (or dilute solutions of these reagents) are metered into specific process units to adjust the pH. For example, a dilute solution of 4 percent sulfuric acid and 4 percent sodium hydroxide could be added to the secondary waste receiving tanks to optimize the evaporation process.

4.2.5.5 Verification Tank Recycle System

To reduce the amount of water added to the process, verification tank water (i.e., verified effluent) is recycled throughout the ETF process. The following tanks and ancillary equipment use verification tank water:

- 4% H^2SO4 solution tank and ancillary equipment
- 4% NaOH solution tank and ancillary equipment
- Clean-in-place tank and ancillary equipment
- ETF evaporator boiler and ancillary equipment
- Thin film dryer boiler and ancillary equipment.

4.2.5.6 Utilities

The ETF maintains the following utility supply systems required for the operation of the ETF:

- Cooling water system - removes heat from process water via heat exchangers and a cooling tower
- Compressed air system - provides air to process equipment and instrumentation
- Seal water system - provides cool, clean, pressurized water to process equipment for pump seal cooling and pump seal lubrication, and provides protection against failure and fluid leakage
- Demineralized water system - removes solids from raw water system to produce high quality, low ion-content, water for steam boilers, and for the hydrogen peroxide feed system.
- Heating, ventilation, and air conditioning system - provides continuous heating, cooling, and air humidity control throughout the ETF.

The following utilities support ETF activities:

- Electrical power
- Sanitary water
- Communication systems
- Raw water

4.3 CONTAINERS

This section provides specific information on container storage and treatment operations at the ETF, including descriptions of containers, labeling, and secondary containment structures.

A list of dangerous and/or mixed waste managed in containers at the ETF is presented in Chapter 1.0. The types of dangerous and/or mixed waste managed in containers in the ETF could include the following secondary waste generated by the ETF processes:

- Waste generated from the treatment process
- Miscellaneous waste generated by operations and maintenance activities.

The secondary treatment train processes the waste by-products from the primary treatment train, which are concentrated and dried into a powder. Containers are filled with dry powder waste from the thin film dryer via a remotely controlled system. Miscellaneous waste generated from maintenance and operations activities are stored at the ETF. The waste could include process waste, such as used filter elements; spent RO membranes; damaged equipment, and decontamination and maintenance waste, such as contaminated rags, gloves, and other personal protective equipment. Liquids generally are packaged with absorbents at a 2 to 1 ratio.

Several container collection areas could be located within the ETF process and container handling areas. These collection areas are used only to accumulate waste in containers. Once a container is filled, the container is transferred to a container storage area (Figure 4.3 and Figure 4.4), to another TSD unit, or to a less-than-90-day storage pad. Containers stored in the additional storage area (Figure 4.4) are elevated or otherwise protected from contact with accumulated liquids. The container storage area within ETF is a 22.9 x 8.5-meter room located adjacent to the ETF process area. The containers within the container storage area are clearly labeled, and access to these containers is limited by barriers and by administrative controls. The ETF floor provides secondary containment, and the ETF roof and walls protects all containers from exposure to the elements.

Waste also could be placed in containers for treatment as indicated in Chapter 1.0. For example, sludge that accumulates in the bottoms of the process tanks is removed periodically and placed into containers. In this example, the waste is solidified by decanting the supernate from the container and the remainder of the waste is allowed to evaporate, or absorbents are added, as necessary, to address remaining liquids. Following treatment, this waste either is stored at the ETF or transferred to another TSD unit.

4.3.1 Description of Containers

The containers used to collect and store dry powder waste are 208-liter steel containers. Most of the maintenance and operation waste is stored in 208-liter steel containers; however, in a few cases, the size of the container could vary to accommodate the size of a particular waste. For example, some process waste, such as spent filters, might not fit into a 208-liter container. In the case of spent resin from the IX columns, the resin is dewatered and could be packaged in a special disposal container. In these few cases, specially sized containers could be required. In all cases, however, only approved containers are used and are compatible with the associated waste. Typically, 208-liter containers are used for treatment.

Current operating practices indicate the use of new 208-liter containers that have either a polyethylene liner or a protective coating. Any reused or reconditioned container is inspected for container integrity before use. Overpack containers are available for use with damaged containers. Overpack containers typically are unlined steel or polyethylene.

Per Chapter 1.0, a maximum of 147,630 liters of dangerous and/or mixed waste could be stored in containers in the ETF.

4.3.2 Container Management Practices

Before use, each container is checked for signs of damage such as dents, distortion, corrosion, or scratched coating. For dry powder loading, empty containers on pallets are raised by a forklift and manually placed on the conveyor that transports the containers to the automatic filling station in the container handling room (Figure 4.14). The container lids are removed and replaced automatically during the filling sequence. After filling, containers exit the container handling room via the filled drum conveyor. Locking rings are installed, the container label is affixed, and the container is moved by dolly or forklift to the container storage area.

Containers used for storing maintenance and operations secondary waste are labeled before being placed in the container storage area or in a collection area. Lids are secured on these containers when not being filled. When the containers in a collection area are full, the containers are transferred by dolly or forklift to the container storage area or to an appropriate TSD unit. Containers used for treating waste also are labeled. The lids on these containers are removed as required to allow for treatment. During treatment, access to these containers is controlled through physical barriers and/or administrative controls.

The filled containers in the container storage area are inventoried, checked for proper labeling, and placed on pallets or in a separate containment device as necessary. Each pallet is moved by forklift. Within the container storage area, palletized containers are stacked no more then three pallets high and in rows no more than two containers wide. Unobstructed aisles with a minimum of 76-centimeter aisle space separate rows.

4.3.3 Container Labeling

Labels are affixed on containers used to store dry powder when the containers leave the container handling room. Labels are affixed on other waste containers before use. Every container is labeled with the date that the container was filled. Appropriate major risk labels, such as "corrosive", "toxic", or "F-listed", also are added. Each container also has a label with an identification number for tracking purposes.

4.3.4 Containment Requirements for Managing Containers

Secondary containment is provided in the container management areas within the ETF. The secondary containment provided for tank systems also serves the container management areas. This section describes the design and operation of the secondary containment structure for these areas.

4.3.4.1 Secondary Containment System Design

For the container management areas, the reinforced concrete floor and a 15.2-centimeter rise (berm) along the walls of the container storage area of the ETF provide secondary containment. The engineering assessment required for tanks (Mausshardt 1995) also describes the design and construction of the secondary containment provided for the ETF container management areas. All systems were designed to national codes and standards (e.g., American Society for Testing Materials, American Concrete Institute standards).

The floor is composed of cast-in-place, pre-formed concrete slabs, and has a minimum thickness of 15.2 centimeters. All slab joints and floor and wall joints have water stops installed at the mid-depth of the slab. In addition, filler was applied to each joint. The floor and berms are coated with a chemically resistant; high-solids epoxy coating system consisting of primer, filler, and top coating. This coating material is compatible with the waste managed in containers and is an integral part of the secondary containment system for containers.

The floor is sloped to drain any solution in the container storage area to floor drains along the west wall. Each floor drain consists of a grating over a 20.3-centimeter diameter drain port connected to a 4-inch

stainless steel transfer pipe. The pipe passes under this wall and connects to a trench running along the east wall of the adjacent process area. This trench drains solution to sump tank 1.

The container storage area is separated from the process area by a common wall and a door for access to the two areas (Figure 4.3). These two areas also share a common floor and trenches that, with the 15.2-centimeter rise of the containing walls, form the secondary containment system for the process area and the container storage area.

4.3.4.2 Structural Integrity of Base

Engineering calculations were performed showing the floor of the container storage area is capable of supporting the weight of containers. These calculations were reviewed and certified by a professional engineer (Mausshardt 1995). The concrete was inspected for damage during construction. Cracks were identified and repaired to the satisfaction of the professional engineer. Documentation of these certifications is included in the engineering assessment (Mausshardt 1995).

4.3.4.3 Containment System Capacity

The container storage area is primarily used to store dry powder and maintenance and operation waste. Where appropriate, absorbents are added to fix any trace liquids present. Large volumes of liquid are not stored in the container storage area. However, liquids might be present in those containers that are in the treatment process. The maximum volume of waste that can be stored in containers in the container storage area is 147,630 liters.

Both the process area and the container storage area are considered in the containment system capacity. The volume available for secondary containment in the process area is approximately 68,000 liters, as discussed in the engineering assessment (Mausshardt 1995). Using the dimensions of the container storage area (22.9 by 8.5 by 0.15 meters), and assuming that 50 percent of the floor area is occupied by containers, the volume of the container storage area is 14,900 liters. The combined volume of both the container storage and process areas available for secondary containment, therefore, is 82,900 liters. This volume is greater than 10 percent of the maximum total volume of containers allowed for storage in the ETF, as discussed previously.

4.3.4.4 Control of Run-on

The container management areas are located within the ETF, which serves to prevent run-on of precipitation.

4.3.4.5 Removal of Liquids from Containment Systems

The container storage area is equipped with drains that route solution to a trench in the process area, which drains to sump tank 1. The sump tanks are equipped with alarms that notify operating personnel that a leak is occurring. The sump tanks also are equipped with pumps to transfer waste to the surge tank or the secondary treatment train.

4.3.4.6 Prevention of Ignitable, Reactive, and Incompatible Wastes in Containers

Individual waste types (i.e., ignitable, corrosive, and reactive) are stored in separate containers. A waste that could be incompatible with other wastes is separated and protected from the incompatible waste. For example, acidic and caustic wastes are stored in separate containers. Free liquids are absorbed in containers that hold incompatible waste at a 2 to 1 ratio. Additionally, ETF-specific packaging requirements for these types of waste provide extra containment with each individual container. For example, each item of acidic waste is individually bagged and sealed within a lined container.

4.4 TANK SYSTEMS

This section provides specific information on tank systems and process units. This section also includes a discussion on the types of waste to be managed in the tanks, tank design information, integrity assessments, and additional information on the ETF tanks that treat and store dangerous and/or mixed

waste. The ETF dangerous waste tanks are identified in Section 4.4.1.1, and the relative locations of the tanks and process units in the ETF are presented in Figure 4.3.

4.4.1 Design Requirements

The following sections provide an overview of the design specifications for the tanks within the ETF. A separate discussion on the design of the process units also is provided. In accordance with the new tank system requirements of WAC 173-303-640(3), the following tank components and specifications were assessed:

- Dimensions, capacities, wall thicknesses, and pipe connections
- Materials of construction and linings and compatibility of materials with the waste being processed
- Materials of construction of foundations and structural supports
- Review of design codes and standards used in construction
- Review of structural design calculations, including seismic design basis
- Waste characteristics and the affects of waste on corrosion

This assessment was documented in the *Final RCRA Information Needs Report* (Mausshardt 1995; the engineering assessment performed for the ETF tank systems by an independent professional engineer. A similar assessment of design requirements was performed for the load-in tanks and is documented in *200 Area Effluent BAT/AKART Implementation, ETF Truck Load-In Facility, Project W-291H Integrity Assessment Report* (KEH 1994).

The specifications for the preparation, design, and construction of the tank systems at the ETF are documented in the *Design Construction Specification, Project C-018H, 242-A Evaporator/PUREX Plant Process Condensate Treatment Facility* (WHC 1992a). The preparation, design, and construction of the load-in tanks are provided in the construction specifications in *Project W-291, 200 Area Effluent BAT/AKART Implementation ETF Truck Load-in Facility* (KEH 1994).

Most of the tanks in the ETF are constructed of stainless steel. According to the design of the ETF, it was determined stainless steel would provide adequate corrosion protection for these tanks. Exceptions include the verification tanks, which are constructed of carbon steel with an epoxy coating. The ETF evaporator/vapor body (and the internal surfaces of the thin film dryer) is constructed of a corrosion resistant alloy, known as alloy 625, to address the specific corrosion concerns in the secondary treatment train. Finally, the hydrogen peroxide decomposer vessels are constructed of carbon steel and coated with a vinyl ester lining.

The shell thicknesses of the tanks identified in Section4.4.1.1 represent a nominal thickness of a new tank when placed into operation. The tank capacities identified in this table represent the maximum operating volumes. For certain tanks (as indicated in the table), the maximum operating volume is also the nominal (routine) operating capacity. Nominal tank volumes represent the volume between the low-level and high-level shutoffs in a tank unit.

4.4.1.1 Codes and Standards for Tank System Construction

Specific standards for the manufacture of tanks and process systems installed in the ETF are briefly discussed in the following sections. In addition to these codes and industrial standards, a seismic analysis for each tank and process system is required [WAC 173-303-806(4)(a)(xi)]. The seismic analysis was performed in accordance with UCRL-15910 *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, Section 4 (UCRL 1987). The results of the seismic analyses are summarized in the engineering assessment of the ETF tank systems (Mausshardt 1995).

Storage and Treatment Tanks. The following tanks store and/or treat dangerous waste at the ETF.

Tank name	Tank number
Surge tank	2025E-60A-TK-1
pH adjustment tank	2025E-60C-TK-1
Effluent pH adjustment tank	2025E-60C-TK-2
First RO feed tank	2025E-60F-TK-1
Second RO feed tank	2025E-60F-TK-2
Verification tanks (three)	2025E-60H-TK-1A/1B/1
Secondary waste receiving tanks (two)	2025E-60I-TK-1A/1B
Concentrate tanks (two)	2025E-60J-TK-1A/1B
Sump tanks (two)	2025E-20B-TK-1/2
Distillate flash tank	2025E-60I-TK-2
Load-in tanks	TK-109/117

The relative location of these tanks is presented in Figure 4.3. These tanks are maintained at or near atmospheric pressure. The codes and standards applicable to the design, construction, and testing of the above tanks and ancillary piping systems are as follows:

ASME - B31.3	Chemical Plant and Petroleum Refinery Piping (ASME 1990)
ASME Sect. VIII, Division I	Pressure Vessels (ASME 1992a)
AWS - D1.1	Structural Welding Code - Steel (AWS 1992)
ANSI - B16.5	Pipe Flanges and Flanged Fittings (ANSI 1992)
ASME Sect. IX	Welding and Brazing Qualifications (ASME 1992b)
API 620	Design and Construction of Large Welded Low Pressure Storage Tanks (API 1990)
AWWA - D100	Welded Steel Tanks for Water Storage (AWWA 1989)
AWWA - D103	Factory-Coated Bolted Steel Tanks for Water Storage (AWWA 1987)
AWWA - D120	Thermosetting Fiberglass-Reinforced Plastic Tanks (AWWA 1984).

The application of these standards to the construction of ETF tanks and independent verification of completed systems ensured that the tank and tank supports had sufficient structural strength and that seams and connections were adequate to ensure tank integrity. In addition, each tank met strict quality assurance requirements. Each tank constructed offsite was tested for integrity and leak tightness before shipment to the Hanford Facility. Following installation, the systems were inspected for damage to ensure against leakage and to verify proper operation. If a tank was damaged during shipment or installation, leak tightness testing was repeated onsite.

4.4.1.2 Design Information for Tanks Located Outside of Effluent Treatment Facility

The load-in tanks, surge tank, and verification tanks are located outside the ETF. These tanks are located within concrete structures that provide secondary containment.

Load-In Tanks and Ancillary Equipment. The load-in tanks are heated and constructed of stainless steel, and have a nominal capacity of 37,900 liters. Ancillary equipment includes transfer pumps, a filtration system, a double encased, fiberglass transfer pipeline, level instruments for tanker trucks, and leak detection equipment. From the Load-In Station, aqueous waste can be routed to the surge tank or to the LERF through a double-encased line. The load-in tanks, sump, pumps, and truck pad are all provided with secondary containment.

Surge Tank and Ancillary Equipment. The surge tank is constructed of stainless steel and has a nominal capacity of 379,000 liters. Ancillary equipment to the surge tank includes two underground double encased (i.e., pipe-within-a-pipe) transfer lines connecting to LERF and three pumps for

transferring aqueous waste to the primary treatment train. The surge tank is located at the south end of the ETF. The surge tank is insulated and the contents heated to prevent freezing. Eductors in the tank provide mixing.

Verification Tanks and Ancillary Equipment. The verification tanks are located north of the ETF. The verification tanks have a nominal capacity of 2,540,000 liters each. For support, the tanks have a center post with a webbing of beams that extend from the center post to the sides of the tank. The roof is constructed of epoxy covered carbon steel that is attached to the cross beams of the webbing. The tank floor also is constructed of epoxy covered carbon steel and is sloped. Eductors are installed in each tank to provide mixing.

Ancillary equipment includes a return pump that provides circulation of treated effluent through the eductors. The return pump also recycles effluent back to the ETF for retreatment and can provide service water for ETF functions. Two transfer pumps are used to discharge treated effluent to SALDS or back to the LERF.

4.4.1.3 Design Information for Tanks Located Inside the Effluent Treatment Facility Building

Most of the ETF tanks and ancillary equipment that store or treat dangerous and/or mixed waste are located within the ETF. The structure serves as secondary containment for the tank systems.

pH Adjustment Tank and Ancillary Equipment. The pH adjustment tank has a nominal capacity of 9,800 liters. Ancillary equipment for this tank includes overflow lines to a sump tank and pumps to transfer waste to other units in the main treatment train.

Effluent pH Adjustment Tank and Ancillary Equipment. The effluent pH adjustment tank has a nominal capacity of 9,500 liters. Ancillary equipment includes overflow lines to a sump tank and pumps to transfer waste to the verification tanks.

First and Second Reverse Osmosis Feed Tanks and Ancillary Equipment. The first RO feed tank is a vertical, stainless steel tank with a round bottom and has a nominal capacity of 11,400 liters. Conversely, the second RO feed tank is a rectangular vessel with the bottom of the tank sloping sharply to a single outlet in the bottom center. The second RO feed tank has a nominal capacity of 7,600 liters. Each RO tank has a pump to transfer waste to the RO arrays. Overflow lines are routed to a sump tank.

Secondary Waste Receiving Tanks and Ancillary Equipment. Two 57,000-liter secondary waste receiving tanks collect waste from the units in the main treatment train, such as reject solution (retentate) from the RO units and regeneration solution from the IX columns. These are vertical, cylindrical tanks with a semi-elliptical bottom and a flat top. Ancillary equipment includes overflow lines to a sump tank and pumps to transfer aqueous waste to the ETF evaporator.

Effluent Treatment Facility Evaporator and Ancillary Equipment. The ETF evaporator, the principal component of the evaporation process, is a cylindrical pressure vessel with a conical bottom. Aqueous waste is fed into the lower portion of the vessel. The top of the vessel is domed and the vapor outlet is configured to prevent carryover of liquid during the foaming or bumping (violent boiling) at the liquid surface. The ETF evaporator has a capacity of approximately 21,000 liters.

The ETF evaporator includes the following ancillary equipment:

- Preheater
- Recirculation pump
- Waste heater with steam level control tank
- Concentrate transfer pump
- Entrainment separator
- Vapor compressor with silencers
- Silencer drain pump.

Distillate Flash Tank and Ancillary Equipment. The distillate flash tank is a horizontal tank that has a nominal operating capacity of 570 liters. Ancillary equipment includes a pump to transfer the distillate to the surge tank for reprocessing.

Concentrate Tanks and Ancillary Equipment. Each of the two concentrate tanks has an approximate capacity of 18,900 liters. Ancillary equipment includes overflow lines to a sump tank and pumps for recirculation and transfer.

Sump Tanks. Sump tanks 1 and 2 are located below floor level. Both sump tanks are double-walled, rectangular tanks, placed inside concrete vaults. Both tanks have a working volume of 3,000 liters each. The sump tanks are located in pits below grade to allow gravity drain of solutions to the tanks. Each sump tank has two vertical pumps for transfer of waste to the secondary waste receiving tanks or to the surge tank for reprocessing.

4.4.1.4 Design Information for Effluent Treatment Facility Process Units

As with the ETF tanks, process units that treat and/or store dangerous and/or mixed waste are maintained at or near atmospheric pressure. These units were constructed to meet a series of design standards, as discussed in the following sections. Table 4.6 presents the materials of construction and the ancillary equipment associated with these process units. All piping systems are designed to withstand the effects of internal pressure, weight, thermal expansion and contraction, and any pulsating flow. The design and integrity of these units are presented in the engineering assessment (Mausshardt 1995).

Filters. The load-in fine and rough filter vessels (including the auxiliary filters) are designed to comply with the ASME Section VIII, Division I, Pressure Vessels (ASME 1992a). The application of these standards to the construction of the ETF filter system and independent inspection ensure that the filter and filter supports have sufficient structural strength and that the seams and connections are adequate to ensure the integrity of the filter vessels.

Ultraviolet Oxidation System. The UV/OX reaction chamber is designed to comply with manufacturers standards.

Degasification System. The codes and standards applicable to the design, fabrication, and testing of the degasification column are identified as follows:

- ASME Section VIII, Division I, Pressure Vessels (ASME 1992a)
- ASME - B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990)
- AWS - D1.1, Structural Welding Code - Steel (AWS 1992)
- ANSI - B16.5, Pipe Flanges and Flanged Fittings (ANSI 1992)

Reverse Osmosis System. The pressure vessels in the RO unit are designed to comply with ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards.

Ion Exchange (Polishers). The IX columns are designed in accordance with ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards. Polisher piping is fabricated of type 304 stainless steel or polyvinyl chloride (PVC) and meets the requirements of ASME B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990).

Effluent Treatment Facility Evaporator. The ETF evaporator is designed to meet the requirements of ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards. The ETF evaporator piping meets the requirements of ASME B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990).

Thin Film Dryer System. The thin film dryer is designed to meet the requirements of ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards. The piping meets the requirements of ASME - B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990).

Integrity Assessments. The integrity assessment for ETF (Mausshardt 1995) attests to the adequacy of design and integrity of the tanks and ancillary equipment to ensure that the tanks and ancillary equipment

will not collapse, rupture, or fail over the intended life considering intended uses. For the load-in tanks, a similar integrity assessment was performed (KEH 1995). Specifically, the assessment documents the following considerations:

- Adequacy of the standards used during design and construction of the facility
- Characteristics of the solution in each tank
- Adequacy of the materials of construction to provide corrosion protection from the solution in each tank
- Results of the leak tests and visual inspections

The results of these assessments demonstrate that tanks and ancillary equipment have sufficient structural integrity and are acceptable for storing and treating dangerous and/or mixed waste. The assessments also state that the tanks and building were designed and constructed to withstand a design-basis earthquake. Independent, qualified registered professional engineers certified these tank assessments.

The scope of the ETF tank integrity assessment was based on characterization data from process condensate. To assess the effect that other aqueous waste might have on the integrity of the ETF tanks, the chemistry of an aqueous waste will be evaluated for its potential to corrode a tank (e.g., chloride concentrations will be evaluated). The tank integrity assessment for the load-in tanks was based on characterization data from several aqueous waste streams. The chemistry of an aqueous waste stream not considered in the load-in tank integrity assessment also will be evaluated for the potential to corrode a load-in tank.

Consistent with the recommendations of the integrity assessment, a corrosion inspection program was developed. Periodic integrity assessments are scheduled for those tanks that are predicted to have the highest potential for corrosion. These inspections are scheduled annually or longer to follow the end of a treatment campaign. These 'indicator tanks' include the concentrate tanks, secondary waste receiving tanks, and verification tanks. One of each of these tanks will be inspected yearly to determine if corrosion or coating failure has occurred. Should significant corrosion or coating failure be found, an additional tank of the same type would be inspected during the same year. In the case of the verification tanks, if corrosion or coating failure is found in the second tank, the third tank also will be inspected. If significant corrosion were observed in all three sets of indicator tanks, the balance of the ETF tanks would be considered for inspection. For tanks predicted to have lower potential for corrosion, inspections also are performed nonroutinely as part of the corrective maintenance program.

4.4.2 Additional Requirements for New Tanks

Procedures for proper installation of tanks, tank supports, piping, concrete, etc., are included in *Construction Specification, Project C-018H, 242-A Evaporator/PUREX Plant Process Condensate Treatment Facility* (WHC 1992a). For the load-in tanks, procedures are included in the construction specifications in *Project W-291, 200 Area Effluent BAT/AKART Implementation ETF Truck Load-in Facility* (KEH 1994). Following installation, an independent, qualified, registered professional engineer inspected the tanks and secondary containment. Deficiencies identified included damage to the surge tank, damage to the verification tank liners, and ETF secondary containment concrete surface cracking. All deficiencies were repaired to the satisfaction of the engineer. The tanks and ancillary equipment were leak tested as part of acceptance of the system from the construction contractor. Information on the inspections and leak tests are included in the engineering assessment (Mausshardt 1995). No deficiencies were identified during installation of the load-in tanks and ancillary equipment.

4.4.3 Secondary Containment and Release Detection for Tank Systems

This section describes the design and operation of secondary containment and leak detection systems at the ETF.

4.4.3.1 Secondary Containment Requirements for All Tank Systems

The specifications for the preparation, design, and construction of the secondary containment systems at the ETF are documented (WHC 1992a). The preparation, design, and construction of the secondary containment for the load-in tanks are provided in the construction specifications (KEH 1994). All systems were designed to national codes and standards. Constructing the ETF per these specifications ensured that foundations are capable of supporting tank and secondary containment systems and that uneven settling and failures from pressure gradients should not occur.

4.4.3.1.1 Common Elements

The following text describes elements of secondary containment that are common to all ETF tank systems. Details on the secondary containment for specific tanks, including leak detection systems and liquids removal, are provided in Section 4.4.4.1.2.

Foundation and Construction. For the tanks within the ETF, except for the sump tanks, secondary containment is provided by a coated concrete floor and a 15.2-centimeter rise (berm) along the containing walls. The double-wall construction of the sump tanks provides secondary containment. Additionally, trenches are provided in the floor that also provides containment and drainage of any liquid to a sump pit. For tanks outside the ETF, secondary containment also is provided with coated concrete floors in a containment pit (load-in tanks) or surrounded by concrete dikes (the surge and verification tanks).

The transfer piping that carries aqueous waste into the ETF is pipe-within-a-pipe construction, and is buried approximately 1.2 meters below ground surface. The pipes between the verification tanks and the verification tank pumps within the ETF are located in a concrete pipe trench.

For this discussion, there are five discrete secondary containment systems associated with the following tanks and ancillary equipment that treat or store dangerous waste:

- Load-in tanks
- Surge tank
- Process area (including sump tanks)
- Verification tanks
- Transfer piping and pipe trenches.

All of the secondary containment systems are designed with reinforcing steel and base and berm thickness to minimize failure caused by pressure gradients, physical contact with the waste, and climatic conditions. Classical theories of structural analysis, soil mechanics, and concrete and structural steel design were used in the design calculations for the foundations and structures. These calculations are maintained at the ETF. In each of the analyses, the major design criteria from the following documents were included:

V-C018HC1-001	Design Construction Specification, Project C-018H, 242A Evaporator/PUREX Plant Process Condensate Treatment Facility (WHC 1992a)
DOE Order 6430.1A	General Design Criteria
SDC-4.1	Standard Architectural-Civil Design Criteria, Design Loads for Facilities (DOE-RL 1988)
UCRL-15910	Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards (UCRL 1987)
UBC-91	Uniform Building Code, 1991 Edition (ICBO 1991).

The design and structural analysis calculations substantiate the structural designs in the referenced drawings. The conclusions drawn from these calculations indicate that the designs are sound and that the specified structural design criteria were met. This conclusion is verified in the independent design review that was part of the engineering assessment (Mausshardt 1995).

Containment Materials. The concrete floor consists of cast-in-place and preformed concrete slabs. All slab joints and floor and wall joints have water stops installed at the mid-depth of the slab. In addition, filler was applied to each joint.

Except for the sump tank vaults, all of the concrete surfaces in the secondary containment system, including berms, trenches, and pits, are coated with a chemical-resistant, high-solids, epoxy coating that consists of a primer, filler, and a top coating. This coating material is compatible with the waste being treated, and with the sulfuric acid, sodium hydroxide, and hydrogen peroxide additives to the process. The coating protects the concrete from contact with any chemical materials that might be harmful to concrete and prevents the concrete from being in contact with waste material. Table 4.8 summarizes the specifies types of filler, primer, second, and finish coats specified for the concrete and masonry surfaces in the ETF. The epoxy coating is considered integral to the secondary containment system for the tanks and ancillary equipment.

The concrete containment systems are maintained such that any cracks, gaps, holes, and other imperfections are repaired in a timely manner. Thus, the concrete containment systems do not allow spilled liquid to reach soil or groundwater. There are a number of personnel doorways and vehicle access points into the ETF process area. Releases of any spilled or leaked material to the environment from these access points are prevented by 15.2-centimeter concrete curbs, sloped areas of the floor (e.g., truck ramp), or trenches.

Containment Capacity and Maintenance. Each of these containment areas is designed to contain more than 100 percent of the volume of the largest tank in each respective system. Secondary containment systems for the surge tank, and the verification tanks, which are outside the ETF, also are large enough to include the additional volume from a 100-year, 24-hour storm event; i.e., 5.3 centimeters of precipitation.

Sprinkler System. The sprinkler system within the ETF supplies firewater protection to the process area and the container storage area. This system is connected to a site wide water supply system and has the capacity to supply sufficient water to suppress a fire at the ETF. However, in the event of failure, the sprinkler system can be hooked up to another water source (e.g., tanker truck).

4.4.3.1.2 Specific Containment Systems

The following discussion presents a description of the individual containment systems associated with specific tank systems.

Load-In Tank Secondary Containment. The load-in tanks are mounted on a 46-centimeter-thick reinforced concrete slab (Drawing H-2-817970). Secondary containment is provided by a pit with 30.5-centimeter-thick walls and a floor constructed of reinforced concrete. The load-in tank pit is sloped to drain solution to a sump. The depth of the pit varies with the slope of the floor, with an average thickness of about 1.1 meters. The volume of the secondary containment is about 79,000 liters, which is capable of containing the volume of at least one load-in tank (i.e., 37,800 liters). Leaks are detected by a leak detector that alarms locally and in the ETF control room and by visual inspection of the secondary containment.

Adjacent to the pit is a 25.4-centimeter-thick reinforced concrete pad that serves as secondary containment for the load-in tanker trucks, containers, transfer pumps, and filter system. The pad is 15.2 centimeters below grade with north and south walls gently sloped to allow truck access. The pad has drainpipes to route waste solution to the adjacent load-in tank pit.

Surge Tank Secondary Containment. The surge tank is mounted on a reinforced concrete ringwall. Inside the ringwall, the flat-bottomed tank is supported by a bed of compacted sand and gravel with a high-density polyethylene liner bonded to the ringwall. The liner prevents galvanic corrosion between the soil and the tank. The secondary containment is reinforced concrete with a 15.2-centimeter thick floor and a 20.3-centimeter thick dike. The secondary containment area shares part of the southern wall of the main process area. The dike extends up 2.9 meters to provide a containment volume of 740,000 liters for the 379,000-liter surge tank.

The floor of the secondary containment slopes to a sump in the northwest corner of the containment area. Leaks into the secondary containment are detected by level instrumentation in the sump, which alarms in the ETF control room, and/or by routine visual inspections. A sump pump is used to transfer solution in the secondary containment to a sump tank.

Process Area Secondary Containment. The process area contains the tanks and ancillary equipment of the primary and secondary treatment trains, and has a jointed, reinforced concrete slab floor. The concrete floor of the process area provides the secondary containment. This floor is a minimum of 15.2 centimeters thick. With doorsills 15.2 centimeter high, the process area has a containment volume of 76,200 liters. The largest tanks in the process area are the secondary waste receiving tanks, which each have a maximum capacity of 56,800 liters.

The floor of the process area is sloped to drain liquids to two trenches that drain to a sump. Each trench is approximately 38.1 centimeters wide with a sloped trough varying from 39.4 to 76.2 centimeters deep. Leaks into the secondary containment are detected by routine visual inspections of the floor area near the tanks, ancillary equipment, and in the trenches.

A small dam was placed in the trench that comes from the thin film dryer room to contain minor liquid spills originating in the dryer room to minimize the spread of contamination into the process area. The dryer room is inspected for leaks in accordance with the inspection schedule in Chapter 6.0. Operators clean up these minor spills by removing the liquid waste and decontaminating the spill area.

A small dam was also placed in the trench adjacent to the chemical feed skid when the chemical berm area was expanded to accommodate acid and caustic pumps, which were moved indoors from the top of the surge tank to resolve a safety concern. This dam was designed to contain minor spills originating in the chemical berm area and prevent them from entering the process sump.

The northwest corner of the process area consists of a pump pit containing the pumps and piping for transferring treated effluent from the verification tanks to SALDS. The pit is built 1.37 meters below the process area floor level and is sloped to drain to a trench built along its north wall that routes liquid to sump tank 1. Leaks into the secondary containment of the pump pit are detected by routine visual inspections.

Sump Tanks. The sump tanks support the secondary containment system, and collect waste from several sources, including:

- Process area drain trenches
- Tank overflows and drains
- Container washing water
- Resin dewatering solution
- Steam boiler blow down
- Sampler system drains.

These double-contained tanks are located within unlined, concrete vaults. The sump tank levels are monitored by remote level indicators or through visual inspections from the sump covers. These indicators are connected to high- and low-level alarms that are monitored in the control room. When a high-level alarm is activated, a pump is activated and the sump tank contents usually are routed to the secondary treatment train for processing. The contents also could be routed to the surge tank for treatment in the primary treatment train. In the event of an abnormally high inflow rate, a second sump pump is initiated automatically.

Verification Tank Secondary Containment. The three verification tanks are each mounted on ringwalls with high-density polyethylene liners similar to the surge tank. The secondary containment for the three tanks is reinforced concrete with a 15.2-centimeter thick floor and a 20.3-centimeter thick dike. The dike extends up 2.6 meters to provide a containment of 110 percent of the capacity of a single tank (i.e., 2,800,000 liters).

The floor of the secondary containment slopes to a sump along the southern wall of the dike. Leaks into the secondary containment are detected by level instrumentation in the sump that alarms in the control room and/or by routine visual inspections. A sump pump is used to transfer solution in the secondary containment to a sump tank.

4.4.3.2 Additional Requirements for Specific Types of Systems

This section addresses additional requirements in WAC 173-303-640 for double-walled tanks like the sump tanks and secondary containment for ancillary equipment and piping associated with the tank systems.

4.4.3.2.1 Double-Walled Tanks

The sump tanks are the only tanks in the ETF classified as 'double-walled' tanks. These tanks are located in unlined concrete vaults and support the secondary containment system for the process area. The sump tanks are equipped with a leak detector between the walls of the tanks that provide continuous monitoring for leaks. The leak detector provides immediate notification through an alarm in the control room. The inner tanks are contained completely within the outer shells. The tanks are contained completely within the concrete structure of the ETF so corrosion protection from external galvanic corrosion is not necessary.

4.4.3.2.2 Ancillary Equipment

The secondary containment provided for the tanks and process systems also serves as secondary containment for the ancillary equipment associated with these systems.

Ancillary Equipment. Section 4.4.4.1 describes the secondary containment systems that also serve most of the ancillary equipment within the ETF. Between the ETF and the verification tanks, a pipeline trench provides secondary containment for four pipelines connecting the transfer pumps (i.e., discharge and return pumps) in the ETF with the verification tanks (Figure 4.2). This concrete trench crosses under the road and extends from the verification tank pumps to the verification tanks. Treated effluent flows through these pipelines from the verification tank pumps to the verification tanks. The return pump is used to return effluent to the ETF for use as service water or for reprocessing.

For all of the ancillary equipment housed within the ETF, the concrete floor, trenches, and berms form the secondary containment system. For the ancillary equipment of the surge tank and the verification tanks, secondary containment is provided by the concrete floors and dikes associated with these tanks. The concrete floor and pit provide secondary containment for the ancillary equipment of the load-in tanks.

Transfer Piping and Pipe Trenches. The two buried transfer lines between LERF and the surge tank have secondary containment in a pipe-within-a-pipe arrangement. The 4-inch transfer line has an 8-inch outer pipe, while the 3-inch transfer, line has a 6-inch outer pipe. The pipes are fiberglass and are sloped towards the surge tank. The outer piping ends with a drain valve in the surge tank secondary containment.

These pipelines are equipped with leak detection located in the annulus between the inner and outer pipes; the leak detection equipment can continuously 'inspect' the pipelines during aqueous waste transfers. The alarms on the leak detection system are monitored in the control room. A low-volume air purge of the annulus is provided to prevent condensation buildup and minimize false alarms by the leak detection system. In the event that these leak detectors are not in service, the pipelines are inspected during transfers by opening a drain valve to check for solution in the annular space between the inner and outer pipe.

The 3-inch transfer line between the load-in tanks and the surge tank has a 6-inch outer pipe in a pipe-within-a-pipe arrangement. The piping is made of fiberglass-reinforced plastic and slopes towards the load-in tank secondary containment pit. The drain valve and leak detection system for the load-in tank pipelines are operated similarly to the leak detection system for the LERF to ETF pipelines.

As previously indicated, four reinforced concrete pipe trenches provide secondary containment for piping under the roadway between the ETF and the verification tanks. Each trench is 1.2 meters wide, 0.76 meter deep, and slopes towards the sump containing the transfer pumps to SALDS. The floor of the trenches is 30.5 centimeters thick and the sides are 15.2 centimeters thick. The concrete trenches are coated with water sealant and covered with metal gratings at ground level to allow vehicle traffic on the roadway.

4.4.4 Tank Management Practices

When an aqueous waste stream is identified for treatment or storage at ETF, the generating unit is required to characterize the waste. Based on characterization data, the waste stream is evaluated to determine if the stream is acceptable for treatment or storage. Specific tank management practices are discussed in the following sections.

4.4.4.1 Rupture, Leakage, Corrosion Prevention

Most aqueous waste streams can be managed such that corrosion would not be a concern. For example, an aqueous waste stream with high concentrations of chloride might cause corrosion problems when concentrated in the secondary treatment train. One approach is to adjust the corrosion control measures in the secondary treatment train. An alternative might be to blend this aqueous waste in a LERF basin with another aqueous waste that has sufficient dissolved solids, such that the concentration of the chlorides in the secondary treatment train would not pose a corrosion concern.

Additionally, the materials of construction used in the tanks systems (Table 4.5) make it unlikely that an aqueous waste would corrode a tank. For more information on corrosion prevention, refer to the waste analysis plan Chapter 3.0.

When a leak in a tank system is discovered, the leak is immediately contained or stopped by isolating the leaking component. Following containment, the leaking tank system is evaluated by facility personnel to determine whether continued operation of affected system would jeopardize the safety of plant personnel, result in a release to the environment, or compromise facility equipment. If determined that a leak could have the aforementioned consequences, the affected system will be immediately removed from service until repairs can be implemented. If a leak would not result in the stated consequences, the tank system will be placed on a maintenance schedule for repair.

4.4.4.2 Overfilling Prevention

Operating practices and administrative controls used at the ETF to prevent overfilling a tank are discussed in the following paragraphs. The ETF process is controlled by the MCS. The MCS monitors liquid levels in the ETF tanks and has alarms that annunciate on high-liquid level to notify operators that actions must be taken to prevent overfilling of these vessels. As an additional precaution to prevent spills, many tanks are equipped with overflow lines that route solutions to sump tanks 1 and 2. These tanks include the pH adjustment tank; RO feed tanks, effluent pH adjustment tank, secondary waste receiving tanks, and concentrate tanks.

The following section discusses feed systems, safety cutoff devices, bypass systems, and pressure controls for specific tanks and process systems.

Tanks. All tanks are equipped with liquid level sensors that give a reading of the tank liquid volume. The surge tank, the verification tanks, the RO tanks, the secondary waste receiving tanks, and the concentrate tanks are equipped further with liquid level alarms that are actuated if the liquid volume is near the tank overflow capacity. In the actuation of the surge tank alarm, a liquid level switch trips, sending a signal to the valve actuator on the tank influent lines, and causing the influent valves to close.

The operating mode for each verification tank, i.e., receiving, holding, or discharging, can be designated through the MCS; modes also switch automatically. When the high-level set point on the receiving verification tank is reached, the flow to this tank is diverted and another tank becomes the receiver. The full tank is switched into verification mode. The third tank is reserved for discharge mode.

The liquid levels in the first and second RO feed tanks are maintained within predetermined operating ranges. Should the second RO feed tank overflow, the excess waste is piped along with any leakage from the feed pump to a sump tank.

When waste in a secondary waste-receiving tank reaches the high-level set point, the influent flow of waste is redirected to the second tank and the first tank becomes the feed tank for the ETF evaporator.

In a similar fashion, the concentrate tanks switch modes when the high-level set point of one tank is reached. The other tank switches from a discharging mode to a receiving mode and the first tank becomes the discharge tank feeding waste to the thin film dryer.

Filter Systems. All filters at ETF (i.e., the Load-In Station, rough, fine, and auxiliary filter systems) are in leak-tight steel casings. For the rough and fine filters, a high differential pressure, which could damage the filter element, activates a valve that shuts off liquid flow to protect the filter element from possible damage. To prevent a high-pressure situation, the filters are cleaned routinely with pulses of compressed air that force water back through the filter. Cleaning is terminated automatically by shutting off the compressed air supply if high pressure develops. The differential pressure across the auxiliary filters also is monitored. A high differential pressure in these filters would result in a system shutdown to allow the filters to be changed out.

The Load-In Station filtration system has pressure gauges for monitoring the differential pressure across each filter. A high differential pressure would result in discontinuing filter operation until the filter is replaced.

Ultraviolet Light/Oxidation System and Decomposers. A rupture disk on the inlet piping to each of the UV/OX reaction vessels relieves to the pH adjustment tank in the event of excessive pressure developing in the piping system. Should the rupture disk fail, the aqueous waste would trip the moisture sensor, shut down the UV lamps, and close the surge tank feed valve. Also provided is a level sensor to protect UV lamps against the risk of exposure to air. Should those sensors be actuated, the UV lamps would be shut down immediately.

The piping and valving for the hydrogen peroxide decomposers are configured to split the waste flow: half flows to one decomposer and half flows to the other decomposer. Alternatively, the total flow of waste can be treated in one decomposer or both decomposers can be bypassed. A safety relief valve on each decomposer vessel can relieve excess system pressure to a sump tank.

Degasification System. The degasification column is typically supplied aqueous waste feed by the pH adjustment tank feed pump. This pump transfers waste solution through the hydrogen peroxide decomposer, the fine filter, and the degasification column to the first RO feed tank.

The degasification column is designed for operation at a partial vacuum. A pressure sensor in the column detects the column pressure. The vacuum in the degasification column is maintained by a blower connected to the vessel off gas system. The column is protected from extremely low pressure developed by the column blower by the use of an intake vent that is maintained in the open position during operation. The column liquid level is regulated by a flow control system with a high- and low-level alarm. Plate-type heat exchanger cools the waste solution fed to the degasification column.

Reverse Osmosis System. The flow through the first and second RO stages is controlled to maintain constant liquid levels in the first and second stage RO feed tanks.

Polisher. Typically, two of the three columns are in operation (lead/lag) and the third (regenerated) column is in standby. When the capacity of the resin in the first column is exceeded, as detected by an increase in the conductivity of the column effluent, the third column, containing freshly regenerated IX resin, is brought online. The first column is taken offline, and the waste is rerouted to the second column, and to the third. Liquid level instrumentation and automatically operated valves are provided in the IX system to prevent overfilling.

Effluent Treatment Facility Evaporator. Liquid level instrumentation in the secondary waste receiving tanks is designed to preclude a tank overflow. A liquid level switch actuated by a high-tank liquid level causes the valves to reposition, closing off flow to the secondary waste receiving tanks. Secondary containment for these tanks routes liquids to a sump tank.

Valves in the ETF evaporator feed line can be positioned to bypass the secondary waste around the ETF evaporator and to transfer the secondary waste to the concentrate tanks.

Thin Film Dryer. The two concentrate tanks alternately feed the thin film dryer. One tank serves as a concentrate waste receiver while the other tank serves as the dryer feed tank. Liquid level instrumentation prevents tank overflow by diverting the concentrate flow from the full concentrate tank to the other concentrate tank. Secondary containment for these tanks routes liquids to a sump tank.

An alternate route is provided from the concentrate receiver tank to the secondary waste receiving tanks. Dilute concentrate in the concentrate receiver tank can be reprocessed through the ETF evaporator by transferring the concentrate back to a secondary waste-receiving tank.

4.4.5 Labels or Signs

Each tank or process unit in the ETF is identified by a nameplate attached in a readily visible location. Included on the nameplate are the equipment number and the equipment title. Those tanks that store or treat dangerous waste at the ETF (Section 4.4.1.1) are identified with a label, which reads "PROCESS WATER/WASTE". The labels are legible at a distance of at least fifty feet or as appropriate for legibility within the ETF. Additionally, these tanks bear a legend that identifies the waste in a manner, which adequately warns employees, emergency personnel, and the public of the major risk(s) associated with the waste being stored or treated in the tank system(s).

Caution plates are used to show possible hazards and warn that precautions are necessary. Caution signs have a yellow background and black panel with yellow letters and bear the word "CAUTION". Danger signs show immediate danger and signify that special precautions are necessary. These signs are red, black, and white and bear the word "DANGER".

Tanks and vessels containing corrosive chemicals are posted with black and white signs bearing the word "CORROSIVE". "DANGER - UNAUTHORIZED PERSONNEL KEEP OUT" signs are posted on all exterior doors of the ETF, and on each interior door leading into the process area. Tank ancillary piping is also labeled "PROCESS WATER" or "PROCESS LIQUID" to alert personnel which pipes in the process area contains dangerous and/or mixed waste.

All tank systems holding dangerous waste are marked with labels or signs to identify the waste contained in the tanks. The labels or signs are legible at a distance of at least 50-feet and bear a legend that identifies the waste in a manner that adequately warns employees, emergency response personnel, and the public, of the major risk(s) associated with the waste being stored or treated in the tank system(s).

4.4.6 Air Emissions

Tank systems that contain extremely hazardous waste that is acutely toxic by inhalation must be designed to prevent the escape of such vapors. To date, no extremely hazardous waste has been managed in ETF tanks and is not anticipated. However, the ETF tanks have forced ventilation that draws air from the tank vapor spaces to prevent exposure of operating personnel to any toxic vapors that might be present. The vapor passes through a charcoal filter and two sets of high-efficiency particulate air filters before discharge to the environment.

4.4.7 Management of Ignitable or Reactive Wastes in Tanks Systems

Although the ETF is permitted to accept waste that is designated ignitable or reactive, such waste would be treated or blended immediately after placement in the tank system so that the resulting waste mixture is no longer ignitable or reactive. Aqueous waste received does not meet the definition of a combustible or flammable liquid given in National Fire Protection Association (NFPA) code number 30 (NFPA 1996).

The buffer zone requirements in NFPA-30, which require tanks containing combustible or flammable solutions be a safe distance from each other and from public way, are not applicable.

4.4.8 Management of Incompatible Wastes in Tanks Systems

The ETF manages dilute solutions that can be mixed without compatibility issues. The ETF is equipped with several systems that can adjust the pH of the waste for treatment activities. Sulfuric acid and sodium hydroxide are added to the process through the MCS for pH adjustment to ensure there will be no large pH fluctuations and adverse reactions in the tank systems.

4.5 SURFACE IMPOUNDMENTS

This section provides specific information on surface impoundment operations at the LERF, including descriptions of the liners and secondary containment structures, as required by WAC 173-303-650 and WAC 173-303-806(4)(d).

The LERF consists of three lined surface impoundments (basins) with a design operating capacity of 29.5 million liters each. The maximum capacity of each basin is 34 million liters. The dimensions of each basin at the anchor wall are approximately 103 meters by 85 meters. The typical top dimensions of the wetted area are approximately 89 meters by 71 meters, while the bottom dimensions are approximately 57 by 38 meters. Total depth from the top of the dike to the bottom of the basin is approximately 7 meters. The typical finished basin bottoms lie at about 4 meters below the initial grade and 175 meters above sea level. The dikes separating the basins have a typical height of 3 meters and typical top width of 11.6 meters around the perimeter of the impoundments.

4.5.1 List of Dangerous Waste

A list of dangerous and/or mixed aqueous waste that can be stored in LERF is presented in Chapter 1.0. The waste analysis plan for the LERF and ETF Chapter 3.0 also provides a discussion of the types of waste that are managed in the LERF.

4.5.2 Construction, Operation, and Maintenance of Liner System

General information concerning the liner system is presented in the following sections. Information regarding loads on the liner, liner coverage, UV light exposure prevention, and location relative to the water table are discussed.

4.5.2.1 Liner Construction Materials

The LERF employs a double-composite liner system with a leachate detection, collection, and removal system between the primary and secondary liners. Each basin is constructed with an upper or primary liner consisting of a high-density polyethylene geomembrane laid over a bentonite carpet liner. The lower or secondary liner in each basin is a composite of a geomembrane laid over a layer of soil/bentonite admixture with a hydraulic conductivity less than 10^{-7} centimeters per second. The synthetic liners extend up the dike wall to a concrete anchor wall that surrounds the basin at the top of the dike. A batten system bolts the layers in place to the anchor wall (Figure 4.16).

Figure 4.17 is a schematic cross-section of the liner system. The liner components, listed from the top to the bottom of the liner system, are the following:

- Primary 1.5-millimeter high-density polyethylene geomembrane
- Bentonite carpet liner
- Geotextile
- Drainage gravel (bottom) and geonet (sides)
- Geotextile
- Secondary 1.5-millimeter high-density polyethylene geomembrane
- Soil/bentonite admixture (91 centimeters on the bottom, 107 centimeters on the sides)
- Geotextile

The primary geomembrane, made of 1.5-millimeter high-density polyethylene, forms the basin surface that holds the aqueous waste. The secondary geomembrane, also 1.5-millimeter high-density polyethylene, forms a barrier surface for leachate that might penetrate the primary liner. The high-density polyethylene chemically is resistant to constituents in the aqueous waste and has a relatively high strength compared to other lining materials. The high-density polyethylene resin specified for the LERF contains carbon black, antioxidants, and heat stabilizers to enhance its resistance to the degrading effects of UV light. The approach to ensuring the compatibility of aqueous waste streams with the LERF liner materials and piping is discussed in the waste analysis plan Chapter 3.0.

Three geotextile layers are used in the LERF liner system. The layers are thin, nonwoven polypropylene fabric that chemically is resistant, highly permeable, and resistant to microbiological growth. The first two layers prevent fine soil particles from infiltrating and clogging the drainage layer. The second geotextile also provides limited protection for the secondary geomembrane from the drainage rock. The third geotextile layer prevents the mixing of the soil/bentonite admixture with the much more porous and granular foundation material.

A 30.5-centimeters-thick gravel drainage layer on the bottom of the basins between the primary and secondary liners provides a flow path for liquid to the leachate detection, collection, and removal system. A geonet (or drainage net) is located immediately above the secondary geomembrane on the basin sidewalls. The geonet functions as a preferential flow path for liquid between the liners, carrying liquid down to the gravel drainage layer and subsequently to the leachate sump. The geonet is a mesh made of high-density polyethylene, with approximately 13-millimeter openings.

The soil/bentonite layer is 97 centimeters thick on the bottom of the basins and 107 centimeters thick on the basin sidewalls; its permeability is less than 10-7 centimeters per second. This composite liner design, consisting of a geomembrane laid over essentially impermeable soil/bentonite, is considered best available technology for solid waste landfills and surface impoundments. The combination of synthetic and clay liners is reported in the literature to provide the maximum protection from waste migration (Forseth and Kmet 1983).

A number of laboratory tests were conducted to measure the engineering properties of the soil/bentonite admixture, in addition to extensive field tests performed on three test fills constructed near the LERF site. For establishing an optimum ratio of bentonite to soil for the soil/bentonite admixture, mixtures of various ratios were tested to determine permeability and shear strength. A mixture of 12 percent bentonite was selected for the soil/bentonite liner and tests described in the following paragraphs demonstrated that the admixture meets the desired permeability of less than 10-7 centimeters per second. Detailed discussion of test procedures and results is provided in Report of Geotechnical Investigation, 242-A Evaporation and PUREX Interim Storage Basins (Chen-Northern 1990).

Direct shear tests were performed according to ASTM D3080 test procedures (ASTM 1990) on soil/bentonite samples of various ratios. Based on these results, the conservative minimum Mohr-Coulomb shear strength value of 30 degrees was estimated for a soil/bentonite admixture containing 12 percent bentonite.

The high degree of compaction of the soil/bentonite layer [92 percent per ASTM D1557 (ASTM 1991)] was expected to maximize the bonding forces between the clay particles, thereby minimizing moisture transport through the liner. With respect to particle movement ('piping'), estimated fluid velocities in this low-permeability material are too low to move the soil particles. Therefore, piping is not considered a problem.

For the soil/bentonite layer, three test fills were constructed to demonstrate that materials, methods, and procedures used would produce a soil/bentonite liner that meets the EPA permeability requirement of less than 10-7 centimeters per second. All test fills met the EPA requirements. A thorough discussion of construction procedures, testing, and results is provided in *Report of Permeability Testing, Soil-bentonite Test Fill* (Chen-Northern 1991a).

The aqueous waste stored in the LERF is typically a dilute mixture of organic and inorganic constituents. Though isolated instances of soil liner incompatibility have been documented in the literature (Forseth and Kmet 1983), these instances have occurred with concentrated solutions that were incompatible with the geomembrane liners in which the solutions were contained. Considering the dilute nature of the aqueous waste that is and will be stored in LERF and the moderate pH, and test results demonstrating the compatibility of the high-density polyethylene liners with the aqueous waste [9090 Test Results (WHC 1991)], gross failure of the soil/bentonite layer is not probable.

Each basin also is equipped with a floating very low-density polyethylene cover. The cover is anchored and tensioned at the concrete wall at the top of the dikes, using a patented mechanical tensioning system. Figure 4.16 depict the tension mechanism and the anchor wall at the perimeter of each basin. Additional information on the cover system is provided in Section 4.5.2.5.

4.5.2.1.1 Material Specifications

Material specifications for the liner system and leachate collection system, including liners, drainage gravel, and drainage net are discussed in the following sections. Material specifications are documented in the *Final Specifications 242-A Evaporator and PUREX Interim Retention Basins* (KEH 1990a) and *Construction Specifications for 242-A Evaporator and PUREX Interim Retention Basins* (KEH 1990b).

Geomembrane Liners. The high-density polyethylene resin for geomembranes for the LERF meets the material specifications listed in Table 4.9. Key physical properties include thickness (1.5 millimeters [60 mil]) and impermeability (hydrostatic resistance of over 360,000 kilogram per square meter). Physical properties meet National Sanitation Foundation Standard 54 (NSF 1985). Testing to determine if the liner material is compatible with typical dilute waste solutions was performed and documented in *9090 Test Results* (WHC 1991).

Soil/Bentonite Liner. The soil/bentonite admixture consists of 11.5 to 14.5 percent bentonite mixed into well-graded silty sand with a maximum particle size of 4.75 millimeters (No. 4 sieve). Test fills were performed to confirm the soil/bentonite admixture applied at LERF has hydraulic conductivity less than 10^{-7} centimeters per second, as required by WAC 173-303-650(2)(j) for new surface impoundments.

Bentonite Carpet Liner. The bentonite carpet liner consists of bentonite (90 percent sodium montmorillonite clay) in a primary backing of woven polypropylene with nylon filler fiber, and a cover fabric of open weave spunlace polyester. The montmorillonite is anticipated to retard migration of solution through the liner, exhibiting a favorable cation exchange for adsorption of some constituents (such as ammonium). Based on composition of the bentonite carpet and of the type of aqueous waste stored at LERF, no chemical attack, dissolution, or degradation of the bentonite carpet liner is anticipated.

Geotextile. The nonwoven geotextile layers consist of long-chain polypropylene polymers containing stabilizers and inhibitors to make the filaments resistant to deterioration from UV light and heat exposure. The geotextile layers consist of continuous geotextile sheets held together by needle punching. Edges of the fabric are sealed or otherwise finished to prevent outer material from pulling away from the fabric or raveling.

Drainage Gravel. The drainage layer consists of thoroughly washed and screened, naturally occurring rock meeting the size specifications for Grading Number 5 in Washington State Department of Transportation construction specifications (WSDOT 1988). The specifications for the drainage layer are given in Table 4.10. Hydraulic conductivity tests (Chen-Northern 1992a, 1992b, 1992c) showed the drainage rock used at LERF met the sieve requirements and had a hydraulic conductivity of at least 1 centimeter per second, which exceeded the minimum of at least 0.1 centimeters per second required by WAC 173-303-650(2)(j) for new surface impoundments.

Geonet. The geonet is fabricated from two sets of parallel high-density polyethylene strands, spaced 1.3 centimeters center-to-center maximum to form a mesh with minimum two strands per 2.54 centimeter in each direction. The geonet is located between the liners on the sloping sidewalls to provide a preferential flow path for leachate to the drainage gravel and subsequently to the leachate sump.

Leachate Collection Sump. Materials used to line the 3.0-meter by 1.8-meter by 0.30-meter-deep leachate sump, at the bottom of each basin in the northwest corner, include [from top to bottom (Figure 4.18)]:

- 25 millimeter high-density polyethylene flat stock (supporting the leachate riser pipe)
- Geotextile
- 1.5-millimeter high-density polyethylene rub sheet
- Secondary composite liner:
  - 1.5-millimeter high-density polyethylene geomembrane
  - 91 centimeters of soil/bentonite admixture
  - Geotextile

Specifications for these materials are identical to those discussed previously.

Leachate System Risers. Risers for the leachate system consist of 10-inch and 4-inch pipes from the leachate collection sump to the catch basin northwest of each basin (Figure 4.18). The risers lay below the primary liner in a gravel-filled trench that also extends from the sump to the concrete catch basin (Figure 4.19).

The risers are high-density polyethylene pipes fabricated to meet the requirements in ASTM D1248 (ASTM 1989). The 10-inch riser is perforated every 20.3 centimeters with 1.3-centimeter holes around the diameter. Level sensors and leachate pump are inserted in the 10-inch riser to monitor and remove leachate from the sump. To prevent clogging of the pump and piping with fine particulate, the end of the riser is encased in a gravel-filled box constructed of high-density polyethylene geonet and wrapped in geotextile. The 4-inch riser is perforated every 10.2 centimeters with 0.64-centimeter holes around the diameter. A level detector is inserted in the 4-inch riser.

Leachate Pump. A deep-well submersible pump, designed to deliver approximately 110 liters per minute, is installed in the 10-inch leachate riser in each basin. Wetted parts of the leachate pump are made of 316L stainless steel, providing both corrosion resistance and durability.

4.5.2.1.2 Loads on Liner System

The LERF liner system is subjected to the following types of stresses.

Stresses from Installation or Construction Operations. Contractors were required to submit construction quality control plans that included procedures, techniques, tools, and equipment used for the construction and care of liner and leachate system. Methods for installation of all components were screened to ensure that the stresses on the liner system were kept to a minimum.

Calculations were performed to estimate the risk of damage to the secondary high-density polyethylene liner during construction (*Calculations for LERF Part B Permit Application* [HNF 1997]). The greatest risk expected was from spreading the gravel layer over the geotextile layer and secondary geomembrane. The results of the calculations show that the strength of the geotextile was sufficiently high to withstand the stress of a small gravel spreader driving on a minimum of 15 centimeters of gravel over the geotextile and geomembrane. The likelihood of damage to the geomembrane lying under the geotextile was considered low.

To avoid driving heavy machinery directly on the secondary liner, a 28-meter conveyer was used to deliver the drainage gravel into the basins. The gravel was spread and consolidated by hand tools and a bulldozer. The bulldozer traveled on a minimum thickness of 30.5 centimeters of gravel. Where the conveyer assembly was placed on top of the liner, cribbing was placed to distribute the conveyer weight. No heavy equipment was allowed for use directly in contact with the geomembranes.

Additional calculations were performed to estimate the ability of the leachate riser pipe to withstand the static and dynamic loading imposed by lightweight construction equipment riding on the gravel layer (HNF 1997). Those calculations demonstrated that the pipe could buckle under the dynamic loading of

small construction equipment; therefore, the pipe was avoided by equipment during spreading of the drainage gravel.

Installation of synthetic lining materials proceeded only when winds were less than 24 kilometers per hour, and not during precipitation. The minimum ambient air temperature for unfolding or unrolling the high-density polyethylene sheets was -10 C, and a minimum temperature of 0 C was required for seaming the high-density polyethylene sheets. Between shifts, geomembranes and geotextile were anchored with sandbags to prevent lifting by wind. Calculations were performed to determine the appropriate spacing of sandbags on the geomembrane to resist lifting caused by 130 kilometer per hour winds (HNF 1997). All of the synthetic components contain UV light inhibitors and no impairment of performance is anticipated from the short-term UV light exposure during construction. Section 4.5.2.4 provides further detail on exposure prevention.

During the laying of the soil/bentonite layer and the overlying geomembrane, moisture content of the admixture was monitored and adjusted to ensure optimum compaction and to avoid development of cracks.

4.5.2.1.3 Static and Dynamic Loads and Stresses from the Maximum Quantity of Waste

When a LERF basin is full, liquid depth is approximately 6.4 meters. Static load on the primary liner is roughly 6,400 kilograms per square meter. Load on the secondary liner is slightly higher because of the weight of the gravel drainage layer. Assuming a density of 805 kilograms per square meter for the drainage gravel [conservative estimate based on specific gravity of 2.65 (Ambrose 1988)], the secondary high-density polyethylene liner carries approximately 7,200 kilograms per square meter when a basin is full.

Side slope liner stresses were calculated for each of the layers in the basin sidewalls and for the pipe trench on the northwest corner of each basin (HNF 1997). Results of these calculations indicate factors of safety against shear were 1.5 or greater for the primary geomembrane, geotextile, geonet, and secondary geomembrane.

Because the LERF is not located in an area of seismic concern, as identified in Appendix VI of 40 CFR 264 and WAC 173-303-282(6)(a)(I), discussion and calculation of potential seismic events are not required.

4.5.2.1.4 Stresses Resulting from Settlement, Subsidence, or Uplift

Uplift stresses from natural sources are expected to have negligible impact on the liner. Groundwater lies approximately 62 meters below the LERF, average annual precipitation is only 16 centimeters, and the average unsaturated permeability of the soils near the basin bottoms is high, ranging from about 5.5×10^4 centimeters per second to about 1 centimeter per second (Chen-Northern 1991b). Therefore, no hydrostatic uplift forces are expected to develop in the soil underneath the basins. In addition, the soil under the basins consists primarily of gravel and sand, and contains few or no organic constituents. Therefore, uplift caused by gas production from organic degradation is not anticipated.

Based on the design of the soil-bentonite liner, no structural uplift stresses are present within the lining system (Chen-Northern 1991b).

Regional subsidence is not anticipated because neither petroleum nor extractable economic minerals are present in the strata underlying the LERF basins, nor is karst (erosive limestone) topography present.

Dike soils and soil/bentonite layers were compacted thoroughly and proof-rolled during construction. Calculation of settlement potential showed that combined settlement for the foundation and soil/bentonite layer is expected to be about 2.7 centimeters. Settlement impact on the liner and basin stability is expected to be minimal (Chen-Northern 1991b).

4.5.2.1.5 Internal and External Pressure Gradients

Pressure gradients across the liner system from groundwater are anticipated to be negligible. The LERF is about 62 meters above the seasonal high water table, which prevents buildup of water pressure below the liner. The native gravel foundation materials of the LERF are relatively permeable and free draining. The 2 percent slope of the secondary liner prevents the pooling of liquids on top of the secondary liner. Finally, the fill rate of the basins is slow enough (average 190 liters per minute) that the load of the liquid waste on the primary liner is gradually and evenly distributed.

To prevent the buildup of gas between the liners, each basin is equipped with 21 vents in the primary geomembrane that allow the reduction of any excess gas pressure. Gas passing through these vents exit through a single pipe that penetrates the anchor wall into a carbon adsorption filter. This filter extracts nearly all of the organic compounds, ensuring that emissions to the air from the basins are not toxic.

4.5.2.2 Liner System Location Relative to High-Water Table

The lowest point of each LERF basin is the northwest corner of the sump, where the typical subgrade elevation is 175 meters above mean sea level. Based on data collected from the groundwater monitoring wells at the LERF site, the seasonal high-water table is located approximately 62 meters or more below the lowest point of the basins. This substantial thickness of unsaturated strata beneath the LERF provides ample protection to the liner from hydrostatic pressure because of groundwater intrusion into the soil/bentonite layer. Further discussion of the unsaturated zone and site hydrogeology is provided in Chapter 5.0.

4.5.2.3 Liner System Foundation

Foundation materials are primarily gravels and cobbles with some sand and silt. The native soils onsite are derived from unconsolidated Holocene sediments. These sediments are fluvial and glaciofluvial sands and gravels deposited during the most recent glacial and postglacial event. Grain-size distributions and shape analyses of the sediments indicate that deposition occurred in a high-energy environment (Chen-Northern 1990).

Analysis of five soil borings from the LERF site was conducted to characterize the natural foundation materials and to determine the suitability of onsite soils for construction of the impoundment dikes and determine optimal design factors. Well-graded gravel containing varying amounts of silt, sand, and cobbles comprises the layer in which the basins were excavated. This gravel layer extends to depths of 10 to 11 meters below land surface (Chen-Northern 1990). The basins are constructed directly on the subgrade. Excavated soils were screened to remove oversize cobbles (greater than 15 centimeters in the largest dimension) and used to construct the dikes.

Settlement potential of the foundation material and soil/bentonite layer was found to be low. The foundation is comprised of undisturbed native soils. The bottom of the basin excavation lies within the well-graded gravel layer, and is dense to very dense. Below the gravel is a layer of dense to very dense poorly graded and well-graded sand. Settlement was calculated for the gravel foundation soils and for the soil/bentonite layer, under the condition of hydrostatic loading from 6.4 meters of fluid depth. The combined settlement for the soils and the soil/bentonite layer is estimated to be about 2.7 centimeters. This amount of settlement is expected to have minimal impact on overall liner or basin stability (Chen-Northern 1991b). Settlement calculations are provided in *Calculations for Liquid Effluent Retention Facility Part B Permit Application* (HNF 1997).

The load bearing capacity of the foundation material, based on the soil analysis discussed previously, is estimated at about 48,800 kilograms per square meter [maximum advisable presumptive bearing capacity (Hough 1969)]. Anticipated static and dynamic loading from a full basin is estimated to be less than 9,000 kilograms per square meter (Section 4.5.2.1.3), which provides an ample factor of safety.

When the basins are empty, excess hydrostatic pressure in the foundation materials under the liner system theoretically could result in uplift and damage. However, because the native soil forming the foundations is unsaturated and relatively permeable, and because the water table is located at a considerable depth

beneath the basins, any infiltration of surface water at the edge of the basin is expected to travel predominantly downward and away from the basins, rather than collecting under the excavation itself. No gas is expected in the foundation because gas-generating organic materials are not present.

Subsidence of undisturbed foundation materials is generally the result of fluid extraction (water or petroleum), mining, or karst topography. Neither petroleum, mineral resources, nor karst are believed to be present in the sediments overlying the Columbia River basalts. Potential groundwater resources do exist below the LERF. Even if these sediments were to consolidate from fluid withdrawal, their depth most likely would produce a broad, gently sloping area of subsidence that would not cause significant strains in the LERF liner system. Consequently, the potential for subsidence related failures are expected to be negligible.

Borings at the LERF site, and extensive additional borings in the 200 East Area, have not identified any significant quantities of soluble materials in the foundation soil or underlying sediments (Last et al. 1989). Consequently, the potential for sinkholes is considered negligible.

4.5.2.4 Liner System Exposure Prevention

Both primary and secondary geomembranes and the floating cover are stabilized with carbon black to prevent degradation from UV light. Furthermore, none of the liner layers experience long-term exposure to the elements. During construction, thin polyethylene sheeting was used to maintain optimum moisture content and provide protection from the wind for the soil/bentonite layer until the secondary geomembrane was laid in place. The secondary geomembrane was covered by the geonet and geotextile as soon as quality control testing was complete. Once the geotextile layer was completed, drainage material immediately was placed over the geotextile. The final (upper) geotextile layer was placed over the drainage gravel and immediately covered by the bentonite carpet liner. This was covered immediately, in turn, by the primary high-density polyethylene liner.

Both high-density polyethylene liners, geotextile layers, and geonet are anchored permanently to a concrete wall at the top of the basin berm. During construction, liners were held in place with many sandbags on both the basin bottoms and side slopes to prevent wind from lifting and damaging the materials. Calculations were performed to determine the amount of fluid needed in a basin to prevent wind lift damage to the primary geomembrane. Approximately 15 to 20 centimeters of solution are kept in each basin to minimize the potential for uplifting the primary liner (HNF 1997).

The entire lining system is covered by a very low-density polyethylene floating cover that is bolted to the concrete anchor wall. The floating cover prevents evaporation and intrusion from dust, precipitation, vegetation, animals, and birds. A patented tensioning system is employed to prevent wind from lifting the cover and automatically accommodate changes in liquid level in the basins. The cover tension mechanism consists of a cable running from the flexible geosynthetic cover over a pulley on the tension tower (located on the concrete anchor wall) to a dead man anchor. These anchors (blocks) simply hang from the cables on the exterior side of the tension towers. The anchor wall also provides for solid attachment of the liner layers and the cover, using a 6.4-millimeter batten and neoprene gasket to bolt the layers to the concrete wall, effectively sealing the basin from the intrusion of light, precipitation, and airborne dust (Figure 4.16).

The floating cover, made of very low-density polyethylene with UV light inhibitors, is not anticipated to experience unacceptable degradation during the service life of the LERF. The very low-density polyethylene material contains carbon black for UV light protection, anti-oxidants to prevent heat degradation, and seaming enhancers to improve its ability to be welded. A typical manufacturer's limited warranty for weathering of very low-density polyethylene products is 20 years (Poly America, undated). This provides a margin of safety for the anticipated medium-term use of the LERF for aqueous waste storage.

The upper 3.4 to 4.6 meters of the sidewall liner also could experience stresses in response to temperature changes. Accommodation of thermal influences for the LERF geosynthetic layers is affected by inclusion of sufficient slack as the liners were installed. Calculations demonstrate that approximately

67 centimeters of slack is required in the long basin bottom dimension, 46 centimeters across the basin, and 34 centimeters from the bottom of the basin to the top of the basin wall (HNF 1997).

Thermal stresses also are experienced by the floating cover. As with the geomembranes, sufficient slack was included in the design to accommodate thermal contraction and expansion.

4.5.2.4.1 Liner Repairs During Operations

Should repair of a basin liner be required while the basin is in operation, the basin contents will be transferred to the ETF or another available basin. After the liner around the leaking section is cleaned, repairs to the geomembrane will be made by the application of a piece of high-density polyethylene sheeting, sufficient in size to extend approximately 8 to 15 centimeters beyond the damaged area, or as recommended by the vendor. A round or oval patch will be installed using the same type of equipment and criteria used for the initial field installations.

4.5.2.4.2 Control of Air Emissions

The floating covers limit evaporation of aqueous waste and releases of volatile organic compounds into the atmosphere. To accommodate volumetric changes in the air between the fluid in the basin and the cover, and to avoid problems related to 'sealing' the basins too tightly, each basin is equipped with a carbon filter breather vent system. Any air escaping from the basins must pass through this vent, consisting of a pipe that penetrates the anchor wall and extends into a carbon adsorption filter unit.

4.5.2.5 Liner Coverage

The liner system covers all of the ground surface that underlies the retention basins. The primary liner extends up the side slopes to a concrete anchor wall at the top of the dike encircling the entire basin (Figure 4.16).

4.5.3 Prevention of Overtopping

Overtopping prevention is accomplished through administrative controls and liquid-level instrumentation installed in each basin. The instrumentation includes local liquid-level indication as well as remote indication at the ETF. Before an aqueous waste is transferred into a basin, administrative controls are implemented to ensure overtopping will not occur during the transfer. The volume of feed to be transferred is compared to the available volume in the receiving basin. The transfer is not initiated unless there is sufficient volume available in the receiving basin or a cut-off level is established. The transfer into the basin would be stopped when this cut-off level is reached.

In the event of a 100-year, 24-hour storm event, precipitation would accumulate on the basin covers. Through the self-tensioning design of the basin covers and maintenance of adequate freeboard, all accumulated precipitation would be contained on the covers and none would flow over the dikes or anchor walls. The 100-year, 24-hour storm is expected to deliver 5.3 centimeters of rain or approximately 61 centimeters of snow. Cover specifications include the requirement that the covers be able to withstand the load from this amount of precipitation. Because the cover floats on the surface of the fluid in the basin, the fluid itself provides the primary support for the weight of the accumulated precipitation. Through the cover self-tensioning mechanism, there is ample 'give' to accommodate the overlying load without overstressing the anchor and attachment points.

Rainwater and snow evaporate readily from the cover, particularly in the arid Hanford Facility climate, where evaporation rates exceed precipitation rates for most months of the year. The black color of the cover further enhances evaporation. Thus, the floating cover prevents the intrusion of precipitation into the basin and provides for evaporation of accumulated rain or snow.

4.5.3.1 Freeboard

Under current operating conditions, 0.61 meter of freeboard is maintained at each LERF basin, which corresponds to an operating level of 6.8 meters, or 29.5 million liters.

4.5.3.2 Immediate Flow Shutoff

The mechanism for transferring aqueous waste is either through pump transfers with on/off switches or through gravity transfers with isolation valves. These methods provide positive ability to shut off transfers immediately in the event of overtopping. Overtopping a basin during a transfer is very unlikely because the low flow rate into the basin provides long response times. At a flow rate of 284 liters per minute, approximately 11 days would be required to fill a LERF basin from the 6.8-meter operating level (i.e., 0.61 meter of freeboard) to maximum capacity of 34 million liters (i.e., the 7.4-meter level).

4.5.3.3 Outflow Destination

Aqueous waste in the LERF is transferred routinely to ETF for treatment. However, should it be necessary to immediately empty a basin, the aqueous waste either would be transferred to the ETF for treatment or transferred to another basin (or basins), whichever is faster. If the waste is transferred to another LERF basin, the single pump for normal operation can be removed, and four submersible pumps can be installed using an emergency pump manifold. This portable piping and pumping system is capable of pumping 2,700 liters per minute. Not including set-up time, it would take approximately 7.6 days to pump the contents of a full basin at this pumping rate.

4.5.4 Structural Integrity of Dikes

The structural integrity of the dikes was certified attesting to the structural integrity of the dikes, signed by a qualified, registered professional engineer.

4.5.4.1 Dike Design, Construction, and Maintenance

The dikes of the LERF are constructed of onsite native soils, generally consisting of cobbles and gravels. Well-graded mixtures were specified, with cobbles up to 15 centimeters in the largest dimension, but not constituting more than 20 percent of the volume of the fill. The dikes are designed with a 3:1 (3 units horizontal to 1 unit vertical) slope on the basin side, and 2.25:1 on the exterior side. The dikes are approximately 8.2 meters high from the bottom of the basin, and 3 meters above grade.

Calculations were performed to verify the structural integrity of the dikes (HNF 1997). The calculations demonstrate that the structural strength of the dikes is such that, without dependence on any lining system, the sides of the basins can withstand the pressure exerted by the maximum allowable quantity of fluid in the impoundment. The dikes have a factor of safety greater than 2.5 against failure by sliding.

4.5.4.2 Dike Stability and Protection

In the following paragraphs, various aspects of stability for the LERF dikes and the concrete anchor wall are presented, including slope failure, hydrostatic pressure, and protection from the environment.

Failure in Dike/Impoundment Cut Slopes. A slope stability analysis was performed to determine the factor of safety against slope failure. The computer program 'PCSTABL5' from Purdue University, using the modified Janbu Method, was employed to evaluate slope stability under both static and seismic loading cases. One hundred surfaces per run were generated and analyzed. The assumptions used were as follows (Chen-Northern 1991b):

- Weight of gravel: 2,160 kilograms per cubic meter
- Maximum dry density of gravel: 2,315 kilograms per cubic meter
- Mohr-Coulomb shear strength angle for gravel: minimum 33 degrees
- Weight of soil/bentonite: 1,600 kilograms per cubic meter
- Mohr-Coulomb shear strength angle for soil/bentonite: minimum 30 degrees
- Slope: 3 horizontal: 1 vertical
- No fluid in impoundment (worst case for stability)
- Soils at in-place moisture (not saturated conditions)

Results of the static stability analysis showed that the dike slopes were stable with a minimum factor of safety of 1.77 (Chen-Northern 1991b).

The standard horizontal acceleration required in the *Hanford Plant Standards*, "Standard Architectural-Civil Design Criteria, Design Loads for Facilities" (DOE-RL 1988), for structures on the Hanford Site is 0.12 g. Adequate factors of safety for cut slopes in units of this type generally are considered 1.5 for static conditions and 1.1 for dynamic stability (Golder 1989). Results of the stability analysis showed that the LERF basin slopes were stable under horizontal accelerations of 0.10 and 0.15 g, with minimum factors of safety of 1.32 and 1.17, respectively (Chen-Northern 1991b). Printouts from the PCSTABL5 program are provided in *Calculations for Liquid Effluent Retention Facility Part B Permit Application* (HNF 1997).

Hydrostatic Pressure. Failure of the dikes due to buildup of hydrostatic pressure, caused by failure of the leachate system or liners, is very unlikely. The liner system is constructed with two essentially impermeable layers consisting of a synthetic layer overlying a soil layer with low-hydraulic conductivity. It would require a catastrophic failure of both liners to cause hydrostatic pressures that could endanger dike integrity. Routine inspections of the leachate detection system, indicating quantities of leachate removed from the basins, provide an early warning of leakage or operational problems that could lead to excessive hydrostatic pressure. A significant precipitation event (e.g., a 100-year, 24-hour storm) will not create a hydrostatic problem because the interior sidewalls of the basins are covered completely by the liners. The covers can accommodate this volume of precipitation without overtopping the dike (Section 4.5.3), and the coarse nature of the dike and foundation materials on the exterior walls provides for rapid drainage of precipitation away from the basins.

Protection from Root Systems. Risk to structural integrity of the dikes because of penetrating root systems is minimal. Excavation and construction removed all vegetation on and around the impoundments, and native plants (such as sagebrush) grow very slowly. The large grain size of the cobbles and gravel used as dike construction material do not provide an advantageous germination medium for native plants. Should plants with extending roots become apparent on the dike walls, the plants will be controlled with appropriate herbicide application.

Protection from Burrowing Mammals. The cobble size materials that make up the dike construction material and the exposed nature of the dike sidewalls do not offer an advantageous habitat for burrowing mammals. Lack of vegetation on the LERF site discourages foraging. The risk to structural integrity of the dikes from burrowing mammals is therefore minimal. Periodic visual inspections of the dikes provide observations of any animals present. Should burrowing mammals be noted onsite, appropriate pest control methods such as trapping or application of rodenticides will be employed.

Protective Cover. Approximately 7.6 centimeters of crushed gravel serve as the cover of the exterior dike walls. This coarse material is inherently resistant to the effect of wind because of its large grain size. Total annual precipitation is low (16 centimeters) and a significant storm event (e.g., a 100-year, 24-hour storm) could result in about 5.3 centimeters of precipitation in a 24-hour period. The absorbent capacity of the soil exceeds this precipitation rate; therefore, the impact of wind and precipitation run-on to the exterior dike walls will be minimal.

4.5.5 Piping Systems

Aqueous waste from the 242-A Evaporator is transferred to the LERF using a pump located in the 242-A Evaporator and approximately 1,500 meters of pipe, consisting of a 3-inch carrier pipe within a 6-inch outer containment pipeline. Flow through the pump is controlled through a valve at flow rates from 150 to 300 liters per minute.

The pipeline exits the 242-A Evaporator below grade and remains below grade at a minimum 1.2-meter depth for freeze protection, until the pipeline emerges at the LERF catch basin, at the corner of each basin. All piping at the catch basin that is less than 1.2 meters below grade is wrapped with electric heat tracing tape and insulated for protection from freezing.

The transfer line from the 242-A Evaporator is centrifugally cast, fiberglass-reinforced epoxy thermoset resin pressure pipe fabricated to meet the requirements of ASME D2997 (ASME 1984). The 3-inch carrier piping is centered and supported within 6-inch containment piping. Pipe supports are fabricated of

the same material as the pipe, and meet the strength requirements of ANSI B31.3 (ANSI 1987) for dead weight, thermal, and seismic loads.

A catch basin is provided at the northwest corner of each basin where piping extends from the basin to allow for basin-to-basin and basin-to-ETF liquid transfers. Drawing H-2-88766, sheets 1 through 4, provide schematic diagrams of the piping system at LERF. Drawing H-2-79604 provides details of the piping from the 242-A Evaporator to LERF.

4.5.5.1 Secondary Containment System for Piping

The 6-inch containment piping encases the 3-inch carrier pipe from the 242-A Evaporator to the LERF. All of the piping and fittings that are not directly over a catch basin or a basin liner are of this pipe-within-a-pipe construction. A catch basin is provided at the northwest corner of each basin where the inlet pipes, leachate risers, and transfer pipe risers emerge from the basin. The catch basin consists of a 20-centimeter-thick concrete pad at the top of the dike. The perimeter of the catch basin has a 20-centimeter-high curb, and the concrete is coated with a chemical resistant epoxy sealant. The concrete pad is sloped so that any leaks or spills from the piping or pipe connections will drain into the basin. The catch basin provides an access point for inspecting, servicing, and operating various systems such as transfer valving, leachate level instrumentation and leachate pump. Drawing H-2-79593 provides a schematic diagram of the catch basins.

4.5.5.2 Leak Detection System

Single-point electronic leak detection elements are installed along the transfer line at 305-meter intervals. The leak detection elements are located in the bottom of specially designed test risers. Each sensor element employs a conductivity sensor, which is connected to a cable leading back to the 242-A Evaporator control room. If a leak develops in the carrier pipe, fluid will travel down the exterior surface of the carrier pipe or the interior of the containment pipe. As moisture contacts a sensor unit, the alarm sounds in the ETF control room and the zone of the leak is indicated on the digital display. The pump located in the 242-A Evaporator is shut down, stopping the flow of aqueous waste through the transfer line. A low-volume air purge of the annulus between the carrier pipe and the containment pipe is provided to prevent condensation buildup and minimize false alarms by the leak detection elements.

The catch basins have conductivity leak detectors that alarm in the 242-A Evaporator control room. Leaks into the catch basins drain back to the basin through a 5.1-centimeter drain on the floor of the catch basin.

4.5.5.3 Certification

Although an integrity assessment is not required for piping associated with surface impoundments, an assessment of the transfer liner was performed, including a hydrostatic leak/pressure test at 10.5 kilograms per square centimeter gauge. A statement by an independent, qualified, registered professional engineer attesting to the integrity of the piping system is included in *Integrity Assessment Report for the 242-A Evaporator/LERF Waste Transfer Piping, Project W105* (WHC 1993), along with the results of the leak/pressure test.

4.5.6 Double Liner and Leak Detection, Collection, and Removal System

The double-liner system for LERF is discussed in Section 4.5.2. The leachate detection, collection, and removal system (Figures 4.18 and 4.19) was designed and constructed to remove leachate that might permeate the primary liner. System components for each basin include:

- 30.5-centimeter layer of drainage gravel below the primary liner at the bottom of the basin
- Geonet below the primary liner on the sidewalls to direct leachate to the gravel layer
- 3.0-meter by 1.8-meter by 0.30-meter-deep leachate collection sump consisting of a 25 millimeter high-density polyethylene flat stock, geotextile to trap large particles in the leachate, and 1.5-millimeter high-density polyethylene rub sheet set on the secondary liner

- 10-inch and 4-inch perforated leachate high-density polyethylene riser pipes from the leachate collection sump to the catch basin northwest of the basin
- Leachate collection sump level instrumentation installed in the 4-inch riser
- Level sensors, submersible leachate pump, and 1.5-inch fiberglass-reinforced epoxy thermoset resin pressure piping installed in the 10-inch riser
- Piping at the catch basin to route the leachate through 1.5-inch high-density polyethylene pipe back to the basins

The bottom of the basins has a two percent slope to allow gravity flow of leachate to the leachate collection sump. This exceeds the minimum of 1 percent slope required by WAC 173-303-650(j) for new surface impoundments. Material specifications for the leachate collection system are given in Section 4.5.2.1.1.

Calculations demonstrate that fluid from a small hole (2 millimeter) (EPA 1989, p. 122) at the furthest end of the basin, under a low head situation, would travel to the sump in less than 24 hours (HNF 1997). Additional calculations indicate the capacity of the pump to remove leachate is sufficient to allow time to readily identify a leak and activate emergency procedures (HNF 1997).

Automated controls maintain the fluid level in each leachate sump below 33 centimeters to prevent significant liquid backup into the drainage layer. The leachate pump is activated when the liquid level in the sump reaches about 28 centimeters, and is shut off when the sump liquid level reaches about 18 centimeters. This operation prevents the leachate pump from cycling with no fluid, which could damage the pump. Liquid level control is accomplished with conductivity probes that trigger relays selected specifically for application to submersible pumps and leachate fluids. A flowmeter/totalizer on the leachate return pipe measures fluid volumes pumped and pumping rate from the leachate collection sumps, and indicates volume and flow rate on local readouts. Other instrumentation provided is real-time continuous level monitoring with a readout at the catch basin and the 242-A Evaporator control room. A sampling port is provided in the leachate piping system at the catch basin. Leak detection is provided through inspections of the leachate flow totalizer readings. For more information on inspections, refer to Chapter 6.0.

The stainless steel leachate pump is designed to deliver 110 liters per minute. The leachate pump returns draw liquid from the sump via 1.5-inch pipe and discharges into the basin through 1.5-inch high-density polyethylene pipe.

4.5.7 Construction Quality Assurance

The construction quality assurance plan and complete report of construction quality assurance inspection and testing results are provided in *242-A Evaporator Interim Retention Basin Construction Quality Assurance Plan* (KEH 1991). A general description of construction quality assurance procedures is outlined in the following paragraphs.

For excavation of the basins and construction of the dikes, regular inspections were conducted to ensure compliance with procedures and drawings, and compaction tests were performed on the dike soils.

For the soil/bentonite layer, test fills were first conducted in accordance with EPA guidance to demonstrate compaction procedures and to confirm compaction and permeability requirements can be met. The ratio of bentonite to soil and moisture content was monitored; lifts did not exceed 15 centimeters before compaction, and specific compaction procedures were followed. Laboratory and field tests of soil properties were performed for each lift and for the completed test fill. The same suite of tests was conducted for each lift during the laying of the soil/bentonite admixture in the basins.

Geotextiles and geomembranes were laid in accordance with detailed procedures and quality assurance programs provided by the manufacturers and installers. These included destructive and nondestructive tests on the geomembrane seams, and documentation of field test results and repairs.

4.5.8 Proposed Action Leakage Rate and Response Action Plan

An action leakage rate limit is established where action must be taken due to excessive leakage from the primary liner. The action leak rate is based on the maximum design flow rate the leak detection system can remove without the fluid head on the bottom liner exceeding 30 centimeters. The limiting factor in the leachate removal rate is the hydraulic conductivity of the drainage gravel. An action leakage rate (also called the rapid or large leak rate) of 20,000 liters per hectare per day was calculated for each basin (WHC 1992b).

When it is determined that the action leakage rate has been exceeded, the response action plan will follow the actions in WAC 173-303-650(11)(b) and (c), which includes notification of Ecology in writing within 7 days, assessing possible causes of the leak, and determining whether waste receipt should be curtailed and/or the basin emptied.

4.5.9 Dike Structural Integrity Engineering Certification

The structural integrity of the dikes was certified attesting to the structural integrity of the dikes, signed by a qualified, registered professional engineer.

4.5.10 Management of Ignitable, Reactive, or Incompatible Wastes

Although ignitable or reactive aqueous waste might be received in small quantities at LERF, such aqueous waste is mixed with dilute solutions in the basins, removing the ignitable or reactive characteristics. For compatibility requirements with the LERF liner, refer to the waste analysis plan Chapter 3.0.

4.6 AIR EMISSIONS CONTROL

This section addresses the ETF requirements of Air Emission Standards for Process Vents, under 40 CFR 264, Subpart AA (incorporated by reference in WAC 173-303-690) and Subpart CC. The requirements of 40 CFR 264, Subpart BB (WAC 173-303-691) is not applicable because aqueous waste with 10 percent or greater organic concentration would not be acceptable for processing at the ETF.

4.6.1 Applicability of Subpart AA Standards

The ETF evaporator and thin film dryer perform operations that specifically require evaluation for applicability of WAC 173-303-690. Aqueous waste in these units routinely contains greater than 10 parts per million concentrations of organic compounds and are, therefore, subject to air emission requirements under WAC 173-303-690. Organic emissions from all affected process vents on the Hanford Facility must be less than 1.4 kilograms per hour and 2.8 megagrams per year, or control devices must be installed to reduce organic emissions by 95 percent.

The vessel off gas system provides a process vent system. This system provides a slight vacuum on the ETF process vessels and tanks (refer to Section 4.2.5.2). Two vessel vent header pipes combine and enter the vessel off gas system filter unit consisting of a demister, electric heater, prefilter, high-efficiency particulate air filters, activated carbon absorber, and two exhaust fans (one fan in service while the other is backup). The vessel off gas system filter unit is located in the high-efficiency particulate air filter room west of the process area. The vessel off gas system exhaust discharges into the larger building ventilation system, with the exhaust fans and stack located outside and immediately west of the ETF. The exhaust stack discharge point is 15.5 meters above ground level.

The annual average flow rate for the ETF stack (which is the combined vessel off gas and building exhaust flow rates) is 220 cubic meters per minute with a total annual flow of approximately 1.2 E+08 cubic meters. During waste processing, the airflow through just the vessel off gas system is about 23 standard cubic meters per minute.

Organic emissions occur during waste processing, which occurs less than 310 days each year (i.e., 85 percent operating efficiency). This operating efficiency represents the maximum annual

operating time for the ETF, as shutdowns are required during the year for planned maintenance outages and for reconfiguring the ETF to accommodate different aqueous waste.

4.6.2 Process Vents - Demonstrating Compliance

This section outlines how the ETF complies with the requirements and includes a discussion of the basis for meeting the organic emissions limits, calculations demonstrating compliance, and conditions for reevaluation.

4.6.2.1 Basis for Meeting Limits/Reductions

The 242-A Evaporator and the 200 Area ETF are currently the only operating TSD units that contribute to the Hanford Facility volatile organic emissions under 40 CFR 264, Subpart AA. The combined release rate is currently well below the threshold of 1.4 kilograms per hour or 2,800 kilograms per year of volatile organic compounds. As a result, the ETF meets these standards without the use of air pollution control devices.

The amount of organic emissions could change as waste streams are changed, or TSD units are brought online or are deactivated. The organic air emissions summation will be re-evaluated periodically as condition warrants. Operations of the TSD units operating under 40 CFR 264, Subpart AA, will be controlled to maintain Hanford Facility emissions below the threshold limits or pollution control device(s) will be added, as necessary, to achieve the reduction standards specified under 40 CFR 264, Subpart AA.

4.6.2.2 Demonstrating Compliance

Calculations to determine organic emissions are performed using the following assumptions:

- Maximum flow rate from LERF to ETF is 568 liters per minute.
- Emissions of organics from tanks and vessels upstream of the UV/OX process are determined from flow and transfer rates given in *Clean Air Act Requirements, WAC 173-400, As-built Documentation, Project C-018H, 242-A Evaporator/PUREX Plant Process Condensate Treatment Facility* (Adtechs 1995).
- UV/OX reaction rate constants and residence times are used to determine the amount of organics, which are destroyed in the UV/OX process. These constants are given in *200 Area Effluent Treatment Facility Delisting Petition* (DOE/RL 1992).
- All organic compounds that are not destroyed in the UV/OX process are assumed to be emitted from the tanks and vessels into the vessel off gas system.
- No credit for removal of organic compounds in the vessel off gas system carbon absorber unit is taken. The activated carbon absorbers are used if required to reduce organic emissions.

The calculation to determine organic emissions consists of the following steps:

1. Determine the quantity of organics emitted from the tanks or vessels upstream of the UV/OX process, using transfer rate values
2. Determine the concentration of organics in the waste after the UV/OX process using UV/OX reaction rates and residence times. If the ETF is configured such that the UV/OX process is not used, a residence time of zero is used in the calculations (i.e., none of the organics are destroyed)
3. Assuming all the remaining organics are emitted, determine the rate which the organics are emitted using the feed flow rate and the concentrations of organics after the UV/OX process
4. The amount of organics emitted from the vessel off gas system is the sum of the amount calculated in steps 1 and 3.

The organic emission rates and quantity of organics emitted during processing are determined using these calculations and are included in the ETF operating record.

4.6.2.3 Reevaluating Compliance with Subpart AA Standards

Calculations to determine compliance with Subpart AA will be reviewed when any of the following conditions occur at the ETF:

- Changes in the maximum feed rate to the ETF (i.e., greater than the 568 liters per minute flow rate)
- Changes in the configuration or operation of the ETF that would modify the assumptions given in Section 4.6.2.2 (e.g., taking credit for the carbon absorbers as a control device)
- Annual operating time exceeds 310 days.

4.6.3 Applicability of Subpart CC Standards

The air emission standards of 40 CFR 264, Subpart CC apply to tank, surface impoundment, and container storage units that manage wastes with average volatile organic concentrations equal to or exceeding 500 parts per million by weight, based on the hazardous waste composition at the point of origination (61 FR 59972). However, TSD units that are used solely for management of mixed waste are exempt. Mixed waste is managed at the ETF and LERF and dangerous waste could be treated and stored at these TSD units.

TSD owner/operators are not required to determine the concentration of volatile organic compounds in a hazardous waste if the wastes are placed in waste management units that employ air emission controls that comply with the Subpart CC standards. Therefore, the approach to Subpart CC compliance at the ETF and LERF is to demonstrate that the ETF and LERF meet the Subpart CC control standards (40 CFR 264.1084 - 264.1086).

4.6.3.1 Demonstrating Compliance with Subpart CC for Tanks

Since the ETF tanks already have process vents regulated under 40 CFR 264, Subpart AA (WAC 173-303-690), they are exempt from Subpart CC [40 CFR 264.1080(b)(8)].

4.6.3.2 Demonstrating Compliance with Subpart CC for Containers

Container Level 1 and Level 2 standards are met at the ETF by managing all dangerous and/or mixed wastes in U.S. Department of Transportation containers [40 CFR 264.1086(f)]. Level 1 containers are those that store more than 0.1 cubic meters and less than or equal to 0.46 cubic meters. Level 2 containers are used to store more than 0.46 cubic meters of waste, which are in "light material service". Light material service is defined where a waste in the container has one or more organic constituents with a vapor pressure greater than 0.3 kilopascals at 20 C, and the total concentration of such constituents is greater than or equal to 20 percent by weight.

The monitoring requirements for Level 1 and Level 2 containers include a visual inspection when the container is received at the ETF and when the waste is initially placed in the container. Additionally, at least once every 12 months when stored onsite for 1 year or more, these containers must be inspected.

If compliant containers are not used at the ETF, alternate container management practices are used that comply with the Level 1 standards. Specifically, the Level 1 standards allow for a "container equipped with a cover and closure devices that form a continuous barrier over the container openings such that when the cover and closure devices are secured in the closed position there are no visible holes, gaps, or other open spaces into the interior of the container. The cover may be a separate cover installed on the container...or may be an integral part of the container structural design…" [40 CFR 264.1086(c)(1)(ii)]. An organic-vapor-suppressing barrier, such as foam, may also be used [40 CFR 264.1086(c)(1)(iii)]. Section 4.3 provides detail on container management practices at the ETF.

Container Level 3 standards apply when a container is used for the "treatment of a hazardous waste by a waste stabilization process" [40 CFR 264.1086(2)]. Because treatment in containers using the stabilization process is not provided at the ETF, these standards do not apply.

4.6.3.3 Demonstrating Compliance with Subpart CC for Surface Impoundments

The Subpart CC emission standards are met at LERF using a floating membrane cover that is constructed of very-low-density polyethylene that forms a continuous barrier over the entire surface area [40 CFR 264.1085(c)]. This membrane has both organic permeability properties equivalent to a high-density polyethylene cover and chemical/physical properties that maintain the material integrity for the intended service life of the material. The additional requirements for the floating cover at the LERF have been met (Section 4.5.2.4).

4.7 ENGINEERING DRAWINGS

4.7.1 Liquid Effluent Retention Facility

Drawings of the containment systems at the LERF are summarized in Table 4.1. Because the failure of these containment systems at LERF could lead to the release of dangerous waste into the environment, modifications that affect these containment systems will be submitted to the Washington State Department of Ecology, as a Class 1, 2, or 3 Permit modification, as required by WAC 173-303-830.

Table 4.1. Liquid Effluent Retention Facility Containment System.

LERF System	Drawing Number	Drawing Title
Bottom Liner	H-2-79590, Sheet 1	Civil Plan, Sections and Details; Cell Basin Bottom Liner
Top Liner	H-2-79591, Sheet 1	Civil Plan, Sections and Details; Cell Basin Bottom Liner
Catch Basin	H-2-79593, Sheet 1	Civil Plan, Section and Details; Catch Basin

The drawings identified in Table 4.2 illustrate the piping and instrumentation configuration within LERF, and of the transfer piping systems between the LERF and the 242-A Evaporator. These drawings are provided for general information and to demonstrate the adequacy of the design of the LERF as a surface impoundment.

Table 4.2. Liquid Effluent Retention Facility Piping and Instrumentation.

LERF System	Drawing Number	Drawing Title
Transfer Piping to 242-A Evaporator	H-2-79604, Sheet 1	Piping Plot and Key Plans; 242-A Evaporator Condensate Stream
LERF Piping and Instrumentation	H-2-88766, Sheet 1	P&ID; LERF Basin and ETF Influent
	H-2-88766, Sheet 2	P&ID; LERF Basin and ETF Influent
	H-2-88766, Sheet 3	P&ID; LERF Basin and ETF Influent
	H-2-88766, Sheet 4	P&ID; LERF Basin and ETF Influent
Legend	H-2-89351, Sheet 1	Piping & Instrumentation Diagram - Legend

4.7.2 200 Area Effluent Treatment Facility

Drawings of the secondary containment systems for the ETF containers, and tanks and process units, and for the Load-In Tanks are summarized in Table 4.3. Because the failure of the secondary containment systems could lead to the release of dangerous waste into the environment, modifications, which affect the secondary containment systems, will be submitted to the Washington State Department of Ecology, as a Class 1, 2, or 3 Permit modification, as required by WAC 173-303-830.

Table 4.3. Effluent Treatment Facility and Load-In Station Secondary Containment Systems

ETF Process Unit	Drawing Number	Drawing Title
Surge Tank, Process/ Container Storage Areas and Trenches - Foundation and Containment	H-2-89063, Sheet 1	Architectural/structural – Foundation and Grade Beam Plan
Sump Tank Containment	H-2-89065, Sheet 1	Architectural/structural – Foundation, Sections and Detail
Verification Tank Foundation and Containment	H-2-89068, Sheet 1	Architectural/structural – Verification Tank Foundation
Load-In Facility Foundation and Containment	H-2-817970, Sheet 1	Structural – ETF Truck Load-in Facility Plans and Sections
Load-In Facility Foundation and Containment	H-2-817970, Sheet 2	Structural – ETF Truck Load-in Facility Sections and Details

The drawings identified in Table 4.4 provide an illustration of the piping and instrumentation configuration for the major process units and tanks at the ETF, and the Load-In Tanks. Drawings of the transfer piping systems between the LERF and ETF, and between the Load-In Station and the ETF also are presented in this table. These drawings are provided for general information and to demonstrate the adequacy of the design of the tank systems.

Table 4.4. Major Process Units and Tanks at the Effluent Treatment Facility and Load-In Station

ETF Process Unit	Drawing Number	Drawing Title
Load-In Facility	H-2-817974, Sheet 1	P&ID – ETF Truck Load-In Facility
Load-In Facility	H-2-817974, Sheet 2	P&ID – ETF Truck Load-In Facility
Surge Tank	H-2-89337, Sheet 1	P&ID – Surge Tank System
UV/Oxidation	H-2-88976, Sheet 1	P&ID – UV Oxidizer Part 1
UV/Oxidation	H-2-89342, Sheet 1	P&ID – UV Oxidizer Part 2
Reverse Osmosis	H-2-88980, Sheet 1	P&ID – 1st RO Stage
Reverse Osmosis	H-2-88982, Sheet 1	P&ID – 2nd RO Stage
IX/Polishers	H-2-88983, Sheet 1	P&ID – Polisher
Verification Tanks	H-2-88985, Sheet 1	P&ID – Verification Tank System
ETF Evaporator	H-2-89335, Sheet 1	P&ID – Evaporator
Thin Film Dryer	H-2-88989, Sheet 1	P&ID – Thin Film Dryer
Transfer Piping from LERF to ETF	H-2-88768, Sheet 1	Piping Plan/Profile 4"– 60M-002-M17 and 3"-60M-001-M17
Transfer Piping from Load-In Facility to ETF	H-2-817969, Sheet 1	Civil – ETF Truck Load-In Facility Site Plan

Figure 4.1. Liquid Effluent Retention Facility Layout

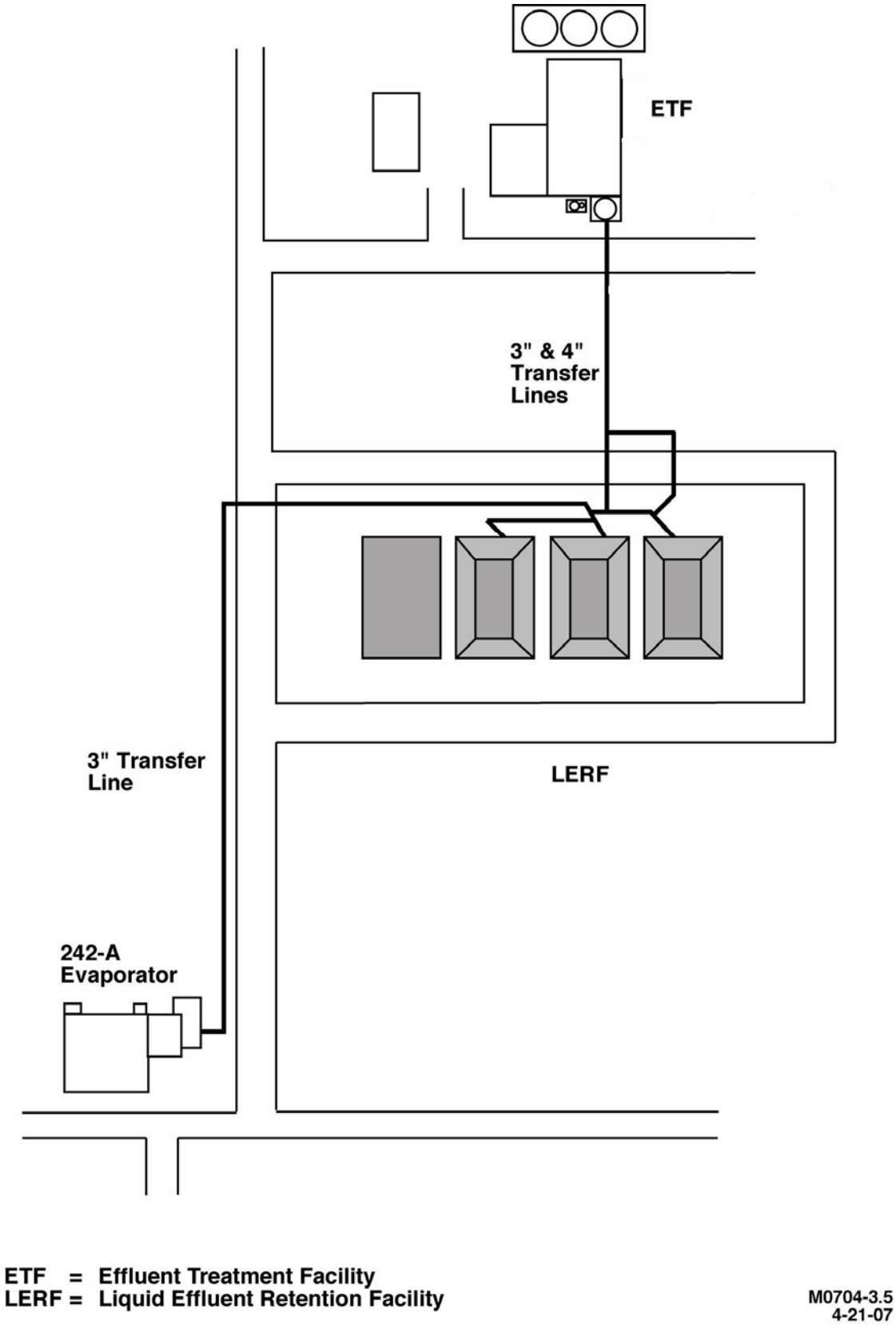


Figure 4.2. Plan View of the 200 Area Effluent Treatment Facility

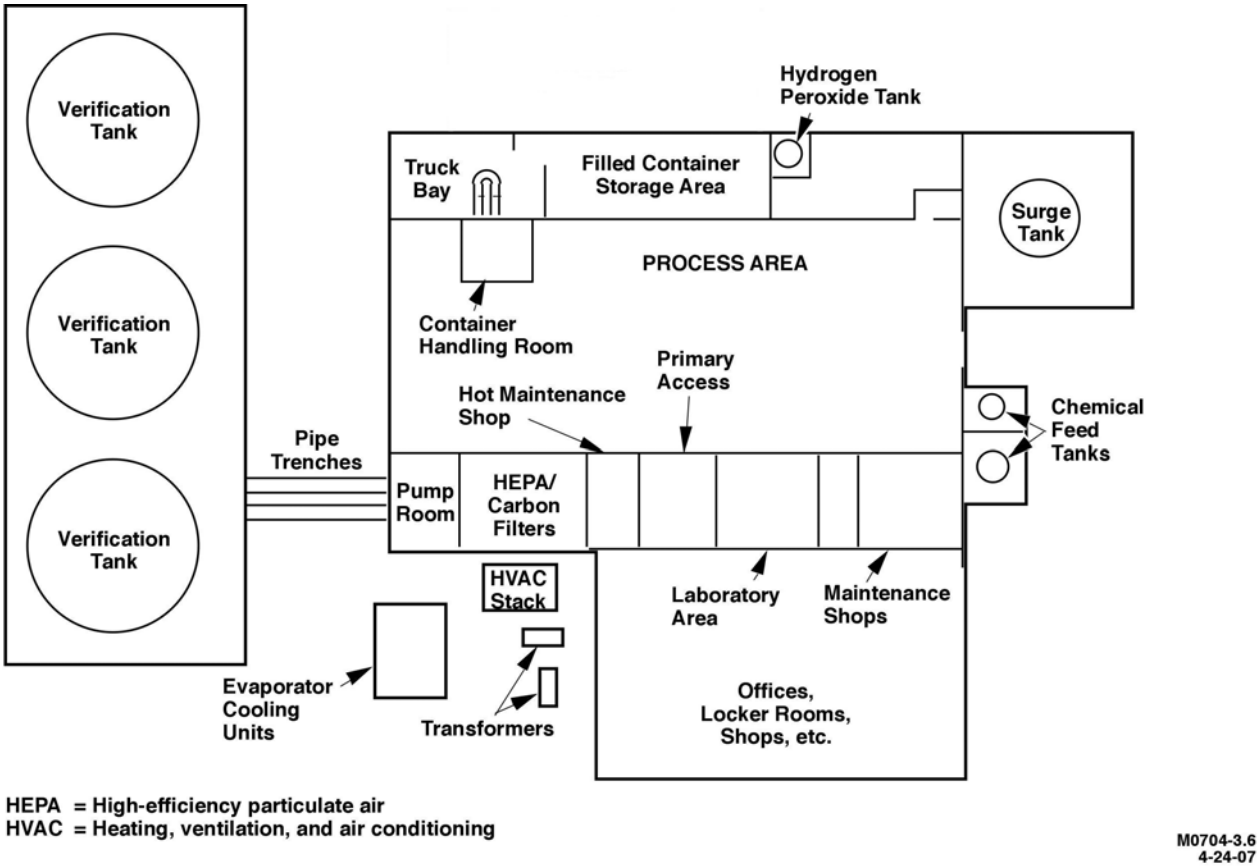


Figure 4.3. 200 Area Effluent Treatment Facility Layout

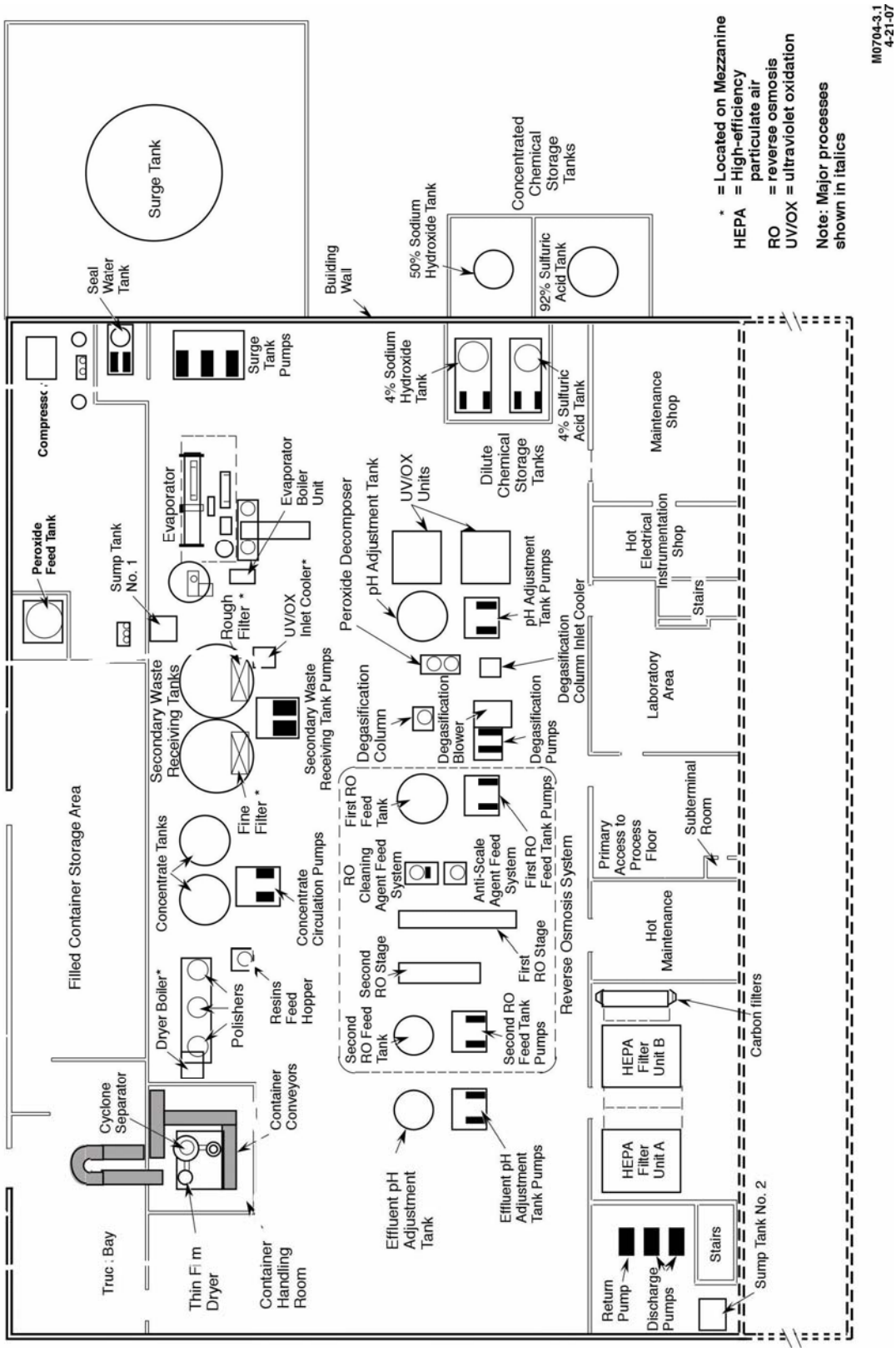


Figure 4.4. 200 Area Effluent Treatment Facility

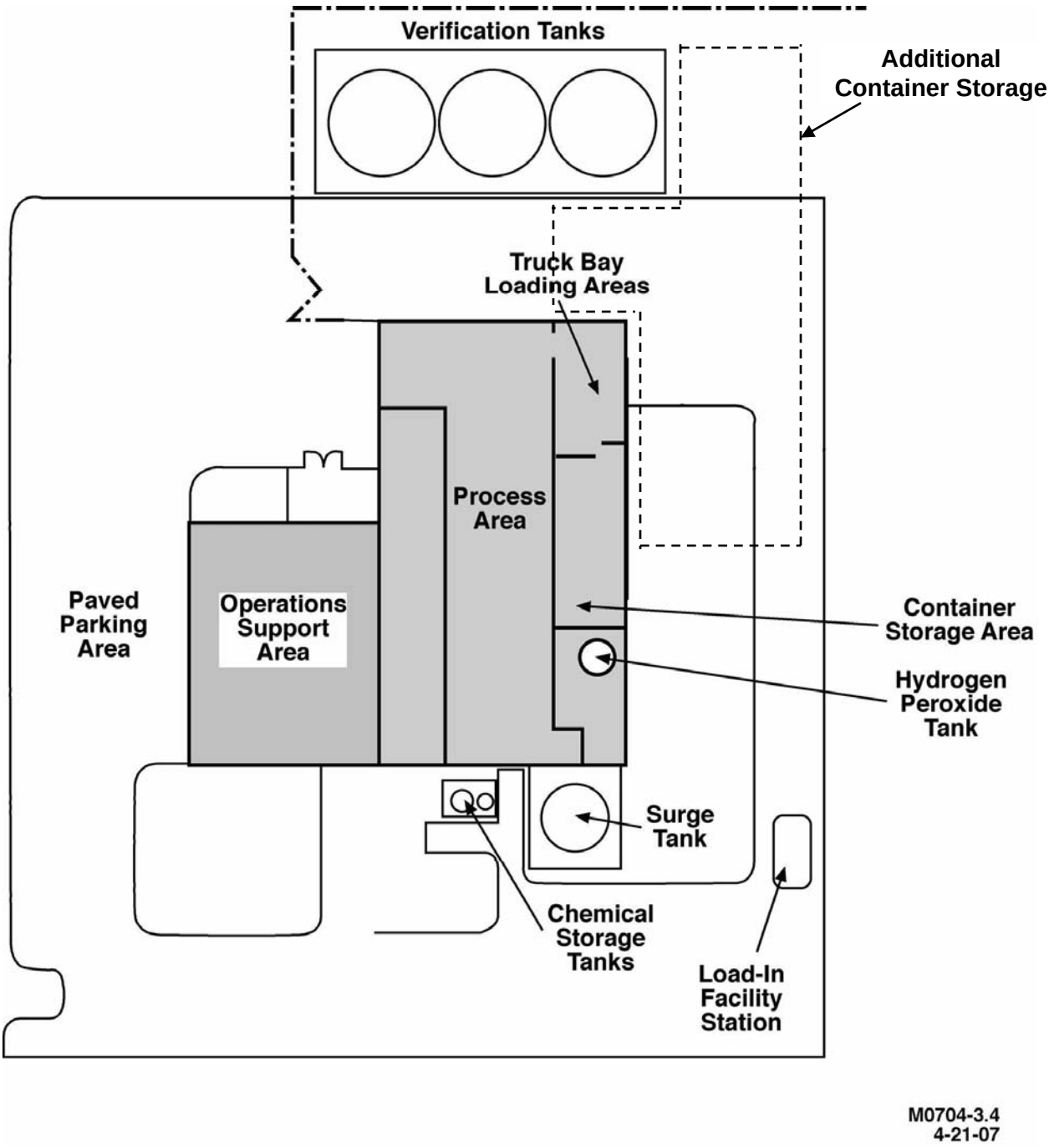


Figure 4.5. Example - 200 Area Effluent Treatment Facility Configuration 1

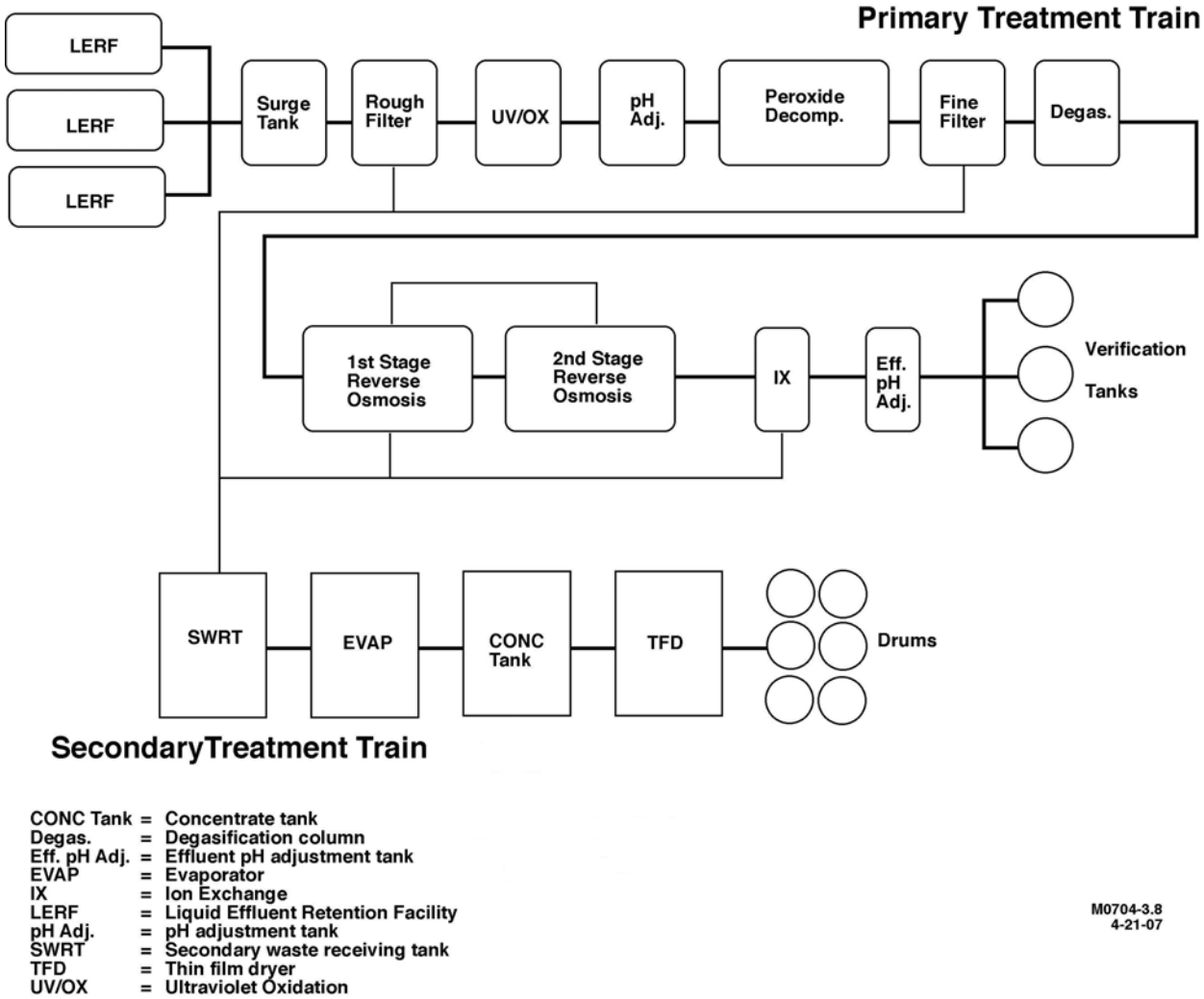


Figure 4.6. Example - 200 Area Effluent Treatment Facility Configuration 2

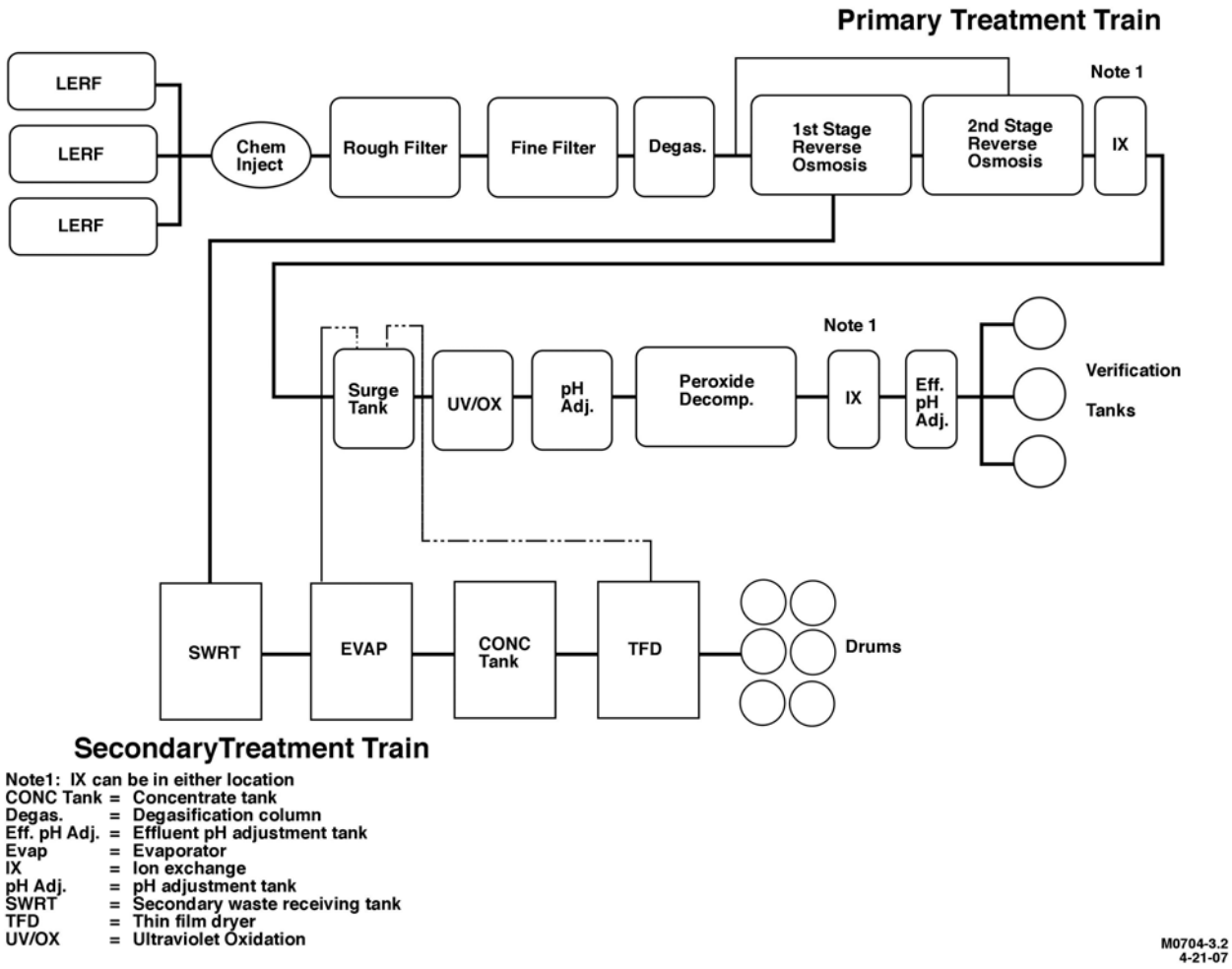


Figure 4.7. Surge Tank

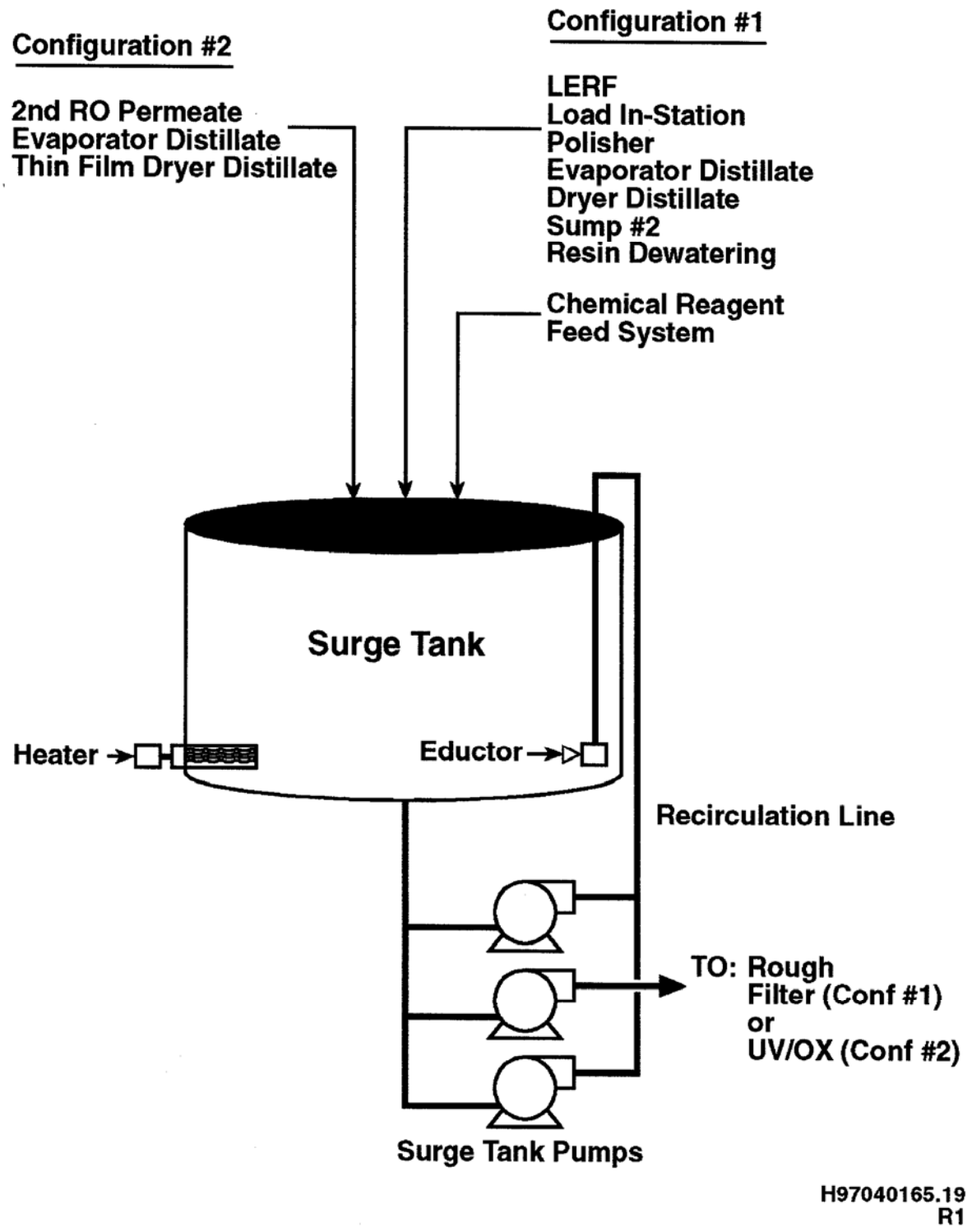


Figure 4.8. Ultraviolet Light/Oxidation Unit

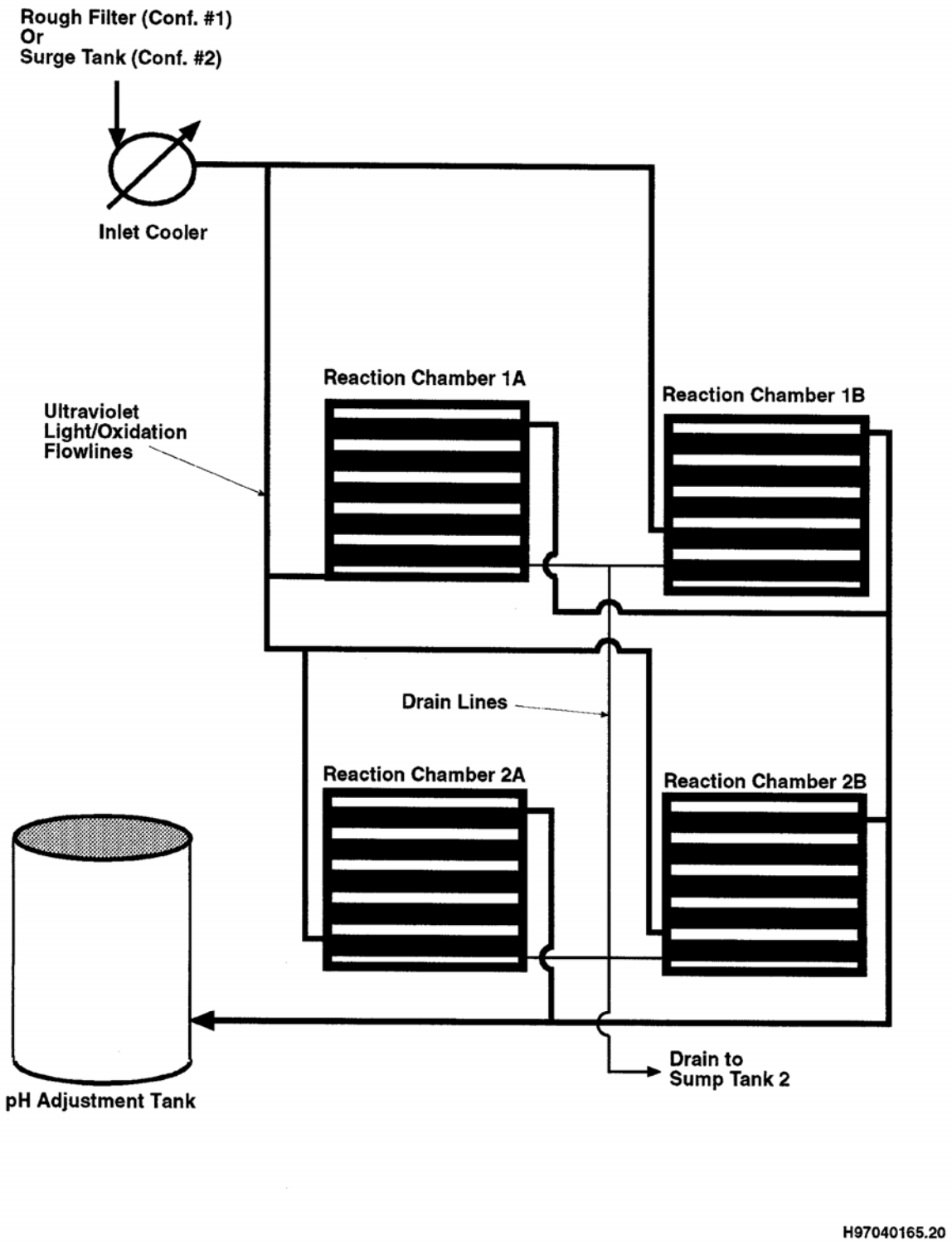


Figure 4.9. Reverse Osmosis Unit.

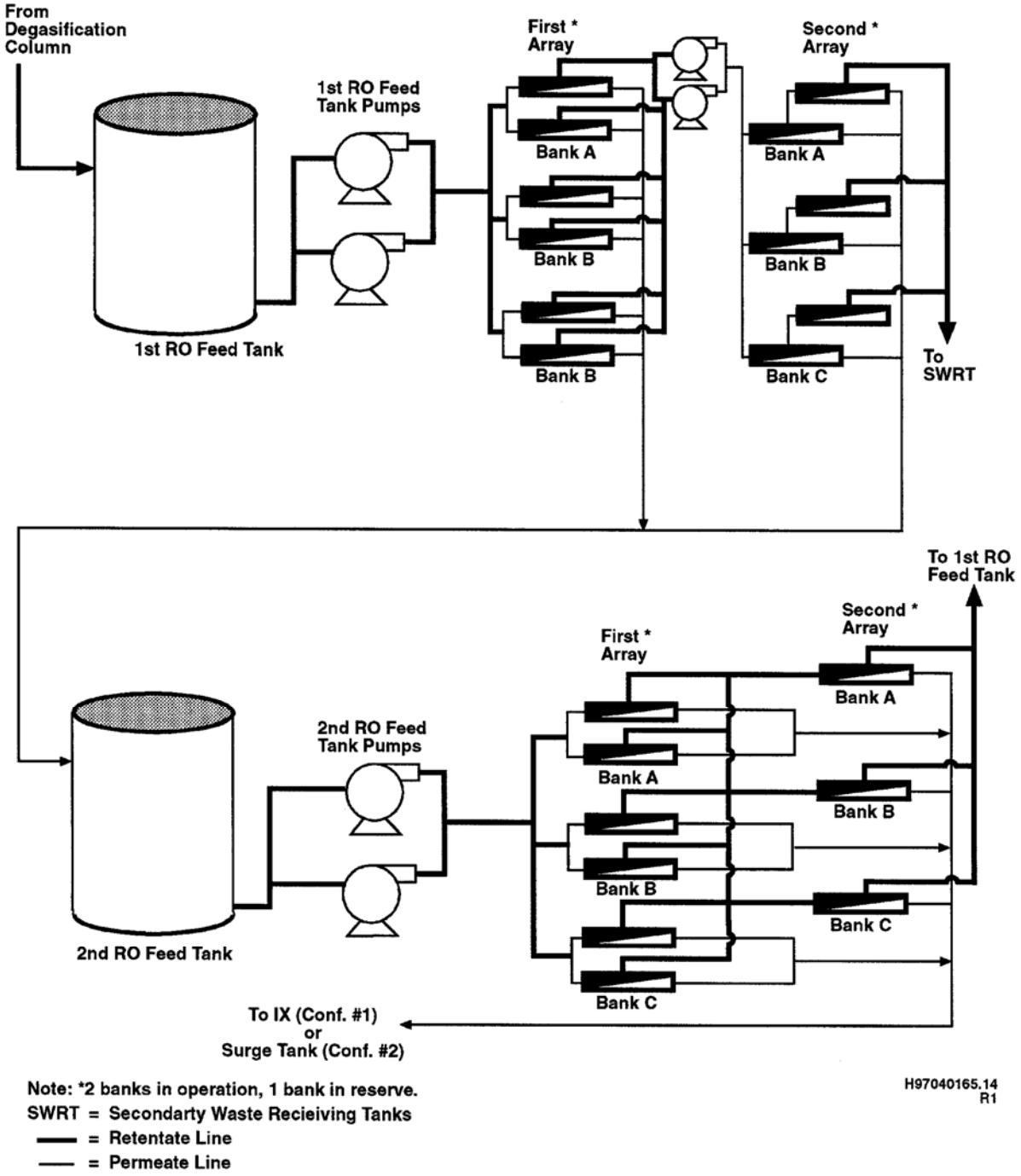


Figure 4.10. Ion Exchange Unit

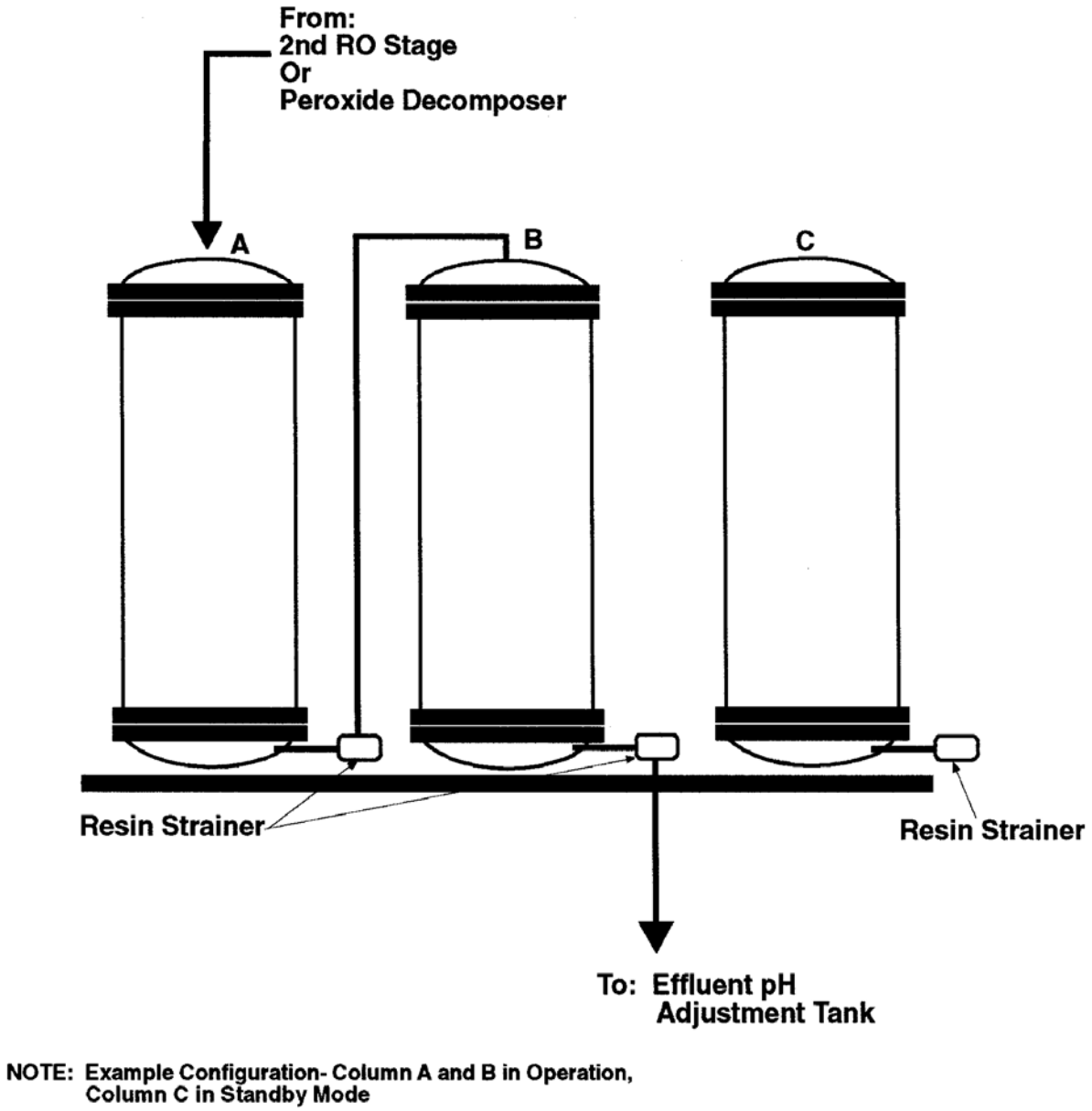


Figure 4.11. Verification Tanks

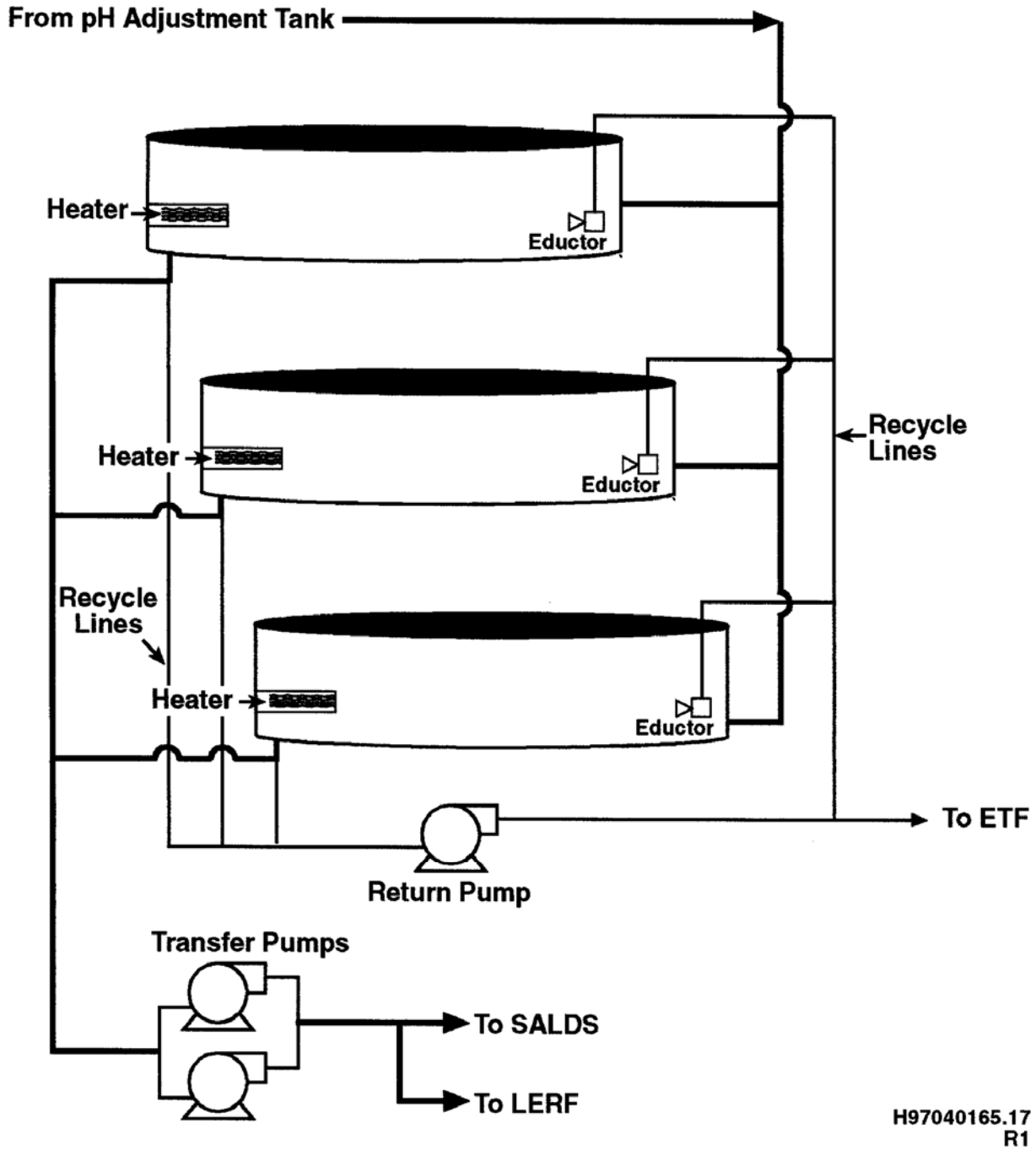
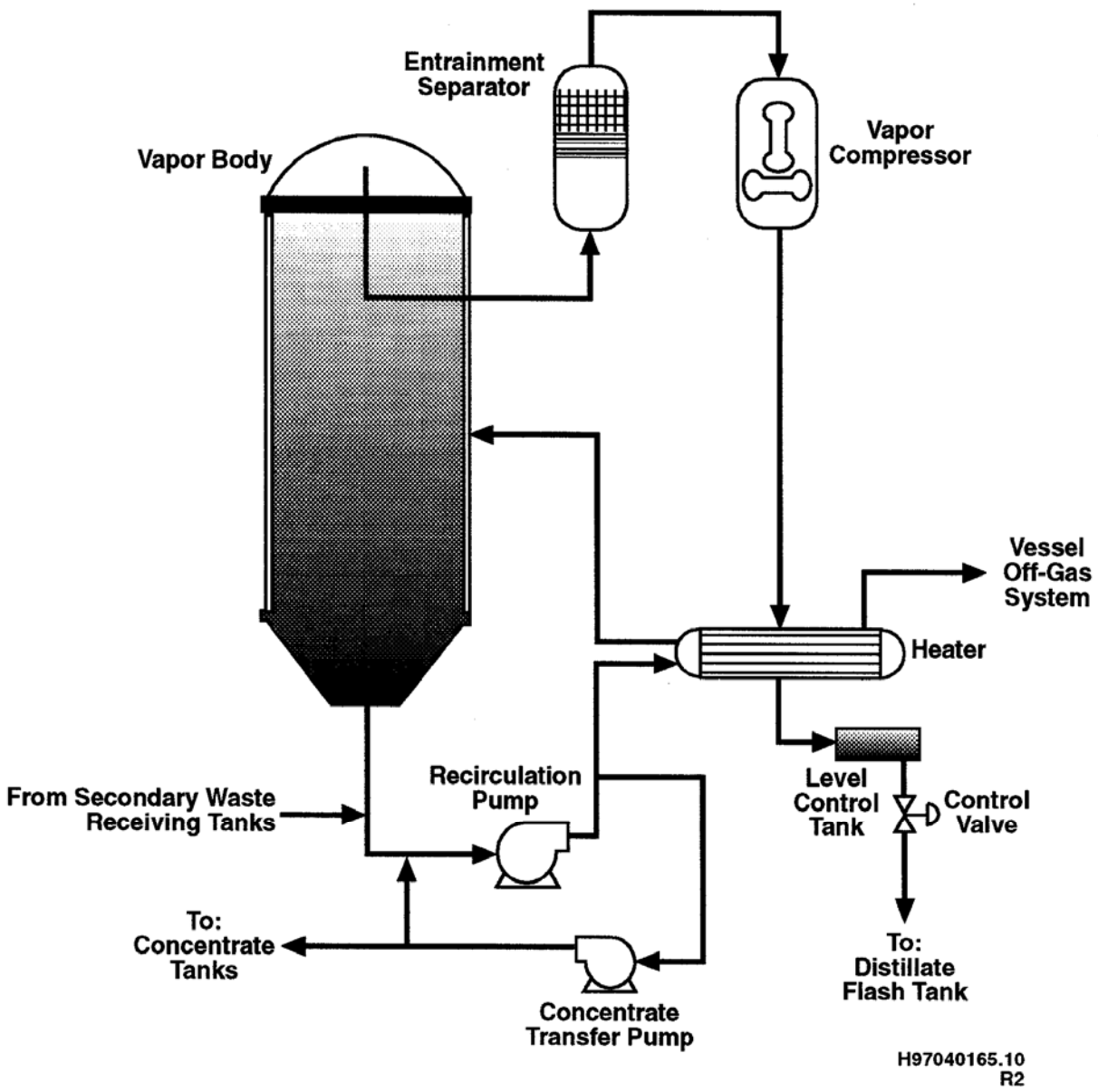


Figure 4.12. Effluent Treatment Facility Evaporator



1 Figure 4.13. Thin Film Dryer

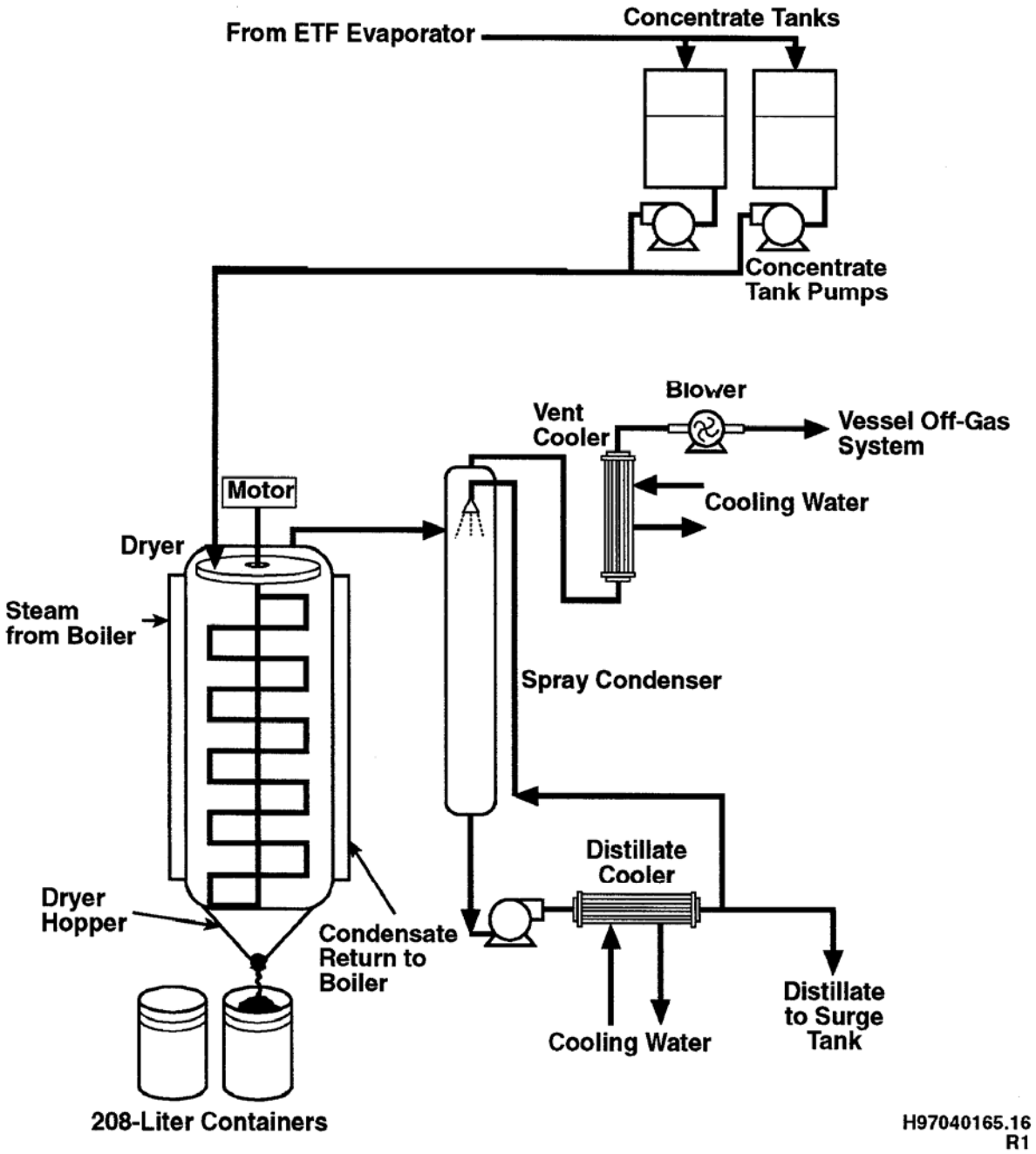


Figure 4.14. Container Handling System

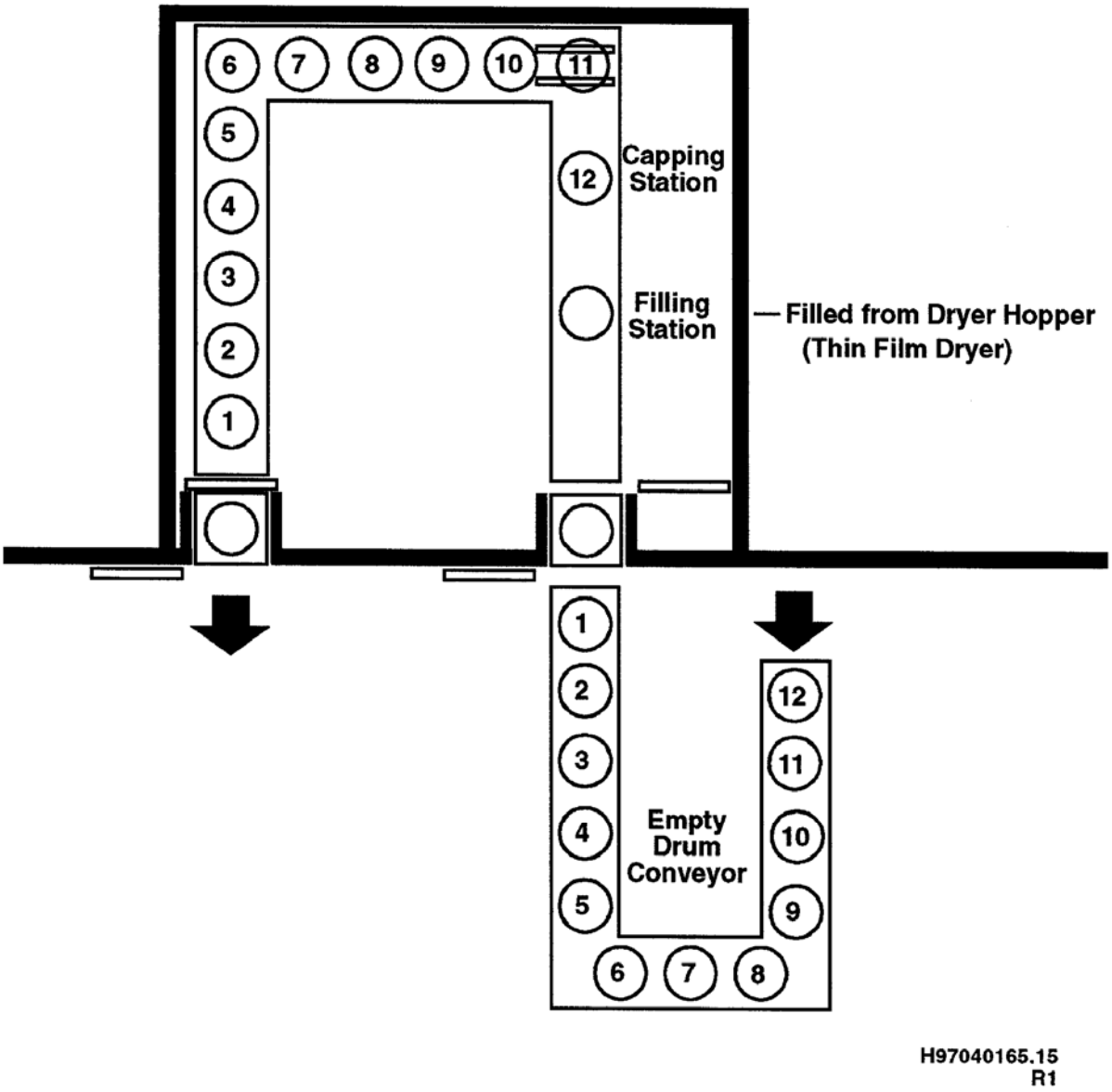


Figure 4.15. Effluent Treatment Facility Sump Tanks

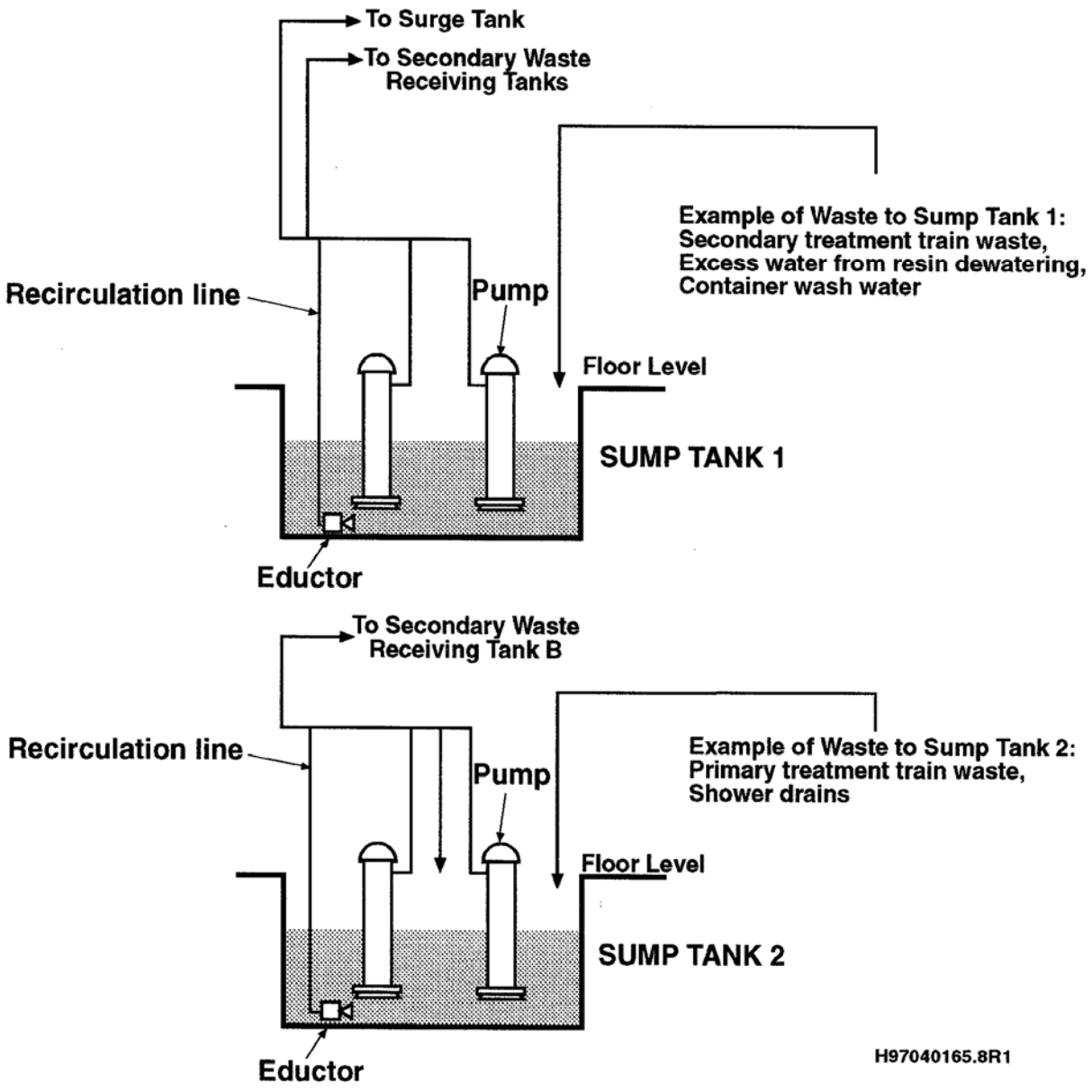


Figure 4.16. Liner Anchor Wall and Cover Tension System

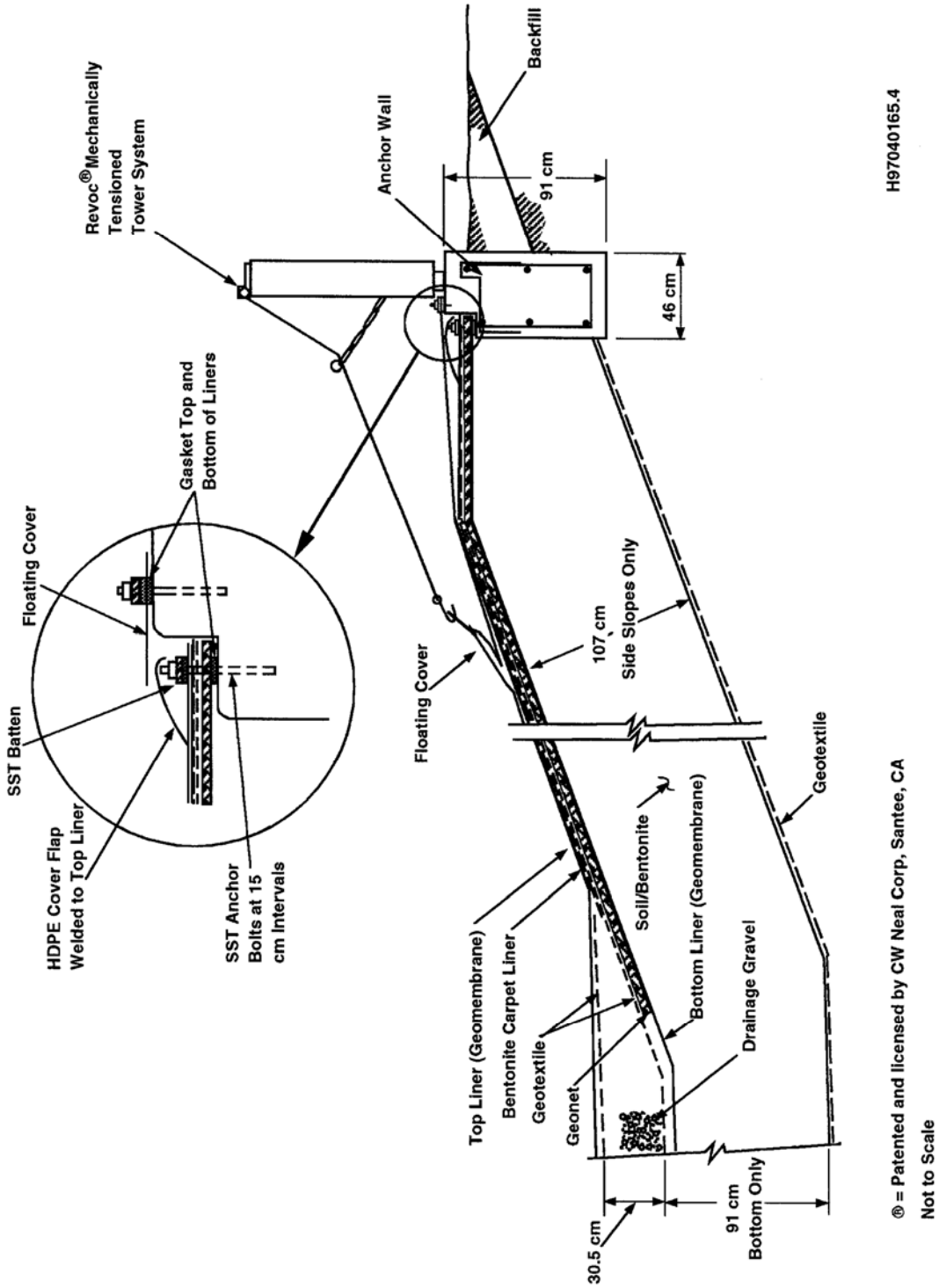


Figure 4.17. Liner System Schematic

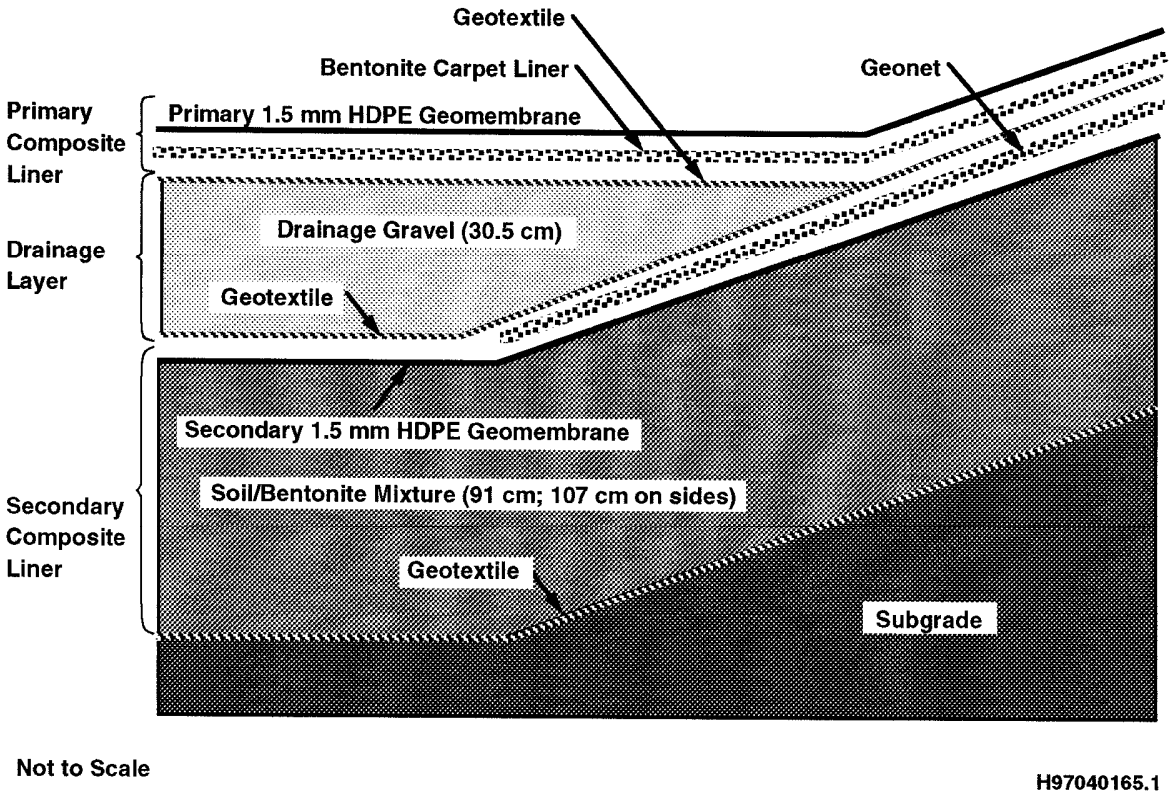


Figure 4.18. Detail of Leachate Collection Sump

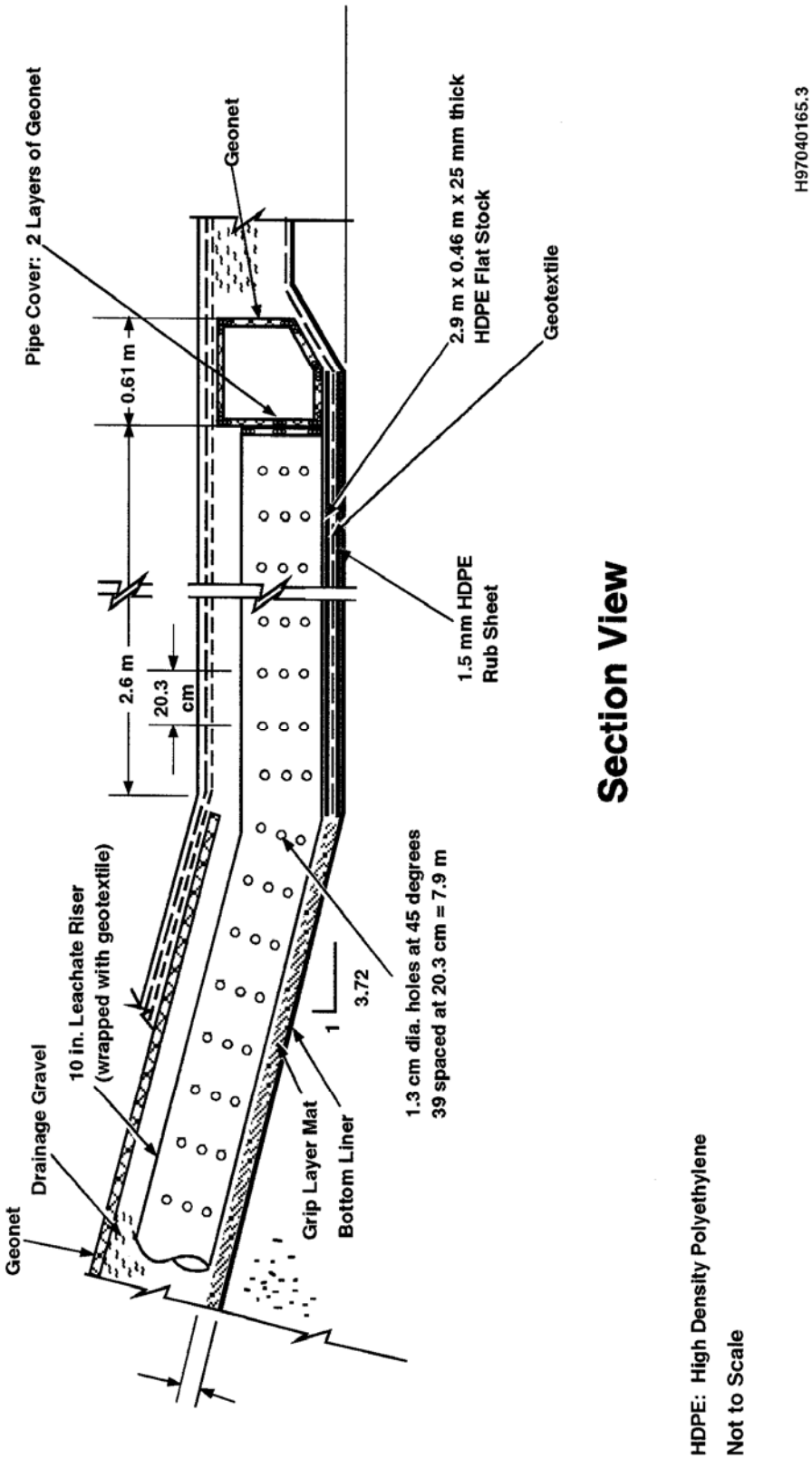


Table 4.5. 200 Area Effluent Treatment Facility Tank Systems Information

Tank Description	Material of Construction	Maximum Tank Capacity [1] liters	Inner diameter meters	Height meters	Shell Thickness [2] centimeters	Corrosion Protection [3]
Load-in tanks (2)	304 SS	37,900	3.6	4.7	0.64	Type 304 SS
Surge tank	304 SS	461,820	7.9	9.2	0.48	Type 304 SS
pH adjustment tank	304 SS	16,660	3.0	2.5	0.64	Type 304 SS
First RO feed tank	304 SS	20,440	3.0	3.2	0.64	Type 304 SS
Second RO feed tank	304 SS	7,600	Nonround tank 3.0 m x 1.5 m	1.5	0.48 w/rib stiffeners	Type 304 SS
Effluent pH adjustment tank	304 SS	14,390	2.4	3.6	0.64	Type 304 SS
Verification tanks (3)	Carbon steel with epoxy lining	2,763,340	18.3	11.4	0.79	epoxy coating
Secondary waste receiving tanks (2)	304 SS	75,700	4.3	5.7	0.64	Type 304 SS
Concentrate tanks (2)	316L SS	24,980	3.0	3.8	0.64	Type 316 SS
ETF evaporator (Vapor Body)	Alloy 625	20,800	2.4	6.8	variable	Alloy 625
Distillate flash tank	304 SS	950	Horizontal tank 0.76	Length 2.2	0.7	304 SS
Sump tank 1	304 SS	4,160	1.5 x 1.5	3.4	3/16	304 SS
Sump tank 2	304 SS	4,160	1.5 x 1.5	3.4	3/16	304 SS

[1] The maximum operating volume of the tanks is identified. For the load-in tanks and the second RO feed tank, the maximum operating volume is also the operating capacity.
[2] The nominal thickness of ETF tanks is represented.
[3] Type 304 SS, 304L, 316 SS and alloy 625 provide corrosion protection.
304 SS = stainless steel type 304 or 304L.
316L SS = stainless steel type 316L.

Table 4.6. 200 Area Effluent Treatment Facility Additional Tank System Information

Tank Description	Liner Materials	Pressure Controls	Foundation Materials	Structural Support	Seams	Connections
Load-in tanks (2)	None	vent to atmosphere	concrete slab	SS skirt bolted to concrete	welded	flanged
Surge tank	None	pressure indicator/vacuum breaker valve	reinforced concrete ring plus concrete slab	structural steel on concrete base	welded	flanged
pH adjustment tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
First RO feed tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
Second RO feed tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel frame	welded	flanged
Effluent pH adjustment tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
Verification tanks (3)	Epoxy	pressure indicator/filtered vent to atmosphere	reinforced concrete ring plus concrete slab	structural steel on concrete base	welded	flanged
Secondary waste receiving tanks (2)	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
Concentrate tanks (2)	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
ETF evaporator (vapor body)	None	pressure indicator/vapor vent - to DFT/VOG	concrete slab	carbon steel frame	welded	flanged
Distillate flash tank	None	vent to VOG	concrete slab	carbon steel I-beam and cradle	welded	flanged
Sump tank 1	None	vent to VOG	concrete containment	reinforced concrete containment basin	welded	flanged
Sump tank 2	None	vent to VOG	concrete containment	reinforced concrete containment basin	welded	flanged

DFT = distillate flash tank
VOG = vessel off gas system

1 **Table 4.7. Ancillary Equipment and Material Data**

System	Ancillary Equipment	Number	Material
Load-in tanks	Load-in/transfer pumps (2)	P-103A/-103B	316 SS
	Load-in filters (3)	59A-FL-001/-002/-003	304 SS
Surge tank	Surge tank pumps (3)	2025E-60A-P-1A/-1B/-1C	304 SS
Rough filter	Rough filter	2025E-60B-FL-1	304 SS
UV/OX	UV oxidation inlet cooler	2025E-60B-E-1	316 SS
	UV oxidizers (4)	2025E-60D-UV-1A/-1B/-2A/-2B	316 SS
pH adjustment	pH adjustment pumps (2)	2025E-60C-P-1A/-1B	304 SS
Peroxide decomposer	H_2O_2 decomposers (2)	2025E-60D-CO-1A/-1B	CS with epoxy coating
Fine filter	Fine filter	2025E-60B-FL-2	304 SS
Degasification	Degasification column inlet cooler	2025E-60E-E-1	316 SS
	Degasification column	2025E-60E-CO-1	FRP
	Degasification pumps (2)	2025E-60E-P-1A/-1B	316 SS
RO	Feed/booster pumps (6)	2025E-60F-P-1A/-1B/-2A/-2B/-3A/-3B	304 SS
	Reverse osmosis arrays (21)	2025E-60F-RO-01 through -21	Membranes: polyamide Outer piping: 304 SS
IX/Polishers	Polishers (3)	2025E-60G-IX-1A/-1B-1C	CS with epoxy coating
	Resins strainers (3)	2025E-60G-S-1A/-1B/-1C	304 SS
Effluent pH adjustment	Recirculation/transfer pumps (2)	2025E-60C-P-2A/-2B	304 SS/PVC
Verification tanks	Return pump	2025E-60H-P-1	304 SS
	Transfer pumps (2)	2025E-60H-P-2A/-2B	
Secondary waste receiving tanks	Secondary waste feed pumps (2)	2025E-60I-P-1A/-1B	304 SS
ETF evaporator system	Feed/distillate heat exchanger	2025E-60I-E-02	Tubes: 316 SS Shell: 304 SS
	Heater (reboiler)	2025E-60I-E-01	Tubes: alloy 625 Shell: 304 SS
	Recirculation pump	2025E-60I-P-02	316 SS
	Concentrate transfer pump	2025E-60I-P-04	316 SS
	Entrainment separator	2025E-60I-DE-01	Top section: 316 SS Bottom section: alloy 625
	Vapor compressor (incl. silencers)	2025E-60I-C-01	304 SS
	Silencer drain pump	2025E-60I-P-06	316 SS
	Level control tank	2025E-60I-TK-5	304 SS
	Distillate flash tank pump	2025E-60I-P-03	316 SS
Concentrate tanks	Concentrate circulation pumps (2)	2025E-60J-P-1A/-1B	316 SS
Thin film dryer	Concentrate feed pump	2025E-60J-P-2	316 SS
	Thin film dryer	2025E-60J-D-1	Interior surfaces: alloy 625 Rotor and blades: 316 SS
	Powder hopper	2025E-60J-H-1	316 SS
	Spray condenser	2025E-60J-DE-01	316 SS
	Distillate condenser	2025E-60J-CND-01	Tubes: 304 SS Shell: CS
	Dryer distillate pump	2025E-60J-P-3	316 SS
Resin dewatering	Dewatering pump	2025E-80E-P-1	

2

Table 4.8. Concrete and Masonary Coatings

Coating	Minimum wet film thickness (mil)	Percentage of film forming solids per volume (%)	Minimum dry film thickness (mil)
Concrete and masonry			
Prime: Amercoat-187*	4.5	22.0	1.0
Second: Amercoat-33	6.4	23.46	1.5
Finish: Amercoat-33	6.4	23.46	1.5
Or			
Prime: Amercoat-385	5-6	66	3-4
Topcoat: Amercoat-450HS	3-4	66	2-2.5
High traffic, container storage area			
Filler: Ameron Nu-Klad 114A**	--	100	--
Prime: Amercoat-105A	2-3	100	2-3
Topcoat: Amercoat-120	20-30	100	20-30

* Amercoat is a trademark of Ameron, Incorporation.
**Nu-Klad is a trademark of Ameron, Incorporation.

Table 4.9. Geomembrane Material Specifications

Property	Value
Specific gravity	0.932 to 0.950
Melt flow index	1.0 g/10 min., maximum
Thickness (thickness of flow marks shall not exceed 200% of the nominal liner thickness)	60 mil 310% (1.5 mm 3 10%)
Carbon black content	1.8 to 3%, bottom liner 2 to 3% top liner
Tensile properties (each direction)	
Tensile strength at yield	21.5 kgf/cm width, minimum
Tensile strength at break	32.2 kgf/cm width, minimum
Elongation at yield	10%, minimum
Elongation at break	500%, minimum
Tear resistance	13.6 kgf, minimum
Puncture resistance	31.3 kgf, minimum
Low temperature/brittleness	-400 C, maximum
Dimensional (%change each direction)	32%, maximum
Environmental stress crack	750 h, minimum
Water absorption	0.1 maximum and weight change
Hydrostatic resistance	316,000 kgf/m^2
Oxidation induction time (200 C/l atm. O_2)	90 minutes

Reference: Construction Specifications (KEH 1990b). Format uses NSF 54 table for high-density polyethylene as a guide (NSF 1985). However, RCRA values for dimensional stability and environmental stress crack have been added.

%	=	percent	max	=	maximum
g	=	gram	kgf	=	kilograms force
min	=	minute	m	=	meters
h	=	hour	mm	=	millimeters

Table 4.10. Drainage Gravel Specifications.

Property	Value
Sieve size	
25 millimeters	100 wt% passing
19 millimeters	80 – 100 wt% passing
9.5 millimeters	10 – 40 wt% passing
4.75 millimeters	0 – 4 wt% passing
Permeability	0.1 cm/sec, minimum

Reference: Sieve size is from WSDOT M41-10-88, Section 9.03.1(3)C for Grading No. 5 (WSDOT 1988). Permeability requirement is from WAC 173-303-650(2)(j) for new surface impoundments.

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Chapter 4.0 Process Information

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4.0 PROCESS INFORMATION

This chapter provides a detailed discussion of the LERF and ETF processes and equipment. The LERF and ETF comprise an aqueous waste treatment system located in the 200 East Area that provides storage and treatment for a variety of aqueous mixed waste. This aqueous waste includes process condensate from the 242-A Evaporator and other aqueous waste generated from onsite remediation and waste management activities.

The LERF consists of three lined surface impoundments, or basins. Aqueous waste from LERF is pumped to the ETF for treatment in a series of process units, or systems, that remove or destroy essentially all of the dangerous waste constituents. The treated effluent is discharged to a State-Approved Land Disposal Site (SALDS) north of the 200 West Area, under the authority of a Washington State Waste Discharge Permit (Ecology 2000) and the Final Delisting (40 CFR 261, Appendix IX, Table 2).

4.1 LIQUID EFFLUENT RETENTION FACILITY PROCESS DESCRIPTION

Each of the three LERF basins has an operating capacity of 29.5-million liters. The LERF receives aqueous waste through several inlets including the following:

- A pipeline that connects LERF with the 242-A Evaporator
- A pipeline from the 200 West Area
- A pipeline that connects LERF to the Load-In Station at the ETF
- A series of sample ports located at each basin.

Figure 4.1 presents a general layout of LERF and associated pipelines. Aqueous waste from LERF is pumped to the ETF through one of two double-walled fiberglass transfer pipelines. Effluent from the ETF also can be transferred back to the LERF through one of these transfer pipelines. These pipelines are equipped with leak detection located in the annulus between the inner and outer pipes. In the event that these leak detectors are not in service, the pipelines are visually inspected during transfers for leakage by opening the secondary containment drain lines at the ETF end of the transfer pipelines.

Each basin is equipped with six available sample risers constructed of 6-inch perforated pipe. A seventh sample riser in each basin is dedicated to influent aqueous waste receipt piping (except for aqueous waste received from the 242-A Evaporator), and an eighth riser in each basin contains liquid level instrumentation. Each riser extends along the sides of each basin from the top to the bottom of the basin and allows samples to be collected from any depth. Personnel access to these sample ports is from the perimeter area of the basins.

A catch basin is provided at the northwest corner of each LERF basin for aboveground piping and manifolds for transfer pumps. Aqueous waste from the 242-A Evaporator is transferred through piping which ties into piping at the catch basins. Under routine operations, a submersible pump is used to transfer aqueous waste from a LERF basin to the ETF for processing or for basin-to-basin transfers. This pump is connected to a fixed manifold on one of four available risers.

Each basin consists of a multilayer liner system supported by a concrete anchor wall around the basin perimeter and a soil-bentonite clay underlayment. The multilayer liner system consists of a primary liner in contact with the aqueous waste, a layer of bentonite carpet, a geonet, a geotextile, a gravel layer, and a secondary liner that rests on the bentonite underlayment. Any aqueous waste leakage through the primary liner flows through the geonet to a leachate collection system. The leachate flows to a sump at the northwest corner of each basin, where the leachate is pumped up the side slope and back into the basin above the primary liner. Each liner is constructed of high-density polyethylene. A floating cover made of very low-density polyethylene is stretched over each basin above the primary liner. These covers serve to keep unwanted material from entering the basins, and to minimize evaporation of the liquid contents.

4.2 EFFLUENT TREATMENT FACILITY PROCESS DESCRIPTION

The ETF is designed as a flexible treatment system that provides treatment for contaminants anticipated in process condensate and other onsite aqueous waste. The design influent flow rate into the ETF is approximately 570 liters per minute, with planned outages for activities such as maintenance on the ETF systems. Maintenance outages typically are scheduled between treating a batch of aqueous waste, referred to as treatment campaigns. The effluent flow (or volume) is equivalent to the influent flow (or volume).

The ETF generally receives aqueous waste directly from the LERF. However, aqueous waste also can be transferred from tanker trucks at the Load-In Station to the ETF and from containers (e.g., carboys, drums) directly to ETF. Aqueous waste is treated and stored in the ETF process area in a series of tank systems, referred to as process units. Within the ETF, waste also is managed in containers through treatment and/or storage. Figure 4.2 provides the relative locations of the process and container storage areas within the ETF.

The process units are grouped in either the primary or the secondary treatment train. The primary treatment train provides for the removal or destruction of contaminants. Typically, the secondary treatment train processes the waste by-products from the primary treatment train by reducing the volume of waste. In the secondary treatment train, contaminants are concentrated and dried to a powder. The liquid fraction is routed to the primary treatment train. Figure 4.3 provides an overview of the layout of the ETF, 2025E Building). Figure 4.4 presents the ETF floor plan, the relative locations of the individual process units and associated tanks within the ETF, and the location of the Load-In Station.

The dry powder waste and maintenance and operations waste are containerized and stored or treated in the container storage areas or in collection or treatment areas within the Process Area. Secondary containment is provided for all containers and tank systems (including ancillary equipment) housed within the ETF. The trenches and floor of the ETF comprise the secondary containment system. The floor includes approximately a 15.2-centimeter rise (berm) along the containing walls of the process and container storage areas. Any spilled or leaked material from within the process area or container storage area is collected into trenches that feed into either sump tank 1 or sump tank 2. From these sump tanks, the spilled or leaked material (i.e., waste) is fed to either the surge tank and processed in the primary treatment train or the secondary waste receiving tanks and processed in the secondary treatment train. All tank systems outside of the ETF are provided with a secondary containment system.

In the following sections, several figures are provided that present general illustrations of the treatment units and the relation to the process.

4.2.1 Load-In Station

The ETF receives aqueous waste from LERF or the Load-In Station. The ETF Load-In Station, located due east of the surge tank and outside of the perimeter fence (Figure 4.4), was designed and constructed to provide the capability to unload, store, and transfer aqueous waste to the ETF or LERF from tanker trucks and other containers (such as drums). The Load-In Station consists of two truck bays equipped with load-in tanks, transfer pumps, filtration system, level instrumentation for tanker trucks, leak detection capabilities for the containment basin and transfer line, and an underground transfer line that connects to lines in the surge tank berm, allowing transfers to either the ETF surge tank or LERF. The Load-In Station is covered with a steel building for weather protection. Tanker trucks and other containers are used to unload aqueous waste at the Load-In Station. To perform unloading, the tanker truck is positioned on a truck pad, a 'load-in' transfer line is connected to the truck, and the tanker contents are pumped into one of the Load-In Station tanks, the surge tank, or directly to the LERF. For container unloading, the container is placed on the truck pad and the container contents are pumped into one of the Load-In Station tanks, the surge tank, or directly to the LERF.

During unloading operations, solids may be removed from the waste by pumping the contents of the tanker truck or container through a filtration system. If solids removal is not needed, the filtration system is not used and the solution is transferred directly to the Load-In Station tanks, surge tank, or to LERF.

Any leaks at the Load-In Station drain to the sump. A leak detector in the sump alarms locally and in the ETF control room. Alternatively, leaks can be visually detected.

4.2.2 Effluent Treatment Facility Operating Configuration

Because the operating configuration of the ETF can be adjusted or modified, most aqueous waste streams can be effectively treated to below Delisting and Discharge Permit limits. The operating configuration of the ETF depends on the unique chemistry of an aqueous waste stream(s). Before an aqueous waste stream is accepted for treatment, the waste is characterized and evaluated. Information from the characterization is used to adjust the treatment process or change the configuration of the ETF process units, as necessary, to optimize the treatment process for a particular aqueous waste stream.

Typically, an aqueous waste is processed first in the primary treatment train, where the ETF is configured to process an aqueous waste through the UV/OX unit first, followed by the RO unit. However, under an alternate configuration, an aqueous waste could be processed in the RO unit first. For example, high concentrations of nitrates in an aqueous waste might interfere with the performance of the UV/OX. In this case, the ETF could be configured to process the waste in the RO unit before the UV/OX unit.

The flexibility of the ETF also allows some aqueous waste to be processed in the secondary treatment train first. For example, for small volume aqueous waste with high concentrations of some anions and metals, the approach could be to first process the waste stream in the secondary treatment train. This approach would prevent premature fouling or scaling of the RO unit. The liquid portion (i.e., untreated overheads from the ETF evaporator and thin film dryer) would be sent to the primary treatment train.

Figures 4.5 and 4.6 provide example process flow diagrams for two different operating configurations.

4.2.3 Primary Treatment Train

The primary treatment train consists of the following processes:

- Influent Receipt/Surge tank - inlet, surge capacity
- Filtration - for suspended solids removal
- UV/OX - organic destruction
- pH adjustment - waste neutralization
- Hydrogen peroxide decomposition - removal of excess hydrogen peroxide
- Degasification - removal of carbon dioxide
- RO - removal of dissolved solids
- IX - removal of dissolved solids
- Verification - holding tanks during verification

Reverse Osmosis. The RO system (Figure 4.9) uses pressure to force clean water molecules through semi-permeable membranes while keeping the larger molecule contaminants such as dissolved solids and large molecular weight organic materials, in the membrane. The RO process uses a staged configuration to maximize water recovery. The process produces two separate streams, including a clean 'permeate' and a concentrate (or retentate), which are concentrated as much as possible to minimize the amount of secondary waste produced.

Influent Receipt/Surge Tank. Depending on the configuration of the ETF, the surge tank is one inlet used to feed an aqueous waste into the ETF for treatment. In Configuration 1 (Figure 4.5), the surge tank is the first component downstream of the LERF. The surge tank provides a storage/surge volume for chemical pretreatment and controls feed flow rates from the LERF to the ETF. However, in Configuration 2 (Figure 4.6), aqueous waste from LERF is fed directly into the treatment units. In this configuration, the surge tank receives aqueous waste that has been processed in the RO units and provides the feed stream to the remaining downstream process units. In yet another configuration, some small volume aqueous waste could be received into the secondary treatment train first for processing. In this case, the aqueous waste would be received directly into the secondary waste receiving tanks. Finally,

the surge tank also receives waste extracted from various systems within the primary and secondary treatment train while in operation.

The surge tank is located outside the ETF on the south side. In the surge tank (Figure 4.7), the pH of an aqueous waste is adjusted using the metered addition of sulfuric acid and sodium hydroxide, as necessary, to prepare the waste for treatment in downstream processes. In addition, hydrogen peroxide or biocides could be added to control biological growth in the surge tank. A pump recirculates the contents in the surge tank, mixing the chemical reagents with the waste to a uniform pH.

Filtration. Two primary filter systems remove suspended particles in an aqueous waste: a rough filter removes the larger particulates, while a fine filter removes the smaller particulates. The location of these filters depends on the configuration of the primary treatment train. However, the filters normally are located upstream of the RO units.

The solids accumulating on these filter elements are backwashed to the secondary waste receiving tanks with pulses of compressed air and water, forcing water back through the filter. The backwash operation is initiated either automatically by a rise in differential pressure across the filter or manually by an operator. The filters are cleaned chemically when the backwashing process does not facilitate acceptable filter performance.

Auxiliary fine and rough filters (e.g., disposable filters) have been installed to provide additional filtration capabilities. Depending on the configuration of the ETF, the auxiliary filters are operated either in series with the primary filters to provide additional filtration or in parallel, instead of the primary fine and rough filters, to allow cleaning of the primary fine and rough filters while the primary treatment train is in operation.

Ultraviolet Light/Oxidation. Organic compounds contained in an aqueous waste stream are destroyed in the UV/OX system (Figure 4.8). Hydrogen peroxide is mixed with the waste. The UV/OX system uses the photochemical reaction of UV light on hydrogen peroxide to form hydroxyl radicals and other reactive species that oxidize the organic compounds. The final products of the complete reaction are carbon dioxide, water, and inorganic ions.

Organic destruction is accomplished in two UV/OX units operating in parallel. During the UV/OX process, the aqueous waste passes through reaction chambers where hydrogen peroxide is added. While in the UV/OX system, the temperature of an aqueous waste is monitored. Heat exchangers are used to reduce the temperature of the waste should the temperature of the waste exceed the upper limits for the UV/OX or RO systems.

pH Adjustment. The pH of a waste stream is monitored and controlled at different points throughout the treatment process. Within the primary treatment train, the pH of a waste can be adjusted with sulfuric acid or sodium hydroxide to optimize operation of downstream treatment processes or adjusted before final discharge. For example, the pH of an aqueous waste would be adjusted in the pH adjustment tank after the UV/OX process and before the RO process. In this example, pH is adjusted to cause certain chemical species such as ammonia to form ammonium sulfate, thereby increasing the rejection rate of the RO.

Hydrogen Peroxide Decomposition. Typically, hydrogen peroxide added into the UV/OX system is not consumed completely by the system. Because hydrogen peroxide is a strong oxidizer, the residual hydrogen peroxide from the UV/OX system is removed to protect the downstream equipment. The hydrogen peroxide decomposer uses activated carbon to break down the hydrogen peroxide that is not consumed completely in the process of organic destruction. The aqueous waste is sent through a column of fluidized activated carbon that breaks down the hydrogen peroxide into water and oxygen. The gas generated by the decomposition of the hydrogen peroxide is vented to the vessel off gas system.

Degasification. The degasification column is used to purge dissolved carbon dioxide from the aqueous waste to reduce the carbonate loading to downstream dissolved solids removal processes within the ETF primary treatment train. The purged carbon dioxide is vented to the vessel off gas system.

Reverse Osmosis. The RO system (Figure 4.9) uses pressure to force clean water molecules through semi-permeable membranes while keeping the larger molecule contaminants, such as dissolved solids, and large molecular weight organic materials, in the membrane. The RO process uses a staged configuration to maximize water recovery. The process produces two separate streams, including a clean 'permeate' and a concentrate (or retentate), which are concentrated as much as possible to minimize the amount of secondary waste produced.

The RO process is divided into first and second stages. Aqueous waste is fed to the first RO stage from the RO feed tank. The secondary waste receiving tanks of the secondary treatment train receive the retentate removed from the first RO stage, while the second RO stage receives the permeate (i.e., 'treated' aqueous waste from the first RO stage). In the second RO stage, the retentate is sent to the first stage RO feed tank while the permeate is sent to the IX system or to the surge tank, depending on the configuration of the ETF.

Two support systems facilitate this process. An anti-scale system injects scale inhibitors as needed into the feed waste to prevent scale from forming on the membrane surface. A clean-in-place system using cleaning agents, such as descalants and surfactants, cleans the membrane pores of surface and subsurface deposits that have fouled the membranes.

Ion Exchange. Because the RO process removes most of the dissolved solids in an aqueous waste, the IX process (Figure 4.10) act as a polishing unit. The IX system consists of three columns containing beds of cation and/or anion resins. This system is designed to allow for regeneration of resins and maintenance of one column while the other two are in operation. Though the two columns generally are operated in series, the two columns also can be operated in parallel or individually.

Typically, the two columns in operation are arranged in a primary/secondary (lead/lag) configuration, and the third (regenerated) column is maintained in standby. When dissolved solids breakthrough the first IX column and are detected by a conductivity sensor, this column is removed from service for regeneration, and the second column replaces the first column and the third column is placed into service. The column normally is regenerated using sulfuric acid and sodium hydroxide. The resulting regeneration waste is collected in the secondary waste receiving tanks.

Spent resins are transferred into a disposal container should regeneration of the IX resins become inefficient. The container is designed to provide dewatering with remote monitoring of the resin and water levels within the container. Displaced air from the vessels is exhausted through an entrainment separator (to remove water drops) and a high-efficiency particulate air filter and into the vessel off gas system. Free water is removed from the container and returned to the surge tank. Dewatered resins are transferred to a final storage/disposal point.

Verification. The three verification tanks (Figure 4.11) are used to hold the treated effluent while a determination is made that the effluent meets discharge limits. The effluent can be returned to the primary treatment train for additional treatment, or to the LERF should a treated effluent not meet Discharge Permit or Final Delisting requirements.

The three verification tanks alternate between three operating modes: receiving treated effluent, holding treated effluent during laboratory analysis and verification, or discharging verified effluent. Treated effluent may also be returned to the ETF to provide 'clean' service water for operational and maintenance functions, e.g., for boiler water and for backwashing the filters. This recycling keeps the quantity of fresh water used to a minimum.

4.2.4 Secondary Treatment Train

The secondary treatment system typically receives and processes the following by-products generated from the primary treatment train: concentrate from the first RO stage, filter backwash, regeneration waste from the ion exchange system, and spillage or overflow received into the process sumps. Depending on the operating configuration, however, some aqueous waste could be processed in the secondary treatment

train before the primary treatment train (refer to Figures 4.5 and 4.6 for example operating configurations).

The secondary treatment train provides the following processes:

- Secondary waste receiving - tank receiving and chemical addition
- Evaporation - concentrates secondary waste streams
- Concentrate staging - concentrate receipt, pH adjustment, and chemical addition
- Thin film drying - dewatering of secondary waste streams
- Container handling - packaging of dewatered secondary waste

Secondary Waste Receiving. Waste to be processed in the secondary treatment train is received into two secondary waste receiving tanks, where the pH can be adjusted with sulfuric acid or sodium hydroxide for optimum evaporator performance. Chemicals, such as reducing agents, may be added to waste in the secondary waste receiving tanks to reduce the toxicity or mobility of constituents in the powder.

Evaporation. The ETF evaporator is fed alternately by the two secondary waste receiving tanks. One tank serves as a waste receiver while the other tank is operated as the feed tank. The ETF evaporator vessel (also referred to as the vapor body) is the principal component of the evaporation process (Figure 4.12).

Feed from the secondary waste receiving tanks is pumped through a heater to the recirculation loop of the ETF evaporator. In this loop, concentrated waste is recirculated from the ETF evaporator, to a heater, and back into the evaporator where vaporization occurs. As water leaves the evaporator system in the vapor phase, the concentration of the waste in the evaporator increases. When the concentration of the waste reaches the appropriate density, a portion of the concentrate is pumped to one of the concentrate tanks.

The vapor that is released from the ETF evaporator is routed to the entrainment separator, where water droplets and/or particulates are separated from the vapor. The 'cleaned' vapor is routed to the vapor compressor and heater. The steam from the vapor compressor/heater is used to heat the recirculating concentrate in the ETF evaporator. From the vapor compressor/heater, the steam is condensed and fed to the distillate flash tank, where the saturated condensate received from the heater drops to atmospheric pressure and cools to the normal boiling point through partial flashing (rapid vaporization caused by a pressure reduction). The resulting distillate is routed to the surge tank. A vacuum blower to the vessel off gas system exhausts noncondensible vapors, such as air.

Concentrate Staging. The concentrate tanks make up the head end of the thin film drying process. From the ETF evaporator, concentrate is pumped into two concentrate tanks, and pH adjusted chemicals, such as reducing agents, may be added to reduce the toxicity or mobility of constituents when converted to powder. Waste is transferred from the concentrate tanks to the thin film dryer for conversion to a powder. The concentrate tanks function alternately between concentrate receiver and feed tank for the thin film dryer.

Because low solubility solids (i.e., calcium and magnesium sulfate) tend to settle in the concentrate tanks, these solids must be removed to prevent fouling and to protect the thin film dryer, and to maintain concentrate tank capacity.

Thin Film Drying. From the concentrate tanks, feed is pumped through a preheater to the thin film dryer (Figure 4.13) that is heated by steam. As the concentrated waste flows down the length of the dryer, the waste is dried. The dried film, or powder, is scraped off the dryer cylinder by blades attached to a rotating shaft. The powder is funneled through a cone-shaped powder hopper at the bottom of the dryer and into the Container Handling System.

Overhead vapor released by the drying of the concentrate is condensed in the distillate condenser. Excess heat is removed from the distillate by a water-cooled heat exchanger. Part of the distillate is circulated back to the condenser spray nozzles. The remaining distillate is pumped to the surge tank. Any

noncondensible vapors and particulates from the spray condenser are exhausted to the vessel off gas system.

Container Handling. Before an empty container is moved into the Container Handling System (Figure 4.14), the lids are loosely placed on the containers and the container is placed on a conveyor. After the lid is removed, the containers are moved into the container filling area after passing through an air lock. The empty container is located under the thin film dryer, and raised into position. The container is sealed to the thin film dryer and a rotary valve begins the transfer of powder to the empty container. Air displaced from the container is vented to the entrainment separator attached to the ETF evaporator that exhausts to the vessel off gas system.

The container is filled to a predetermined level, recapped, and moved along the conveyor to the smear station airlock. At the smear station airlock, the container is moved onto the conveyor by remote control. The airlock is opened, the smear sample (surface wipe) is taken, and the contamination level counted. A 'C' ring is installed to secure the container lid. If the container has contaminated material on the outside, the container is moved to the wash down station and washed. The container wash water drains to sump tank 1. The washed container is air-dried and retested. Filled containers that pass the smear test are labeled, placed on pallets, and moved by forklift to the filled container storage area. Section 4.3 provides a more detailed discussion of container handling.

4.2.5 Other Effluent Treatment Facility Systems

The ETF is provided with support systems that facilitate treatment in the primary and secondary treatment trains and that provide for worker safety and environmental protection. An overview of the following systems is provided:

- Monitor and control system
- Vessel off gas system
- Sump collection system
- Chemical injection feed system
- Verification tank recycle system
- Utilities

4.2.5.1 Monitor and Control System

The operation of the ETF is monitored and controlled by a centralized computer system (i.e., monitor and control system or MCS). The MCS continuously monitors data from various field indicators, such as pH, flow, tank level, temperature, pressure, conductivity, alarm status, and valve switch positions. Data gathered by the MCS enable operations and engineering personnel to document and adjust the operation of the ETF.

4.2.5.2 Vessel Off gas System

Ventilation for various tanks and vessels is provided through the vessel off gas system. The system includes a moisture separator, duct heater, pre-filter, high-efficiency particulate air filters, carbon absorber (when required to reduce organic emissions), exhaust fans, and ductwork. Gasses ventilated from the tanks and vessels enter the exhaust system through the connected ductwork. The vessel off gas system draws vapors and gasses off the following tanks and treatment systems:

- Surge tank
- ETF evaporator
- pH adjustment tank
- Concentrate tanks
- Degasification system
- First and second RO stages
- Dry powder hopper
- Effluent pH adjustment tank

- Drum capping station
- Secondary waste receiving tanks
- Resin dewatering system
- Distillate condenser (off the thin film dryer)
- Sump tanks 1 and 2

The vessel off gas system maintains a negative pressure with respect to the atmosphere, which produces a slight vacuum within tanks, vessels, and ancillary equipment for the containment of gas vapor. This system also provides for the collection, monitoring, and treatment of confined airborne in-vessel contaminants to preclude over-pressurization. The high-efficiency particulate air filters remove particulates and condensate from the air stream before these are discharged to the heating, ventilation, and air conditioning system.

4.2.5.3 Sump Collection System

Sump tanks 1 and 2 compose the sump collection system that provides containment of waste streams and liquid overflow associated with the ETF processes. The process area floor is sloped to two separate trenches that each drain to a sump tank located under the floor of the ETF (Figure 4.15). One trench runs the length of the primary treatment train and drains to Sump Tank 2, located underneath the verification tank pump floor. The second trench collects spillage primarily from the secondary treatment train and flows to Sump Tank 1, located near the ETF evaporator. Sump tanks 1 and 2 are located below floor level (Figure 4.15). An eductor in these tanks prevents sludge from accumulating.

4.2.5.4 Chemical Injection Feed System

At several points within the primary and secondary treatment trains, sulfuric acid and sodium hydroxide (or dilute solutions of these reagents) are metered into specific process units to adjust the pH. For example, a dilute solution of 4 percent sulfuric acid and 4 percent sodium hydroxide could be added to the secondary waste receiving tanks to optimize the evaporation process.

4.2.5.5 Verification Tank Recycle System

To reduce the amount of water added to the process, verification tank water (i.e., verified effluent) is recycled throughout the ETF process. The following tanks and ancillary equipment use verification tank water:

- 4% H^2SO4 solution tank and ancillary equipment
- 4% NaOH solution tank and ancillary equipment
- Clean-in-place tank and ancillary equipment
- ETF evaporator boiler and ancillary equipment
- Thin film dryer boiler and ancillary equipment.

4.2.5.6 Utilities

The ETF maintains the following utility supply systems required for the operation of the ETF:

- Cooling water system - removes heat from process water via heat exchangers and a cooling tower
- Compressed air system - provides air to process equipment and instrumentation
- Seal water system - provides cool, clean, pressurized water to process equipment for pump seal cooling and pump seal lubrication, and provides protection against failure and fluid leakage
- Demineralized water system - removes solids from raw water system to produce high quality, low ion-content, water for steam boilers, and for the hydrogen peroxide feed system.
- Heating, ventilation, and air conditioning system - provides continuous heating, cooling, and air humidity control throughout the ETF.

The following utilities support ETF activities:

- Electrical power
- Sanitary water
- Communication systems
- Raw water

4.3 CONTAINERS

This section provides specific information on container storage and treatment operations at the ETF, including descriptions of containers, labeling, and secondary containment structures.

A list of dangerous and/or mixed waste managed in containers at the ETF is presented in Chapter 1.0. The types of dangerous and/or mixed waste managed in containers in the ETF could include the following secondary waste generated by the ETF processes:

- Waste generated from the treatment process
- Miscellaneous waste generated by operations and maintenance activities.

The secondary treatment train processes the waste by-products from the primary treatment train, which are concentrated and dried into a powder. Containers are filled with dry powder waste from the thin film dryer via a remotely controlled system. Miscellaneous waste generated from maintenance and operations activities are stored at the ETF. The waste could include process waste, such as used filter elements; spent RO membranes; damaged equipment, and decontamination and maintenance waste, such as contaminated rags, gloves, and other personal protective equipment. Liquids generally are packaged with absorbents at a 2 to 1 ratio.

Several container collection areas could be located within the ETF process and container handling areas. These collection areas are used only to accumulate waste in containers. Once a container is filled, the container is transferred to a container storage area (Figure 4.3 and Figure 4.4), to another TSD unit, or to a less-than-90-day storage pad. Containers stored in the additional storage area (Figure 4.4) are elevated or otherwise protected from contact with accumulated liquids. The container storage area within ETF is a 22.9 x 8.5-meter room located adjacent to the ETF process area. The containers within the container storage area are clearly labeled, and access to these containers is limited by barriers and by administrative controls. The ETF floor provides secondary containment, and the ETF roof and walls protects all containers from exposure to the elements.

Waste also could be placed in containers for treatment as indicated in Chapter 1.0. For example, sludge that accumulates in the bottoms of the process tanks is removed periodically and placed into containers. In this example, the waste is solidified by decanting the supernate from the container and the remainder of the waste is allowed to evaporate, or absorbents are added, as necessary, to address remaining liquids. Following treatment, this waste either is stored at the ETF or transferred to another TSD unit.

4.3.1 Description of Containers

The containers used to collect and store dry powder waste are 208-liter steel containers. Most of the maintenance and operation waste is stored in 208-liter steel containers; however, in a few cases, the size of the container could vary to accommodate the size of a particular waste. For example, some process waste, such as spent filters, might not fit into a 208-liter container. In the case of spent resin from the IX columns, the resin is dewatered and could be packaged in a special disposal container. In these few cases, specially sized containers could be required. In all cases, however, only approved containers are used and are compatible with the associated waste. Typically, 208-liter containers are used for treatment.

Current operating practices indicate the use of new 208-liter containers that have either a polyethylene liner or a protective coating. Any reused or reconditioned container is inspected for container integrity before use. Overpack containers are available for use with damaged containers. Overpack containers typically are unlined steel or polyethylene.

Per Chapter 1.0, a maximum of 147,630 liters of dangerous and/or mixed waste could be stored in containers in the ETF.

4.3.2 Container Management Practices

Before use, each container is checked for signs of damage such as dents, distortion, corrosion, or scratched coating. For dry powder loading, empty containers on pallets are raised by a forklift and manually placed on the conveyor that transports the containers to the automatic filling station in the container handling room (Figure 4.14). The container lids are removed and replaced automatically during the filling sequence. After filling, containers exit the container handling room via the filled drum conveyor. Locking rings are installed, the container label is affixed, and the container is moved by dolly or forklift to the container storage area.

Containers used for storing maintenance and operations secondary waste are labeled before being placed in the container storage area or in a collection area. Lids are secured on these containers when not being filled. When the containers in a collection area are full, the containers are transferred by dolly or forklift to the container storage area or to an appropriate TSD unit. Containers used for treating waste also are labeled. The lids on these containers are removed as required to allow for treatment. During treatment, access to these containers is controlled through physical barriers and/or administrative controls.

The filled containers in the container storage area are inventoried, checked for proper labeling, and placed on pallets or in a separate containment device as necessary. Each pallet is moved by forklift. Within the container storage area, palletized containers are stacked no more then three pallets high and in rows no more than two containers wide. Unobstructed aisles with a minimum of 76-centimeter aisle space separate rows.

4.3.3 Container Labeling

Labels are affixed on containers used to store dry powder when the containers leave the container handling room. Labels are affixed on other waste containers before use. Every container is labeled with the date that the container was filled. Appropriate major risk labels, such as "corrosive", "toxic", or "F-listed", also are added. Each container also has a label with an identification number for tracking purposes.

4.3.4 Containment Requirements for Managing Containers

Secondary containment is provided in the container management areas within the ETF. The secondary containment provided for tank systems also serves the container management areas. This section describes the design and operation of the secondary containment structure for these areas.

4.3.4.1 Secondary Containment System Design

For the container management areas, the reinforced concrete floor and a 15.2-centimeter rise (berm) along the walls of the container storage area of the ETF provide secondary containment. The engineering assessment required for tanks (Mausshardt 1995) also describes the design and construction of the secondary containment provided for the ETF container management areas. All systems were designed to national codes and standards (e.g., American Society for Testing Materials, American Concrete Institute standards).

The floor is composed of cast-in-place, pre-formed concrete slabs, and has a minimum thickness of 15.2 centimeters. All slab joints and floor and wall joints have water stops installed at the mid-depth of the slab. In addition, filler was applied to each joint. The floor and berms are coated with a chemically resistant; high-solids epoxy coating system consisting of primer, filler, and top coating. This coating material is compatible with the waste managed in containers and is an integral part of the secondary containment system for containers.

The floor is sloped to drain any solution in the container storage area to floor drains along the west wall. Each floor drain consists of a grating over a 20.3-centimeter diameter drain port connected to a 4-inch

stainless steel transfer pipe. The pipe passes under this wall and connects to a trench running along the east wall of the adjacent process area. This trench drains solution to sump tank 1.

The container storage area is separated from the process area by a common wall and a door for access to the two areas (Figure 4.3). These two areas also share a common floor and trenches that, with the 15.2-centimeter rise of the containing walls, form the secondary containment system for the process area and the container storage area.

4.3.4.2 Structural Integrity of Base

Engineering calculations were performed showing the floor of the container storage area is capable of supporting the weight of containers. These calculations were reviewed and certified by a professional engineer (Mausshardt 1995). The concrete was inspected for damage during construction. Cracks were identified and repaired to the satisfaction of the professional engineer. Documentation of these certifications is included in the engineering assessment (Mausshardt 1995).

4.3.4.3 Containment System Capacity

The container storage area is primarily used to store dry powder and maintenance and operation waste. Where appropriate, absorbents are added to fix any trace liquids present. Large volumes of liquid are not stored in the container storage area. However, liquids might be present in those containers that are in the treatment process. The maximum volume of waste that can be stored in containers in the container storage area is 147,630 liters.

Both the process area and the container storage area are considered in the containment system capacity. The volume available for secondary containment in the process area is approximately 68,000 liters, as discussed in the engineering assessment (Mausshardt 1995). Using the dimensions of the container storage area (22.9 by 8.5 by 0.15 meters), and assuming that 50 percent of the floor area is occupied by containers, the volume of the container storage area is 14,900 liters. The combined volume of both the container storage and process areas available for secondary containment, therefore, is 82,900 liters. This volume is greater than 10 percent of the maximum total volume of containers allowed for storage in the ETF, as discussed previously.

4.3.4.4 Control of Run-on

The container management areas are located within the ETF, which serves to prevent run-on of precipitation.

4.3.4.5 Removal of Liquids from Containment Systems

The container storage area is equipped with drains that route solution to a trench in the process area, which drains to sump tank 1. The sump tanks are equipped with alarms that notify operating personnel that a leak is occurring. The sump tanks also are equipped with pumps to transfer waste to the surge tank or the secondary treatment train.

4.3.4.6 Prevention of Ignitable, Reactive, and Incompatible Wastes in Containers

Individual waste types (i.e., ignitable, corrosive, and reactive) are stored in separate containers. A waste that could be incompatible with other wastes is separated and protected from the incompatible waste. For example, acidic and caustic wastes are stored in separate containers. Free liquids are absorbed in containers that hold incompatible waste at a 2 to 1 ratio. Additionally, ETF-specific packaging requirements for these types of waste provide extra containment with each individual container. For example, each item of acidic waste is individually bagged and sealed within a lined container.

4.4 TANK SYSTEMS

This section provides specific information on tank systems and process units. This section also includes a discussion on the types of waste to be managed in the tanks, tank design information, integrity assessments, and additional information on the ETF tanks that treat and store dangerous and/or mixed

waste. The ETF dangerous waste tanks are identified in Section 4.4.1.1, and the relative locations of the tanks and process units in the ETF are presented in Figure 4.3.

4.4.1 Design Requirements

The following sections provide an overview of the design specifications for the tanks within the ETF. A separate discussion on the design of the process units also is provided. In accordance with the new tank system requirements of WAC 173-303-640(3), the following tank components and specifications were assessed:

- Dimensions, capacities, wall thicknesses, and pipe connections
- Materials of construction and linings and compatibility of materials with the waste being processed
- Materials of construction of foundations and structural supports
- Review of design codes and standards used in construction
- Review of structural design calculations, including seismic design basis
- Waste characteristics and the affects of waste on corrosion

This assessment was documented in the *Final RCRA Information Needs Report* (Mausshardt 1995; the engineering assessment performed for the ETF tank systems by an independent professional engineer. A similar assessment of design requirements was performed for the load-in tanks and is documented in *200 Area Effluent BAT/AKART Implementation, ETF Truck Load-In Facility, Project W-291H Integrity Assessment Report* (KEH 1994).

The specifications for the preparation, design, and construction of the tank systems at the ETF are documented in the *Design Construction Specification, Project C-018H, 242-A Evaporator/PUREX Plant Process Condensate Treatment Facility* (WHC 1992a). The preparation, design, and construction of the load-in tanks are provided in the construction specifications in *Project W-291, 200 Area Effluent BAT/AKART Implementation ETF Truck Load-in Facility* (KEH 1994).

Most of the tanks in the ETF are constructed of stainless steel. According to the design of the ETF, it was determined stainless steel would provide adequate corrosion protection for these tanks. Exceptions include the verification tanks, which are constructed of carbon steel with an epoxy coating. The ETF evaporator/vapor body (and the internal surfaces of the thin film dryer) is constructed of a corrosion resistant alloy, known as alloy 625, to address the specific corrosion concerns in the secondary treatment train. Finally, the hydrogen peroxide decomposer vessels are constructed of carbon steel and coated with a vinyl ester lining.

The shell thicknesses of the tanks identified in Section4.4.1.1 represent a nominal thickness of a new tank when placed into operation. The tank capacities identified in this table represent the maximum operating volumes. For certain tanks (as indicated in the table), the maximum operating volume is also the nominal (routine) operating capacity. Nominal tank volumes represent the volume between the low-level and high-level shutoffs in a tank unit.

4.4.1.1 Codes and Standards for Tank System Construction

Specific standards for the manufacture of tanks and process systems installed in the ETF are briefly discussed in the following sections. In addition to these codes and industrial standards, a seismic analysis for each tank and process system is required [WAC 173-303-806(4)(a)(xi)]. The seismic analysis was performed in accordance with UCRL-15910 *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, Section 4 (UCRL 1987). The results of the seismic analyses are summarized in the engineering assessment of the ETF tank systems (Mausshardt 1995).

Storage and Treatment Tanks. The following tanks store and/or treat dangerous waste at the ETF.

Tank name	Tank number
Surge tank	2025E-60A-TK-1
pH adjustment tank	2025E-60C-TK-1
Effluent pH adjustment tank	2025E-60C-TK-2
First RO feed tank	2025E-60F-TK-1
Second RO feed tank	2025E-60F-TK-2
Verification tanks (three)	2025E-60H-TK-1A/1B/1
Secondary waste receiving tanks (two)	2025E-60I-TK-1A/1B
Concentrate tanks (two)	2025E-60J-TK-1A/1B
Sump tanks (two)	2025E-20B-TK-1/2
Distillate flash tank	2025E-60I-TK-2
Load-in tanks	TK-109/117

The relative location of these tanks is presented in Figure 4.3. These tanks are maintained at or near atmospheric pressure. The codes and standards applicable to the design, construction, and testing of the above tanks and ancillary piping systems are as follows:

ASME - B31.3	Chemical Plant and Petroleum Refinery Piping (ASME 1990)
ASME Sect. VIII, Division I	Pressure Vessels (ASME 1992a)
AWS - D1.1	Structural Welding Code - Steel (AWS 1992)
ANSI - B16.5	Pipe Flanges and Flanged Fittings (ANSI 1992)
ASME Sect. IX	Welding and Brazing Qualifications (ASME 1992b)
API 620	Design and Construction of Large Welded Low Pressure Storage Tanks (API 1990)
AWWA - D100	Welded Steel Tanks for Water Storage (AWWA 1989)
AWWA - D103	Factory-Coated Bolted Steel Tanks for Water Storage (AWWA 1987)
AWWA - D120	Thermosetting Fiberglass-Reinforced Plastic Tanks (AWWA 1984).

The application of these standards to the construction of ETF tanks and independent verification of completed systems ensured that the tank and tank supports had sufficient structural strength and that seams and connections were adequate to ensure tank integrity. In addition, each tank met strict quality assurance requirements. Each tank constructed offsite was tested for integrity and leak tightness before shipment to the Hanford Facility. Following installation, the systems were inspected for damage to ensure against leakage and to verify proper operation. If a tank was damaged during shipment or installation, leak tightness testing was repeated onsite.

4.4.1.2 Design Information for Tanks Located Outside of Effluent Treatment Facility

The load-in tanks, surge tank, and verification tanks are located outside the ETF. These tanks are located within concrete structures that provide secondary containment.

Load-In Tanks and Ancillary Equipment. The load-in tanks are heated and constructed of stainless steel, and have a nominal capacity of 37,900 liters. Ancillary equipment includes transfer pumps, a filtration system, a double encased, fiberglass transfer pipeline, level instruments for tanker trucks, and leak detection equipment. From the Load-In Station, aqueous waste can be routed to the surge tank or to the LERF through a double-encased line. The load-in tanks, sump, pumps, and truck pad are all provided with secondary containment.

Surge Tank and Ancillary Equipment. The surge tank is constructed of stainless steel and has a nominal capacity of 379,000 liters. Ancillary equipment to the surge tank includes two underground double encased (i.e., pipe-within-a-pipe) transfer lines connecting to LERF and three pumps for

transferring aqueous waste to the primary treatment train. The surge tank is located at the south end of the ETF. The surge tank is insulated and the contents heated to prevent freezing. Eductors in the tank provide mixing.

Verification Tanks and Ancillary Equipment. The verification tanks are located north of the ETF. The verification tanks have a nominal capacity of 2,540,000 liters each. For support, the tanks have a center post with a webbing of beams that extend from the center post to the sides of the tank. The roof is constructed of epoxy covered carbon steel that is attached to the cross beams of the webbing. The tank floor also is constructed of epoxy covered carbon steel and is sloped. Eductors are installed in each tank to provide mixing.

Ancillary equipment includes a return pump that provides circulation of treated effluent through the eductors. The return pump also recycles effluent back to the ETF for retreatment and can provide service water for ETF functions. Two transfer pumps are used to discharge treated effluent to SALDS or back to the LERF.

4.4.1.3 Design Information for Tanks Located Inside the Effluent Treatment Facility Building

Most of the ETF tanks and ancillary equipment that store or treat dangerous and/or mixed waste are located within the ETF. The structure serves as secondary containment for the tank systems.

pH Adjustment Tank and Ancillary Equipment. The pH adjustment tank has a nominal capacity of 9,800 liters. Ancillary equipment for this tank includes overflow lines to a sump tank and pumps to transfer waste to other units in the main treatment train.

Effluent pH Adjustment Tank and Ancillary Equipment. The effluent pH adjustment tank has a nominal capacity of 9,500 liters. Ancillary equipment includes overflow lines to a sump tank and pumps to transfer waste to the verification tanks.

First and Second Reverse Osmosis Feed Tanks and Ancillary Equipment. The first RO feed tank is a vertical, stainless steel tank with a round bottom and has a nominal capacity of 11,400 liters. Conversely, the second RO feed tank is a rectangular vessel with the bottom of the tank sloping sharply to a single outlet in the bottom center. The second RO feed tank has a nominal capacity of 7,600 liters. Each RO tank has a pump to transfer waste to the RO arrays. Overflow lines are routed to a sump tank.

Secondary Waste Receiving Tanks and Ancillary Equipment. Two 57,000-liter secondary waste receiving tanks collect waste from the units in the main treatment train, such as reject solution (retentate) from the RO units and regeneration solution from the IX columns. These are vertical, cylindrical tanks with a semi-elliptical bottom and a flat top. Ancillary equipment includes overflow lines to a sump tank and pumps to transfer aqueous waste to the ETF evaporator.

Effluent Treatment Facility Evaporator and Ancillary Equipment. The ETF evaporator, the principal component of the evaporation process, is a cylindrical pressure vessel with a conical bottom. Aqueous waste is fed into the lower portion of the vessel. The top of the vessel is domed and the vapor outlet is configured to prevent carryover of liquid during the foaming or bumping (violent boiling) at the liquid surface. The ETF evaporator has a capacity of approximately 21,000 liters.

The ETF evaporator includes the following ancillary equipment:

- Preheater
- Recirculation pump
- Waste heater with steam level control tank
- Concentrate transfer pump
- Entrainment separator
- Vapor compressor with silencers
- Silencer drain pump.

Distillate Flash Tank and Ancillary Equipment. The distillate flash tank is a horizontal tank that has a nominal operating capacity of 570 liters. Ancillary equipment includes a pump to transfer the distillate to the surge tank for reprocessing.

Concentrate Tanks and Ancillary Equipment. Each of the two concentrate tanks has an approximate capacity of 18,900 liters. Ancillary equipment includes overflow lines to a sump tank and pumps for recirculation and transfer.

Sump Tanks. Sump tanks 1 and 2 are located below floor level. Both sump tanks are double-walled, rectangular tanks, placed inside concrete vaults. Both tanks have a working volume of 3,000 liters each. The sump tanks are located in pits below grade to allow gravity drain of solutions to the tanks. Each sump tank has two vertical pumps for transfer of waste to the secondary waste receiving tanks or to the surge tank for reprocessing.

4.4.1.4 Design Information for Effluent Treatment Facility Process Units

As with the ETF tanks, process units that treat and/or store dangerous and/or mixed waste are maintained at or near atmospheric pressure. These units were constructed to meet a series of design standards, as discussed in the following sections. Table 4.6 presents the materials of construction and the ancillary equipment associated with these process units. All piping systems are designed to withstand the effects of internal pressure, weight, thermal expansion and contraction, and any pulsating flow. The design and integrity of these units are presented in the engineering assessment (Mausshardt 1995).

Filters. The load-in fine and rough filter vessels (including the auxiliary filters) are designed to comply with the ASME Section VIII, Division I, Pressure Vessels (ASME 1992a). The application of these standards to the construction of the ETF filter system and independent inspection ensure that the filter and filter supports have sufficient structural strength and that the seams and connections are adequate to ensure the integrity of the filter vessels.

Ultraviolet Oxidation System. The UV/OX reaction chamber is designed to comply with manufacturers standards.

Degasification System. The codes and standards applicable to the design, fabrication, and testing of the degasification column are identified as follows:

- ASME Section VIII, Division I, Pressure Vessels (ASME 1992a)
- ASME - B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990)
- AWS - D1.1, Structural Welding Code - Steel (AWS 1992)
- ANSI - B16.5, Pipe Flanges and Flanged Fittings (ANSI 1992)

Reverse Osmosis System. The pressure vessels in the RO unit are designed to comply with ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards.

Ion Exchange (Polishers). The IX columns are designed in accordance with ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards. Polisher piping is fabricated of type 304 stainless steel or polyvinyl chloride (PVC) and meets the requirements of ASME B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990).

Effluent Treatment Facility Evaporator. The ETF evaporator is designed to meet the requirements of ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards. The ETF evaporator piping meets the requirements of ASME B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990).

Thin Film Dryer System. The thin film dryer is designed to meet the requirements of ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards. The piping meets the requirements of ASME - B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990).

Integrity Assessments. The integrity assessment for ETF (Mausshardt 1995) attests to the adequacy of design and integrity of the tanks and ancillary equipment to ensure that the tanks and ancillary equipment

will not collapse, rupture, or fail over the intended life considering intended uses. For the load-in tanks, a similar integrity assessment was performed (KEH 1995). Specifically, the assessment documents the following considerations:

- Adequacy of the standards used during design and construction of the facility
- Characteristics of the solution in each tank
- Adequacy of the materials of construction to provide corrosion protection from the solution in each tank
- Results of the leak tests and visual inspections

The results of these assessments demonstrate that tanks and ancillary equipment have sufficient structural integrity and are acceptable for storing and treating dangerous and/or mixed waste. The assessments also state that the tanks and building were designed and constructed to withstand a design-basis earthquake. Independent, qualified registered professional engineers certified these tank assessments.

The scope of the ETF tank integrity assessment was based on characterization data from process condensate. To assess the effect that other aqueous waste might have on the integrity of the ETF tanks, the chemistry of an aqueous waste will be evaluated for its potential to corrode a tank (e.g., chloride concentrations will be evaluated). The tank integrity assessment for the load-in tanks was based on characterization data from several aqueous waste streams. The chemistry of an aqueous waste stream not considered in the load-in tank integrity assessment also will be evaluated for the potential to corrode a load-in tank.

Consistent with the recommendations of the integrity assessment, a corrosion inspection program was developed. Periodic integrity assessments are scheduled for those tanks that are predicted to have the highest potential for corrosion. These inspections are scheduled annually or longer to follow the end of a treatment campaign. These 'indicator tanks' include the concentrate tanks, secondary waste receiving tanks, and verification tanks. One of each of these tanks will be inspected yearly to determine if corrosion or coating failure has occurred. Should significant corrosion or coating failure be found, an additional tank of the same type would be inspected during the same year. In the case of the verification tanks, if corrosion or coating failure is found in the second tank, the third tank also will be inspected. If significant corrosion were observed in all three sets of indicator tanks, the balance of the ETF tanks would be considered for inspection. For tanks predicted to have lower potential for corrosion, inspections also are performed nonroutinely as part of the corrective maintenance program.

4.4.2 Additional Requirements for New Tanks

Procedures for proper installation of tanks, tank supports, piping, concrete, etc., are included in *Construction Specification, Project C-018H, 242-A Evaporator/PUREX Plant Process Condensate Treatment Facility* (WHC 1992a). For the load-in tanks, procedures are included in the construction specifications in *Project W-291, 200 Area Effluent BAT/AKART Implementation ETF Truck Load-in Facility* (KEH 1994). Following installation, an independent, qualified, registered professional engineer inspected the tanks and secondary containment. Deficiencies identified included damage to the surge tank, damage to the verification tank liners, and ETF secondary containment concrete surface cracking. All deficiencies were repaired to the satisfaction of the engineer. The tanks and ancillary equipment were leak tested as part of acceptance of the system from the construction contractor. Information on the inspections and leak tests are included in the engineering assessment (Mausshardt 1995). No deficiencies were identified during installation of the load-in tanks and ancillary equipment.

4.4.3 Secondary Containment and Release Detection for Tank Systems

This section describes the design and operation of secondary containment and leak detection systems at the ETF.

4.4.3.1 Secondary Containment Requirements for All Tank Systems

The specifications for the preparation, design, and construction of the secondary containment systems at the ETF are documented (WHC 1992a). The preparation, design, and construction of the secondary containment for the load-in tanks are provided in the construction specifications (KEH 1994). All systems were designed to national codes and standards. Constructing the ETF per these specifications ensured that foundations are capable of supporting tank and secondary containment systems and that uneven settling and failures from pressure gradients should not occur.

4.4.3.1.1 Common Elements

The following text describes elements of secondary containment that are common to all ETF tank systems. Details on the secondary containment for specific tanks, including leak detection systems and liquids removal, are provided in Section 4.4.4.1.2.

Foundation and Construction. For the tanks within the ETF, except for the sump tanks, secondary containment is provided by a coated concrete floor and a 15.2-centimeter rise (berm) along the containing walls. The double-wall construction of the sump tanks provides secondary containment. Additionally, trenches are provided in the floor that also provides containment and drainage of any liquid to a sump pit. For tanks outside the ETF, secondary containment also is provided with coated concrete floors in a containment pit (load-in tanks) or surrounded by concrete dikes (the surge and verification tanks).

The transfer piping that carries aqueous waste into the ETF is pipe-within-a-pipe construction, and is buried approximately 1.2 meters below ground surface. The pipes between the verification tanks and the verification tank pumps within the ETF are located in a concrete pipe trench.

For this discussion, there are five discrete secondary containment systems associated with the following tanks and ancillary equipment that treat or store dangerous waste:

- Load-in tanks
- Surge tank
- Process area (including sump tanks)
- Verification tanks
- Transfer piping and pipe trenches.

All of the secondary containment systems are designed with reinforcing steel and base and berm thickness to minimize failure caused by pressure gradients, physical contact with the waste, and climatic conditions. Classical theories of structural analysis, soil mechanics, and concrete and structural steel design were used in the design calculations for the foundations and structures. These calculations are maintained at the ETF. In each of the analyses, the major design criteria from the following documents were included:

V-C018HC1-001	Design Construction Specification, Project C-018H, 242A Evaporator/PUREX Plant Process Condensate Treatment Facility (WHC 1992a)
DOE Order 6430.1A	General Design Criteria
SDC-4.1	Standard Architectural-Civil Design Criteria, Design Loads for Facilities (DOE-RL 1988)
UCRL-15910	Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards (UCRL 1987)
UBC-91	Uniform Building Code, 1991 Edition (ICBO 1991).

The design and structural analysis calculations substantiate the structural designs in the referenced drawings. The conclusions drawn from these calculations indicate that the designs are sound and that the specified structural design criteria were met. This conclusion is verified in the independent design review that was part of the engineering assessment (Mausshardt 1995).

Containment Materials. The concrete floor consists of cast-in-place and preformed concrete slabs. All slab joints and floor and wall joints have water stops installed at the mid-depth of the slab. In addition, filler was applied to each joint.

Except for the sump tank vaults, all of the concrete surfaces in the secondary containment system, including berms, trenches, and pits, are coated with a chemical-resistant, high-solids, epoxy coating that consists of a primer, filler, and a top coating. This coating material is compatible with the waste being treated, and with the sulfuric acid, sodium hydroxide, and hydrogen peroxide additives to the process. The coating protects the concrete from contact with any chemical materials that might be harmful to concrete and prevents the concrete from being in contact with waste material. Table 4.8 summarizes the specifies types of filler, primer, second, and finish coats specified for the concrete and masonry surfaces in the ETF. The epoxy coating is considered integral to the secondary containment system for the tanks and ancillary equipment.

The concrete containment systems are maintained such that any cracks, gaps, holes, and other imperfections are repaired in a timely manner. Thus, the concrete containment systems do not allow spilled liquid to reach soil or groundwater. There are a number of personnel doorways and vehicle access points into the ETF process area. Releases of any spilled or leaked material to the environment from these access points are prevented by 15.2-centimeter concrete curbs, sloped areas of the floor (e.g., truck ramp), or trenches.

Containment Capacity and Maintenance. Each of these containment areas is designed to contain more than 100 percent of the volume of the largest tank in each respective system. Secondary containment systems for the surge tank, and the verification tanks, which are outside the ETF, also are large enough to include the additional volume from a 100-year, 24-hour storm event; i.e., 5.3 centimeters of precipitation.

Sprinkler System. The sprinkler system within the ETF supplies firewater protection to the process area and the container storage area. This system is connected to a site wide water supply system and has the capacity to supply sufficient water to suppress a fire at the ETF. However, in the event of failure, the sprinkler system can be hooked up to another water source (e.g., tanker truck).

4.4.3.1.2 Specific Containment Systems

The following discussion presents a description of the individual containment systems associated with specific tank systems.

Load-In Tank Secondary Containment. The load-in tanks are mounted on a 46-centimeter-thick reinforced concrete slab (Drawing H-2-817970). Secondary containment is provided by a pit with 30.5-centimeter-thick walls and a floor constructed of reinforced concrete. The load-in tank pit is sloped to drain solution to a sump. The depth of the pit varies with the slope of the floor, with an average thickness of about 1.1 meters. The volume of the secondary containment is about 79,000 liters, which is capable of containing the volume of at least one load-in tank (i.e., 37,800 liters). Leaks are detected by a leak detector that alarms locally and in the ETF control room and by visual inspection of the secondary containment.

Adjacent to the pit is a 25.4-centimeter-thick reinforced concrete pad that serves as secondary containment for the load-in tanker trucks, containers, transfer pumps, and filter system. The pad is 15.2 centimeters below grade with north and south walls gently sloped to allow truck access. The pad has drainpipes to route waste solution to the adjacent load-in tank pit.

Surge Tank Secondary Containment. The surge tank is mounted on a reinforced concrete ringwall. Inside the ringwall, the flat-bottomed tank is supported by a bed of compacted sand and gravel with a high-density polyethylene liner bonded to the ringwall. The liner prevents galvanic corrosion between the soil and the tank. The secondary containment is reinforced concrete with a 15.2-centimeter thick floor and a 20.3-centimeter thick dike. The secondary containment area shares part of the southern wall of the main process area. The dike extends up 2.9 meters to provide a containment volume of 740,000 liters for the 379,000-liter surge tank.

The floor of the secondary containment slopes to a sump in the northwest corner of the containment area. Leaks into the secondary containment are detected by level instrumentation in the sump, which alarms in the ETF control room, and/or by routine visual inspections. A sump pump is used to transfer solution in the secondary containment to a sump tank.

Process Area Secondary Containment. The process area contains the tanks and ancillary equipment of the primary and secondary treatment trains, and has a jointed, reinforced concrete slab floor. The concrete floor of the process area provides the secondary containment. This floor is a minimum of 15.2 centimeters thick. With doorsills 15.2 centimeter high, the process area has a containment volume of 76,200 liters. The largest tanks in the process area are the secondary waste receiving tanks, which each have a maximum capacity of 56,800 liters.

The floor of the process area is sloped to drain liquids to two trenches that drain to a sump. Each trench is approximately 38.1 centimeters wide with a sloped trough varying from 39.4 to 76.2 centimeters deep. Leaks into the secondary containment are detected by routine visual inspections of the floor area near the tanks, ancillary equipment, and in the trenches.

A small dam was placed in the trench that comes from the thin film dryer room to contain minor liquid spills originating in the dryer room to minimize the spread of contamination into the process area. The dryer room is inspected for leaks in accordance with the inspection schedule in Chapter 6.0. Operators clean up these minor spills by removing the liquid waste and decontaminating the spill area.

A small dam was also placed in the trench adjacent to the chemical feed skid when the chemical berm area was expanded to accommodate acid and caustic pumps, which were moved indoors from the top of the surge tank to resolve a safety concern. This dam was designed to contain minor spills originating in the chemical berm area and prevent them from entering the process sump.

The northwest corner of the process area consists of a pump pit containing the pumps and piping for transferring treated effluent from the verification tanks to SALDS. The pit is built 1.37 meters below the process area floor level and is sloped to drain to a trench built along its north wall that routes liquid to sump tank 1. Leaks into the secondary containment of the pump pit are detected by routine visual inspections.

Sump Tanks. The sump tanks support the secondary containment system, and collect waste from several sources, including:

- Process area drain trenches
- Tank overflows and drains
- Container washing water
- Resin dewatering solution
- Steam boiler blow down
- Sampler system drains.

These double-contained tanks are located within unlined, concrete vaults. The sump tank levels are monitored by remote level indicators or through visual inspections from the sump covers. These indicators are connected to high- and low-level alarms that are monitored in the control room. When a high-level alarm is activated, a pump is activated and the sump tank contents usually are routed to the secondary treatment train for processing. The contents also could be routed to the surge tank for treatment in the primary treatment train. In the event of an abnormally high inflow rate, a second sump pump is initiated automatically.

Verification Tank Secondary Containment. The three verification tanks are each mounted on ringwalls with high-density polyethylene liners similar to the surge tank. The secondary containment for the three tanks is reinforced concrete with a 15.2-centimeter thick floor and a 20.3-centimeter thick dike. The dike extends up 2.6 meters to provide a containment of 110 percent of the capacity of a single tank (i.e., 2,800,000 liters).

The floor of the secondary containment slopes to a sump along the southern wall of the dike. Leaks into the secondary containment are detected by level instrumentation in the sump that alarms in the control room and/or by routine visual inspections. A sump pump is used to transfer solution in the secondary containment to a sump tank.

4.4.3.2 Additional Requirements for Specific Types of Systems

This section addresses additional requirements in WAC 173-303-640 for double-walled tanks like the sump tanks and secondary containment for ancillary equipment and piping associated with the tank systems.

4.4.3.2.1 Double-Walled Tanks

The sump tanks are the only tanks in the ETF classified as 'double-walled' tanks. These tanks are located in unlined concrete vaults and support the secondary containment system for the process area. The sump tanks are equipped with a leak detector between the walls of the tanks that provide continuous monitoring for leaks. The leak detector provides immediate notification through an alarm in the control room. The inner tanks are contained completely within the outer shells. The tanks are contained completely within the concrete structure of the ETF so corrosion protection from external galvanic corrosion is not necessary.

4.4.3.2.2 Ancillary Equipment

The secondary containment provided for the tanks and process systems also serves as secondary containment for the ancillary equipment associated with these systems.

Ancillary Equipment. Section 4.4.4.1 describes the secondary containment systems that also serve most of the ancillary equipment within the ETF. Between the ETF and the verification tanks, a pipeline trench provides secondary containment for four pipelines connecting the transfer pumps (i.e., discharge and return pumps) in the ETF with the verification tanks (Figure 4.2). This concrete trench crosses under the road and extends from the verification tank pumps to the verification tanks. Treated effluent flows through these pipelines from the verification tank pumps to the verification tanks. The return pump is used to return effluent to the ETF for use as service water or for reprocessing.

For all of the ancillary equipment housed within the ETF, the concrete floor, trenches, and berms form the secondary containment system. For the ancillary equipment of the surge tank and the verification tanks, secondary containment is provided by the concrete floors and dikes associated with these tanks. The concrete floor and pit provide secondary containment for the ancillary equipment of the load-in tanks.

Transfer Piping and Pipe Trenches. The two buried transfer lines between LERF and the surge tank have secondary containment in a pipe-within-a-pipe arrangement. The 4-inch transfer line has an 8-inch outer pipe, while the 3-inch transfer, line has a 6-inch outer pipe. The pipes are fiberglass and are sloped towards the surge tank. The outer piping ends with a drain valve in the surge tank secondary containment.

These pipelines are equipped with leak detection located in the annulus between the inner and outer pipes; the leak detection equipment can continuously 'inspect' the pipelines during aqueous waste transfers. The alarms on the leak detection system are monitored in the control room. A low-volume air purge of the annulus is provided to prevent condensation buildup and minimize false alarms by the leak detection system. In the event that these leak detectors are not in service, the pipelines are inspected during transfers by opening a drain valve to check for solution in the annular space between the inner and outer pipe.

The 3-inch transfer line between the load-in tanks and the surge tank has a 6-inch outer pipe in a pipe-within-a-pipe arrangement. The piping is made of fiberglass-reinforced plastic and slopes towards the load-in tank secondary containment pit. The drain valve and leak detection system for the load-in tank pipelines are operated similarly to the leak detection system for the LERF to ETF pipelines.

As previously indicated, four reinforced concrete pipe trenches provide secondary containment for piping under the roadway between the ETF and the verification tanks. Each trench is 1.2 meters wide, 0.76 meter deep, and slopes towards the sump containing the transfer pumps to SALDS. The floor of the trenches is 30.5 centimeters thick and the sides are 15.2 centimeters thick. The concrete trenches are coated with water sealant and covered with metal gratings at ground level to allow vehicle traffic on the roadway.

4.4.4 Tank Management Practices

When an aqueous waste stream is identified for treatment or storage at ETF, the generating unit is required to characterize the waste. Based on characterization data, the waste stream is evaluated to determine if the stream is acceptable for treatment or storage. Specific tank management practices are discussed in the following sections.

4.4.4.1 Rupture, Leakage, Corrosion Prevention

Most aqueous waste streams can be managed such that corrosion would not be a concern. For example, an aqueous waste stream with high concentrations of chloride might cause corrosion problems when concentrated in the secondary treatment train. One approach is to adjust the corrosion control measures in the secondary treatment train. An alternative might be to blend this aqueous waste in a LERF basin with another aqueous waste that has sufficient dissolved solids, such that the concentration of the chlorides in the secondary treatment train would not pose a corrosion concern.

Additionally, the materials of construction used in the tanks systems (Table 4.5) make it unlikely that an aqueous waste would corrode a tank. For more information on corrosion prevention, refer to the waste analysis plan Chapter 3.0.

When a leak in a tank system is discovered, the leak is immediately contained or stopped by isolating the leaking component. Following containment, the leaking tank system is evaluated by facility personnel to determine whether continued operation of affected system would jeopardize the safety of plant personnel, result in a release to the environment, or compromise facility equipment. If determined that a leak could have the aforementioned consequences, the affected system will be immediately removed from service until repairs can be implemented. If a leak would not result in the stated consequences, the tank system will be placed on a maintenance schedule for repair.

4.4.4.2 Overfilling Prevention

Operating practices and administrative controls used at the ETF to prevent overfilling a tank are discussed in the following paragraphs. The ETF process is controlled by the MCS. The MCS monitors liquid levels in the ETF tanks and has alarms that annunciate on high-liquid level to notify operators that actions must be taken to prevent overfilling of these vessels. As an additional precaution to prevent spills, many tanks are equipped with overflow lines that route solutions to sump tanks 1 and 2. These tanks include the pH adjustment tank; RO feed tanks, effluent pH adjustment tank, secondary waste receiving tanks, and concentrate tanks.

The following section discusses feed systems, safety cutoff devices, bypass systems, and pressure controls for specific tanks and process systems.

Tanks. All tanks are equipped with liquid level sensors that give a reading of the tank liquid volume. The surge tank, the verification tanks, the RO tanks, the secondary waste receiving tanks, and the concentrate tanks are equipped further with liquid level alarms that are actuated if the liquid volume is near the tank overflow capacity. In the actuation of the surge tank alarm, a liquid level switch trips, sending a signal to the valve actuator on the tank influent lines, and causing the influent valves to close.

The operating mode for each verification tank, i.e., receiving, holding, or discharging, can be designated through the MCS; modes also switch automatically. When the high-level set point on the receiving verification tank is reached, the flow to this tank is diverted and another tank becomes the receiver. The full tank is switched into verification mode. The third tank is reserved for discharge mode.

The liquid levels in the first and second RO feed tanks are maintained within predetermined operating ranges. Should the second RO feed tank overflow, the excess waste is piped along with any leakage from the feed pump to a sump tank.

When waste in a secondary waste-receiving tank reaches the high-level set point, the influent flow of waste is redirected to the second tank and the first tank becomes the feed tank for the ETF evaporator.

In a similar fashion, the concentrate tanks switch modes when the high-level set point of one tank is reached. The other tank switches from a discharging mode to a receiving mode and the first tank becomes the discharge tank feeding waste to the thin film dryer.

Filter Systems. All filters at ETF (i.e., the Load-In Station, rough, fine, and auxiliary filter systems) are in leak-tight steel casings. For the rough and fine filters, a high differential pressure, which could damage the filter element, activates a valve that shuts off liquid flow to protect the filter element from possible damage. To prevent a high-pressure situation, the filters are cleaned routinely with pulses of compressed air that force water back through the filter. Cleaning is terminated automatically by shutting off the compressed air supply if high pressure develops. The differential pressure across the auxiliary filters also is monitored. A high differential pressure in these filters would result in a system shutdown to allow the filters to be changed out.

The Load-In Station filtration system has pressure gauges for monitoring the differential pressure across each filter. A high differential pressure would result in discontinuing filter operation until the filter is replaced.

Ultraviolet Light/Oxidation System and Decomposers. A rupture disk on the inlet piping to each of the UV/OX reaction vessels relieves to the pH adjustment tank in the event of excessive pressure developing in the piping system. Should the rupture disk fail, the aqueous waste would trip the moisture sensor, shut down the UV lamps, and close the surge tank feed valve. Also provided is a level sensor to protect UV lamps against the risk of exposure to air. Should those sensors be actuated, the UV lamps would be shut down immediately.

The piping and valving for the hydrogen peroxide decomposers are configured to split the waste flow: half flows to one decomposer and half flows to the other decomposer. Alternatively, the total flow of waste can be treated in one decomposer or both decomposers can be bypassed. A safety relief valve on each decomposer vessel can relieve excess system pressure to a sump tank.

Degasification System. The degasification column is typically supplied aqueous waste feed by the pH adjustment tank feed pump. This pump transfers waste solution through the hydrogen peroxide decomposer, the fine filter, and the degasification column to the first RO feed tank.

The degasification column is designed for operation at a partial vacuum. A pressure sensor in the column detects the column pressure. The vacuum in the degasification column is maintained by a blower connected to the vessel off gas system. The column is protected from extremely low pressure developed by the column blower by the use of an intake vent that is maintained in the open position during operation. The column liquid level is regulated by a flow control system with a high- and low-level alarm. Plate-type heat exchanger cools the waste solution fed to the degasification column.

Reverse Osmosis System. The flow through the first and second RO stages is controlled to maintain constant liquid levels in the first and second stage RO feed tanks.

Polisher. Typically, two of the three columns are in operation (lead/lag) and the third (regenerated) column is in standby. When the capacity of the resin in the first column is exceeded, as detected by an increase in the conductivity of the column effluent, the third column, containing freshly regenerated IX resin, is brought online. The first column is taken offline, and the waste is rerouted to the second column, and to the third. Liquid level instrumentation and automatically operated valves are provided in the IX system to prevent overfilling.

Effluent Treatment Facility Evaporator. Liquid level instrumentation in the secondary waste receiving tanks is designed to preclude a tank overflow. A liquid level switch actuated by a high-tank liquid level causes the valves to reposition, closing off flow to the secondary waste receiving tanks. Secondary containment for these tanks routes liquids to a sump tank.

Valves in the ETF evaporator feed line can be positioned to bypass the secondary waste around the ETF evaporator and to transfer the secondary waste to the concentrate tanks.

Thin Film Dryer. The two concentrate tanks alternately feed the thin film dryer. One tank serves as a concentrate waste receiver while the other tank serves as the dryer feed tank. Liquid level instrumentation prevents tank overflow by diverting the concentrate flow from the full concentrate tank to the other concentrate tank. Secondary containment for these tanks routes liquids to a sump tank.

An alternate route is provided from the concentrate receiver tank to the secondary waste receiving tanks. Dilute concentrate in the concentrate receiver tank can be reprocessed through the ETF evaporator by transferring the concentrate back to a secondary waste-receiving tank.

4.4.5 Labels or Signs

Each tank or process unit in the ETF is identified by a nameplate attached in a readily visible location. Included on the nameplate are the equipment number and the equipment title. Those tanks that store or treat dangerous waste at the ETF (Section 4.4.1.1) are identified with a label, which reads "PROCESS WATER/WASTE". The labels are legible at a distance of at least fifty feet or as appropriate for legibility within the ETF. Additionally, these tanks bear a legend that identifies the waste in a manner, which adequately warns employees, emergency personnel, and the public of the major risk(s) associated with the waste being stored or treated in the tank system(s).

Caution plates are used to show possible hazards and warn that precautions are necessary. Caution signs have a yellow background and black panel with yellow letters and bear the word "CAUTION". Danger signs show immediate danger and signify that special precautions are necessary. These signs are red, black, and white and bear the word "DANGER".

Tanks and vessels containing corrosive chemicals are posted with black and white signs bearing the word "CORROSIVE". "DANGER - UNAUTHORIZED PERSONNEL KEEP OUT" signs are posted on all exterior doors of the ETF, and on each interior door leading into the process area. Tank ancillary piping is also labeled "PROCESS WATER" or "PROCESS LIQUID" to alert personnel which pipes in the process area contains dangerous and/or mixed waste.

All tank systems holding dangerous waste are marked with labels or signs to identify the waste contained in the tanks. The labels or signs are legible at a distance of at least 50-feet and bear a legend that identifies the waste in a manner that adequately warns employees, emergency response personnel, and the public, of the major risk(s) associated with the waste being stored or treated in the tank system(s).

4.4.6 Air Emissions

Tank systems that contain extremely hazardous waste that is acutely toxic by inhalation must be designed to prevent the escape of such vapors. To date, no extremely hazardous waste has been managed in ETF tanks and is not anticipated. However, the ETF tanks have forced ventilation that draws air from the tank vapor spaces to prevent exposure of operating personnel to any toxic vapors that might be present. The vapor passes through a charcoal filter and two sets of high-efficiency particulate air filters before discharge to the environment.

4.4.7 Management of Ignitable or Reactive Wastes in Tanks Systems

Although the ETF is permitted to accept waste that is designated ignitable or reactive, such waste would be treated or blended immediately after placement in the tank system so that the resulting waste mixture is no longer ignitable or reactive. Aqueous waste received does not meet the definition of a combustible or flammable liquid given in National Fire Protection Association (NFPA) code number 30 (NFPA 1996).

The buffer zone requirements in NFPA-30, which require tanks containing combustible or flammable solutions be a safe distance from each other and from public way, are not applicable.

4.4.8 Management of Incompatible Wastes in Tanks Systems

The ETF manages dilute solutions that can be mixed without compatibility issues. The ETF is equipped with several systems that can adjust the pH of the waste for treatment activities. Sulfuric acid and sodium hydroxide are added to the process through the MCS for pH adjustment to ensure there will be no large pH fluctuations and adverse reactions in the tank systems.

4.5 SURFACE IMPOUNDMENTS

This section provides specific information on surface impoundment operations at the LERF, including descriptions of the liners and secondary containment structures, as required by WAC 173-303-650 and WAC 173-303-806(4)(d).

The LERF consists of three lined surface impoundments (basins) with a design operating capacity of 29.5 million liters each. The maximum capacity of each basin is 34 million liters. The dimensions of each basin at the anchor wall are approximately 103 meters by 85 meters. The typical top dimensions of the wetted area are approximately 89 meters by 71 meters, while the bottom dimensions are approximately 57 by 38 meters. Total depth from the top of the dike to the bottom of the basin is approximately 7 meters. The typical finished basin bottoms lie at about 4 meters below the initial grade and 175 meters above sea level. The dikes separating the basins have a typical height of 3 meters and typical top width of 11.6 meters around the perimeter of the impoundments.

4.5.1 List of Dangerous Waste

A list of dangerous and/or mixed aqueous waste that can be stored in LERF is presented in Chapter 1.0. The waste analysis plan for the LERF and ETF Chapter 3.0 also provides a discussion of the types of waste that are managed in the LERF.

4.5.2 Construction, Operation, and Maintenance of Liner System

General information concerning the liner system is presented in the following sections. Information regarding loads on the liner, liner coverage, UV light exposure prevention, and location relative to the water table are discussed.

4.5.2.1 Liner Construction Materials

The LERF employs a double-composite liner system with a leachate detection, collection, and removal system between the primary and secondary liners. Each basin is constructed with an upper or primary liner consisting of a high-density polyethylene geomembrane laid over a bentonite carpet liner. The lower or secondary liner in each basin is a composite of a geomembrane laid over a layer of soil/bentonite admixture with a hydraulic conductivity less than 10^{-7} centimeters per second. The synthetic liners extend up the dike wall to a concrete anchor wall that surrounds the basin at the top of the dike. A batten system bolts the layers in place to the anchor wall (Figure 4.16).

Figure 4.17 is a schematic cross-section of the liner system. The liner components, listed from the top to the bottom of the liner system, are the following:

- Primary 1.5-millimeter high-density polyethylene geomembrane
- Bentonite carpet liner
- Geotextile
- Drainage gravel (bottom) and geonet (sides)
- Geotextile
- Secondary 1.5-millimeter high-density polyethylene geomembrane
- Soil/bentonite admixture (91 centimeters on the bottom, 107 centimeters on the sides)
- Geotextile

The primary geomembrane, made of 1.5-millimeter high-density polyethylene, forms the basin surface that holds the aqueous waste. The secondary geomembrane, also 1.5-millimeter high-density polyethylene, forms a barrier surface for leachate that might penetrate the primary liner. The high-density polyethylene chemically is resistant to constituents in the aqueous waste and has a relatively high strength compared to other lining materials. The high-density polyethylene resin specified for the LERF contains carbon black, antioxidants, and heat stabilizers to enhance its resistance to the degrading effects of UV light. The approach to ensuring the compatibility of aqueous waste streams with the LERF liner materials and piping is discussed in the waste analysis plan Chapter 3.0.

Three geotextile layers are used in the LERF liner system. The layers are thin, nonwoven polypropylene fabric that chemically is resistant, highly permeable, and resistant to microbiological growth. The first two layers prevent fine soil particles from infiltrating and clogging the drainage layer. The second geotextile also provides limited protection for the secondary geomembrane from the drainage rock. The third geotextile layer prevents the mixing of the soil/bentonite admixture with the much more porous and granular foundation material.

A 30.5-centimeters-thick gravel drainage layer on the bottom of the basins between the primary and secondary liners provides a flow path for liquid to the leachate detection, collection, and removal system. A geonet (or drainage net) is located immediately above the secondary geomembrane on the basin sidewalls. The geonet functions as a preferential flow path for liquid between the liners, carrying liquid down to the gravel drainage layer and subsequently to the leachate sump. The geonet is a mesh made of high-density polyethylene, with approximately 13-millimeter openings.

The soil/bentonite layer is 97 centimeters thick on the bottom of the basins and 107 centimeters thick on the basin sidewalls; its permeability is less than 10-7 centimeters per second. This composite liner design, consisting of a geomembrane laid over essentially impermeable soil/bentonite, is considered best available technology for solid waste landfills and surface impoundments. The combination of synthetic and clay liners is reported in the literature to provide the maximum protection from waste migration (Forseth and Kmet 1983).

A number of laboratory tests were conducted to measure the engineering properties of the soil/bentonite admixture, in addition to extensive field tests performed on three test fills constructed near the LERF site. For establishing an optimum ratio of bentonite to soil for the soil/bentonite admixture, mixtures of various ratios were tested to determine permeability and shear strength. A mixture of 12 percent bentonite was selected for the soil/bentonite liner and tests described in the following paragraphs demonstrated that the admixture meets the desired permeability of less than 10-7 centimeters per second. Detailed discussion of test procedures and results is provided in Report of Geotechnical Investigation, 242-A Evaporation and PUREX Interim Storage Basins (Chen-Northern 1990).

Direct shear tests were performed according to ASTM D3080 test procedures (ASTM 1990) on soil/bentonite samples of various ratios. Based on these results, the conservative minimum Mohr-Coulomb shear strength value of 30 degrees was estimated for a soil/bentonite admixture containing 12 percent bentonite.

The high degree of compaction of the soil/bentonite layer [92 percent per ASTM D1557 (ASTM 1991)] was expected to maximize the bonding forces between the clay particles, thereby minimizing moisture transport through the liner. With respect to particle movement ('piping'), estimated fluid velocities in this low-permeability material are too low to move the soil particles. Therefore, piping is not considered a problem.

For the soil/bentonite layer, three test fills were constructed to demonstrate that materials, methods, and procedures used would produce a soil/bentonite liner that meets the EPA permeability requirement of less than 10-7 centimeters per second. All test fills met the EPA requirements. A thorough discussion of construction procedures, testing, and results is provided in *Report of Permeability Testing, Soil-bentonite Test Fill* (Chen-Northern 1991a).

The aqueous waste stored in the LERF is typically a dilute mixture of organic and inorganic constituents. Though isolated instances of soil liner incompatibility have been documented in the literature (Forseth and Kmet 1983), these instances have occurred with concentrated solutions that were incompatible with the geomembrane liners in which the solutions were contained. Considering the dilute nature of the aqueous waste that is and will be stored in LERF and the moderate pH, and test results demonstrating the compatibility of the high-density polyethylene liners with the aqueous waste [9090 Test Results (WHC 1991)], gross failure of the soil/bentonite layer is not probable.

Each basin also is equipped with a floating very low-density polyethylene cover. The cover is anchored and tensioned at the concrete wall at the top of the dikes, using a patented mechanical tensioning system. Figure 4.16 depict the tension mechanism and the anchor wall at the perimeter of each basin. Additional information on the cover system is provided in Section 4.5.2.5.

4.5.2.1.1 Material Specifications

Material specifications for the liner system and leachate collection system, including liners, drainage gravel, and drainage net are discussed in the following sections. Material specifications are documented in the *Final Specifications 242-A Evaporator and PUREX Interim Retention Basins* (KEH 1990a) and *Construction Specifications for 242-A Evaporator and PUREX Interim Retention Basins* (KEH 1990b).

Geomembrane Liners. The high-density polyethylene resin for geomembranes for the LERF meets the material specifications listed in Table 4.9. Key physical properties include thickness (1.5 millimeters [60 mil]) and impermeability (hydrostatic resistance of over 360,000 kilogram per square meter). Physical properties meet National Sanitation Foundation Standard 54 (NSF 1985). Testing to determine if the liner material is compatible with typical dilute waste solutions was performed and documented in *9090 Test Results* (WHC 1991).

Soil/Bentonite Liner. The soil/bentonite admixture consists of 11.5 to 14.5 percent bentonite mixed into well-graded silty sand with a maximum particle size of 4.75 millimeters (No. 4 sieve). Test fills were performed to confirm the soil/bentonite admixture applied at LERF has hydraulic conductivity less than 10^{-7} centimeters per second, as required by WAC 173-303-650(2)(j) for new surface impoundments.

Bentonite Carpet Liner. The bentonite carpet liner consists of bentonite (90 percent sodium montmorillonite clay) in a primary backing of woven polypropylene with nylon filler fiber, and a cover fabric of open weave spunlace polyester. The montmorillonite is anticipated to retard migration of solution through the liner, exhibiting a favorable cation exchange for adsorption of some constituents (such as ammonium). Based on composition of the bentonite carpet and of the type of aqueous waste stored at LERF, no chemical attack, dissolution, or degradation of the bentonite carpet liner is anticipated.

Geotextile. The nonwoven geotextile layers consist of long-chain polypropylene polymers containing stabilizers and inhibitors to make the filaments resistant to deterioration from UV light and heat exposure. The geotextile layers consist of continuous geotextile sheets held together by needle punching. Edges of the fabric are sealed or otherwise finished to prevent outer material from pulling away from the fabric or raveling.

Drainage Gravel. The drainage layer consists of thoroughly washed and screened, naturally occurring rock meeting the size specifications for Grading Number 5 in Washington State Department of Transportation construction specifications (WSDOT 1988). The specifications for the drainage layer are given in Table 4.10. Hydraulic conductivity tests (Chen-Northern 1992a, 1992b, 1992c) showed the drainage rock used at LERF met the sieve requirements and had a hydraulic conductivity of at least 1 centimeter per second, which exceeded the minimum of at least 0.1 centimeters per second required by WAC 173-303-650(2)(j) for new surface impoundments.

Geonet. The geonet is fabricated from two sets of parallel high-density polyethylene strands, spaced 1.3 centimeters center-to-center maximum to form a mesh with minimum two strands per 2.54 centimeter in each direction. The geonet is located between the liners on the sloping sidewalls to provide a preferential flow path for leachate to the drainage gravel and subsequently to the leachate sump.

Leachate Collection Sump. Materials used to line the 3.0-meter by 1.8-meter by 0.30-meter-deep leachate sump, at the bottom of each basin in the northwest corner, include [from top to bottom (Figure 4.18)]:

- 25 millimeter high-density polyethylene flat stock (supporting the leachate riser pipe)
- Geotextile
- 1.5-millimeter high-density polyethylene rub sheet
- Secondary composite liner:
  - 1.5-millimeter high-density polyethylene geomembrane
  - 91 centimeters of soil/bentonite admixture
  - Geotextile

Specifications for these materials are identical to those discussed previously.

Leachate System Risers. Risers for the leachate system consist of 10-inch and 4-inch pipes from the leachate collection sump to the catch basin northwest of each basin (Figure 4.18). The risers lay below the primary liner in a gravel-filled trench that also extends from the sump to the concrete catch basin (Figure 4.19).

The risers are high-density polyethylene pipes fabricated to meet the requirements in ASTM D1248 (ASTM 1989). The 10-inch riser is perforated every 20.3 centimeters with 1.3-centimeter holes around the diameter. Level sensors and leachate pump are inserted in the 10-inch riser to monitor and remove leachate from the sump. To prevent clogging of the pump and piping with fine particulate, the end of the riser is encased in a gravel-filled box constructed of high-density polyethylene geonet and wrapped in geotextile. The 4-inch riser is perforated every 10.2 centimeters with 0.64-centimeter holes around the diameter. A level detector is inserted in the 4-inch riser.

Leachate Pump. A deep-well submersible pump, designed to deliver approximately 110 liters per minute, is installed in the 10-inch leachate riser in each basin. Wetted parts of the leachate pump are made of 316L stainless steel, providing both corrosion resistance and durability.

4.5.2.1.2 Loads on Liner System

The LERF liner system is subjected to the following types of stresses.

Stresses from Installation or Construction Operations. Contractors were required to submit construction quality control plans that included procedures, techniques, tools, and equipment used for the construction and care of liner and leachate system. Methods for installation of all components were screened to ensure that the stresses on the liner system were kept to a minimum.

Calculations were performed to estimate the risk of damage to the secondary high-density polyethylene liner during construction (*Calculations for LERF Part B Permit Application* [HNF 1997]). The greatest risk expected was from spreading the gravel layer over the geotextile layer and secondary geomembrane. The results of the calculations show that the strength of the geotextile was sufficiently high to withstand the stress of a small gravel spreader driving on a minimum of 15 centimeters of gravel over the geotextile and geomembrane. The likelihood of damage to the geomembrane lying under the geotextile was considered low.

To avoid driving heavy machinery directly on the secondary liner, a 28-meter conveyer was used to deliver the drainage gravel into the basins. The gravel was spread and consolidated by hand tools and a bulldozer. The bulldozer traveled on a minimum thickness of 30.5 centimeters of gravel. Where the conveyer assembly was placed on top of the liner, cribbing was placed to distribute the conveyer weight. No heavy equipment was allowed for use directly in contact with the geomembranes.

Additional calculations were performed to estimate the ability of the leachate riser pipe to withstand the static and dynamic loading imposed by lightweight construction equipment riding on the gravel layer (HNF 1997). Those calculations demonstrated that the pipe could buckle under the dynamic loading of

small construction equipment; therefore, the pipe was avoided by equipment during spreading of the drainage gravel.

Installation of synthetic lining materials proceeded only when winds were less than 24 kilometers per hour, and not during precipitation. The minimum ambient air temperature for unfolding or unrolling the high-density polyethylene sheets was -10 C, and a minimum temperature of 0 C was required for seaming the high-density polyethylene sheets. Between shifts, geomembranes and geotextile were anchored with sandbags to prevent lifting by wind. Calculations were performed to determine the appropriate spacing of sandbags on the geomembrane to resist lifting caused by 130 kilometer per hour winds (HNF 1997). All of the synthetic components contain UV light inhibitors and no impairment of performance is anticipated from the short-term UV light exposure during construction. Section 4.5.2.4 provides further detail on exposure prevention.

During the laying of the soil/bentonite layer and the overlying geomembrane, moisture content of the admixture was monitored and adjusted to ensure optimum compaction and to avoid development of cracks.

4.5.2.1.3 Static and Dynamic Loads and Stresses from the Maximum Quantity of Waste

When a LERF basin is full, liquid depth is approximately 6.4 meters. Static load on the primary liner is roughly 6,400 kilograms per square meter. Load on the secondary liner is slightly higher because of the weight of the gravel drainage layer. Assuming a density of 805 kilograms per square meter for the drainage gravel [conservative estimate based on specific gravity of 2.65 (Ambrose 1988)], the secondary high-density polyethylene liner carries approximately 7,200 kilograms per square meter when a basin is full.

Side slope liner stresses were calculated for each of the layers in the basin sidewalls and for the pipe trench on the northwest corner of each basin (HNF 1997). Results of these calculations indicate factors of safety against shear were 1.5 or greater for the primary geomembrane, geotextile, geonet, and secondary geomembrane.

Because the LERF is not located in an area of seismic concern, as identified in Appendix VI of 40 CFR 264 and WAC 173-303-282(6)(a)(I), discussion and calculation of potential seismic events are not required.

4.5.2.1.4 Stresses Resulting from Settlement, Subsidence, or Uplift

Uplift stresses from natural sources are expected to have negligible impact on the liner. Groundwater lies approximately 62 meters below the LERF, average annual precipitation is only 16 centimeters, and the average unsaturated permeability of the soils near the basin bottoms is high, ranging from about 5.5×10^4 centimeters per second to about 1 centimeter per second (Chen-Northern 1991b). Therefore, no hydrostatic uplift forces are expected to develop in the soil underneath the basins. In addition, the soil under the basins consists primarily of gravel and sand, and contains few or no organic constituents. Therefore, uplift caused by gas production from organic degradation is not anticipated.

Based on the design of the soil-bentonite liner, no structural uplift stresses are present within the lining system (Chen-Northern 1991b).

Regional subsidence is not anticipated because neither petroleum nor extractable economic minerals are present in the strata underlying the LERF basins, nor is karst (erosive limestone) topography present.

Dike soils and soil/bentonite layers were compacted thoroughly and proof-rolled during construction. Calculation of settlement potential showed that combined settlement for the foundation and soil/bentonite layer is expected to be about 2.7 centimeters. Settlement impact on the liner and basin stability is expected to be minimal (Chen-Northern 1991b).

4.5.2.1.5 Internal and External Pressure Gradients

Pressure gradients across the liner system from groundwater are anticipated to be negligible. The LERF is about 62 meters above the seasonal high water table, which prevents buildup of water pressure below the liner. The native gravel foundation materials of the LERF are relatively permeable and free draining. The 2 percent slope of the secondary liner prevents the pooling of liquids on top of the secondary liner. Finally, the fill rate of the basins is slow enough (average 190 liters per minute) that the load of the liquid waste on the primary liner is gradually and evenly distributed.

To prevent the buildup of gas between the liners, each basin is equipped with 21 vents in the primary geomembrane that allow the reduction of any excess gas pressure. Gas passing through these vents exit through a single pipe that penetrates the anchor wall into a carbon adsorption filter. This filter extracts nearly all of the organic compounds, ensuring that emissions to the air from the basins are not toxic.

4.5.2.2 Liner System Location Relative to High-Water Table

The lowest point of each LERF basin is the northwest corner of the sump, where the typical subgrade elevation is 175 meters above mean sea level. Based on data collected from the groundwater monitoring wells at the LERF site, the seasonal high-water table is located approximately 62 meters or more below the lowest point of the basins. This substantial thickness of unsaturated strata beneath the LERF provides ample protection to the liner from hydrostatic pressure because of groundwater intrusion into the soil/bentonite layer. Further discussion of the unsaturated zone and site hydrogeology is provided in Chapter 5.0.

4.5.2.3 Liner System Foundation

Foundation materials are primarily gravels and cobbles with some sand and silt. The native soils onsite are derived from unconsolidated Holocene sediments. These sediments are fluvial and glaciofluvial sands and gravels deposited during the most recent glacial and postglacial event. Grain-size distributions and shape analyses of the sediments indicate that deposition occurred in a high-energy environment (Chen-Northern 1990).

Analysis of five soil borings from the LERF site was conducted to characterize the natural foundation materials and to determine the suitability of onsite soils for construction of the impoundment dikes and determine optimal design factors. Well-graded gravel containing varying amounts of silt, sand, and cobbles comprises the layer in which the basins were excavated. This gravel layer extends to depths of 10 to 11 meters below land surface (Chen-Northern 1990). The basins are constructed directly on the subgrade. Excavated soils were screened to remove oversize cobbles (greater than 15 centimeters in the largest dimension) and used to construct the dikes.

Settlement potential of the foundation material and soil/bentonite layer was found to be low. The foundation is comprised of undisturbed native soils. The bottom of the basin excavation lies within the well-graded gravel layer, and is dense to very dense. Below the gravel is a layer of dense to very dense poorly graded and well-graded sand. Settlement was calculated for the gravel foundation soils and for the soil/bentonite layer, under the condition of hydrostatic loading from 6.4 meters of fluid depth. The combined settlement for the soils and the soil/bentonite layer is estimated to be about 2.7 centimeters. This amount of settlement is expected to have minimal impact on overall liner or basin stability (Chen-Northern 1991b). Settlement calculations are provided in *Calculations for Liquid Effluent Retention Facility Part B Permit Application* (HNF 1997).

The load bearing capacity of the foundation material, based on the soil analysis discussed previously, is estimated at about 48,800 kilograms per square meter [maximum advisable presumptive bearing capacity (Hough 1969)]. Anticipated static and dynamic loading from a full basin is estimated to be less than 9,000 kilograms per square meter (Section 4.5.2.1.3), which provides an ample factor of safety.

When the basins are empty, excess hydrostatic pressure in the foundation materials under the liner system theoretically could result in uplift and damage. However, because the native soil forming the foundations is unsaturated and relatively permeable, and because the water table is located at a considerable depth

beneath the basins, any infiltration of surface water at the edge of the basin is expected to travel predominantly downward and away from the basins, rather than collecting under the excavation itself. No gas is expected in the foundation because gas-generating organic materials are not present.

Subsidence of undisturbed foundation materials is generally the result of fluid extraction (water or petroleum), mining, or karst topography. Neither petroleum, mineral resources, nor karst are believed to be present in the sediments overlying the Columbia River basalts. Potential groundwater resources do exist below the LERF. Even if these sediments were to consolidate from fluid withdrawal, their depth most likely would produce a broad, gently sloping area of subsidence that would not cause significant strains in the LERF liner system. Consequently, the potential for subsidence related failures are expected to be negligible.

Borings at the LERF site, and extensive additional borings in the 200 East Area, have not identified any significant quantities of soluble materials in the foundation soil or underlying sediments (Last et al. 1989). Consequently, the potential for sinkholes is considered negligible.

4.5.2.4 Liner System Exposure Prevention

Both primary and secondary geomembranes and the floating cover are stabilized with carbon black to prevent degradation from UV light. Furthermore, none of the liner layers experience long-term exposure to the elements. During construction, thin polyethylene sheeting was used to maintain optimum moisture content and provide protection from the wind for the soil/bentonite layer until the secondary geomembrane was laid in place. The secondary geomembrane was covered by the geonet and geotextile as soon as quality control testing was complete. Once the geotextile layer was completed, drainage material immediately was placed over the geotextile. The final (upper) geotextile layer was placed over the drainage gravel and immediately covered by the bentonite carpet liner. This was covered immediately, in turn, by the primary high-density polyethylene liner.

Both high-density polyethylene liners, geotextile layers, and geonet are anchored permanently to a concrete wall at the top of the basin berm. During construction, liners were held in place with many sandbags on both the basin bottoms and side slopes to prevent wind from lifting and damaging the materials. Calculations were performed to determine the amount of fluid needed in a basin to prevent wind lift damage to the primary geomembrane. Approximately 15 to 20 centimeters of solution are kept in each basin to minimize the potential for uplifting the primary liner (HNF 1997).

The entire lining system is covered by a very low-density polyethylene floating cover that is bolted to the concrete anchor wall. The floating cover prevents evaporation and intrusion from dust, precipitation, vegetation, animals, and birds. A patented tensioning system is employed to prevent wind from lifting the cover and automatically accommodate changes in liquid level in the basins. The cover tension mechanism consists of a cable running from the flexible geosynthetic cover over a pulley on the tension tower (located on the concrete anchor wall) to a dead man anchor. These anchors (blocks) simply hang from the cables on the exterior side of the tension towers. The anchor wall also provides for solid attachment of the liner layers and the cover, using a 6.4-millimeter batten and neoprene gasket to bolt the layers to the concrete wall, effectively sealing the basin from the intrusion of light, precipitation, and airborne dust (Figure 4.16).

The floating cover, made of very low-density polyethylene with UV light inhibitors, is not anticipated to experience unacceptable degradation during the service life of the LERF. The very low-density polyethylene material contains carbon black for UV light protection, anti-oxidants to prevent heat degradation, and seaming enhancers to improve its ability to be welded. A typical manufacturer's limited warranty for weathering of very low-density polyethylene products is 20 years (Poly America, undated). This provides a margin of safety for the anticipated medium-term use of the LERF for aqueous waste storage.

The upper 3.4 to 4.6 meters of the sidewall liner also could experience stresses in response to temperature changes. Accommodation of thermal influences for the LERF geosynthetic layers is affected by inclusion of sufficient slack as the liners were installed. Calculations demonstrate that approximately

67 centimeters of slack is required in the long basin bottom dimension, 46 centimeters across the basin, and 34 centimeters from the bottom of the basin to the top of the basin wall (HNF 1997).

Thermal stresses also are experienced by the floating cover. As with the geomembranes, sufficient slack was included in the design to accommodate thermal contraction and expansion.

4.5.2.4.1 Liner Repairs During Operations

Should repair of a basin liner be required while the basin is in operation, the basin contents will be transferred to the ETF or another available basin. After the liner around the leaking section is cleaned, repairs to the geomembrane will be made by the application of a piece of high-density polyethylene sheeting, sufficient in size to extend approximately 8 to 15 centimeters beyond the damaged area, or as recommended by the vendor. A round or oval patch will be installed using the same type of equipment and criteria used for the initial field installations.

4.5.2.4.2 Control of Air Emissions

The floating covers limit evaporation of aqueous waste and releases of volatile organic compounds into the atmosphere. To accommodate volumetric changes in the air between the fluid in the basin and the cover, and to avoid problems related to 'sealing' the basins too tightly, each basin is equipped with a carbon filter breather vent system. Any air escaping from the basins must pass through this vent, consisting of a pipe that penetrates the anchor wall and extends into a carbon adsorption filter unit.

4.5.2.5 Liner Coverage

The liner system covers all of the ground surface that underlies the retention basins. The primary liner extends up the side slopes to a concrete anchor wall at the top of the dike encircling the entire basin (Figure 4.16).

4.5.3 Prevention of Overtopping

Overtopping prevention is accomplished through administrative controls and liquid-level instrumentation installed in each basin. The instrumentation includes local liquid-level indication as well as remote indication at the ETF. Before an aqueous waste is transferred into a basin, administrative controls are implemented to ensure overtopping will not occur during the transfer. The volume of feed to be transferred is compared to the available volume in the receiving basin. The transfer is not initiated unless there is sufficient volume available in the receiving basin or a cut-off level is established. The transfer into the basin would be stopped when this cut-off level is reached.

In the event of a 100-year, 24-hour storm event, precipitation would accumulate on the basin covers. Through the self-tensioning design of the basin covers and maintenance of adequate freeboard, all accumulated precipitation would be contained on the covers and none would flow over the dikes or anchor walls. The 100-year, 24-hour storm is expected to deliver 5.3 centimeters of rain or approximately 61 centimeters of snow. Cover specifications include the requirement that the covers be able to withstand the load from this amount of precipitation. Because the cover floats on the surface of the fluid in the basin, the fluid itself provides the primary support for the weight of the accumulated precipitation. Through the cover self-tensioning mechanism, there is ample 'give' to accommodate the overlying load without overstressing the anchor and attachment points.

Rainwater and snow evaporate readily from the cover, particularly in the arid Hanford Facility climate, where evaporation rates exceed precipitation rates for most months of the year. The black color of the cover further enhances evaporation. Thus, the floating cover prevents the intrusion of precipitation into the basin and provides for evaporation of accumulated rain or snow.

4.5.3.1 Freeboard

Under current operating conditions, 0.61 meter of freeboard is maintained at each LERF basin, which corresponds to an operating level of 6.8 meters, or 29.5 million liters.

4.5.3.2 Immediate Flow Shutoff

The mechanism for transferring aqueous waste is either through pump transfers with on/off switches or through gravity transfers with isolation valves. These methods provide positive ability to shut off transfers immediately in the event of overtopping. Overtopping a basin during a transfer is very unlikely because the low flow rate into the basin provides long response times. At a flow rate of 284 liters per minute, approximately 11 days would be required to fill a LERF basin from the 6.8-meter operating level (i.e., 0.61 meter of freeboard) to maximum capacity of 34 million liters (i.e., the 7.4-meter level).

4.5.3.3 Outflow Destination

Aqueous waste in the LERF is transferred routinely to ETF for treatment. However, should it be necessary to immediately empty a basin, the aqueous waste either would be transferred to the ETF for treatment or transferred to another basin (or basins), whichever is faster. If the waste is transferred to another LERF basin, the single pump for normal operation can be removed, and four submersible pumps can be installed using an emergency pump manifold. This portable piping and pumping system is capable of pumping 2,700 liters per minute. Not including set-up time, it would take approximately 7.6 days to pump the contents of a full basin at this pumping rate.

4.5.4 Structural Integrity of Dikes

The structural integrity of the dikes was certified attesting to the structural integrity of the dikes, signed by a qualified, registered professional engineer.

4.5.4.1 Dike Design, Construction, and Maintenance

The dikes of the LERF are constructed of onsite native soils, generally consisting of cobbles and gravels. Well-graded mixtures were specified, with cobbles up to 15 centimeters in the largest dimension, but not constituting more than 20 percent of the volume of the fill. The dikes are designed with a 3:1 (3 units horizontal to 1 unit vertical) slope on the basin side, and 2.25:1 on the exterior side. The dikes are approximately 8.2 meters high from the bottom of the basin, and 3 meters above grade.

Calculations were performed to verify the structural integrity of the dikes (HNF 1997). The calculations demonstrate that the structural strength of the dikes is such that, without dependence on any lining system, the sides of the basins can withstand the pressure exerted by the maximum allowable quantity of fluid in the impoundment. The dikes have a factor of safety greater than 2.5 against failure by sliding.

4.5.4.2 Dike Stability and Protection

In the following paragraphs, various aspects of stability for the LERF dikes and the concrete anchor wall are presented, including slope failure, hydrostatic pressure, and protection from the environment.

Failure in Dike/Impoundment Cut Slopes. A slope stability analysis was performed to determine the factor of safety against slope failure. The computer program 'PCSTABL5' from Purdue University, using the modified Janbu Method, was employed to evaluate slope stability under both static and seismic loading cases. One hundred surfaces per run were generated and analyzed. The assumptions used were as follows (Chen-Northern 1991b):

- Weight of gravel: 2,160 kilograms per cubic meter
- Maximum dry density of gravel: 2,315 kilograms per cubic meter
- Mohr-Coulomb shear strength angle for gravel: minimum 33 degrees
- Weight of soil/bentonite: 1,600 kilograms per cubic meter
- Mohr-Coulomb shear strength angle for soil/bentonite: minimum 30 degrees
- Slope: 3 horizontal: 1 vertical
- No fluid in impoundment (worst case for stability)
- Soils at in-place moisture (not saturated conditions)

Results of the static stability analysis showed that the dike slopes were stable with a minimum factor of safety of 1.77 (Chen-Northern 1991b).

The standard horizontal acceleration required in the *Hanford Plant Standards*, "Standard Architectural-Civil Design Criteria, Design Loads for Facilities" (DOE-RL 1988), for structures on the Hanford Site is 0.12 g. Adequate factors of safety for cut slopes in units of this type generally are considered 1.5 for static conditions and 1.1 for dynamic stability (Golder 1989). Results of the stability analysis showed that the LERF basin slopes were stable under horizontal accelerations of 0.10 and 0.15 g, with minimum factors of safety of 1.32 and 1.17, respectively (Chen-Northern 1991b). Printouts from the PCSTABL5 program are provided in *Calculations for Liquid Effluent Retention Facility Part B Permit Application* (HNF 1997).

Hydrostatic Pressure. Failure of the dikes due to buildup of hydrostatic pressure, caused by failure of the leachate system or liners, is very unlikely. The liner system is constructed with two essentially impermeable layers consisting of a synthetic layer overlying a soil layer with low-hydraulic conductivity. It would require a catastrophic failure of both liners to cause hydrostatic pressures that could endanger dike integrity. Routine inspections of the leachate detection system, indicating quantities of leachate removed from the basins, provide an early warning of leakage or operational problems that could lead to excessive hydrostatic pressure. A significant precipitation event (e.g., a 100-year, 24-hour storm) will not create a hydrostatic problem because the interior sidewalls of the basins are covered completely by the liners. The covers can accommodate this volume of precipitation without overtopping the dike (Section 4.5.3), and the coarse nature of the dike and foundation materials on the exterior walls provides for rapid drainage of precipitation away from the basins.

Protection from Root Systems. Risk to structural integrity of the dikes because of penetrating root systems is minimal. Excavation and construction removed all vegetation on and around the impoundments, and native plants (such as sagebrush) grow very slowly. The large grain size of the cobbles and gravel used as dike construction material do not provide an advantageous germination medium for native plants. Should plants with extending roots become apparent on the dike walls, the plants will be controlled with appropriate herbicide application.

Protection from Burrowing Mammals. The cobble size materials that make up the dike construction material and the exposed nature of the dike sidewalls do not offer an advantageous habitat for burrowing mammals. Lack of vegetation on the LERF site discourages foraging. The risk to structural integrity of the dikes from burrowing mammals is therefore minimal. Periodic visual inspections of the dikes provide observations of any animals present. Should burrowing mammals be noted onsite, appropriate pest control methods such as trapping or application of rodenticides will be employed.

Protective Cover. Approximately 7.6 centimeters of crushed gravel serve as the cover of the exterior dike walls. This coarse material is inherently resistant to the effect of wind because of its large grain size. Total annual precipitation is low (16 centimeters) and a significant storm event (e.g., a 100-year, 24-hour storm) could result in about 5.3 centimeters of precipitation in a 24-hour period. The absorbent capacity of the soil exceeds this precipitation rate; therefore, the impact of wind and precipitation run-on to the exterior dike walls will be minimal.

4.5.5 Piping Systems

Aqueous waste from the 242-A Evaporator is transferred to the LERF using a pump located in the 242-A Evaporator and approximately 1,500 meters of pipe, consisting of a 3-inch carrier pipe within a 6-inch outer containment pipeline. Flow through the pump is controlled through a valve at flow rates from 150 to 300 liters per minute.

The pipeline exits the 242-A Evaporator below grade and remains below grade at a minimum 1.2-meter depth for freeze protection, until the pipeline emerges at the LERF catch basin, at the corner of each basin. All piping at the catch basin that is less than 1.2 meters below grade is wrapped with electric heat tracing tape and insulated for protection from freezing.

The transfer line from the 242-A Evaporator is centrifugally cast, fiberglass-reinforced epoxy thermoset resin pressure pipe fabricated to meet the requirements of ASME D2997 (ASME 1984). The 3-inch carrier piping is centered and supported within 6-inch containment piping. Pipe supports are fabricated of

the same material as the pipe, and meet the strength requirements of ANSI B31.3 (ANSI 1987) for dead weight, thermal, and seismic loads.

A catch basin is provided at the northwest corner of each basin where piping extends from the basin to allow for basin-to-basin and basin-to-ETF liquid transfers. Drawing H-2-88766, sheets 1 through 4, provide schematic diagrams of the piping system at LERF. Drawing H-2-79604 provides details of the piping from the 242-A Evaporator to LERF.

4.5.5.1 Secondary Containment System for Piping

The 6-inch containment piping encases the 3-inch carrier pipe from the 242-A Evaporator to the LERF. All of the piping and fittings that are not directly over a catch basin or a basin liner are of this pipe-within-a-pipe construction. A catch basin is provided at the northwest corner of each basin where the inlet pipes, leachate risers, and transfer pipe risers emerge from the basin. The catch basin consists of a 20-centimeter-thick concrete pad at the top of the dike. The perimeter of the catch basin has a 20-centimeter-high curb, and the concrete is coated with a chemical resistant epoxy sealant. The concrete pad is sloped so that any leaks or spills from the piping or pipe connections will drain into the basin. The catch basin provides an access point for inspecting, servicing, and operating various systems such as transfer valving, leachate level instrumentation and leachate pump. Drawing H-2-79593 provides a schematic diagram of the catch basins.

4.5.5.2 Leak Detection System

Single-point electronic leak detection elements are installed along the transfer line at 305-meter intervals. The leak detection elements are located in the bottom of specially designed test risers. Each sensor element employs a conductivity sensor, which is connected to a cable leading back to the 242-A Evaporator control room. If a leak develops in the carrier pipe, fluid will travel down the exterior surface of the carrier pipe or the interior of the containment pipe. As moisture contacts a sensor unit, the alarm sounds in the ETF control room and the zone of the leak is indicated on the digital display. The pump located in the 242-A Evaporator is shut down, stopping the flow of aqueous waste through the transfer line. A low-volume air purge of the annulus between the carrier pipe and the containment pipe is provided to prevent condensation buildup and minimize false alarms by the leak detection elements.

The catch basins have conductivity leak detectors that alarm in the 242-A Evaporator control room. Leaks into the catch basins drain back to the basin through a 5.1-centimeter drain on the floor of the catch basin.

4.5.5.3 Certification

Although an integrity assessment is not required for piping associated with surface impoundments, an assessment of the transfer liner was performed, including a hydrostatic leak/pressure test at 10.5 kilograms per square centimeter gauge. A statement by an independent, qualified, registered professional engineer attesting to the integrity of the piping system is included in *Integrity Assessment Report for the 242-A Evaporator/LERF Waste Transfer Piping, Project W105* (WHC 1993), along with the results of the leak/pressure test.

4.5.6 Double Liner and Leak Detection, Collection, and Removal System

The double-liner system for LERF is discussed in Section 4.5.2. The leachate detection, collection, and removal system (Figures 4.18 and 4.19) was designed and constructed to remove leachate that might permeate the primary liner. System components for each basin include:

- 30.5-centimeter layer of drainage gravel below the primary liner at the bottom of the basin
- Geonet below the primary liner on the sidewalls to direct leachate to the gravel layer
- 3.0-meter by 1.8-meter by 0.30-meter-deep leachate collection sump consisting of a 25 millimeter high-density polyethylene flat stock, geotextile to trap large particles in the leachate, and 1.5-millimeter high-density polyethylene rub sheet set on the secondary liner

- 10-inch and 4-inch perforated leachate high-density polyethylene riser pipes from the leachate collection sump to the catch basin northwest of the basin
- Leachate collection sump level instrumentation installed in the 4-inch riser
- Level sensors, submersible leachate pump, and 1.5-inch fiberglass-reinforced epoxy thermoset resin pressure piping installed in the 10-inch riser
- Piping at the catch basin to route the leachate through 1.5-inch high-density polyethylene pipe back to the basins

The bottom of the basins has a two percent slope to allow gravity flow of leachate to the leachate collection sump. This exceeds the minimum of 1 percent slope required by WAC 173-303-650(j) for new surface impoundments. Material specifications for the leachate collection system are given in Section 4.5.2.1.1.

Calculations demonstrate that fluid from a small hole (2 millimeter) (EPA 1989, p. 122) at the furthest end of the basin, under a low head situation, would travel to the sump in less than 24 hours (HNF 1997). Additional calculations indicate the capacity of the pump to remove leachate is sufficient to allow time to readily identify a leak and activate emergency procedures (HNF 1997).

Automated controls maintain the fluid level in each leachate sump below 33 centimeters to prevent significant liquid backup into the drainage layer. The leachate pump is activated when the liquid level in the sump reaches about 28 centimeters, and is shut off when the sump liquid level reaches about 18 centimeters. This operation prevents the leachate pump from cycling with no fluid, which could damage the pump. Liquid level control is accomplished with conductivity probes that trigger relays selected specifically for application to submersible pumps and leachate fluids. A flowmeter/totalizer on the leachate return pipe measures fluid volumes pumped and pumping rate from the leachate collection sumps, and indicates volume and flow rate on local readouts. Other instrumentation provided is real-time continuous level monitoring with a readout at the catch basin and the 242-A Evaporator control room. A sampling port is provided in the leachate piping system at the catch basin. Leak detection is provided through inspections of the leachate flow totalizer readings. For more information on inspections, refer to Chapter 6.0.

The stainless steel leachate pump is designed to deliver 110 liters per minute. The leachate pump returns draw liquid from the sump via 1.5-inch pipe and discharges into the basin through 1.5-inch high-density polyethylene pipe.

4.5.7 Construction Quality Assurance

The construction quality assurance plan and complete report of construction quality assurance inspection and testing results are provided in *242-A Evaporator Interim Retention Basin Construction Quality Assurance Plan* (KEH 1991). A general description of construction quality assurance procedures is outlined in the following paragraphs.

For excavation of the basins and construction of the dikes, regular inspections were conducted to ensure compliance with procedures and drawings, and compaction tests were performed on the dike soils.

For the soil/bentonite layer, test fills were first conducted in accordance with EPA guidance to demonstrate compaction procedures and to confirm compaction and permeability requirements can be met. The ratio of bentonite to soil and moisture content was monitored; lifts did not exceed 15 centimeters before compaction, and specific compaction procedures were followed. Laboratory and field tests of soil properties were performed for each lift and for the completed test fill. The same suite of tests was conducted for each lift during the laying of the soil/bentonite admixture in the basins.

Geotextiles and geomembranes were laid in accordance with detailed procedures and quality assurance programs provided by the manufacturers and installers. These included destructive and nondestructive tests on the geomembrane seams, and documentation of field test results and repairs.

4.5.8 Proposed Action Leakage Rate and Response Action Plan

An action leakage rate limit is established where action must be taken due to excessive leakage from the primary liner. The action leak rate is based on the maximum design flow rate the leak detection system can remove without the fluid head on the bottom liner exceeding 30 centimeters. The limiting factor in the leachate removal rate is the hydraulic conductivity of the drainage gravel. An action leakage rate (also called the rapid or large leak rate) of 20,000 liters per hectare per day was calculated for each basin (WHC 1992b).

When it is determined that the action leakage rate has been exceeded, the response action plan will follow the actions in WAC 173-303-650(11)(b) and (c), which includes notification of Ecology in writing within 7 days, assessing possible causes of the leak, and determining whether waste receipt should be curtailed and/or the basin emptied.

4.5.9 Dike Structural Integrity Engineering Certification

The structural integrity of the dikes was certified attesting to the structural integrity of the dikes, signed by a qualified, registered professional engineer.

4.5.10 Management of Ignitable, Reactive, or Incompatible Wastes

Although ignitable or reactive aqueous waste might be received in small quantities at LERF, such aqueous waste is mixed with dilute solutions in the basins, removing the ignitable or reactive characteristics. For compatibility requirements with the LERF liner, refer to the waste analysis plan Chapter 3.0.

4.6 AIR EMISSIONS CONTROL

This section addresses the ETF requirements of Air Emission Standards for Process Vents, under 40 CFR 264, Subpart AA (incorporated by reference in WAC 173-303-690) and Subpart CC. The requirements of 40 CFR 264, Subpart BB (WAC 173-303-691) is not applicable because aqueous waste with 10 percent or greater organic concentration would not be acceptable for processing at the ETF.

4.6.1 Applicability of Subpart AA Standards

The ETF evaporator and thin film dryer perform operations that specifically require evaluation for applicability of WAC 173-303-690. Aqueous waste in these units routinely contains greater than 10 parts per million concentrations of organic compounds and are, therefore, subject to air emission requirements under WAC 173-303-690. Organic emissions from all affected process vents on the Hanford Facility must be less than 1.4 kilograms per hour and 2.8 megagrams per year, or control devices must be installed to reduce organic emissions by 95 percent.

The vessel off gas system provides a process vent system. This system provides a slight vacuum on the ETF process vessels and tanks (refer to Section 4.2.5.2). Two vessel vent header pipes combine and enter the vessel off gas system filter unit consisting of a demister, electric heater, prefilter, high-efficiency particulate air filters, activated carbon absorber, and two exhaust fans (one fan in service while the other is backup). The vessel off gas system filter unit is located in the high-efficiency particulate air filter room west of the process area. The vessel off gas system exhaust discharges into the larger building ventilation system, with the exhaust fans and stack located outside and immediately west of the ETF. The exhaust stack discharge point is 15.5 meters above ground level.

The annual average flow rate for the ETF stack (which is the combined vessel off gas and building exhaust flow rates) is 220 cubic meters per minute with a total annual flow of approximately 1.2 E+08 cubic meters. During waste processing, the airflow through just the vessel off gas system is about 23 standard cubic meters per minute.

Organic emissions occur during waste processing, which occurs less than 310 days each year (i.e., 85 percent operating efficiency). This operating efficiency represents the maximum annual

operating time for the ETF, as shutdowns are required during the year for planned maintenance outages and for reconfiguring the ETF to accommodate different aqueous waste.

4.6.2 Process Vents - Demonstrating Compliance

This section outlines how the ETF complies with the requirements and includes a discussion of the basis for meeting the organic emissions limits, calculations demonstrating compliance, and conditions for reevaluation.

4.6.2.1 Basis for Meeting Limits/Reductions

The 242-A Evaporator and the 200 Area ETF are currently the only operating TSD units that contribute to the Hanford Facility volatile organic emissions under 40 CFR 264, Subpart AA. The combined release rate is currently well below the threshold of 1.4 kilograms per hour or 2,800 kilograms per year of volatile organic compounds. As a result, the ETF meets these standards without the use of air pollution control devices.

The amount of organic emissions could change as waste streams are changed, or TSD units are brought online or are deactivated. The organic air emissions summation will be re-evaluated periodically as condition warrants. Operations of the TSD units operating under 40 CFR 264, Subpart AA, will be controlled to maintain Hanford Facility emissions below the threshold limits or pollution control device(s) will be added, as necessary, to achieve the reduction standards specified under 40 CFR 264, Subpart AA.

4.6.2.2 Demonstrating Compliance

Calculations to determine organic emissions are performed using the following assumptions:

- Maximum flow rate from LERF to ETF is 568 liters per minute.
- Emissions of organics from tanks and vessels upstream of the UV/OX process are determined from flow and transfer rates given in *Clean Air Act Requirements, WAC 173-400, As-built Documentation, Project C-018H, 242-A Evaporator/PUREX Plant Process Condensate Treatment Facility* (Adtechs 1995).
- UV/OX reaction rate constants and residence times are used to determine the amount of organics, which are destroyed in the UV/OX process. These constants are given in *200 Area Effluent Treatment Facility Delisting Petition* (DOE/RL 1992).
- All organic compounds that are not destroyed in the UV/OX process are assumed to be emitted from the tanks and vessels into the vessel off gas system.
- No credit for removal of organic compounds in the vessel off gas system carbon absorber unit is taken. The activated carbon absorbers are used if required to reduce organic emissions.

The calculation to determine organic emissions consists of the following steps:

1. Determine the quantity of organics emitted from the tanks or vessels upstream of the UV/OX process, using transfer rate values
2. Determine the concentration of organics in the waste after the UV/OX process using UV/OX reaction rates and residence times. If the ETF is configured such that the UV/OX process is not used, a residence time of zero is used in the calculations (i.e., none of the organics are destroyed)
3. Assuming all the remaining organics are emitted, determine the rate which the organics are emitted using the feed flow rate and the concentrations of organics after the UV/OX process
4. The amount of organics emitted from the vessel off gas system is the sum of the amount calculated in steps 1 and 3.

The organic emission rates and quantity of organics emitted during processing are determined using these calculations and are included in the ETF operating record.

4.6.2.3 Reevaluating Compliance with Subpart AA Standards

Calculations to determine compliance with Subpart AA will be reviewed when any of the following conditions occur at the ETF:

- Changes in the maximum feed rate to the ETF (i.e., greater than the 568 liters per minute flow rate)
- Changes in the configuration or operation of the ETF that would modify the assumptions given in Section 4.6.2.2 (e.g., taking credit for the carbon absorbers as a control device)
- Annual operating time exceeds 310 days.

4.6.3 Applicability of Subpart CC Standards

The air emission standards of 40 CFR 264, Subpart CC apply to tank, surface impoundment, and container storage units that manage wastes with average volatile organic concentrations equal to or exceeding 500 parts per million by weight, based on the hazardous waste composition at the point of origination (61 FR 59972). However, TSD units that are used solely for management of mixed waste are exempt. Mixed waste is managed at the ETF and LERF and dangerous waste could be treated and stored at these TSD units.

TSD owner/operators are not required to determine the concentration of volatile organic compounds in a hazardous waste if the wastes are placed in waste management units that employ air emission controls that comply with the Subpart CC standards. Therefore, the approach to Subpart CC compliance at the ETF and LERF is to demonstrate that the ETF and LERF meet the Subpart CC control standards (40 CFR 264.1084 - 264.1086).

4.6.3.1 Demonstrating Compliance with Subpart CC for Tanks

Since the ETF tanks already have process vents regulated under 40 CFR 264, Subpart AA (WAC 173-303-690), they are exempt from Subpart CC [40 CFR 264.1080(b)(8)].

4.6.3.2 Demonstrating Compliance with Subpart CC for Containers

Container Level 1 and Level 2 standards are met at the ETF by managing all dangerous and/or mixed wastes in U.S. Department of Transportation containers [40 CFR 264.1086(f)]. Level 1 containers are those that store more than 0.1 cubic meters and less than or equal to 0.46 cubic meters. Level 2 containers are used to store more than 0.46 cubic meters of waste, which are in "light material service". Light material service is defined where a waste in the container has one or more organic constituents with a vapor pressure greater than 0.3 kilopascals at 20 C, and the total concentration of such constituents is greater than or equal to 20 percent by weight.

The monitoring requirements for Level 1 and Level 2 containers include a visual inspection when the container is received at the ETF and when the waste is initially placed in the container. Additionally, at least once every 12 months when stored onsite for 1 year or more, these containers must be inspected.

If compliant containers are not used at the ETF, alternate container management practices are used that comply with the Level 1 standards. Specifically, the Level 1 standards allow for a "container equipped with a cover and closure devices that form a continuous barrier over the container openings such that when the cover and closure devices are secured in the closed position there are no visible holes, gaps, or other open spaces into the interior of the container. The cover may be a separate cover installed on the container...or may be an integral part of the container structural design…" [40 CFR 264.1086(c)(1)(ii)]. An organic-vapor-suppressing barrier, such as foam, may also be used [40 CFR 264.1086(c)(1)(iii)]. Section 4.3 provides detail on container management practices at the ETF.

Container Level 3 standards apply when a container is used for the "treatment of a hazardous waste by a waste stabilization process" [40 CFR 264.1086(2)]. Because treatment in containers using the stabilization process is not provided at the ETF, these standards do not apply.

4.6.3.3 Demonstrating Compliance with Subpart CC for Surface Impoundments

The Subpart CC emission standards are met at LERF using a floating membrane cover that is constructed of very-low-density polyethylene that forms a continuous barrier over the entire surface area [40 CFR 264.1085(c)]. This membrane has both organic permeability properties equivalent to a high-density polyethylene cover and chemical/physical properties that maintain the material integrity for the intended service life of the material. The additional requirements for the floating cover at the LERF have been met (Section 4.5.2.4).

4.7 ENGINEERING DRAWINGS

4.7.1 Liquid Effluent Retention Facility

Drawings of the containment systems at the LERF are summarized in Table 4.1. Because the failure of these containment systems at LERF could lead to the release of dangerous waste into the environment, modifications that affect these containment systems will be submitted to the Washington State Department of Ecology, as a Class 1, 2, or 3 Permit modification, as required by WAC 173-303-830.

Table 4.1. Liquid Effluent Retention Facility Containment System.

LERF System	Drawing Number	Drawing Title
Bottom Liner	H-2-79590, Sheet 1	Civil Plan, Sections and Details; Cell Basin Bottom Liner
Top Liner	H-2-79591, Sheet 1	Civil Plan, Sections and Details; Cell Basin Bottom Liner
Catch Basin	H-2-79593, Sheet 1	Civil Plan, Section and Details; Catch Basin

The drawings identified in Table 4.2 illustrate the piping and instrumentation configuration within LERF, and of the transfer piping systems between the LERF and the 242-A Evaporator. These drawings are provided for general information and to demonstrate the adequacy of the design of the LERF as a surface impoundment.

Table 4.2. Liquid Effluent Retention Facility Piping and Instrumentation.

LERF System	Drawing Number	Drawing Title
Transfer Piping to 242-A Evaporator	H-2-79604, Sheet 1	Piping Plot and Key Plans; 242-A Evaporator Condensate Stream
LERF Piping and Instrumentation	H-2-88766, Sheet 1	P&ID; LERF Basin and ETF Influent
	H-2-88766, Sheet 2	P&ID; LERF Basin and ETF Influent
	H-2-88766, Sheet 3	P&ID; LERF Basin and ETF Influent
	H-2-88766, Sheet 4	P&ID; LERF Basin and ETF Influent
Legend	H-2-89351, Sheet 1	Piping & Instrumentation Diagram - Legend

4.7.2 200 Area Effluent Treatment Facility

Drawings of the secondary containment systems for the ETF containers, and tanks and process units, and for the Load-In Tanks are summarized in Table 4.3. Because the failure of the secondary containment systems could lead to the release of dangerous waste into the environment, modifications, which affect the secondary containment systems, will be submitted to the Washington State Department of Ecology, as a Class 1, 2, or 3 Permit modification, as required by WAC 173-303-830.

Table 4.3. Effluent Treatment Facility and Load-In Station Secondary Containment Systems

ETF Process Unit	Drawing Number	Drawing Title
Surge Tank, Process/ Container Storage Areas and Trenches - Foundation and Containment	H-2-89063, Sheet 1	Architectural/structural – Foundation and Grade Beam Plan
Sump Tank Containment	H-2-89065, Sheet 1	Architectural/structural – Foundation, Sections and Detail
Verification Tank Foundation and Containment	H-2-89068, Sheet 1	Architectural/structural – Verification Tank Foundation
Load-In Facility Foundation and Containment	H-2-817970, Sheet 1	Structural – ETF Truck Load-in Facility Plans and Sections
Load-In Facility Foundation and Containment	H-2-817970, Sheet 2	Structural – ETF Truck Load-in Facility Sections and Details

The drawings identified in Table 4.4 provide an illustration of the piping and instrumentation configuration for the major process units and tanks at the ETF, and the Load-In Tanks. Drawings of the transfer piping systems between the LERF and ETF, and between the Load-In Station and the ETF also are presented in this table. These drawings are provided for general information and to demonstrate the adequacy of the design of the tank systems.

Table 4.4. Major Process Units and Tanks at the Effluent Treatment Facility and Load-In Station

ETF Process Unit	Drawing Number	Drawing Title
Load-In Facility	H-2-817974, Sheet 1	P&ID – ETF Truck Load-In Facility
Load-In Facility	H-2-817974, Sheet 2	P&ID – ETF Truck Load-In Facility
Surge Tank	H-2-89337, Sheet 1	P&ID – Surge Tank System
UV/Oxidation	H-2-88976, Sheet 1	P&ID – UV Oxidizer Part 1
UV/Oxidation	H-2-89342, Sheet 1	P&ID – UV Oxidizer Part 2
Reverse Osmosis	H-2-88980, Sheet 1	P&ID – 1st RO Stage
Reverse Osmosis	H-2-88982, Sheet 1	P&ID – 2nd RO Stage
IX/Polishers	H-2-88983, Sheet 1	P&ID – Polisher
Verification Tanks	H-2-88985, Sheet 1	P&ID – Verification Tank System
ETF Evaporator	H-2-89335, Sheet 1	P&ID – Evaporator
Thin Film Dryer	H-2-88989, Sheet 1	P&ID – Thin Film Dryer
Transfer Piping from LERF to ETF	H-2-88768, Sheet 1	Piping Plan/Profile 4"– 60M-002-M17 and 3"-60M-001-M17
Transfer Piping from Load-In Facility to ETF	H-2-817969, Sheet 1	Civil – ETF Truck Load-In Facility Site Plan

Figure 4.1. Liquid Effluent Retention Facility Layout

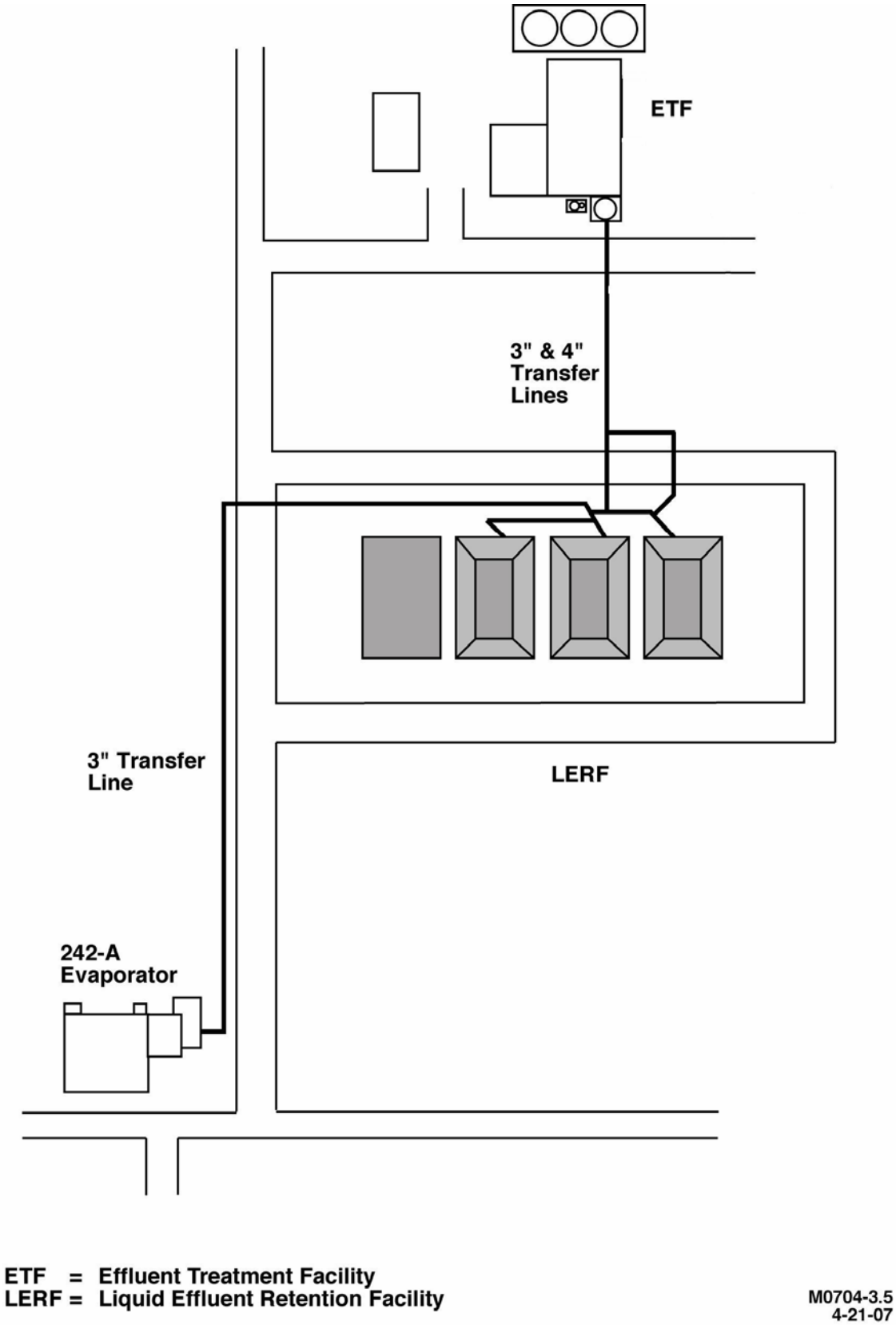


Figure 4.2. Plan View of the 200 Area Effluent Treatment Facility

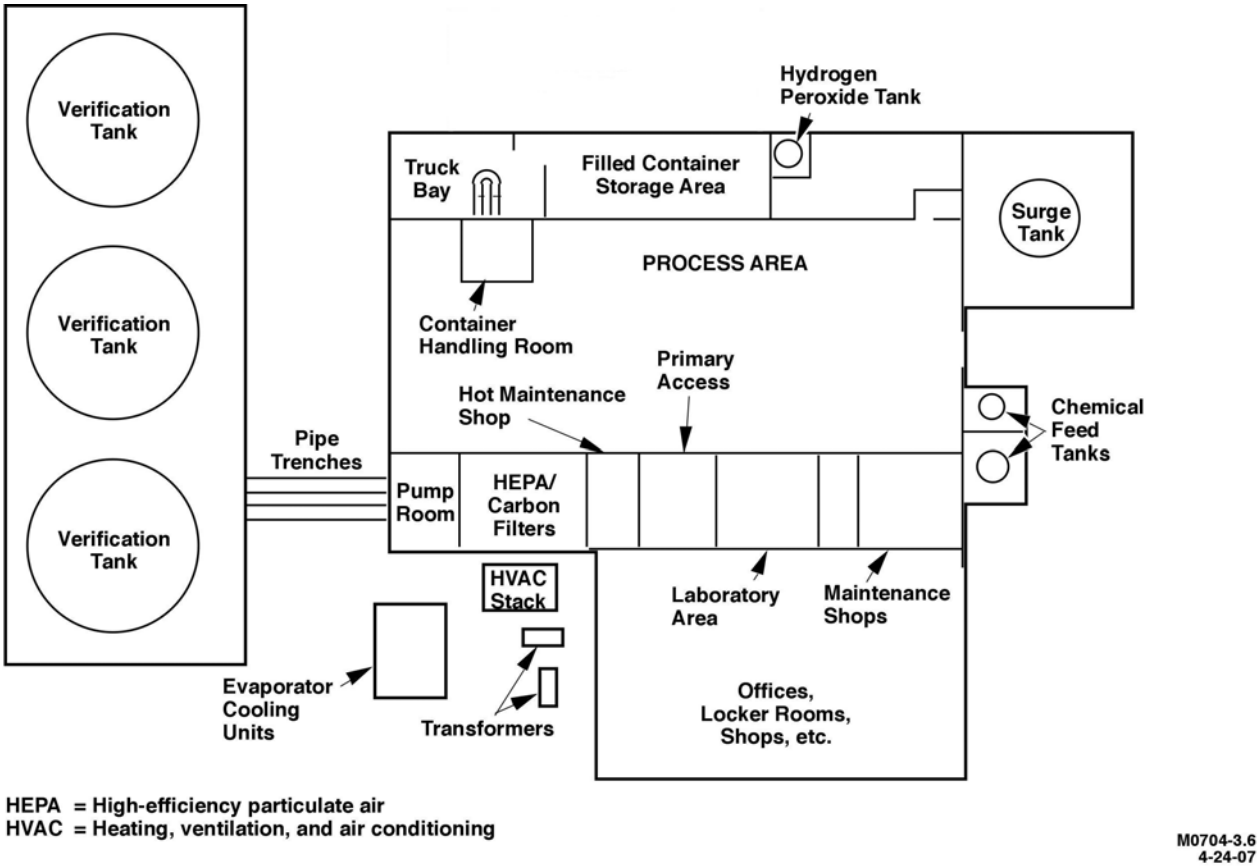


Figure 4.3. 200 Area Effluent Treatment Facility Layout

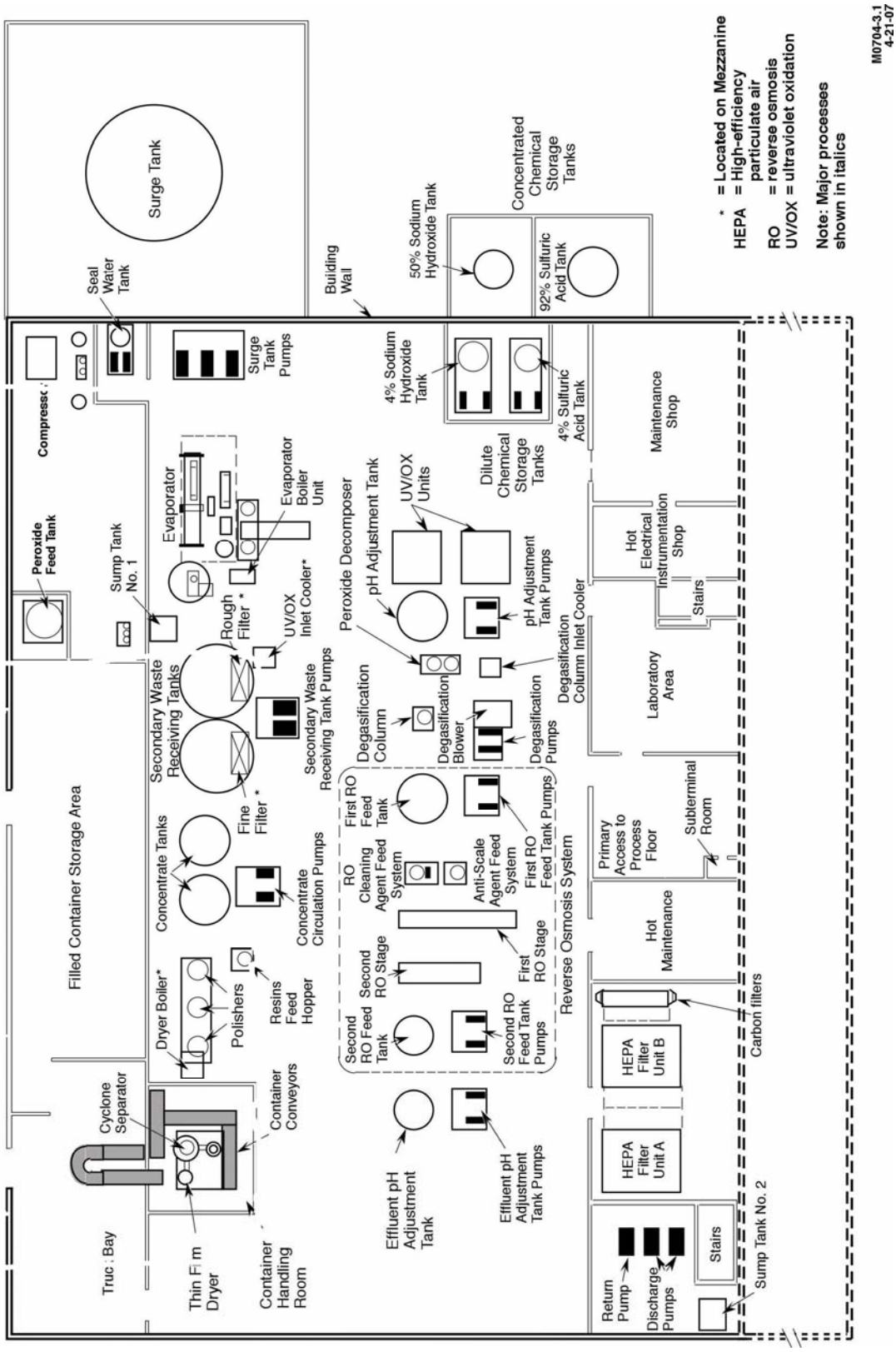


Figure 4.4. 200 Area Effluent Treatment Facility

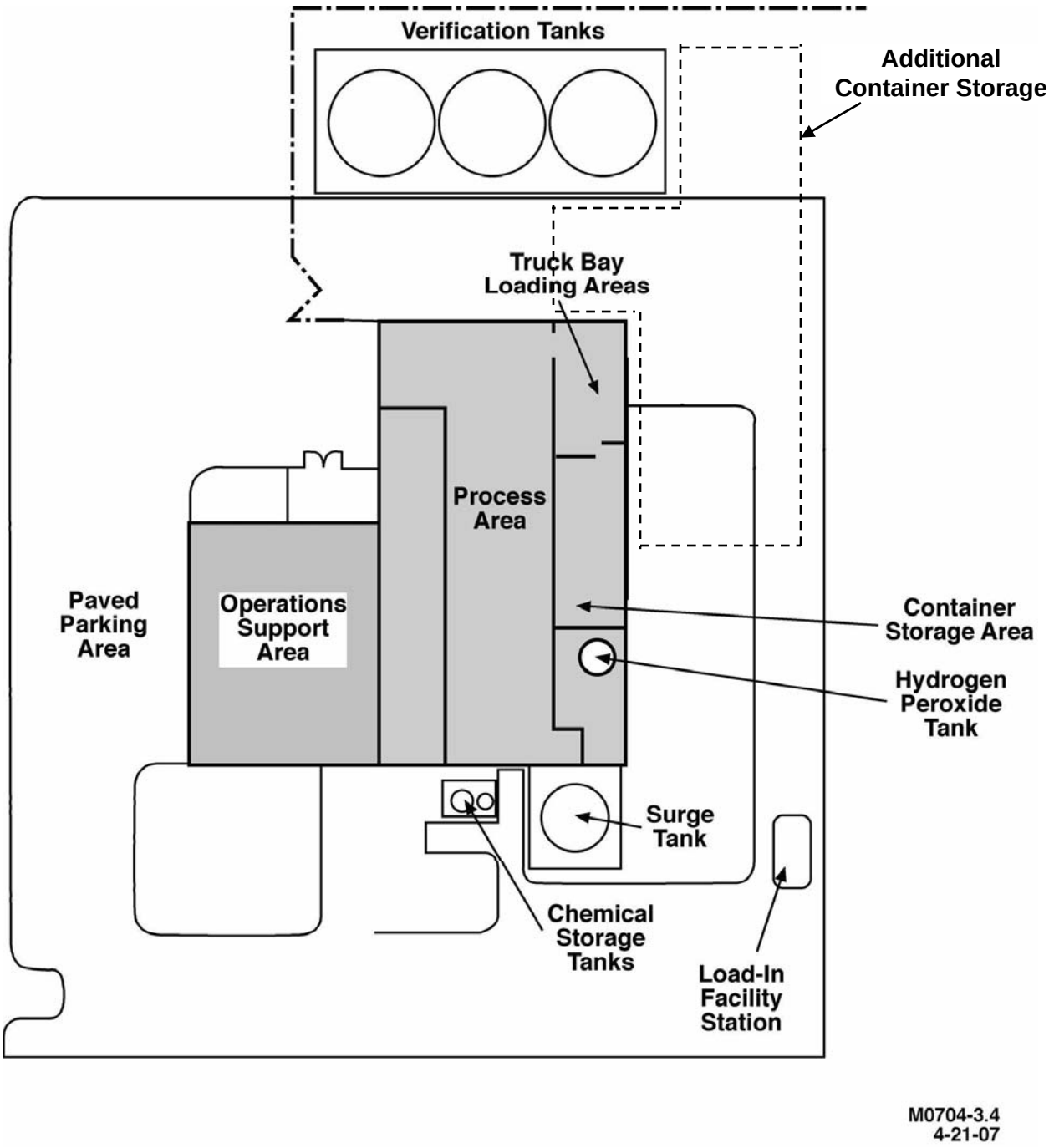


Figure 4.5. Example - 200 Area Effluent Treatment Facility Configuration 1

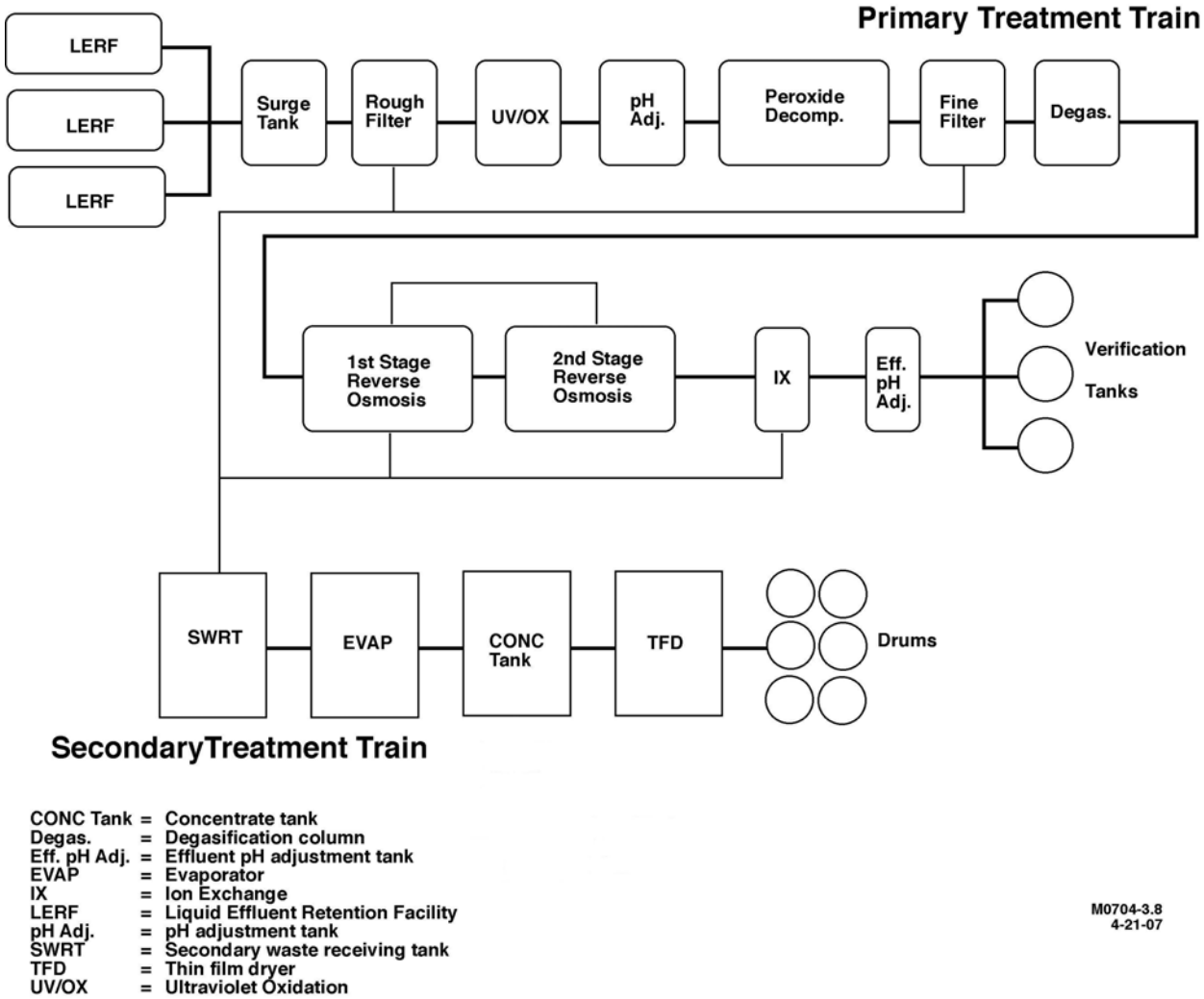


Figure 4.6. Example - 200 Area Effluent Treatment Facility Configuration 2

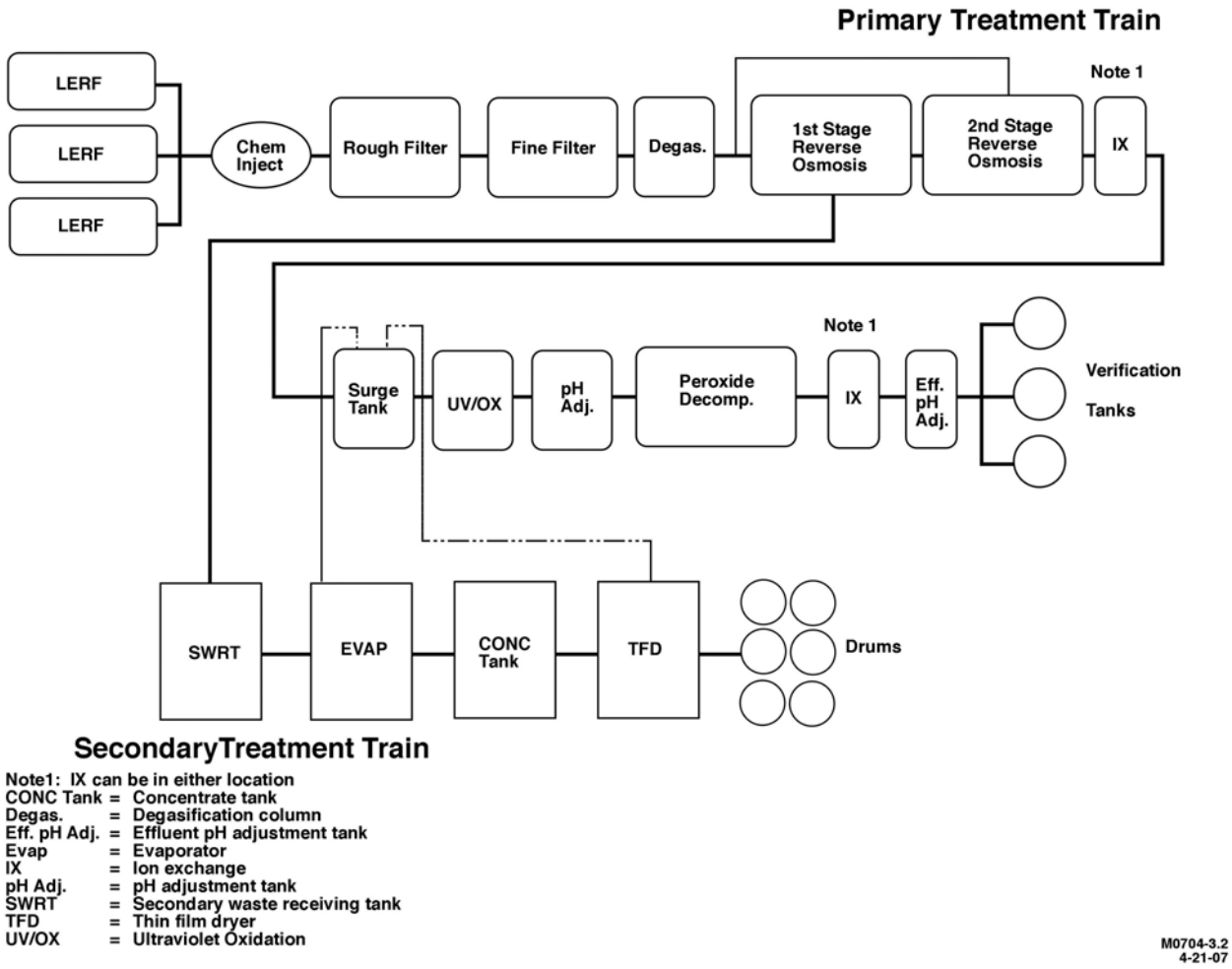


Figure 4.7. Surge Tank

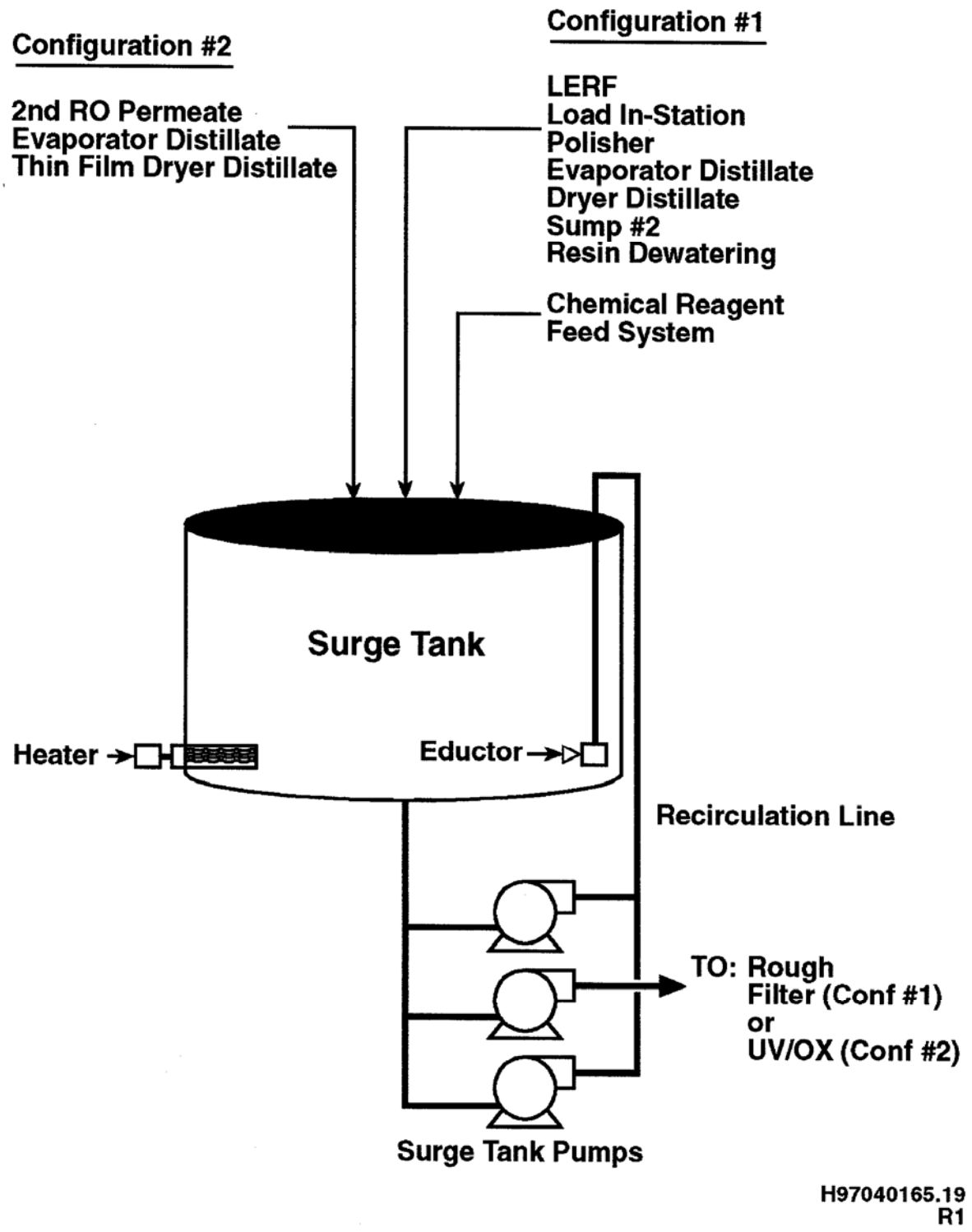


Figure 4.8. Ultraviolet Light/Oxidation Unit

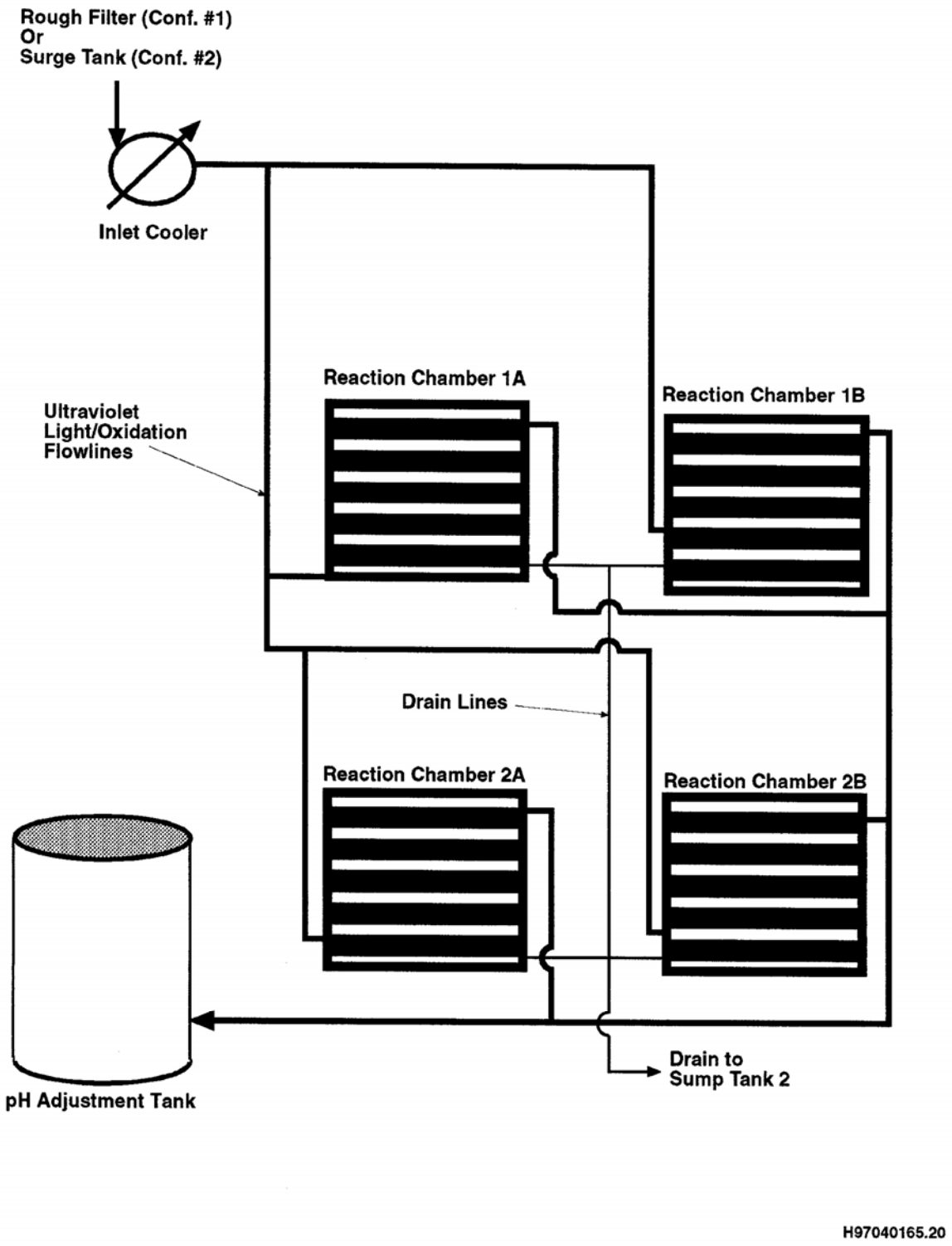


Figure 4.9. Reverse Osmosis Unit.

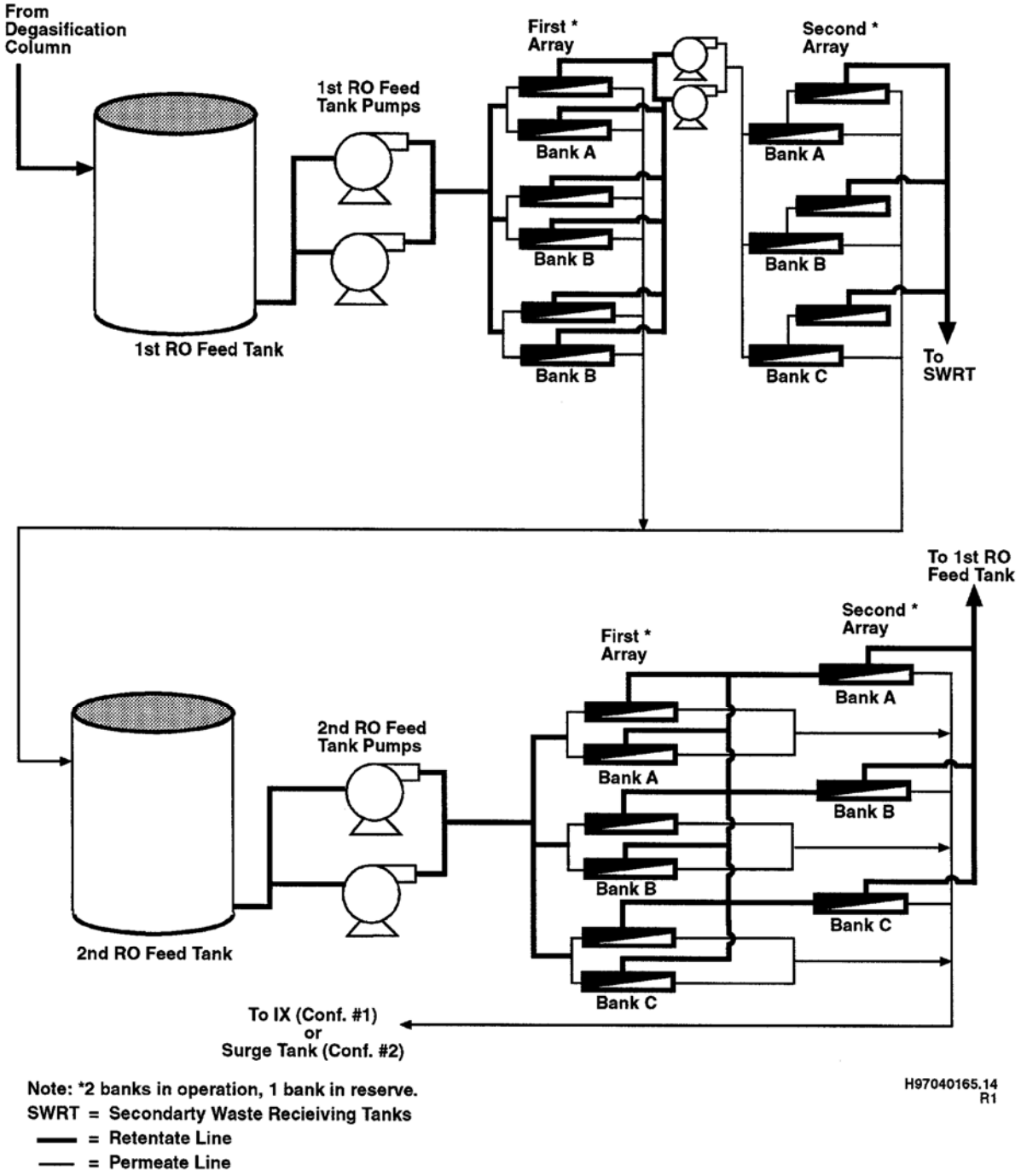


Figure 4.10. Ion Exchange Unit

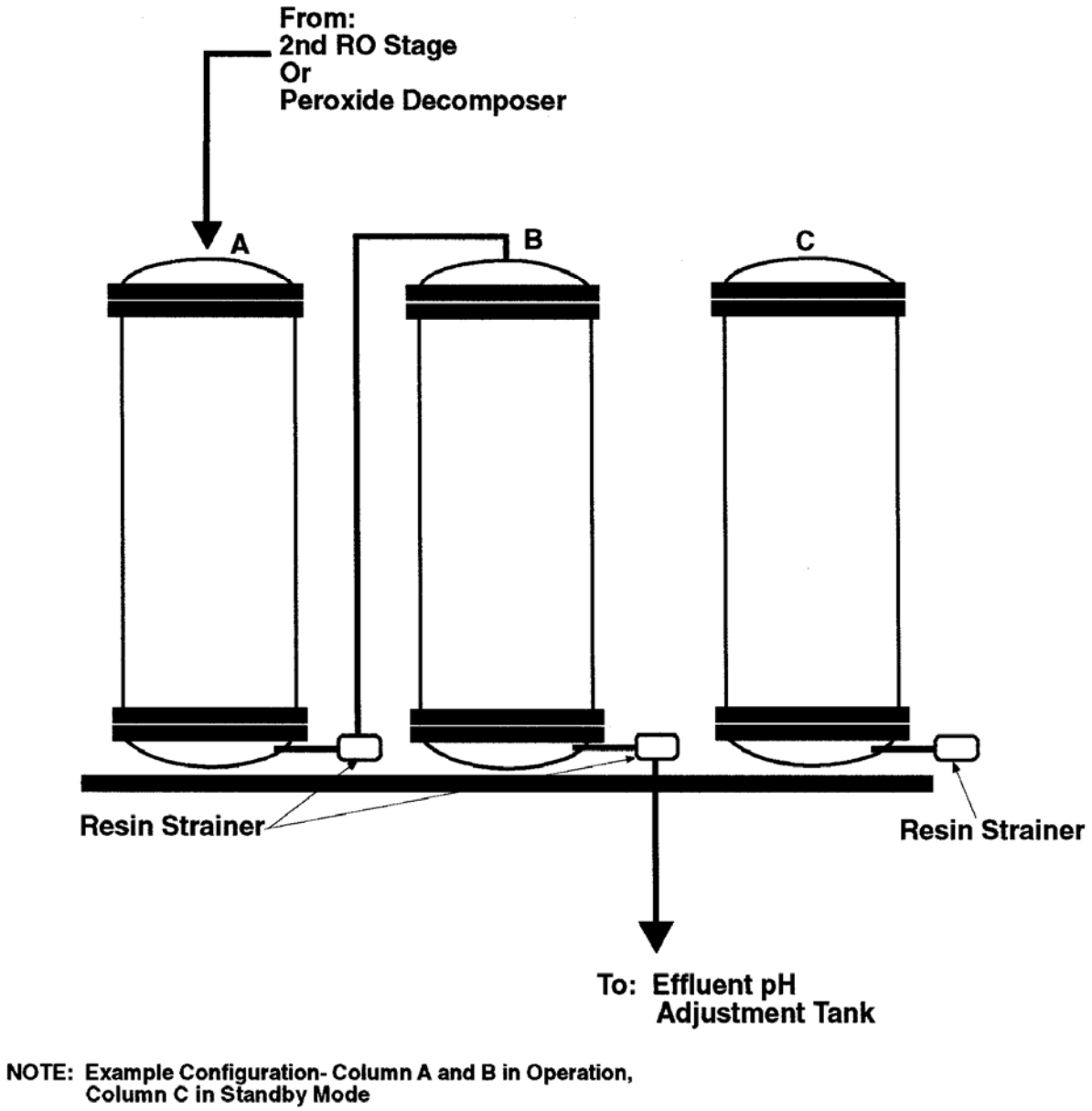


Figure 4.11. Verification Tanks

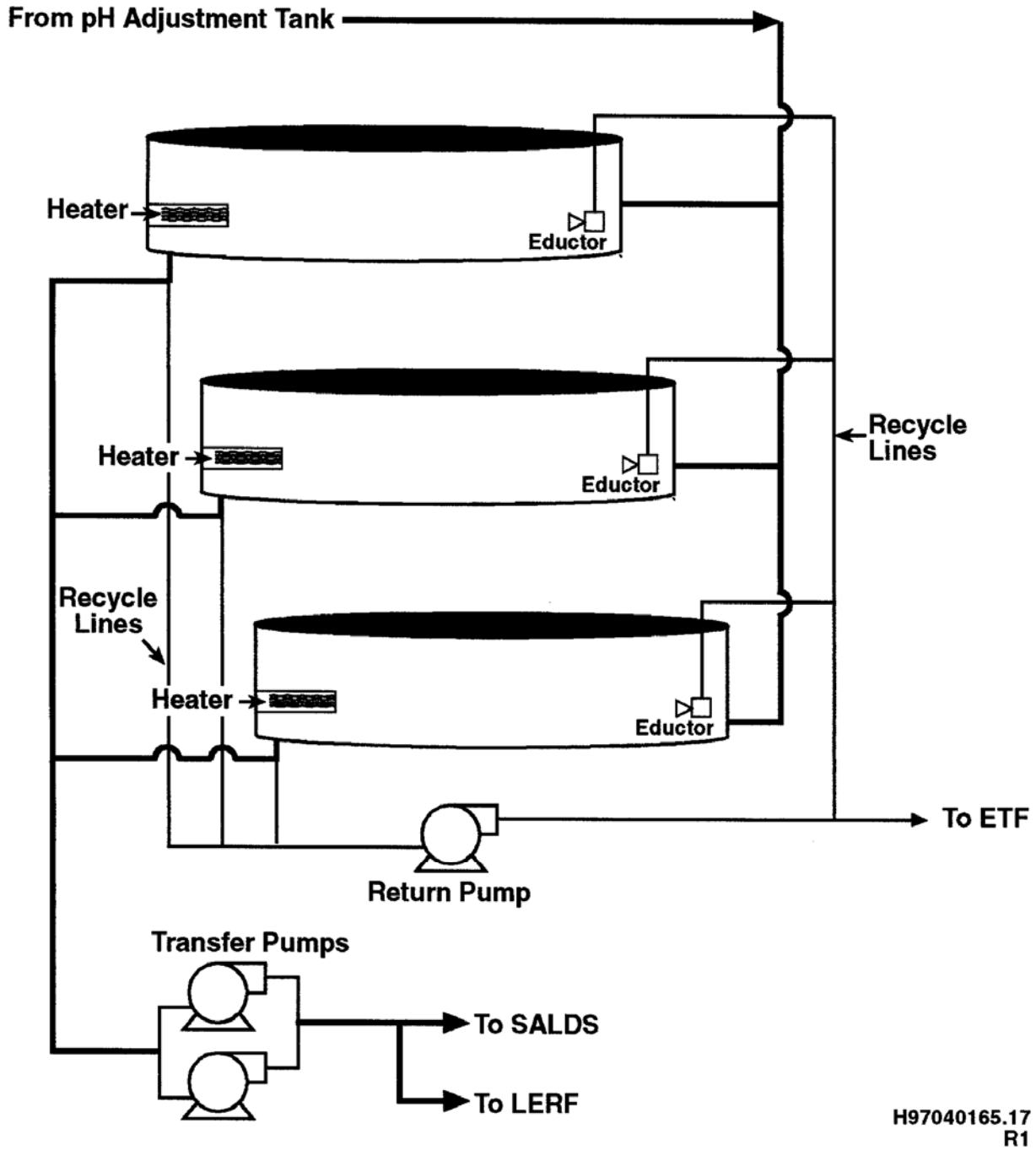
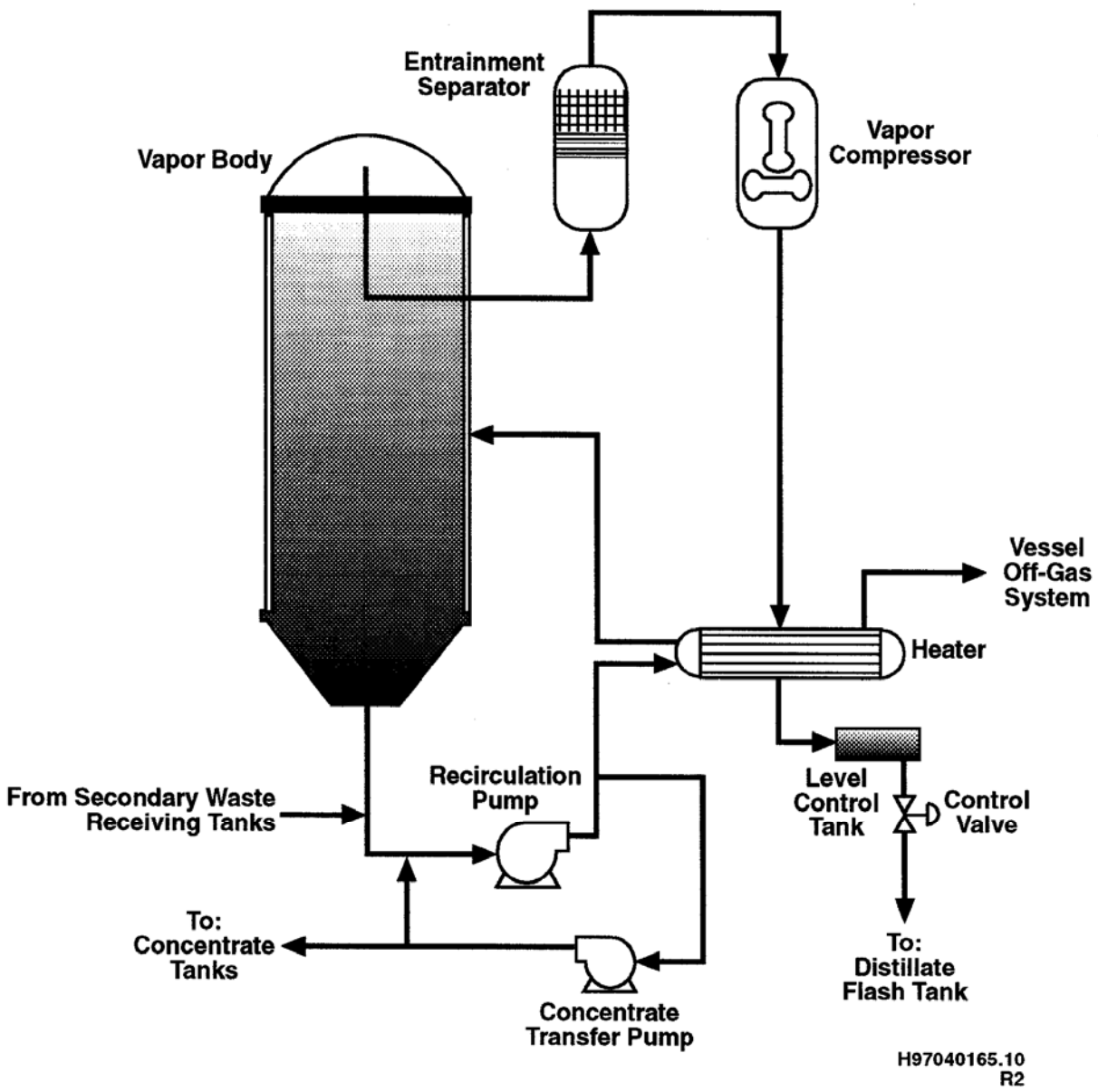


Figure 4.12. Effluent Treatment Facility Evaporator



1 Figure 4.13. Thin Film Dryer

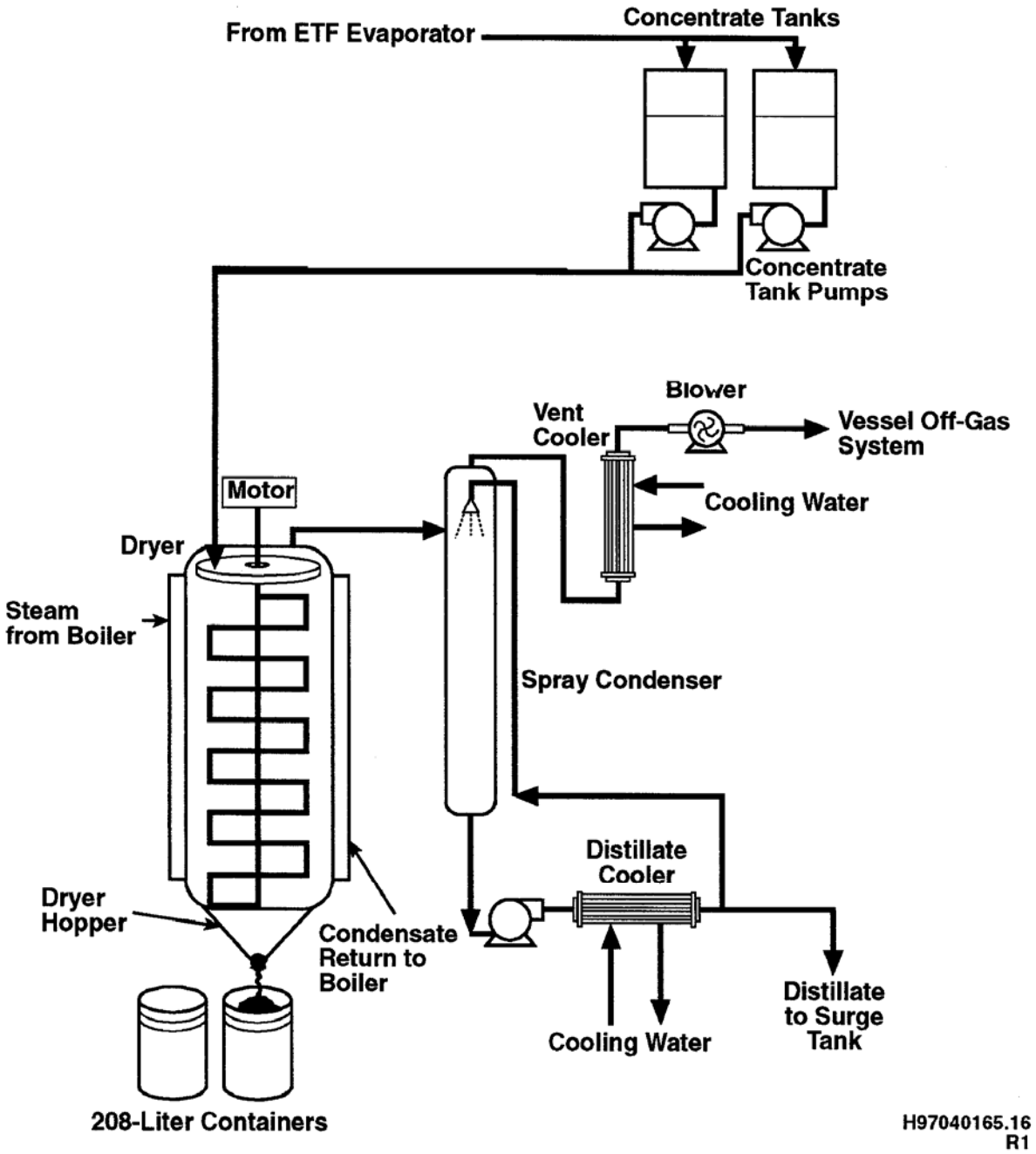


Figure 4.14. Container Handling System

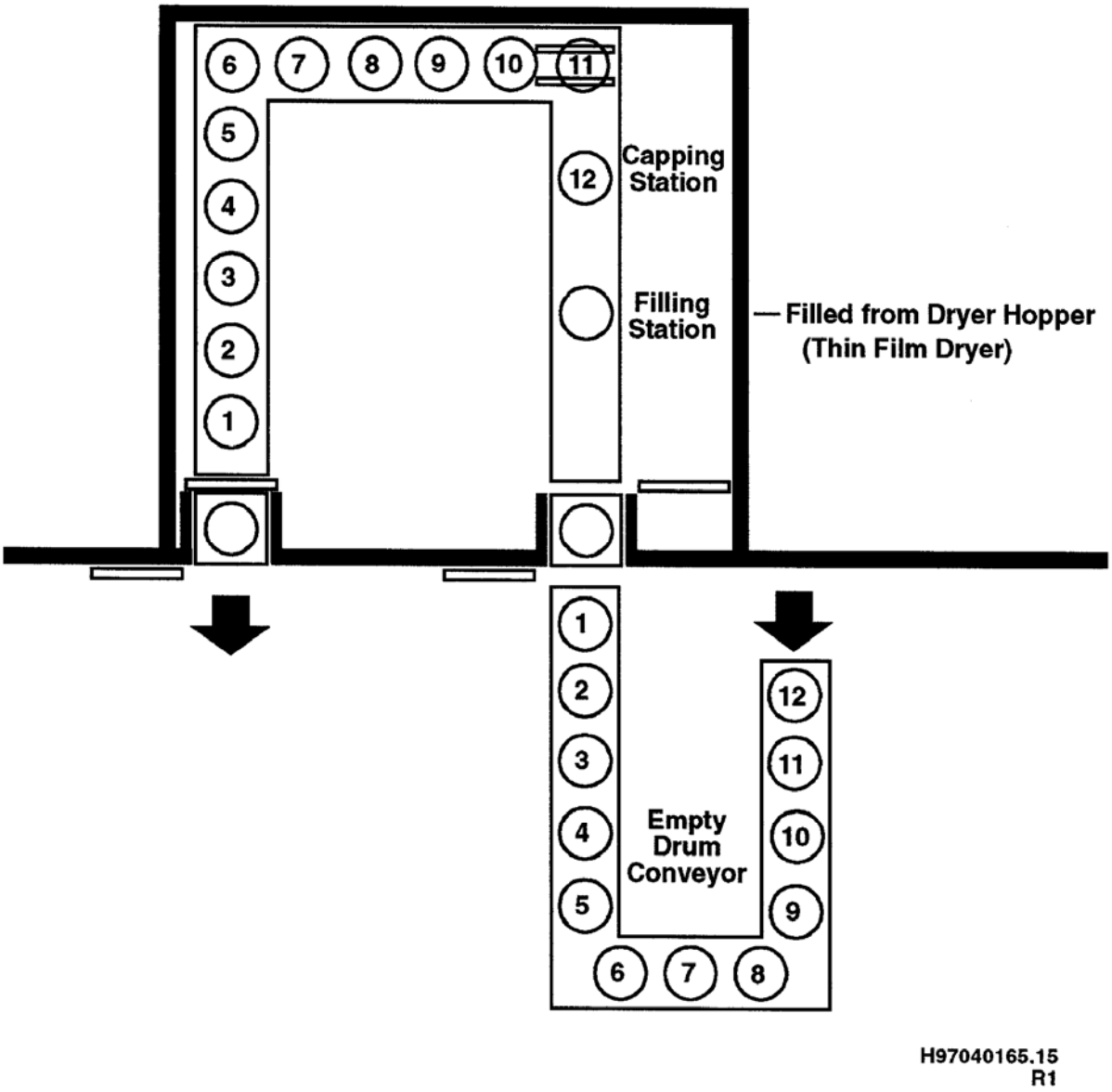


Figure 4.15. Effluent Treatment Facility Sump Tanks

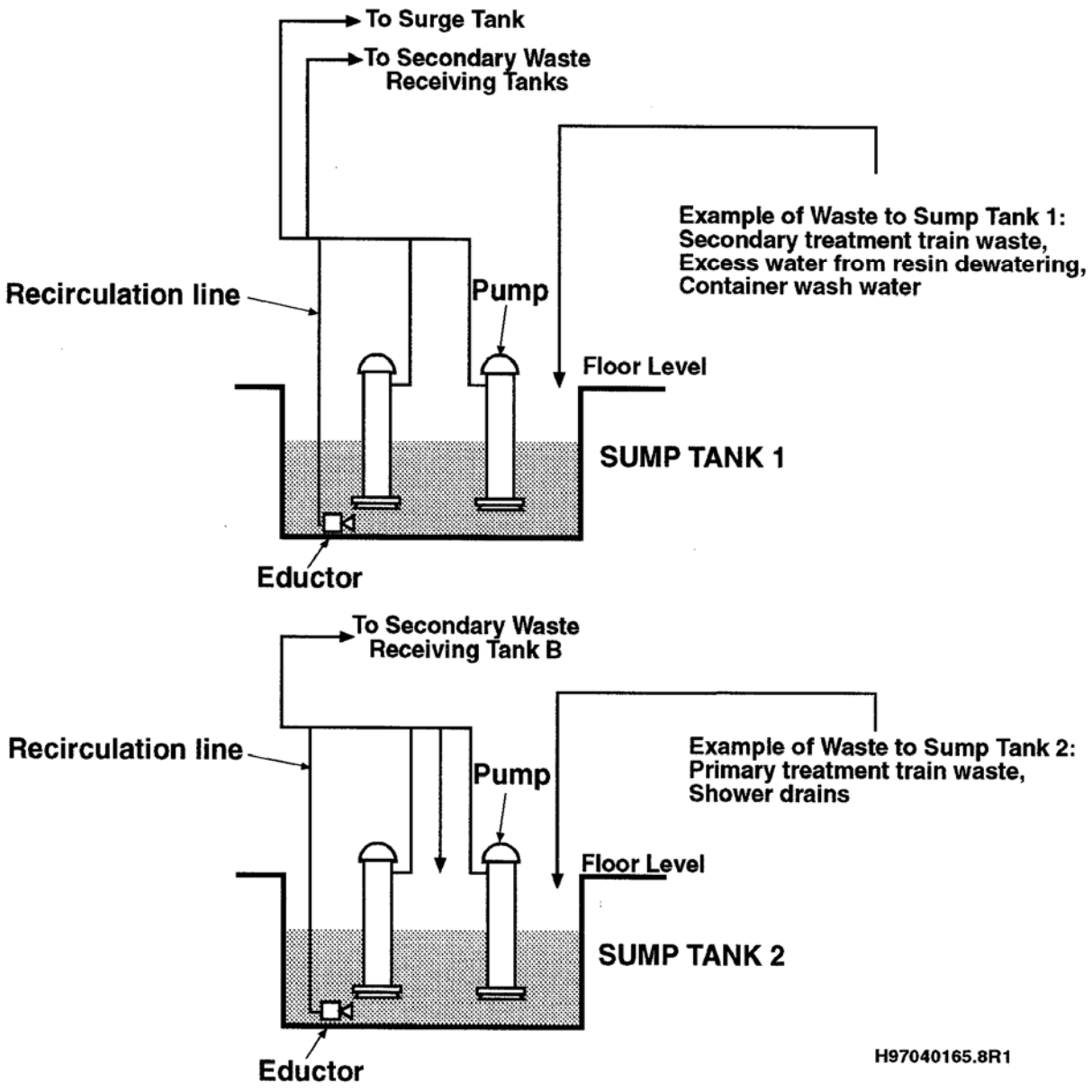


Figure 4.16. Liner Anchor Wall and Cover Tension System

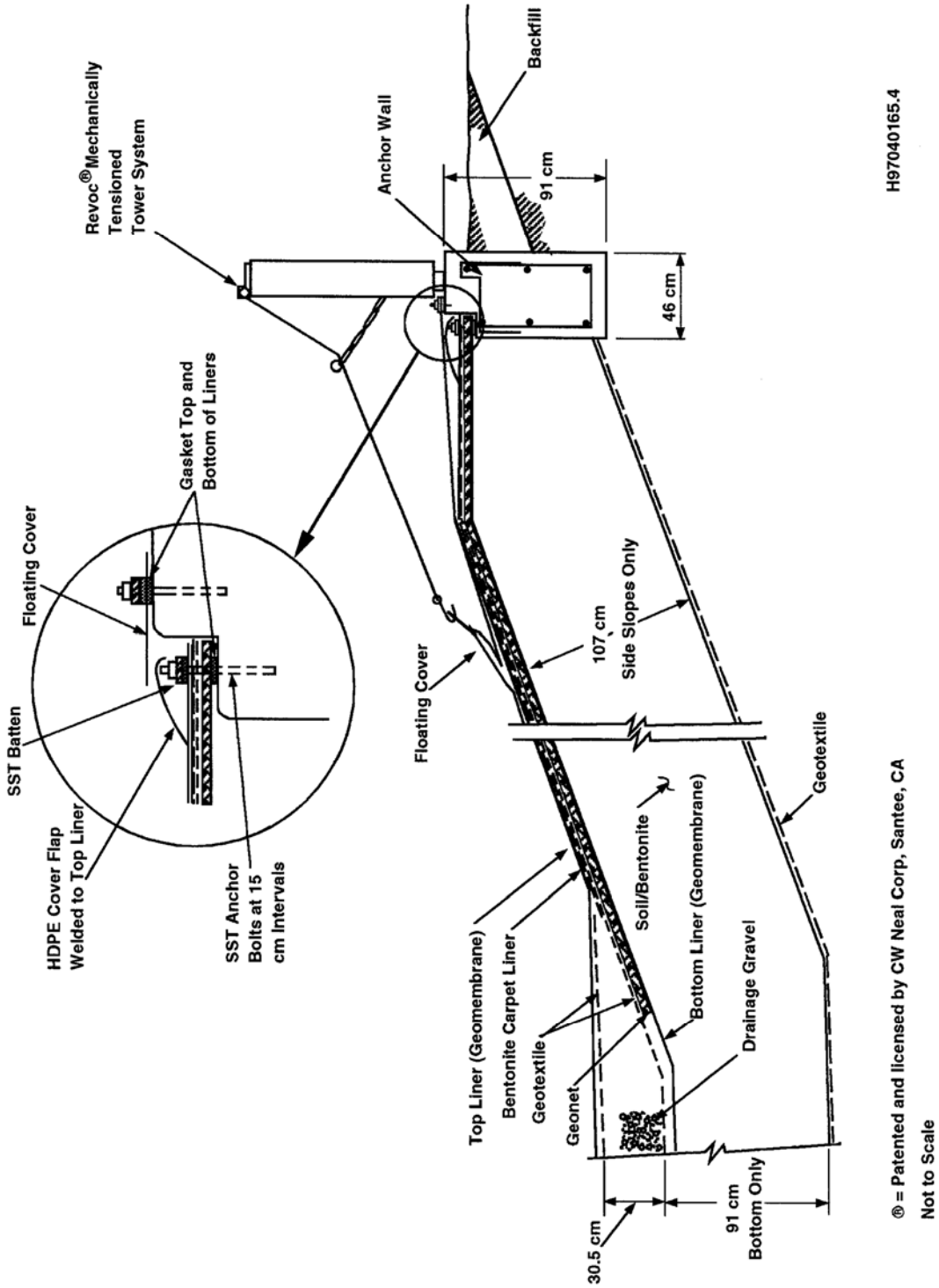


Figure 4.17. Liner System Schematic

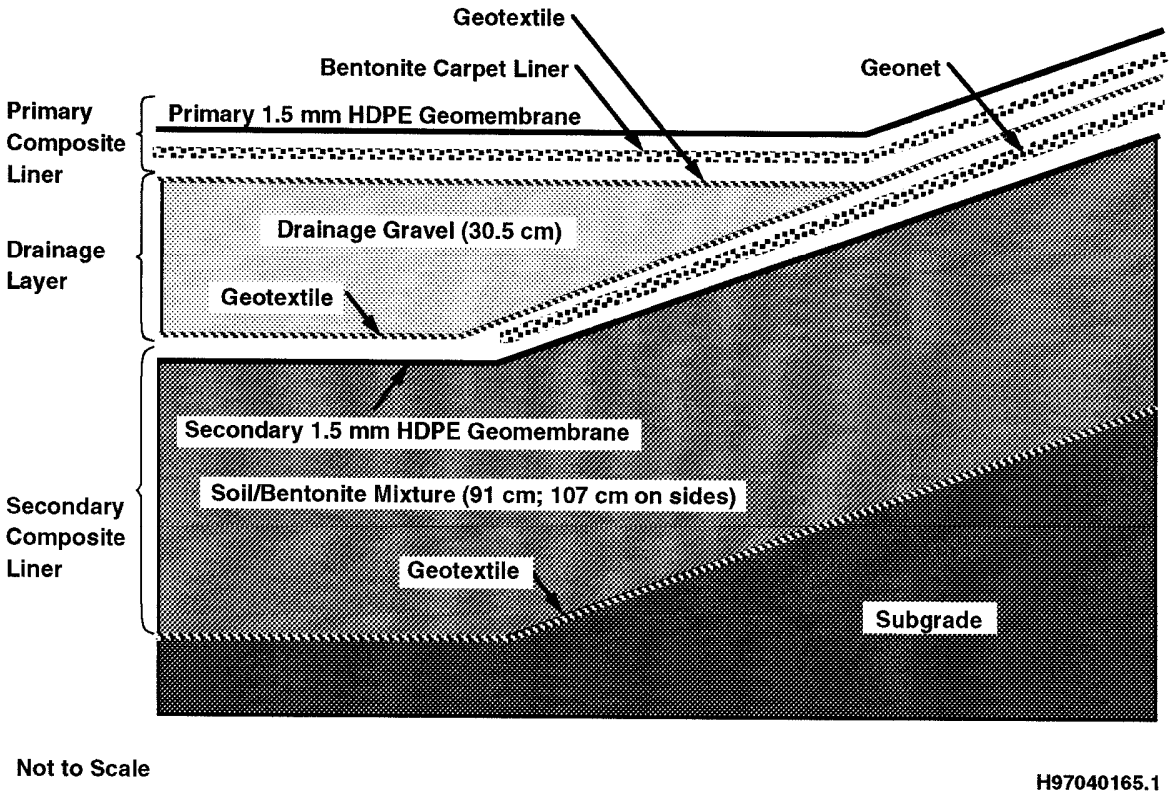


Figure 4.18. Detail of Leachate Collection Sump

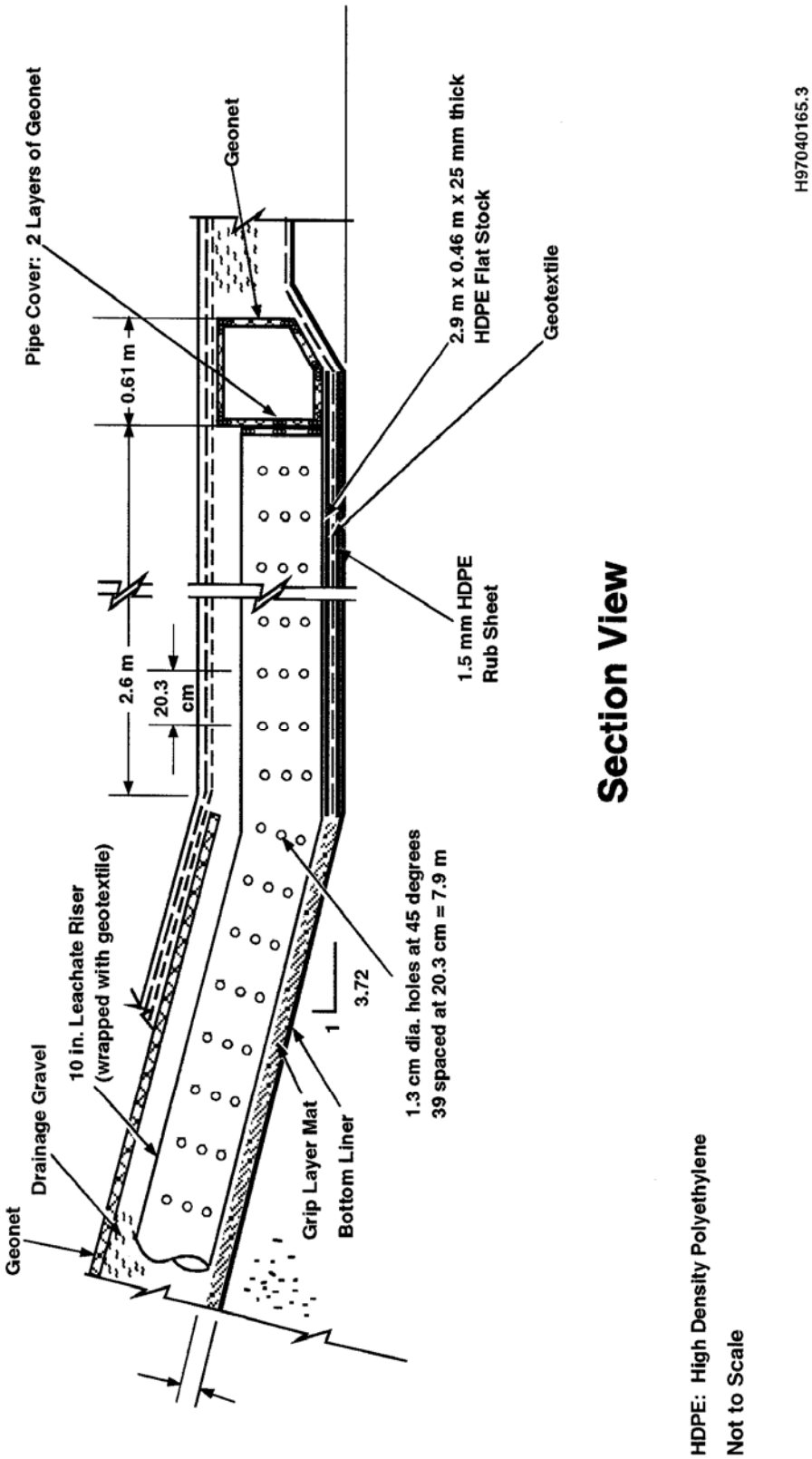


Table 4.5. 200 Area Effluent Treatment Facility Tank Systems Information

Tank Description	Material of Construction	Maximum Tank Capacity [1] liters	Inner diameter meters	Height meters	Shell Thickness [2] centimeters	Corrosion Protection [3]
Load-in tanks (2)	304 SS	37,900	3.6	4.7	0.64	Type 304 SS
Surge tank	304 SS	461,820	7.9	9.2	0.48	Type 304 SS
pH adjustment tank	304 SS	16,660	3.0	2.5	0.64	Type 304 SS
First RO feed tank	304 SS	20,440	3.0	3.2	0.64	Type 304 SS
Second RO feed tank	304 SS	7,600	Nonround tank 3.0 m x 1.5 m	1.5	0.48 w/rib stiffeners	Type 304 SS
Effluent pH adjustment tank	304 SS	14,390	2.4	3.6	0.64	Type 304 SS
Verification tanks (3)	Carbon steel with epoxy lining	2,763,340	18.3	11.4	0.79	epoxy coating
Secondary waste receiving tanks (2)	304 SS	75,700	4.3	5.7	0.64	Type 304 SS
Concentrate tanks (2)	316L SS	24,980	3.0	3.8	0.64	Type 316 SS
ETF evaporator (Vapor Body)	Alloy 625	20,800	2.4	6.8	variable	Alloy 625
Distillate flash tank	304 SS	950	Horizontal tank 0.76	Length 2.2	0.7	304 SS
Sump tank 1	304 SS	4,160	1.5 x 1.5	3.4	3/16	304 SS
Sump tank 2	304 SS	4,160	1.5 x 1.5	3.4	3/16	304 SS

[1] The maximum operating volume of the tanks is identified. For the load-in tanks and the second RO feed tank, the maximum operating volume is also the operating capacity.
[2] The nominal thickness of ETF tanks is represented.
[3] Type 304 SS, 304L, 316 SS and alloy 625 provide corrosion protection.
304 SS = stainless steel type 304 or 304L.
316L SS = stainless steel type 316L.

Table 4.6. 200 Area Effluent Treatment Facility Additional Tank System Information

Tank Description	Liner Materials	Pressure Controls	Foundation Materials	Structural Support	Seams	Connections
Load-in tanks (2)	None	vent to atmosphere	concrete slab	SS skirt bolted to concrete	welded	flanged
Surge tank	None	pressure indicator/vacuum breaker valve	reinforced concrete ring plus concrete slab	structural steel on concrete base	welded	flanged
pH adjustment tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
First RO feed tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
Second RO feed tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel frame	welded	flanged
Effluent pH adjustment tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
Verification tanks (3)	Epoxy	pressure indicator/filtered vent to atmosphere	reinforced concrete ring plus concrete slab	structural steel on concrete base	welded	flanged
Secondary waste receiving tanks (2)	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
Concentrate tanks (2)	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
ETF evaporator (vapor body)	None	pressure indicator/vapor vent - to DFT/VOG	concrete slab	carbon steel frame	welded	flanged
Distillate flash tank	None	vent to VOG	concrete slab	carbon steel I-beam and cradle	welded	flanged
Sump tank 1	None	vent to VOG	concrete containment	reinforced concrete containment basin	welded	flanged
Sump tank 2	None	vent to VOG	concrete containment	reinforced concrete containment basin	welded	flanged

DFT = distillate flash tank
VOG = vessel off gas system

1 **Table 4.7. Ancillary Equipment and Material Data**

System	Ancillary Equipment	Number	Material
Load-in tanks	Load-in/transfer pumps (2)	P-103A/-103B	316 SS
	Load-in filters (3)	59A-FL-001/-002/-003	304 SS
Surge tank	Surge tank pumps (3)	2025E-60A-P-1A/-1B/-1C	304 SS
Rough filter	Rough filter	2025E-60B-FL-1	304 SS
UV/OX	UV oxidation inlet cooler	2025E-60B-E-1	316 SS
	UV oxidizers (4)	2025E-60D-UV-1A/-1B/-2A/-2B	316 SS
pH adjustment	pH adjustment pumps (2)	2025E-60C-P-1A/-1B	304 SS
Peroxide decomposer	H_2O_2 decomposers (2)	2025E-60D-CO-1A/-1B	CS with epoxy coating
Fine filter	Fine filter	2025E-60B-FL-2	304 SS
Degasification	Degasification column inlet cooler	2025E-60E-E-1	316 SS
	Degasification column	2025E-60E-CO-1	FRP
	Degasification pumps (2)	2025E-60E-P-1A/-1B	316 SS
RO	Feed/booster pumps (6)	2025E-60F-P-1A/-1B/-2A/-2B/-3A/-3B	304 SS
	Reverse osmosis arrays (21)	2025E-60F-RO-01 through -21	Membranes: polyamide Outer piping: 304 SS
IX/Polishers	Polishers (3)	2025E-60G-IX-1A/-1B-1C	CS with epoxy coating
	Resins strainers (3)	2025E-60G-S-1A/-1B/-1C	304 SS
Effluent pH adjustment	Recirculation/transfer pumps (2)	2025E-60C-P-2A/-2B	304 SS/PVC
Verification tanks	Return pump	2025E-60H-P-1	304 SS
	Transfer pumps (2)	2025E-60H-P-2A/-2B	
Secondary waste receiving tanks	Secondary waste feed pumps (2)	2025E-60I-P-1A/-1B	304 SS
ETF evaporator system	Feed/distillate heat exchanger	2025E-60I-E-02	Tubes: 316 SS Shell: 304 SS
	Heater (reboiler)	2025E-60I-E-01	Tubes: alloy 625 Shell: 304 SS
	Recirculation pump	2025E-60I-P-02	316 SS
	Concentrate transfer pump	2025E-60I-P-04	316 SS
	Entrainment separator	2025E-60I-DE-01	Top section: 316 SS Bottom section: alloy 625
	Vapor compressor (incl. silencers)	2025E-60I-C-01	304 SS
	Silencer drain pump	2025E-60I-P-06	316 SS
	Level control tank	2025E-60I-TK-5	304 SS
	Distillate flash tank pump	2025E-60I-P-03	316 SS
Concentrate tanks	Concentrate circulation pumps (2)	2025E-60J-P-1A/-1B	316 SS
Thin film dryer	Concentrate feed pump	2025E-60J-P-2	316 SS
	Thin film dryer	2025E-60J-D-1	Interior surfaces: alloy 625 Rotor and blades: 316 SS
	Powder hopper	2025E-60J-H-1	316 SS
	Spray condenser	2025E-60J-DE-01	316 SS
	Distillate condenser	2025E-60J-CND-01	Tubes: 304 SS Shell: CS
	Dryer distillate pump	2025E-60J-P-3	316 SS
Resin dewatering	Dewatering pump	2025E-80E-P-1	

2

Table 4.8. Concrete and Masonary Coatings

Coating	Minimum wet film thickness (mil)	Percentage of film forming solids per volume (%)	Minimum dry film thickness (mil)
Concrete and masonry			
Prime: Amercoat-187*	4.5	22.0	1.0
Second: Amercoat-33	6.4	23.46	1.5
Finish: Amercoat-33	6.4	23.46	1.5
Or			
Prime: Amercoat-385	5-6	66	3-4
Topcoat: Amercoat-450HS	3-4	66	2-2.5
High traffic, container storage area			
Filler: Ameron Nu-Klad 114A**	--	100	--
Prime: Amercoat-105A	2-3	100	2-3
Topcoat: Amercoat-120	20-30	100	20-30

* Amercoat is a trademark of Ameron, Incorporation.
**Nu-Klad is a trademark of Ameron, Incorporation.

Table 4.9. Geomembrane Material Specifications

Property	Value
Specific gravity	0.932 to 0.950
Melt flow index	1.0 g/10 min., maximum
Thickness (thickness of flow marks shall not exceed 200% of the nominal liner thickness)	60 mil 310% (1.5 mm 3 10%)
Carbon black content	1.8 to 3%, bottom liner 2 to 3% top liner
Tensile properties (each direction)	
Tensile strength at yield	21.5 kgf/cm width, minimum
Tensile strength at break	32.2 kgf/cm width, minimum
Elongation at yield	10%, minimum
Elongation at break	500%, minimum
Tear resistance	13.6 kgf, minimum
Puncture resistance	31.3 kgf, minimum
Low temperature/brittleness	-400 C, maximum
Dimensional (%change each direction)	32%, maximum
Environmental stress crack	750 h, minimum
Water absorption	0.1 maximum and weight change
Hydrostatic resistance	316,000 kgf/m^2
Oxidation induction time (200 C/l atm. O_2)	90 minutes

Reference: Construction Specifications (KEH 1990b). Format uses NSF 54 table for high-density polyethylene as a guide (NSF 1985). However, RCRA values for dimensional stability and environmental stress crack have been added.

%	=	percent	max	=	maximum
g	=	gram	kgf	=	kilograms force
min	=	minute	m	=	meters
h	=	hour	mm	=	millimeters

Table 4.10. Drainage Gravel Specifications.

Property	Value
Sieve size	
25 millimeters	100 wt% passing
19 millimeters	80 – 100 wt% passing
9.5 millimeters	10 – 40 wt% passing
4.75 millimeters	0 – 4 wt% passing
Permeability	0.1 cm/sec, minimum

Reference: Sieve size is from WSDOT M41-10-88, Section 9.03.1(3)C for Grading No. 5 (WSDOT 1988). Permeability requirement is from WAC 173-303-650(2)(j) for new surface impoundments.

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Chapter 5.0 **Groundwater Monitoring**

5.0 GROUNDWATER MONITORING [D-10] 5.1

5.1 EXEMPTION FROM GROUNDWATER PROTECTION REQUIREMENTS [D-10a] 5.1

5.2 INTERIM STATUS PERIOD GROUNDWATER MONITORING DATA [D-10b] 5.1

5.3 AQUIFER IDENTIFICATION [D-10c] 5.1

5.4 CONTAMINANT PLUME DESCRIPTION [D-10d] 5.1

5.5 DETECTION MONITORING PROGRAM [D-10e] 5.1

5.6 LIQUID EFFLUENT TREATMENT FACILITY GROUNDWATER MONITORING PLAN, PNNL-11620 ..... 5.3

5.7 INTERIM STATUS GROUNDWATER MONITORING PLAN FOR THE 200 EAST AREA LIQUID EFFLUENT TREATMENT FACILITY, WHC-SD-EN-AP-024, REVISION 1. ..... 5.5

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5.0 GROUNDWATER MONITORING [D-10]

5.1 EXEMPTION FROM GROUNDWATER PROTECTION REQUIREMENTS [D-10a]

A waiver from the groundwater monitoring requirements as allowed under WAC 173-303-645 is not requested. Therefore, the requirements of the Washington Administrate Code for groundwater monitoring are applicable to the LERF, except as modified in accordance with Ecology variance discussed in Section 5.5.

5.2 INTERIM STATUS PERIOD GROUNDWATER MONITORING DATA [D-10b]

Information on interim status groundwater monitoring activities is provided in *Interim Status Ground Water Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility* (WHC 1991a), in *Hanford Site Groundwater Monitoring for Fiscal Year 1999* (PNNL 2000), and in the Hanford Environmental Information System. Groundwater monitoring data provided no evidence that dangerous, non-radioactive constituent from the site has entered the groundwater.

5.3 AQUIFER IDENTIFICATION [D-10c]

The characteristics of the uppermost aquifer beneath the LERF and the regional physiographic, geologic, and hydrogeologic setting of the LERF are summarized in Chapter 5.0 of the General Information Portion (DOE/RL-91-28).

5.4 CONTAMINANT PLUME DESCRIPTION [D-10d]

A description of the contaminant plumes existing beneath the 200 East Area and 200 West Area is provided in Chapter 5.0 of the General Information Portion (DOE/RL-91-28).

5.5 DETECTION MONITORING PROGRAM [D-10e]

A groundwater monitoring program meeting the interim status groundwater monitoring standards will be implemented using one upgradient and two downgradient monitoring wells The groundwater monitoring requirements of 40 CFR 265 Subpart F will remain in effect except for downgradient well coverage, for which a variance has been granted. This approach has been approved by the Washington State Department of Ecology in a letter dated September 22, 1999 granting the U.S. Department of Energy a variance from interim status groundwater monitoring requirements. This monitoring program will remain in effect until an approved final status monitoring plan is designed and implemented through incorporation via permit modification. The variance for downgradient well coverage will end on the earlier of eighteen months after September 22, 1999, or the inability of another monitoring well to produce representative samples of groundwater. A revised final status monitoring plan including the process for transitioning to alternative monitoring as wells go dry will be submitted to Ecology for approval.

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5.6 LIQUID EFFLUENT TREATMENT FACILITY GROUNDWATER MONITORING PLAN, PNNL-11620.

PNNL-11620
UC-402, 502, 630

Liquid Effluent Retention Facility Final-Status Groundwater Monitoring Plan

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September 1997

Prepared by
Pacific Northwest National Laboratory[a]
for the U.S. Department of Energy under
Contract DE-AC06-76RLO 1830

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(a) Also prepared by Rust Federal Services Hanford.

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1.0 Introduction

The following sections describe the groundwater-monitoring program for the Liquid Effluent Retention Facility (LERF). The LERF is regulated under the Resource Conservation and Recovery Act of 1976 (RCRA). The LERF is included in the "Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste, Permit WA890008967", (referred to herein as the Permit) (Ecology 1994) and is subject to final-status requirements for groundwater monitoring (WAC 173-303-645).

This document describes a RCRA/WAC groundwater detection-monitoring program for groundwater in the uppermost aquifer system at the LERF. This plan describes the LERF monitoring network, constituent list, sampling schedule, statistical methods, and sampling and analysis protocols that will be employed for the LERF. This plan will be used to meet the groundwater monitoring requirements from the time the LERF becomes part of the Permit and through the post-closure care period, until certification of final closure.

1.1 History of Groundwater Monitoring at the LERF

A groundwater-monitoring network was installed at the LERF in 1990 before final construction of the facility. Samples were collected quarterly from the four wells (one upgradient and three downgradient from the LERF) and interim-status evaluation of indicator parameters began before waste was transferred to the basins. Constituents analyzed during the first year of sampling included the analytes listed in 40 CFR 265 Appendix IX, groundwater-quality parameters, and several site-specific constituents. Data for these analytes are in the Hanford Environmental Information System (HEIS) database. The selection of site-specific constituents was based on waste-stream analysis of the primary generating facility, the 242-A Evaporator. Total organic carbon, total organic halogen, pH and specific conductivity, collectively known as indicator parameters, were also evaluated during the first year; the critical means specific to this facility were calculated for these parameters. Once the critical means were established, groundwater sampling was changed to a semiannual schedule.

1.2 Changes from Interim-Status Groundwater Monitoring

The LERF will enter final status in detection-level monitoring, a program similar to indicator-evaluation monitoring conducted under interim status. The two programs differ substantially, however, in sampling requirements and in statistical analysis. Interim-status regulations require the collection of multiple samples (replicates) in one sampling event. The default procedure under final-status regulations require independent samples, which involve waiting periods between samples. The proposed sampling method is described in Section 4.0. Statistical methods proposed in this document are also different than those used under interim-status, and the proposed method represents a preferred alternative to the default procedure as described in WAC 173-303-645 (h). The proposed program also relies on a shorter constituent list than did the previous program.

The "assessment" program under interim status is equivalent to a "compliance" program in final status. In compliance monitoring, specific constituents are chosen and compared to concentration limits. If these limits are exceeded, then the site enters a corrective-action phase.

The radioactive portion of mixed waste is interpreted by DOE to be regulated under the Atomic Energy Act of 1954; the non-radioactive hazardous portion of the mixed waste is interpreted to be regulated under RCRA and WAC 173-303. It is the position of DOE that any procedures, methods, data, or information associated with this monitoring program that relate solely to the radioactive constituent of mixed wastes is outside the scope of the Hanford Facility RCRA Permit but are included for the sake of completeness. It is the position of Ecology that the radioactive portion influences safe storage of the waste and, therefore, information about radioactive constituents is necessary to ensure compliance with WAC 173-303 and the RCRA permit. Both agencies acknowledge the other's position, but to avoid a conflict on the issue, DOE has agreed to provide information on the radioactive constituents without agreeing with Ecology's position and Ecology has agreed to accept the information in this context without giving up its position.

2.0 Facility Description

This section provides an overview of the physical structures, operational history, and waste characteristics for the LERF. More detail is provided in the *Conceptual Design Report 242-A Evaporation and PUREX Interim Retention Basin* (Rieck 1990).

2.1 Physical Structure

The LERF is located in the central portion of the Hanford Site on the eastern boundary of the 200 East Area (Figure 2.1). Construction of the LERF was completed in 1991. This facility, originally classified as a surface impoundment for mixed waste storage, will be permitted as a RCRA Treatment, Storage, and Disposal (TSD) Facility. The LERF received a surface impoundment-treatment exemption from land disposal restrictions (40 CFR 268.4) in 1995 and is now regulated as a treatment facility.

The facility originally was designed with four basins arranged side by side on a 16-hectacre site. Four excavations were made; only three of the four excavations are lined and are currently scheduled for use. The dimensions of the basins at the anchor wall are 103 m by 85 m at the top, with a design capacity of 2.5E07 L. The are basins constructed with primary and secondary liners, consisting of 1.5-mm membranes over low-permeability soil composites (DOE 1991).

The leachate detection, collection, and removal system is designed, constructed, and operated to detect, collect, and remove liquids that could permeate the primary liner. System components include a layer of drainage gravel sloped to a lined sump, high-density polyethylene (HDPE) drainage net on the basin sidewalls, a perforated leachate riser extending down between the two liners, a dedicated submersible leachate pump installed in the riser, piping, and associated instrumentation. The total estimated capacity of the drainage layer to store leachate is approximately 1.8E05 L. The pumping system is designed to remove that quantity of fluids, and the removal system is designed to start at 10% of the layer capacity. Based on these design parameters, it is unlikely that the drainage layer would ever fill to capacity (DOE 1991).

An interim-status detection-level groundwater-monitoring network was installed around the LERF in 1990 in accordance with the interim-status groundwater-monitoring plan for the 200 East Area Liquid Effluent Retention Facility (Schmid 1990).

2.2 Operational History

The LERF originally was constructed to provide interim storage of 242-A Evaporator process-condensate effluent containing listed and dangerous waste constituents (Rieck 1990). From 1977 until 1989, process condensate from the 242-A Evaporator was disposed to the 216-A-37-1 Crib via the 207-A

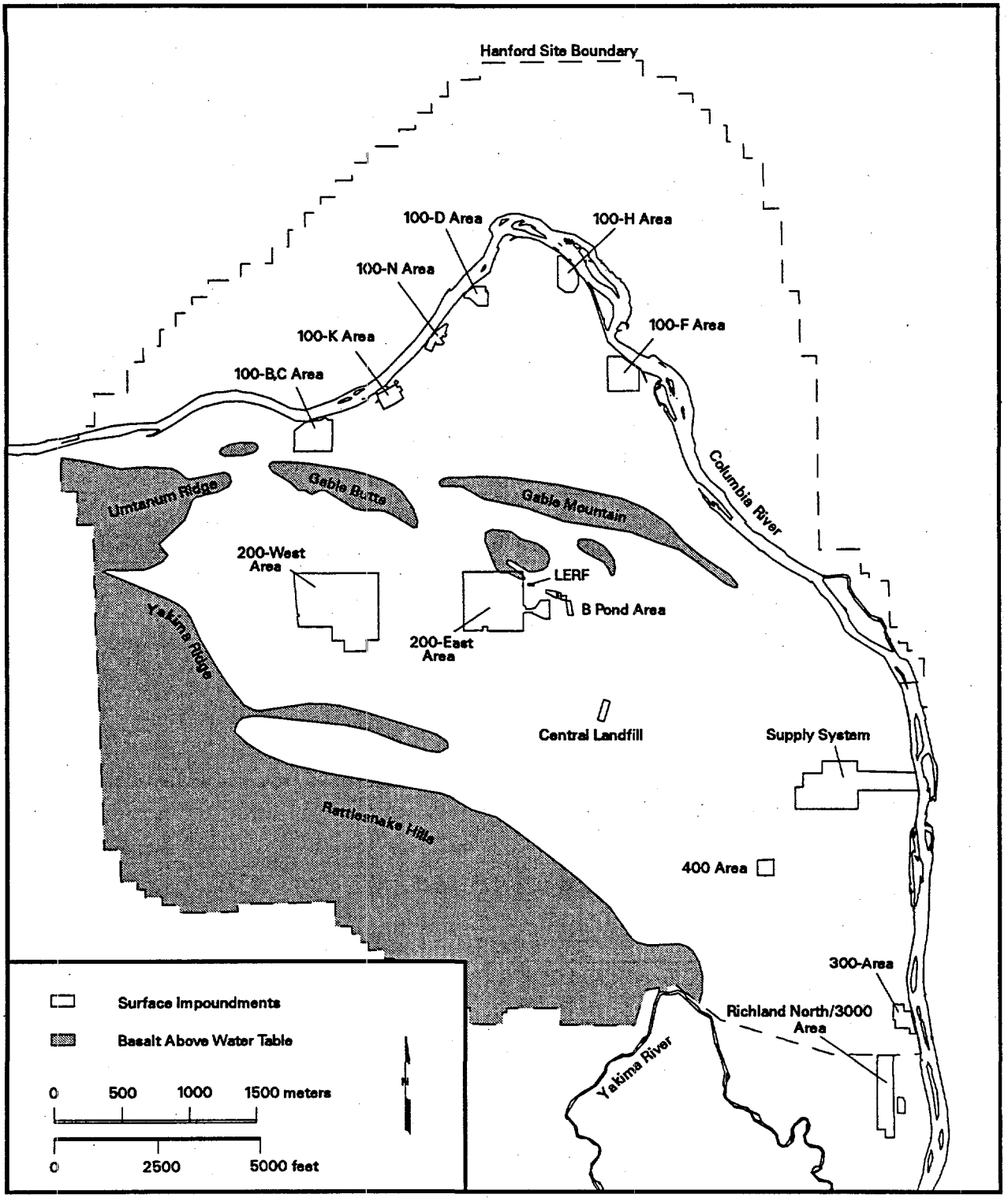

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Figure 2.1. Hanford Site Location Map

Retention Basins (Smith and Kasper 1983). The 242-A Evaporator was shut down in 1989 and was placed on temporary-standby status pending construction of a waste-disposal alternative to supplant use of the soil-column crib (Schmid 1991a).

Construction of the LERF began in February 1990 with a geotechnical investigation of the site. The facility was completed in November 1993 and was ready to begin receiving waste from the 242-A Evaporator. The evaporator upgrades necessary for the re-start were not completed until 1993, and the first waste-reduction campaign did not begin until April of 1994. The effluent from 242-A Evaporator is the result of evaporative-condensation campaigns of liquids held in the double-shell tanks (DSTs). Figure 2.2 details the configuration of the LERF, along with the location of nearby wells and the facility boundaries.

The 242-A Evaporator and the LERF are part of a volume-reduction process for high-level radioactive wastes stored in underground-storage tanks at the Hanford Site. As part of a Tri-Party Agreement (Ecology et al. 1989) milestone, the volume of high-level waste in tanks at Hanford have been reduced by 2.13E07 L after treatment with the 242-A Evaporator system (Guthrie 1994; 1995). This volume reduction has relieved the shortage of adequate DST space, allowing other Hanford Site operations to continue. Since the completion of the 200 Area Effluent Treatment Facility (ETF), the LERF has been incorporated into the treatment process and will continue to provide storage for operations at the ETF throughout its entire life cycle.

The LERF also is linked to Tri-Party Agreement milestones that involve treatment or elimination of selected effluent streams, some of which were previously discharged to cribs, ponds, or ditches. LERF basins have been identified as storage capacity for other Hanford Site projects involving contaminated waste streams. Future waste streams are identified as generators for LERF as cleanup activities at the site progress.

2.3 Waste Characteristics

The ETF was intended and designed to treat a variety of radioactive and/or aqueous mixed wastes. During the initial phases of developing the dangerous waste permit application for the LERF and ETF, however, process condensate from the 242-A Evaporator was the only mixed waste identified for storage and treatment in the LERF and the ETF. As cleanup activities at Hanford progress, many of the aqueous wastes generated from site remediation and waste-management activities will be sent to the ETF and LERF for treatment and storage.

Contaminants in the process condensate are expected to consist chiefly of volatile organics that boil off with the water, and radionuclides that are entrained in the vapors, and may include acetone, methyl ethyl ketone, methyl isobutyl ketone waste, and tritium. Other aqueous wastes that will be treated and stored at the ETF and LERF include, but are not limited to the following Hanford wastes: contaminated groundwater from pump-and-treat remediation activities such as groundwater from the 200-UP-1 Operable Unit; water from deactivation activities such as water from the spent-fuel-storage basins at deactivated reactors (e.g., N Reactor); laboratory aqueous waste from unused samples and sample analyses; and leachate from landfills, such as the Environmental Restoration Disposal Facility.

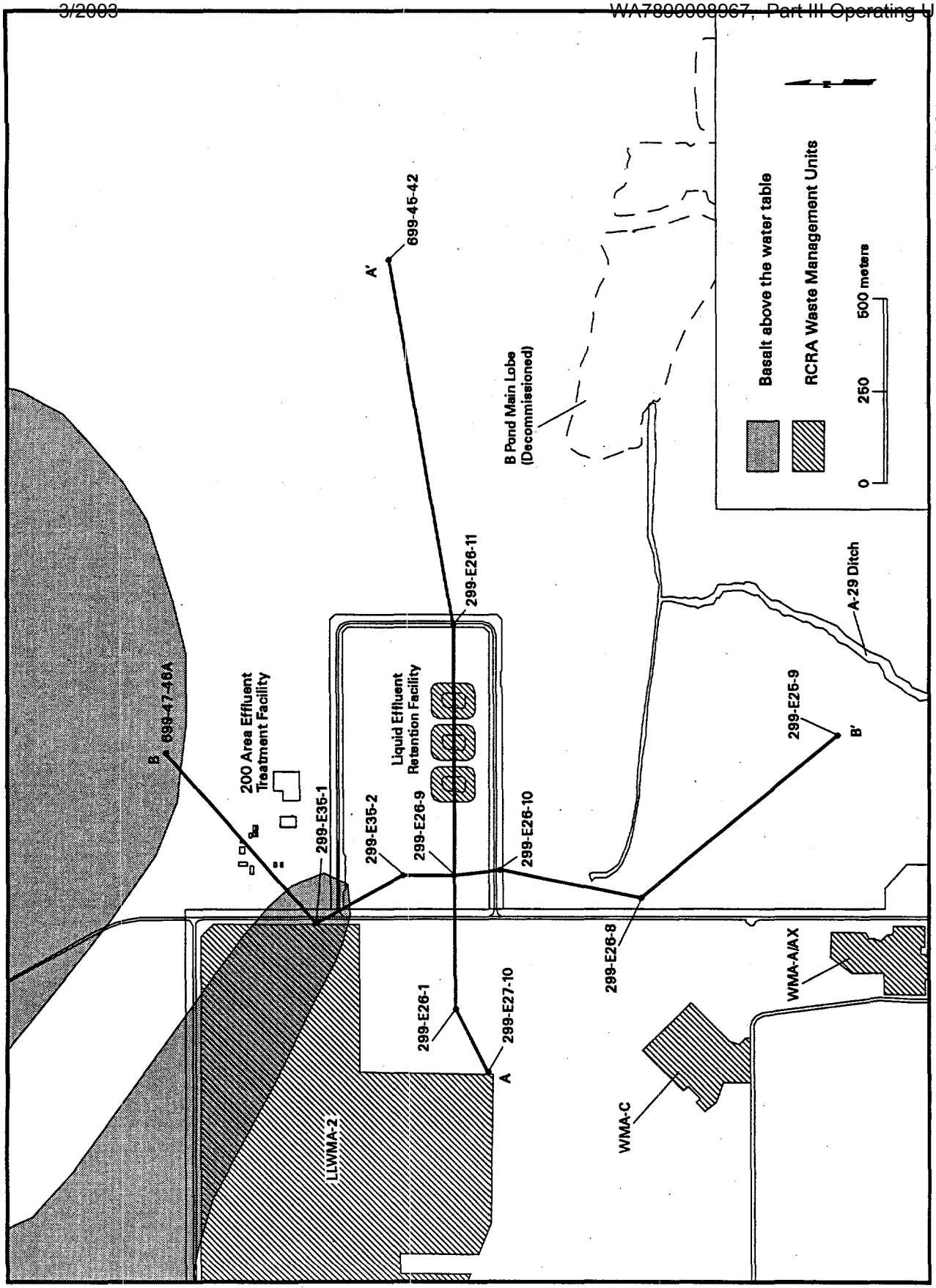


Figure 2.2. LERF Location Map

3.0 Hydrogeology and Groundwater-Monitoring Results

This section describes the stratigraphy, physical hydrology, and groundwater chemistry beneath the LERF Area.

3.1 Geology

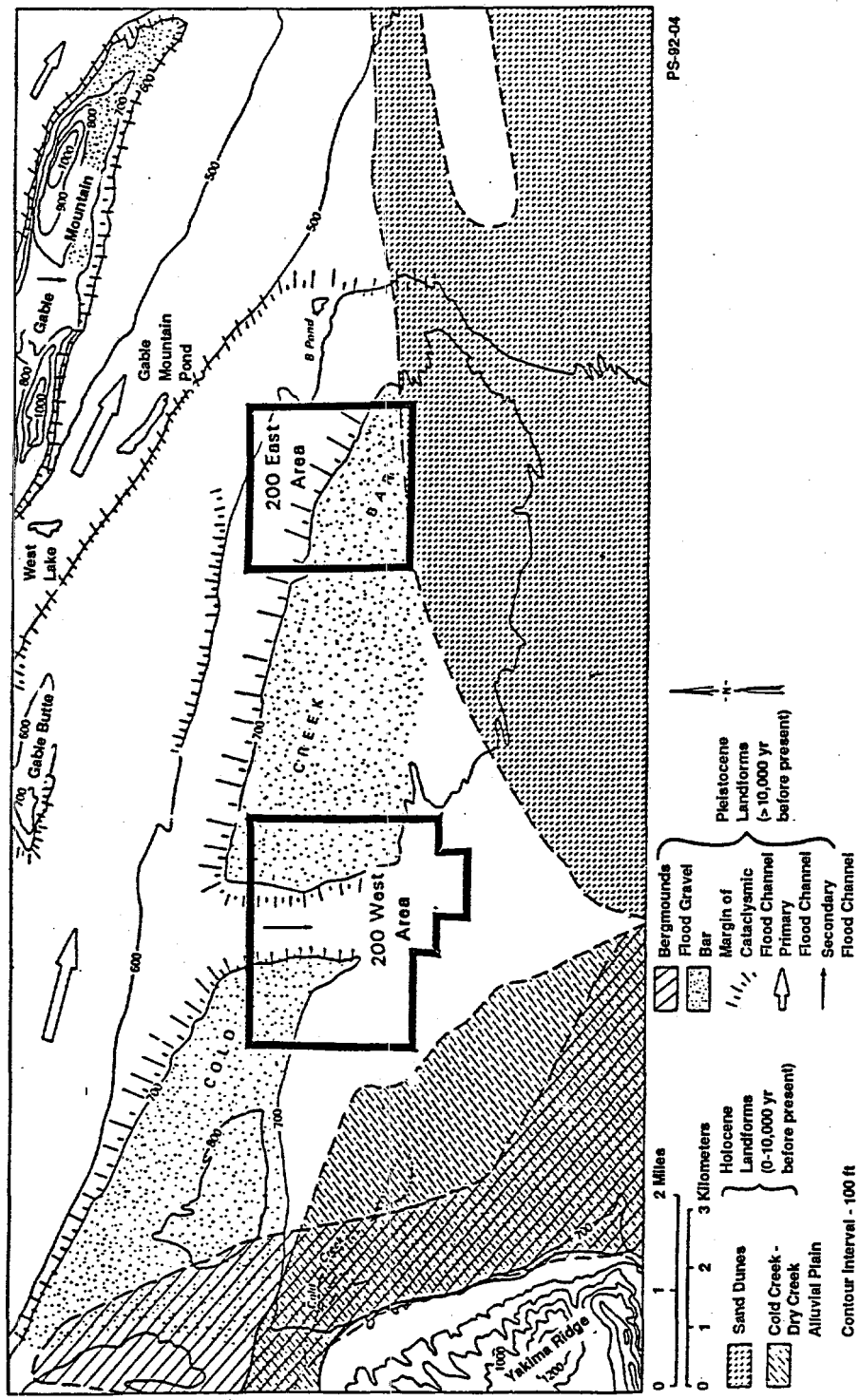
This section summarizes the geology in the vicinity of the LERF. More detailed discussions are found in Delaney et al. (1991), Lindsey et al. (1992), and Sweeney et al. (1994). The terrain surrounding the LERF is relatively flat and the average elevation is about 195 m above msl. The prevailing wind is from the northwest, although strong winds are from the southwest. Sagebrush and cheatgrass cover the area except for access roads and the site itself.

The LERF lies in the Pasco Basin, northeast of the Cold Creek Bar (Figure 3.1) between the axis of the Umtanum-Gable Mountain anticlinal ridge and the axis of the Cold Creek syncline (Figure 3.2). The site is situated on the north flank of the syncline and on the south flank of a principal anticlinal flexture (Figure 3.2).

The stratigraphy beneath the LERF Area has been interpreted principally from the four boreholes drilled to construct the groundwater-monitoring network for the facility (Sweeney et al. 1994). Other correlations were made with sediment data from the 200 East Low-Level Burial Ground Waste-Management Area 2 (LLBG WMA 2) and the 216-B-3 Pond (B Pond). Stratigraphic correlations are presented in Figure 3.3. This figure compares the general stratigraphy of Lindsey (1995) with the conceptual hydrostratigraphic units of Thorne et al. (1993). The thickness of the super-basalt sediments beneath the LERF Area is about 61 m.

Geologic cross sections (Figures 3.4 and 3.5) show the distribution and characteristics of geologic units within the LERF Area. The following sections discuss the geologic units beneath the LERF Area in more detail. Locations of this cross section, along with the locations of all boreholes used in this study, are shown in Figure 2.2.

Three principal stratigraphic units are present near the LERF: the Hanford formation, the Ringold Formation, and the Columbia River basalt. The Hanford formation consists of mostly uncemented gravel, sand, and silt deposited by glacial-outburst cataclysmic floods, which occurred periodically throughout the Pleistocene (Fecht et al. 1987; Baker et al. 1991). The Hanford formation is up to 75 m thick in the vicinity of LERF. The Hanford formation has been divided into three lithofacies that grade and transition from one to the other. The three facies are referred to a gravel-, sand-, and silt-dominated facies by Lindsey et al. (1992) and gravel, plane-laminated sand, and graded rhythmite facies by Baker et al. (1991). The gravel facies is the predominant lithofacies in proximity to high-energy cataclysmic flood channels, such as at the LERF. Sand- and silt-dominated facies are more common southward, away from the axes of the main flood channels. More detailed discussions of the Hanford formation are presented in DOE (1988), Baker et al. (1991), Lindsey et al. (1992; 1994), and Connelly et al. (1992).



*** Keyed features are specifically selected and do not encompass all features.**

Figure 3.1. Geomorphic Features of the 200 Areas

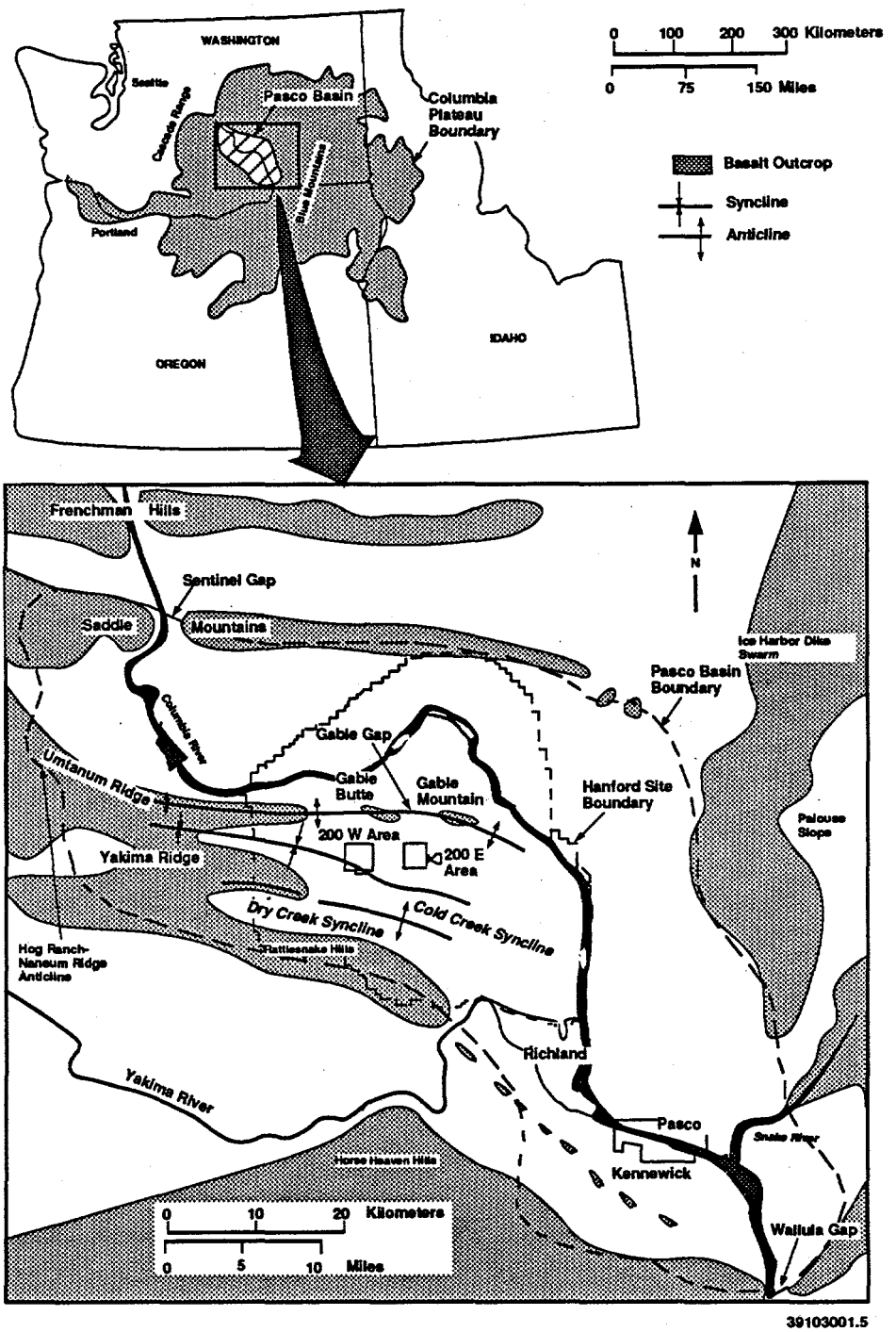


Figure 3.2. Generalized Structural Features of the Pasco Basin, Washington

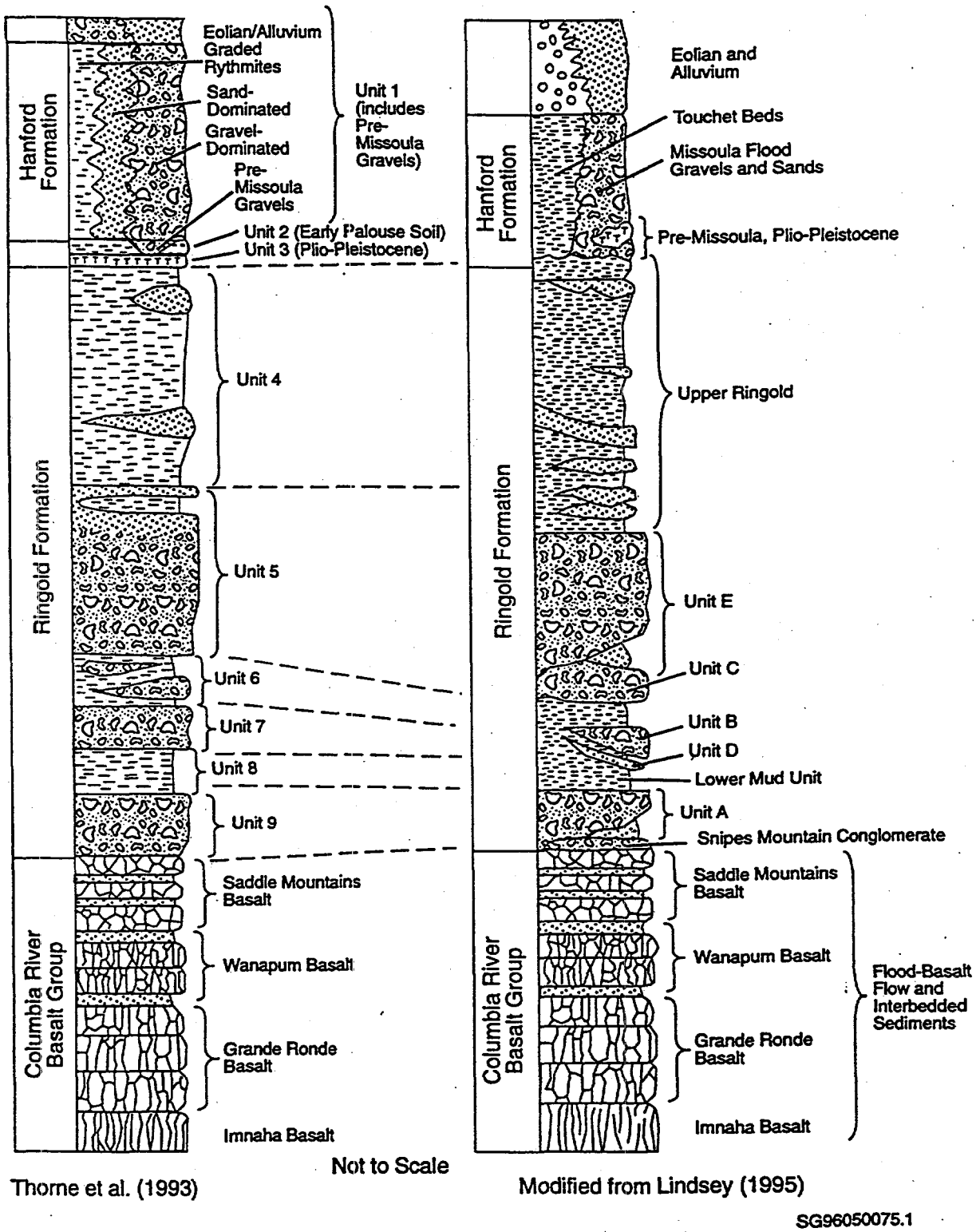
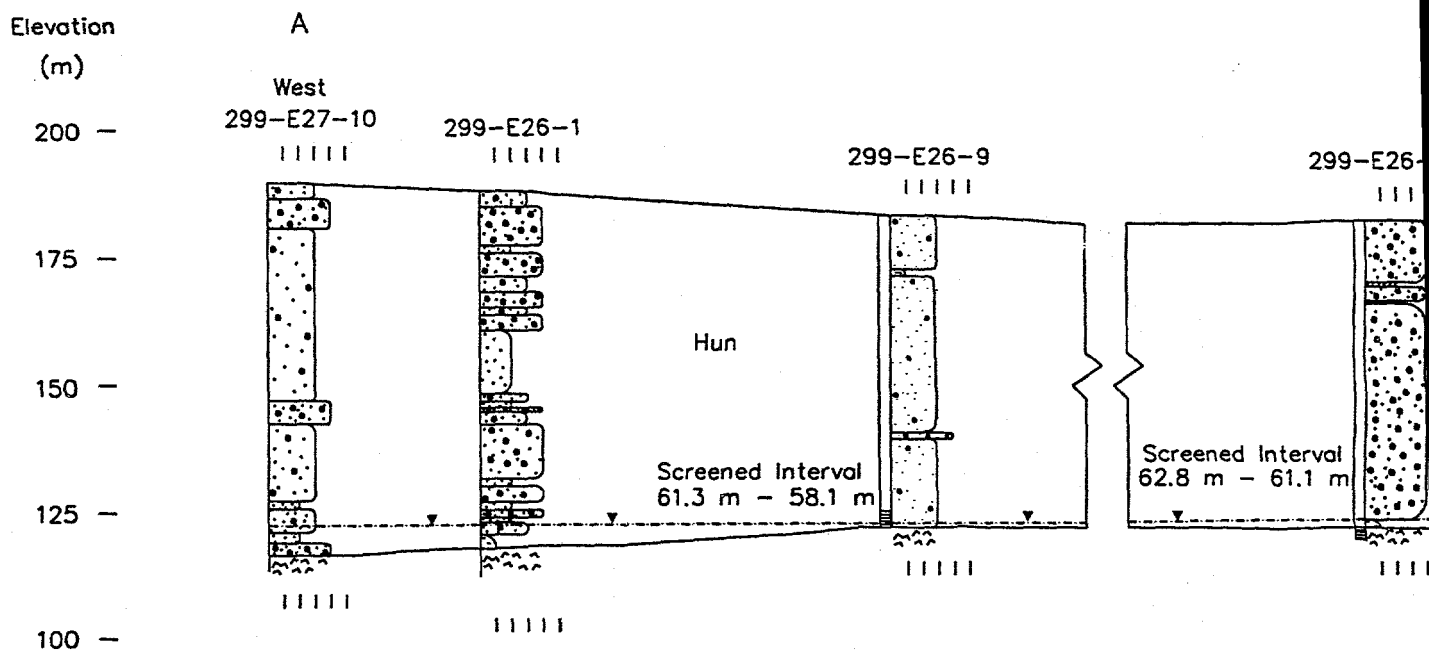


Figure 3.3. Comparison of Generalized Geology and Hydrogeologic Stratigraphic Columns



Explanation

Dominant grain size scale

S P
C/Z GS C/B

C/Z – Clay and Silt
S – Sand
GS – Gravelly Sand
P – Pebble Gravel
C/B – Cobble & Boulder Gravel

Lithologic Symbols

G Gravel
SG Sandy Gravel
GS Gravelly Sand
S Sand
MS Muddy Sand
SM Sandy Mud
M Mud
Basalt

Stratigrap
Hanford fo
Hug – u
Hs – s
Hlg – lo
Hun – u
Ringold Fo
RA – u
Saddle Mo
EM – E

Form
Facie
Water

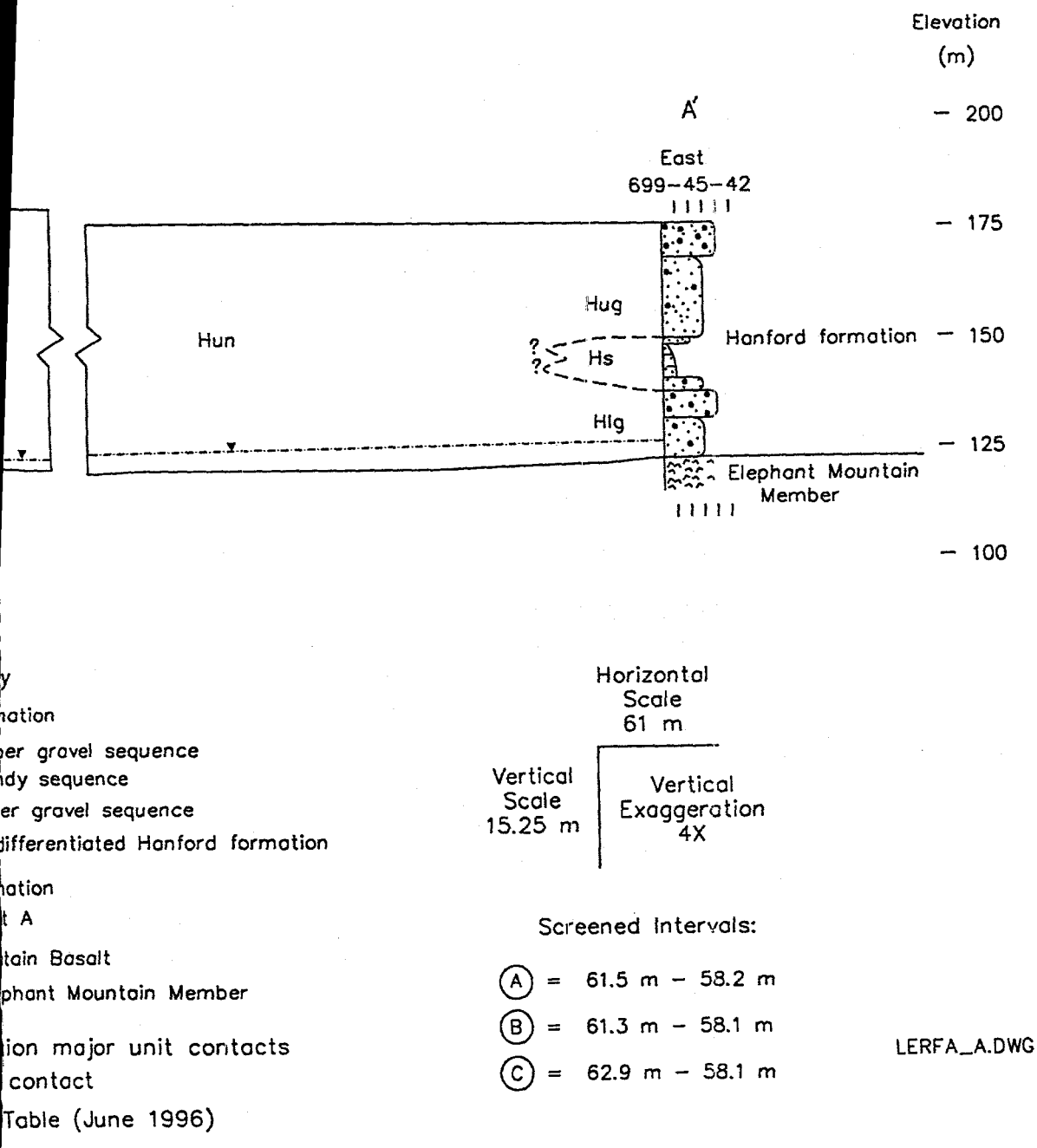
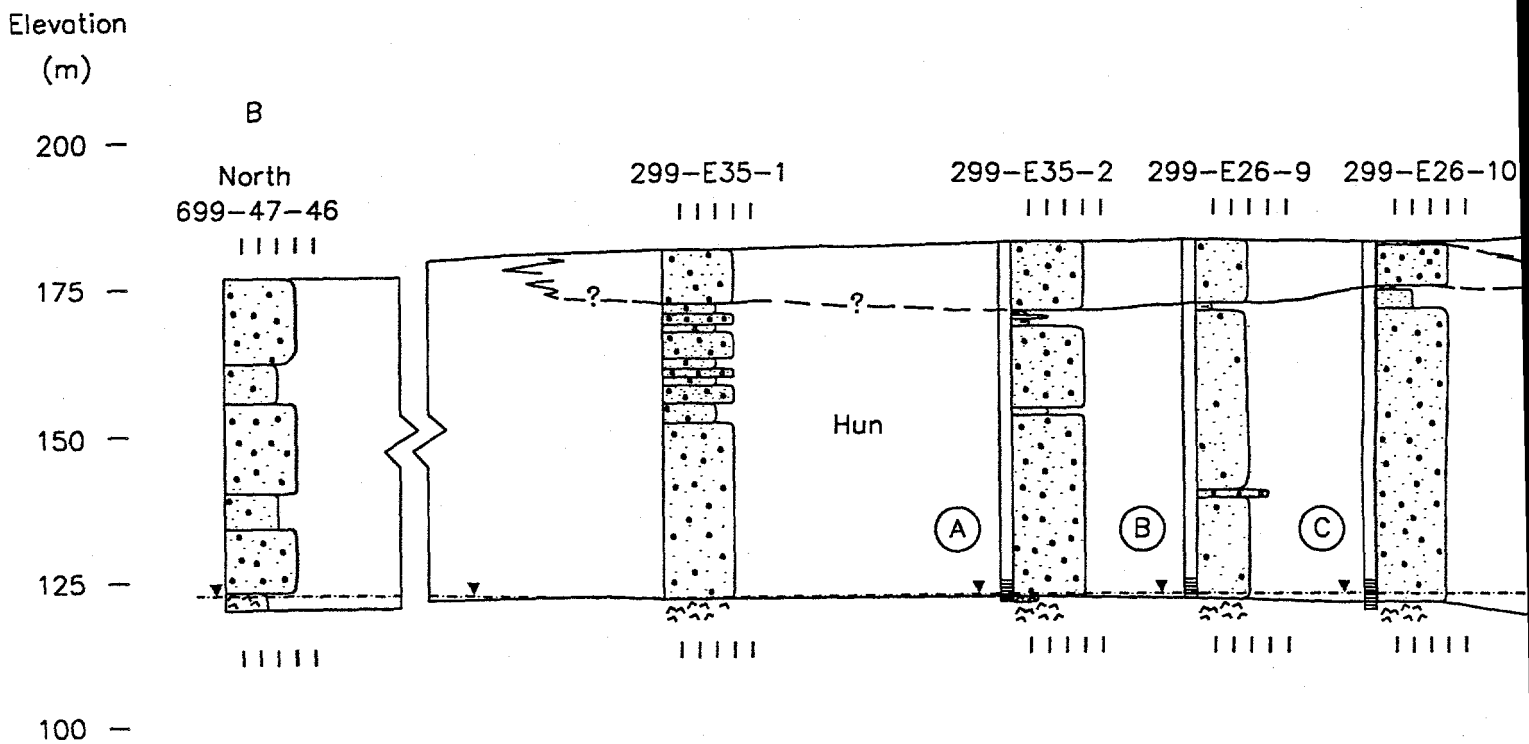


Figure 3.4. West to East Cross Section Through the LERF Area (A-A')



Explanation

Dominant grain size scale

S P
C/Z GS C/B

C/Z – Clay and Silt
S – Sand
GS – Gravelly Sand
P – Pebble Gravel
C/B – Cobble & Boulder Gravel

Lithologic Symbols

G Gravel
SG Sandy Gravel
GS Gravelly Sand
S Sand
MS Muddy Sand
SM Sandy Mud
M Mud
Basalt

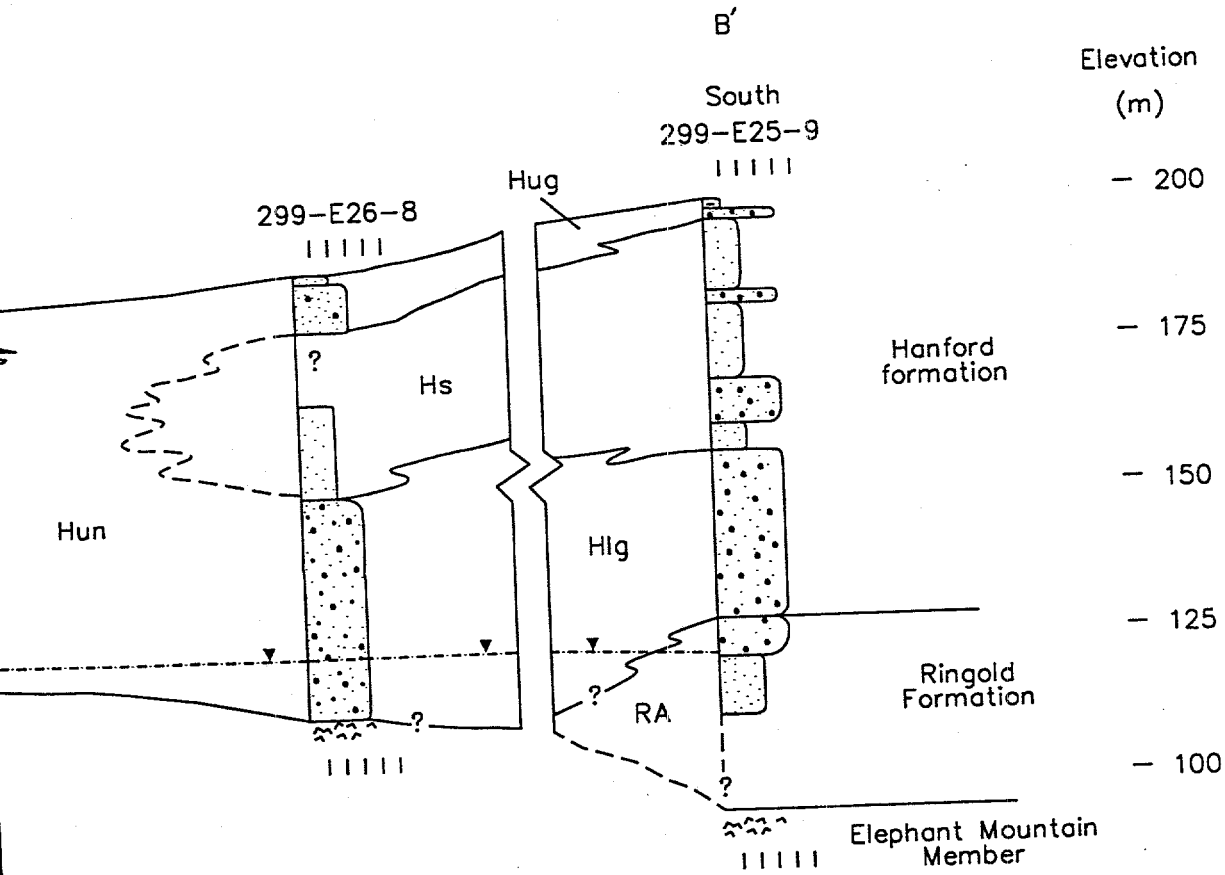
Stratigraphy

Hanford formation
Hug – upper gr
Hs – sandy se
Hlg – lower gr
Hun – undiffere

Ringold Formation
RA – unit A

Saddle Mountain E
EM – Elephant

Formation r
Facies cont
Water Table



Horizontal Scale 61 m

Vertical Scale 15.25 m

Vertical Exaggeration 4X

el sequence
uence
el sequence
iated Hanford formation

salt
Mountain Member

ajor unit contacts
ct
(June 1996)

Screened Intervals:

(A) = 61.5 m – 58.2 m

(B) = 61.3 m – 58.1 m

(C) = 62.9 m – 58.1 m

LERFB_B.DWG

Figure 3.5. North to South Cross Section Through the LERF Area (B-B')

3.1.1 Hanford Formation

The Hanford formation in the vicinity of the LERF consists predominantly of a loose, sandy, pebble-cobble gravel, and a gravelly sand, with occasional layers of sand and/or muddy sand. Sometimes a sequence of the sand-dominated facies occurs between sequences of gravel-dominated facies (Connelly et al. 1992; Lindberg et al. 1993), especially to the south and west of the LERF site. Where this occurs, the Hanford formation is subdivided into an upper gravel sequence (Hug), a sandy sequence (Hs), and a lower gravel sequence (Hlg) (Figures 3.4 and 3.5). The sandy sequence only is present locally within a few of the wells beneath the LERF. Where the sandy sequence is missing, the single sequence of gravel-dominated facies exists, designated as undifferentiated (Hun) on the cross sections (Figures 3.4 and 3.5).

The LERF is located along the southern flank of a major WNW-ESE trending cataclysmic flood channel. Because of multiple flood events, and the turbulence and extremely high-energy associated with these floods, it is difficult to impossible to correlate individual strata within flood sequences; correlations must be done with extreme caution. In outcrops of the Hanford formation elsewhere in the Pasco Basin, for example, it is not uncommon to see gravel-dominated facies grade into and juxtaposed against sand- and silt-dominated facies over a distance of a few tens of meters.

3.1.2 Ringold Formation

The Ringold Formation represents ancient fluvial and lacustrine deposits associated with the ancestral Columbia River, which accumulated sediments in the Pasco Basin between ~3.0-8.5 Ma. Characteristics of the Ringold Formation include a higher degree of consolidation and weathering, compared to the Hanford formation. Isolated, erosional remnants of the Ringold Formation exist locally between the Hanford formation and basalt bedrock beneath the LERF. Thin (few meters or less) pockets of Ringold Formation occur to the south (well 299-E25-9) (Figure 3.5). The Ringold sediments preserved are from the older unit (Unit A), identified in Lindsey et al (1992, 1994), Lindberg et al. (1993), and Connelly et al. (1992).

3.1.3 Elephant Mountain Member

Basalt was encountered in all four of the boreholes drilled around the LERF Area. Samples of the basalt from three of the wells were sent to Washington State University for X-ray fluorescence (XRF) analysis. The results of the XRF analysis indicate that all three basalt samples were of the Elephant Mountain Member chemical type (Sweeney et al. 1994). This tholeiitic basalt member has been dated at 10.5 Ma (McKee et al. 1977). The Elephant Mountain Member has been described as having medium- to fine-grained texture with abundant microphenocrysts of plagioclase, transitional to normal magnetic polarity, is one of the youngest members of the Saddle Mountains Basalt, and is the uppermost member expected in this area (Reidel and Fecht 1981; DOE 1988; Graham et al. 1984; Tallman et al. 1979).

The top of the basalt forms the base of the unconfined aquifer in the LERF Area. All four wells in the LERF-monitoring network reached total depth at the top of the Elephant Mountain Member and are screened across the entire saturated zone in the Hanford formation. These monitoring wells will generally lose their capability to produce representative samples in relation to their position on the top of basalt surface of the Elephant Mountain Member. The top of basalt for the Elephant Mountain Member dips gently to the south with a gradient of 2.0E-02 across most of the 200 East Area (Figure 3.6).

3.2 Groundwater Hydrology

The uppermost aquifer in the LERF Area generally resides in the gravels of the Hanford formation. Figure 3.7 shows the water table in the LERF Area in June 1996. The thickness of the saturated zone varies throughout the LERF groundwater-monitoring network. A regional groundwater elevation decline has occurred since the monitoring network was installed (Figure 3.8). This has resulted in a saturated thickness of 0.6 to 1 m at the northwest portion of the network, 2.5 m in the southwest, and 4.0 m in the east. This constant decline eventually will lead to a saturated thickness of 0 m under most of the LERF (Figure 3.9).

Hydrologic testing was performed at the LERF in 1990 after the installation of the monitoring well network. The purpose of the testing was to provide estimates of transmissivity and hydraulic conductivity of the screened interval.

Slug tests were performed in the unconfined aquifer of the Hanford formation in all four wells. Transmissivity was estimated by the Bouwer and Rice (1976) and Cooper et al. (1967) methods. Values ranged from 11 to 232.5 m^2/d for well 299-E26-9. This produces an equivalent hydraulic conductivity of approximately 6 to 122 m/d, assuming an aquifer thickness of 1.8 to 1.9 m. Substantially lower transmissivity and conductivity data were obtained from wells 299-E26-11 and 299-E35-2. The transmissivity and conductivity for these wells are 6 m^2/d and 11 m/d for 299-E26-11 and 6 m^2/d and 40 m/d for 299-E35-2. The results for the three wells that were reported are indicative of the range of values that can be obtained in the 200 East Area. Data were not obtained for well 299-E26-10 (Sweeney et al. 1994).

Regional groundwater flow is from west to east, but impacted by groundwater mounding resulting from waste-water discharges. Groundwater generally flows from east to west in the uppermost aquifer beneath the LERF Area. The direction of groundwater flow is dominated by residual hydraulic mounding at the 216-B-3 Pond System (Figure 3.7). Decades of effluent discharges to this facility continue to affect groundwater flow, both inside and to the east of the 200 East Area. As discharges in effluent disposal have declined, the mound beneath B Pond either has changed its shape or its position as evidenced by the water level measurements surrounding the facility (Figure 3.10). Groundwater elevations are predicted to reach their pre-production levels in this area as the mound beneath the 216-B-3 Pond System dissipates.

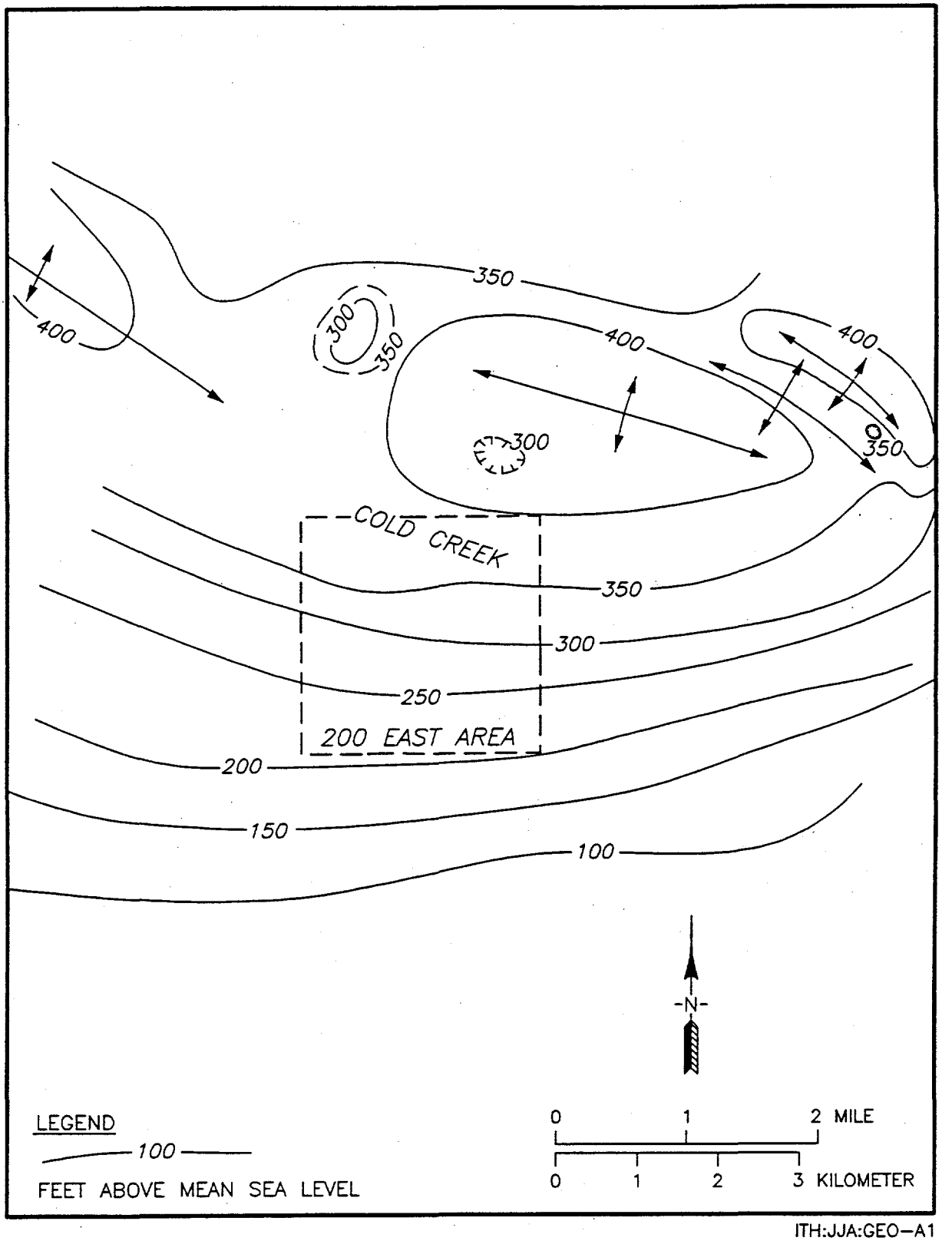


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Figure 3.6. Top of Basalt Structure Contour Map (after Fecht, Reidel, and Chamness)

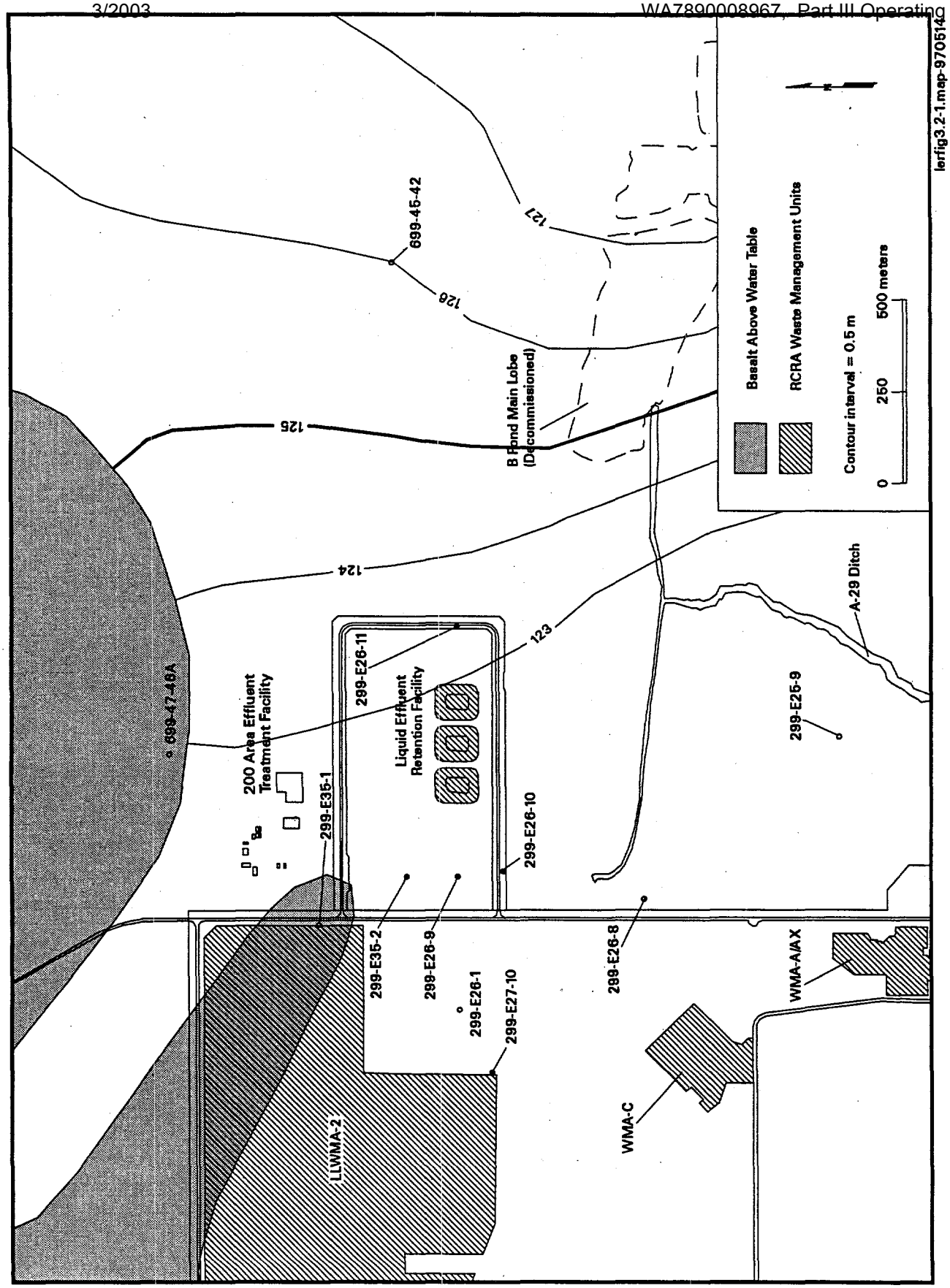


Figure 3.7. Water Table Map of the LERF Area, June 1996

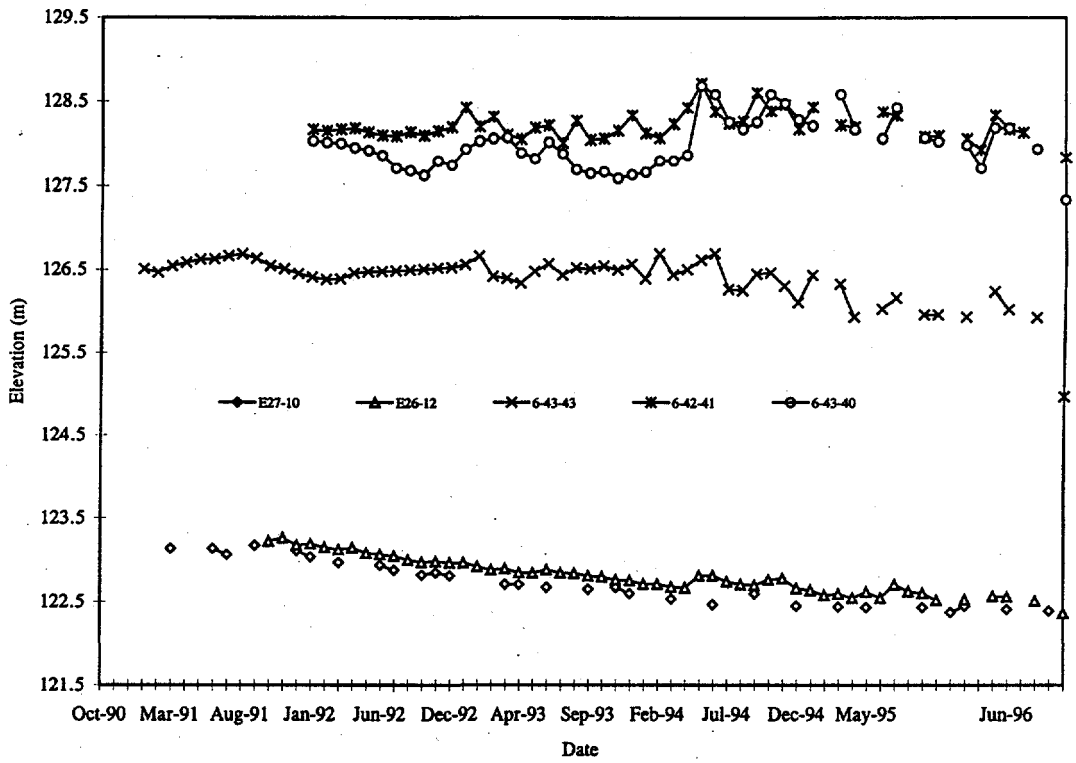


Figure 3.8. Hydrograph of Ground-Water Monitoring Wells Near the LERF Area

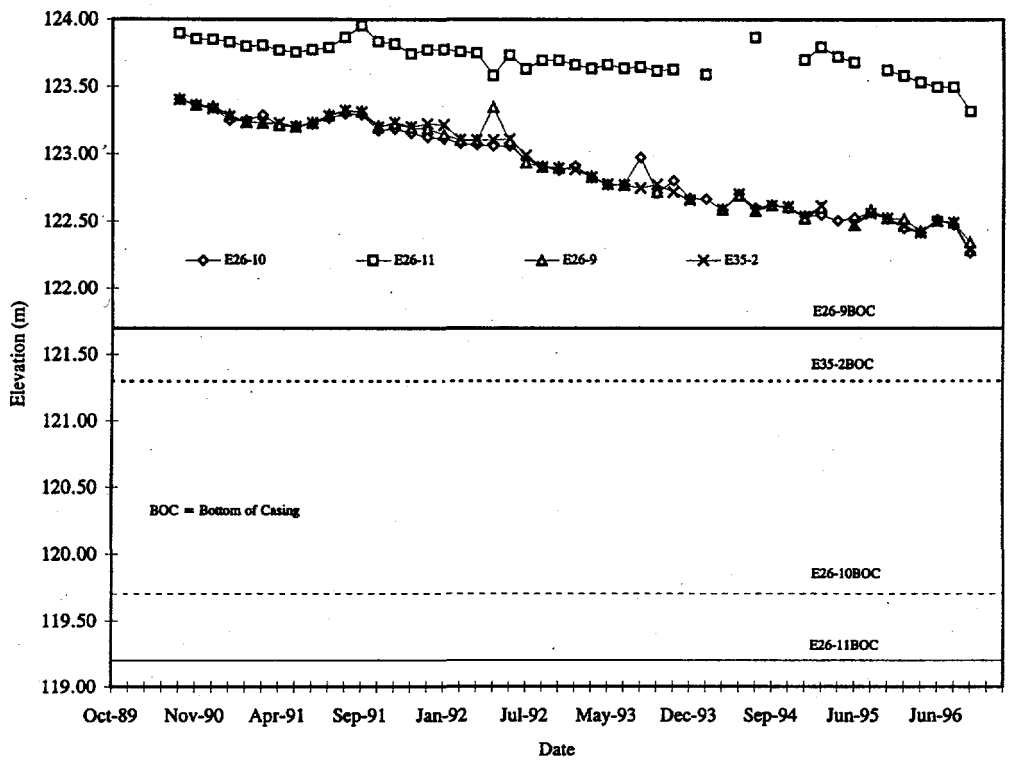
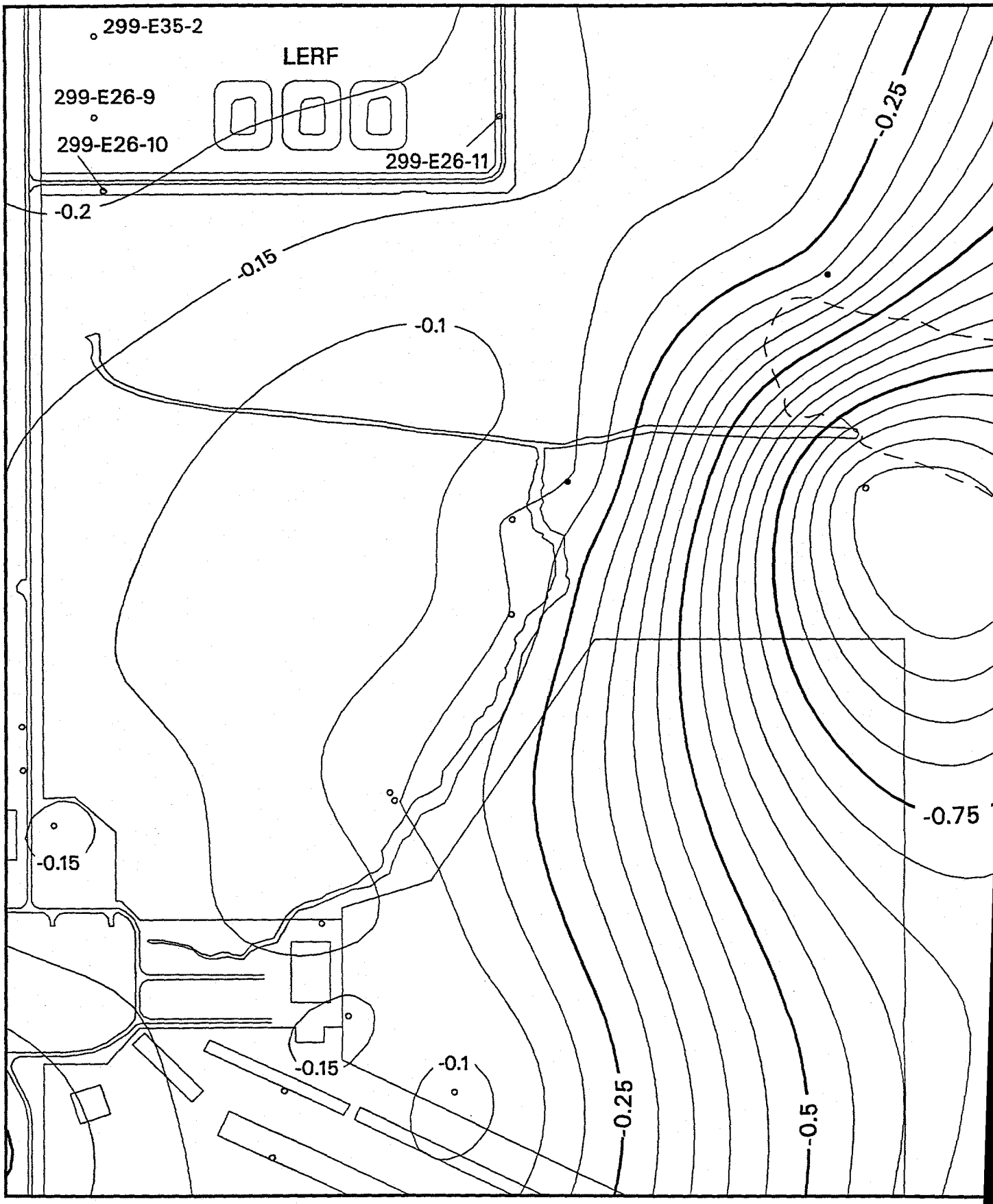


Figure 3.9. Hydrograph of LERF Ground-Water Monitoring Wells


299-E35-2
LERF
299-E26-9
299-E26-10
299-E26-11
-0.2
-0.15
-0.1
-0.25
-0.75
-0.15
-0.15
-0.1
-0.25
-0.5

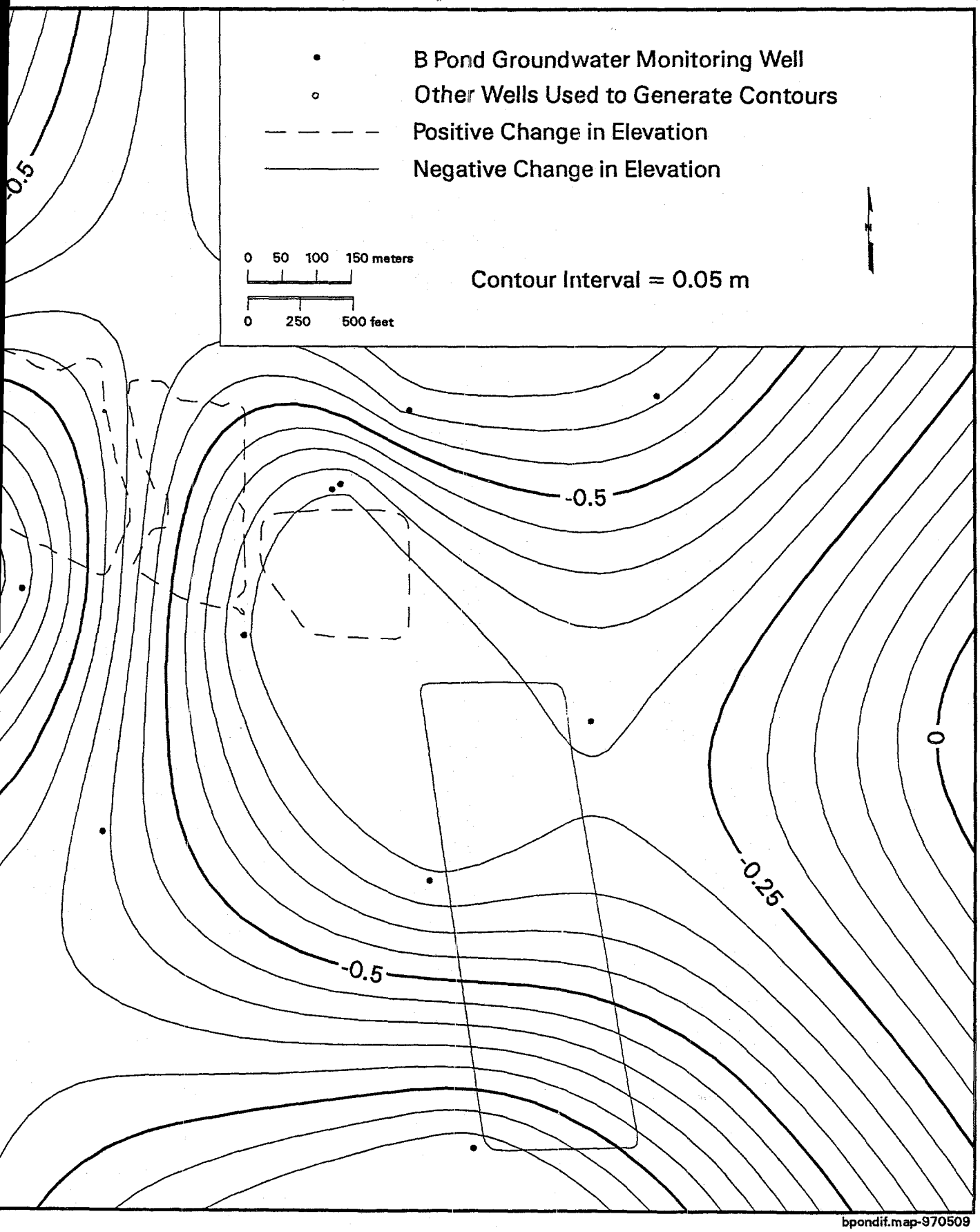


Figure 3.10. Ground-Water Elevation Differential, June 1996 to January 1997

3.3 Groundwater Chemistry

Groundwater chemistry in the uppermost aquifer beneath the LERF has been affected by liquid waste discharged at the 216-B-3 Pond System. No specific pattern of chemical contamination has been identified, but groundwater has been significantly diluted because of the large volume of river water with lower dissolved solids than ambient groundwater (Reidel et al. 1995). Concentrations of arsenic (Johnson 1993) and elevated total organic halides (TOX) have been identified in groundwater beneath the 216-B-3 Pond System. The presence of arsenic has been proposed to be an artifact of discharges to other facilities (e.g., the 216-A-29 Ditch and the 216-A-37 or 216-A-30 Cribs [Reidel et al. 1995]). Arsenic, as well as uranium, was detected in the lower portion of well 699-37-47A. This well was drilled for the PUREX Plant Cribs in 1996 (Lindberg et al. 1997). The constituent identified as contributing to the elevated TOX is tris-2-chloroethyl phosphate (Hartman and Dresel 1997). The source of this constituent currently is being investigated. Neither of these constituents are increasing in concentration and are not considered to impact groundwater significantly in the LERF Area. No exceedences of interim-status groundwater-monitoring parameters have been found.

4.0 Groundwater-Monitoring Program

This section proposes a final-status RCRA detection-level groundwater-monitoring program for the LERF. The groundwater-monitoring program is designed to achieve the following goals in a technically sound and cost-effective manner:

- protect human health and the environment
- comply with the intent of final-status groundwater-monitoring requirements of WAC 173-303-645 and 40 CFR 264 Subpart F
- provide information for groundwater investigation and/or remediation.

This section presents a monitoring network design consisting of the existing wells; methods for sampling and analysis, and a statistical approach for data evaluation.

The elements of this monitoring program were developed through a data quality objectives (DQO) process (EPA 1993). The primary purpose of the DQO process is to ensure that the type, quantity, and quality of data used in monitoring are appropriate for their intended purposes.

4.1 Objectives of RCRA Monitoring

Three stages of groundwater monitoring programs are defined in WAC 173-303-645 with three separate objectives. The detection monitoring program [173-303-645(9)] is designed to determine whether a RCRA-regulated unit has adversely affected the groundwater quality in the uppermost aquifer beneath the regulated unit (i.e., whether a release has occurred). This is accomplished by comparing downgradient concentrations of constituents of concern to values indicative of background concentrations. If a statistically significant increase (or pH decrease) over background occurs in any downgradient well, then a compliance-monitoring program is initiated. In compliance monitoring, downgradient groundwater concentrations of constituents of concern are compared to the concentration limits set in the facility's permit. Concentration limits could be those specified in WAC 173-303-645 5(a)(ii) or alternative concentration limits established by Ecology. If concentration limits are exceeded, the regulated unit must implement a corrective action program. The objective of corrective-action is to protect human health and the environment by removing the dangerous waste constituents and parameters or treating them in place.

Results of the interim-status groundwater-monitoring program indicate that the LERF has not impacted the groundwater quality beneath the site. Thus, a detection-monitoring program is deemed appropriate for the site.

4.2 Chemical Parameters and Dangerous Constituents

Nitrate, TOX, total organic carbon (TOC), tritium, gross alpha- and gross beta-emitting isotopes were selected as the constituents of concern. The following factors were considered in deriving a constituent list for the LERF: 242-A Evaporator campaign analysis, history of detection in the site groundwater, and other potential source streams that have been identified for storage in the LERF. Because the likelihood is small that any release has occurred during LERF operational activities, the selection of the constituents of concern was not driven by patterns of groundwater contamination. A broad analytical approach was selected due to the inherent uncertainties associated with predicting long-term use of the LERF for effluent treatment. Although waste treatment campaigns of DST wastes have produced a relatively narrow range of effluent variability, future treatment campaigns may produce elevated levels of constituents that cannot be predicted. Also, cleanup efforts throughout the site will produce source streams beyond the narrowly defined chemical makeup of effluents generated by the 242-A Evaporator.

Nitrate was selected for groundwater analysis due to concentrations of ammonia in 242-A Evaporator process condensate. The TOX and TOC analyses were selected to detect a wide variety of organic constituents from various sources. These analytical methods will detect the presence of acetone, 1-butanol, 2-butanone, methyl isobutyl keytone, and pyridine in groundwater samples. As a group, these constituents represent the current process knowledge for organic contaminants in the 242-A Evaporator process condensate. Radiological contaminants entrained in the process condensate necessitated the use of screening techniques to identify gross activities for both beta- and alpha-emitting isotopes. Tritium was also identified in the process condensate and will be an early indication of contaminant transport to groundwater.

4.3 Concentration Limits

This section proposes the concentration limits for the LERF constituents of concern. These concentration limits serve as the compliance standards in case the regulated unit is found to impact the quality of groundwater and the facility enters into compliance-monitoring status. At that time, concentration limits for additional constituents of concern will be proposed and a revised groundwater-monitoring plan will be prepared. These concentration limits would be applied during compliance monitoring to determine whether corrective action might be necessary. It should be noted that concentration limits are not proposed for the general contamination-indicator parameters (i.e., TOC, TOX, gross alpha, and gross beta). These indicator species can only provide an indication of the presence of dangerous constituents in the groundwater. They cannot identify the specific constituent(s) that cause the degradation in groundwater quality.

- Nitrate: 45,000 ppb (as NO_3); based on final maximum contaminant level (MCL), 56 FR, January 30 1991

- Tritium: 80,000 pCi/L[a] (Eckerman et al.).

(a) Concentration assumed to yield an effective dose equivalent of 4 mrem/yr from a drinking-water pathway.

4.4 Groundwater-Monitoring Network and Point of Compliance

The proposed groundwater-monitoring network for the LERF contains four wells. Upgradient monitoring is accomplished with well 299-E26-11. The downgradient wells drilled for this facility include 299-E26-9, 299-E26-10, and 299-E35-2 (Figure 2.1). All wells were drilled to fulfill the requirements for well network monitoring for RCRA sites (WAC 173-160). The well construction and completion summaries, including schematics, for the four wells can be found in Appendix A. Specifically, the objective was to select well locations that would monitor the uppermost aquifer for waste constituents of concern. In the instance of the LERF, the constituents of concern include TOX, TOC, nitrate, tritium, gross beta, and gross alpha. None of these constituents has been detected in significant quantities from LERF wells. The three downgradient wells are west of the LERF to intercept any groundwater contaminants emanating from the LERF and flowing with the groundwater in directions consistent with the operational history of the facility.

Based on the Monitoring Efficiency Model (Wilson et al. 1992), the proposed downgradient wells should provide a monitoring efficiency of approximately 95.5%, assuming a groundwater-flow direction to the west. The location of 299-E26-11 was selected to provide upgradient groundwater conditions for the facility while attempting to minimize the influences of the 216-B-3 Pond System. The capability of the monitoring network to provide representative samples will decline as groundwater reverts to the pre-weapons production easterly flow direction. This reversal will have less impact than the overall decline of water table elevation. The declines eventually will leave two downgradient wells without enough groundwater to provide representative samples.

The point of compliance (POC) is defined in 40 CFR 264.95 and WAC 173-303-645 (6) as a "vertical surface" located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated unit. For the LERF, the POC should be the three downgradient monitoring wells as described above (i.e., 299-E26-9, 299-E26-10, and 299-E35-2; Figure 2.1).

4.5 Compliance Period

The compliance period is the number of years equal to the active life of the unit (including any waste-management activity before permitting and the closure period). Typically, groundwater monitoring is required for a period of 30 years following completion of closure activities, although this period may be shortened or extended by the regulatory authority. If the regulated unit undergoes corrective action, then the compliance period will be extended until it can be demonstrated that the applicable limit has not been exceeded for a period of three consecutive years.

4.6 Sampling and Analysis

This section describes the sampling and analysis program for the regulated unit, including monitoring parameters, analytical methods, monitoring frequency, and sampling protocols.

4.6.1 Monitoring Parameters

Table 4.1 lists constituents to be analyzed for the regulated unit. This list includes the following:

- the indicator constituents identified in Section 4.2 (Only the constituents of concern to the LERF will be used to determine whether statistically significant evidence of contamination has occurred)
- additional constituents to aid data interpretation (alkalinity, anions, and inductively coupled plasma (ICP) metals)
- field parameters routinely acquired at the well head (pH, turbidity, specific conductance, and temperature).

4.6.2 Sampling Frequency

The hazardous-waste regulations under RCRA require owners and operators of hazardous-waste facilities to use design features and control features that prevent the release of hazardous waste into groundwater. Regulated units are also subject to the groundwater-monitoring and corrective-action standards of 40 CFR Part 264, Subpart F and WAC 173-303-645. These regulations require that a statistical method and sampling procedure approved by the regulator(s) be used to determine whether there are releases from regulated units into groundwater. Default statistical methods and sampling procedures are specified in these regulations; however, alternatives are available as discussed below.

Historically, the default statistical method for detecting release from the regulated unit is *the tests on mean concentrations* between upgradient (background) and downgradient wells. For facilities regulated under the interim-status regulations, for example, a t-test is required to make this determination [40 CFR 265.93(b)]. For facilities regulated under the final status regulations, the recommended approach at the time of promulgation was analysis of variance (ANOVA) (EPA 1989, page 4-1 and page 5-3) where the

Table 4.1. Constituent List for the 200 Areas LERF

Constituent List		
Indicator Constituents	Field Parameters	Other
TOC TOX Nitrate Tritium Gross Alpha Gross Beta	pH Turbidity Temperature Specific Conductance	Alkalinity Anions Metals (filtered) by ICP[a] Method
(a) ICP = Inductively Coupled Plasma.		

means of different groups of observations are compared to determine whether there are any significant differences among the groups (e.g., background wells and compliance wells). If so, then contrast procedures may be used to determine where the differences lie.

The owner and operator has the latitude within the interim-status regulations to choose a t-test that will accommodate the data collected, however. There is much less choice with regard to the data collection requirement. Four replicate measurements (analyzed on the same sample) must be collected for the general contamination-indicator parameters during each sampling event.

Under final status regulations, two sampling procedures are allowed: (1) a sequence of at least four samples taken at an interval that ensures, to the greatest extent technically feasible, that an independent sample is obtained (i.e., the default sampling procedure); and (2) an alternate sampling procedure proposed by the owner or operator and approved by the regulator(s) that is to be protective of human health and the environment [40 CFR 264.97(g)(1) and (2), WAC 173-303-645 (8)(g)(i) and (ii)]. Under the default sampling procedure, the minimum number of samples that are to be collected each testing period is *four*. This minimum number was selected by the EPA to maintain consistency with the prior requirements (i.e., interim-status requirements using a t-test on means) that specified that the owner or operator collect one sample from each well and divide it into four replicate samples for laboratory analysis (53FR, 39725). Hence, EPA contended that requiring four samples to be collected from each well for laboratory analysis should not impose an increase in the number of analyses but recognized that there may be an increase in the field sampling costs associated with this sampling procedure. The requirement of four independent samples, therefore, reflected EPA's position (in 1989) of being consistent with interim-status requirements to collect four replicate samples and to use a test on mean concentrations as a default statistical method.

The most far-reaching change is the extension of groundwater-monitoring requirements to solid waste facilities, mandated in the 40 CFR Part 258, Subtitle D regulations. In particular, the solid waste Final Rule of 1991 dropped the four independent samples per monitoring period requirement (only one measurement is required per monitoring event).

Another major change included the issuance of an Addendum (EPA 1992) to *Interim Final Guidance on Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities* (EPA 1989). This Addendum reflects more current thinking within the statistics profession and offers a series of currently recommended techniques and updated advice concerning the Interim Final Guidance document (EPA 1992, page 1). One of the revisions is the recommendation of using a two-phased testing strategy (EPA 1992, pages 67-74) that evaluates each sample *individually* rather than relying on a test of the mean concentrations of several independent samples (i.e., the ANOVA procedure). This revision is prompted because the ANOVA method is to be avoided in the groundwater-monitoring applications for the following reasons (see Gibbons 1994, page 260 and EPA 1992, page 67): (1) the ANOVA procedure may have lower power for detecting a narrow plume of contamination that affects only one or two wells in a much larger network (approximately twenty or more comparisons); (2) a significant ANOVA test result will not indicate which well or wells is potentially contaminated without further post-hoc comparisons (i.e., comparisons that are found to be of interest after the data were collected); (3) because the one-way ANOVA procedure is not designed to test multiple constituents simultaneously, the overall false positive rate will be approximately 5% *per constituent*, leading to a potentially high overall network-wide false-positive rate if many constituents need to

be tested (It should be noted that a site such as LERF with six indicator constituents will have a 26% = 1 - $(0.95)^6$ overall false positive rate); and (4) collection of four independent samples at a given well may necessitate a several-month wait if the natural groundwater velocity at that well is low.

In summary, the reason for the requirement of four independent samples during each monitoring event for facilities regulated under final status is that the one-way ANOVA can be performed (Davis and McNichols 1994). This requirement was dropped in the solid waste Final Rule of 1991. The EPA 1992 Addendum acknowledges that the one-way ANOVA procedures (parametric and nonparametric) are less attractive. It is desirable to seek alternative strategies (e.g., tolerance limits, prediction limits, or both) that allow statistical testing for each new groundwater sample individually as it is collected and analyzed. Furthermore, because each compliance well is compared with the interval limits separately, a narrow plume of contamination can be identified more efficiently than with an ANOVA procedure. That is, no post-hoc comparisons are necessary to find the contaminated wells, and the two-phased testing method has more power against the "needle-in-a-haystack" contamination hypothesis. The alternative strategy, set out below, is consistent with the Addendum to the Interim Final Guidance but does not require the collection of four independent samples during each monitoring event.

The regulations allow the use of an alternate sampling procedure [40 CFR 264.97(g) (2) and WAC 173-303-645 (8)(g)(ii)] and statistical method, provided they meet the performance standards as specified in 40 CFR 264.97(i) and in WAC 173-303-645(8)(ii). It also should be noted that in referring to "statistical methods" EPA endorsed a system approach to groundwater monitoring that evaluates the choice of a level of significance, the choice of a statistical test, the sampling requirement, the number of samples, and the frequency of sampling in their entirety, not by individual components (EPA 1989, page 2-4).

Based on justifications provided above, an alternate sampling procedure that is endorsed by EPA as being protective of human health and the environment is described briefly below. The compliance wells and background wells will be sampled for indicator constituents (see column 1 of Table 4.1) at least semi-annually during the compliance period. Other constituents will be sampled in all monitoring wells on an annual basis. A two-staged testing strategy as recommended by EPA (1992) is proposed (see Section 4.7 for detail). During each semiannual sampling event, one sample will be collected from each well and individually compared to the background values established for the regulated unit (i.e., the first stage). The second stage is applicable to instance(s) where an initial exceedance(s) has occurred. In this stage, an upper prediction limit (using background data) will be calculated and compared to results of verification samples (i.e., confirmation sampling). Specifically, two verification resamples are to be obtained sequentially (from each well which exceeds the tolerance limit) and analyzed for the constituent in question. A statistical exceedance is declared if both verification resamples exceed the prediction limit. The use of upgradient-monitoring data to establish the upper tolerance limits as background values (i.e., the first stage) is described in Section 4.7.2. The proposed resampling scheme (i.e., the second stage) is discussed in Section 4.7.3. Temporal variabilities caused by seasonal effects are not expected in groundwater at the LERF.

4.6.3 Sampling Procedures

Groundwater-sampling procedures, sample-collection documentation, sample preservation and shipment, and chain-of-custody requirements are described in Environmental Investigation Instructions (EII) (WHC 1992), or superseding equivalent contractor procedures, and in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1993) (or in superseding equivalent PNNL project quality assurance plan, in preparation). Work by subcontractors shall be conducted to their equivalent approved standard operating procedures.

All field-sampling activities will be recorded in the proper field logbook as specified in EII 1.5, or superseding procedures, and subsequent revisions. Before sampling each well, the static water level will be measured and recorded as specified in EII 10.2, or superseding procedures. Based on the measured water level and well construction details, the volume of water in the well will be calculated and documented on the well sampling form or field notebook. Each well will be purged until the approved criteria are met, as specified in EII 5.8, or superseding procedures. Purge water will be managed according to EII 10.3, or superseding procedures. If a well pumps dry because of very slow recharge or low water levels, then samples will be collected after recharge.

Quality assurance requirements are defined in the PNL-MA-70, *Quality Assurance Manual* (PNNL 1997) and Article 31 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology and EPA 1996). The RCRA sampling and analysis program is supported by WHC (1993) or equivalent PNNL documents. Sample-preservation and chain-of-custody procedures are described in EII 5.1 (WHC-CM-7-7), or superseding procedures.

4.6.4 Analytical Procedures

Procedures for field measurements (pH, specific conductance, temperature, and turbidity) are specified in the user's manual for the meters used. The laboratory approved for the groundwater-monitoring program will operate under the requirements of current laboratory contracts and will use standard laboratory procedures as listed in the SW-846 (EPA 1986) or an alternate equivalent. Alternative procedures, when used, will meet the guidelines of SW-846, Chapter 10. Analytical methods and quality control for the RCRA groundwater-monitoring activities are described in WHC (1993) (or superseding PNNL quality assurance plan, in preparation).

4.7 Statistical Methods

This section proposes statistical evaluation procedures for the LERF groundwater monitoring program. Statistical evaluation of groundwater-monitoring data will comply with requirements set forth in the WAC 173-303-645(8)(h) and (i) final status regulations. Acceptable statistical methods for a final-status detection-monitoring program includes ANOVA, tolerance intervals, prediction intervals, control charts, test of proportions, or other statistical methods approved by Ecology [WAC 173-303-645(8)(h)]. The type of monitoring, the nature of the data, the proportions of nondetects, spatial and temporal variations are

important factors to consider when selecting appropriate statistical methods. Procedures outlined in the following EPA technical guidance documents will be followed:

- *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Interim Final Guidance* (EPA 1989)

- *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Draft Addendum to Interim Final Guidance* (EPA 1992).

The concentrations of constituents of concern in POC wells will be compared with data from background wells semiannually to determine whether there is a statistically significant increase over background concentrations.

4.7.1 Approach

The goals of statistical evaluation methods proposed for the LERF are:

- The network-wide false-positive rate (across all constituents and wells being tested) should be kept at an acceptable low level. (Note that the false-positive rate [or Type I error rate] is the probability that the test will indicate contamination falsely although no contamination has occurred); and

- The test strategy should have adequate statistical power to detect real contamination when it occurs.

When the number of upgradient/downgradient comparisons is moderate to large (approximately twenty or more), the false-positive rate associated with the testing network as a whole can be quite high. If the test network consists of twenty separate comparisons (e.g., four wells multiplied by five constituents) and a false-positive rate for each individual well comparison is set at 1%, for example, then one would expect an overall network-wide (i.e., facility-wide) false positive rate of over 18% [note that 18% – 1 - $(0.99)^{20}$]. This means there is nearly one chance in five that one or more comparisons will register potential contamination falsely even if none has occurred, adding additional sampling and analysis expense to verify the false-positive results. To lower the network-wide false-positive rate, the number of tested constituents should be limited to the most useful indicators (EPA 1992, page 62; Gibbons 1994, page 16); therefore, only the constituents of concern will be subject to statistical evaluations for the LERF. Another strategy to lower the overall false-positive rate is to perform verification sampling to determine whether the statistically significant difference between background and compliance-point wells is an artifact caused by an error in sampling, analysis, statistical evaluation, or natural variation in groundwater chemistry.

Another goal of the statistical method is to maintain adequate statistical power for detecting contamination. The power of a test depends on several factors, including the background sample size, the type of test proposed, and the number of comparisons (i.e., the false-positive rate). Other things being equal, the larger the sample size (number of background samples), the larger the statistical power; therefore, the proposed statistical method should use historical groundwater-monitoring data (collected under

the interim-status) to the greatest extent possible. The ANOVA procedures (either the parametric method or the Kruskal-Wallis test) are not proposed because they may have less power for detecting a narrow plume of contamination. Furthermore, a significant ANOVA test result will not indicate which well or wells is potentially contaminated without further evaluation (see Section 4.6.2).

After careful evaluation of statistical methods (that are acceptable for a final-status detection monitoring), a two-phase testing strategy that is recommended by EPA (1992, pages 67-75) is proposed for the LERF. In the first stage, an upper tolerance limit (for each constituent of concern) with pre-specified average coverage will be calculated based on background (upgradient well) data and will be compared to individual compliance-point (downgradient well) samples. The second stage is applicable to instance(s) where an initial exceedance(s) occurred. In this stage, an upper prediction limit (using background data) will be calculated and compared to results of verification samples (i.e., confirmation sampling). Specifically, two verification resamples are to be obtained sequentially (from each well which exceeds the tolerance limit) and analyzed for the constituent in question. A statistical exceedance is declared if both verification re-samples exceed the prediction limit.

The use of an upper tolerance limit as an initial screening tool is more powerful than the use of an upper prediction limit. An upper tolerance limit is designed to cover a certain specified percentage of all future measurements from the background distribution with $(1 - \alpha)\%$ confidence. By contrast, an upper prediction limit is designed to cover 100% of the future k measurements. If the number of future comparisons (e.g., the product of the number of monitoring wells and the number of constituents) is moderate to large (e.g., ≥twenty), the tolerance limits will be smaller than prediction limits. The proposed screening approach results in a statistical comparison that is more conservative in detecting small releases, and is therefore more protective of human health and the environment. Once an initial exceedance is observed, however, an upper prediction limit should be used for the verification resampling to control the overall false positive rate; an artifact of the built-in failure rate associated the upper tolerance limit (i.e., incomplete well coverage). The use of upgradient monitoring data to establish the upper tolerance limits (i.e., the first stage) is described in Section 4.7.2. The proposed re-sampling scheme (i.e., the second stage) is discussed in Section 4.7.3.

4.7.2 Background Values

Certain assumptions concerning the statistical model or methods are required to determine and interpret background groundwater characteristics properly at the regulated unit. These assumptions and/or justifications are stated below.

- Groundwater-monitoring data are representative of actual groundwater conditions in the uppermost aquifer beneath the site. Representativeness is best satisfied by following prescribed sampling and analysis procedures and collecting a sufficient number of samples.

- Seasonal or temporal variations are insignificant. As discussed earlier, temporal variabilities caused by seasonal effects are not expected at the LERF.

- Groundwater-chemistry data are typically log-normally distributed. The use of a log-normal distribution as a default statistical model is justified because: (1) most groundwater-monitoring data are positively skewed and are restricted to positive values; (2) all of the available statistical tests for distribution assumptions are inadequate when the sample size is small (approximately less than twenty observations); (3) EPA's experience with contaminant concentration data, and groundwater-monitoring data in particular, suggests that a log-normal distribution generally is more appropriate as a default statistical model than normal distribution (EPA 1992, page 2); and (4) pollutant sources are randomly diluted in a multiplicative fashion through repeated dilution and mixing with uncontaminated water, which can lead mathematically to a log-normal distribution (Ott 1990).

Background values (area) are defined as the levels of chemical, physical, biological, and radiological constituents or parameters upgradient of a unit, practice, or activity that have not been affected by that unit, practice, or activity. Background groundwater concentration, for a particular constituent of concern, is defined statistically as the 95% ("the coverage") upper tolerance limit with a 95% confidence ("the tolerance coefficient") (Ecology 1996a, page 65). The use of a coverage of 95% and a tolerance coefficient of 95% is also recommended by EPA (1989 and 1992). These recommendations are consistent with methods for defining background concentrations as required under the "Model Toxics Control Act Cleanup Regulation," WAC 173-340 (Ecology 1996b amended). One-sided upper tolerance limit for normally distributed data is of the form:

$$\bar{x} + ks \qquad (1)$$

where $\bar{x}$ is the sample mean; k is a multiplier based on the coverage, the confidence level, and sample size; and s is the sample standard deviation. Values of k can be obtained from Natrella (1966) and Gilbert (1987, Table A.3). The upper tolerance limit for log-normally distributed data can be estimated by (1) transforming the raw data using $\log_{10}$ (common logarithm) or $\log_e$ (natural logarithm); (2) calculating the upper tolerance limit using the log-transformed data and Equation (1); and (3) back-transforming (antilog) to the original unit.

Before using these parametric limits that depend heavily on the normality (or log-normality) assumption, the adequacy of normal (or log-normal) distribution as a model will be assessed by probability plots and/or statistical goodness-of-fit tests, such as the Shapiro-Wilk test or the Lilliefors test of normality (Gilbert 1987; Conover 1980).

When the normal or log-normal distribution cannot be justified, the use of nonparametric tolerance intervals may be considered. The upper tolerance limit is usually the largest observed value in a random sample. The nonparametric tolerance intervals, however, require a large number of samples to provide a

reasonable coverage and tolerance coefficient. The number of samples needed for a minimum coverage of P% and a tolerance coefficient of (1 - α)% is (Gumbel 1958, page 68):

$$n = \frac{\log_{10} \alpha}{\log_{10} P} \tag{2}$$

To have a minimum coverage of 95% and 95% confidence, 59 background samples are needed. Due to the large background sample size requirement, a non-parametric tolerance limit (with a minimum coverage of 95% and a 95% confidence) may not be practical in groundwater-detection monitoring. If one can use an average coverage of 95% (not the minimum as discussed above), however, then at least nineteen background samples are needed to achieve 95% coverage on the average. [Note: When the maximum sample value is chosen as the upper tolerance limit, then it can be shown that the expected coverage is equal to n/(n+1)]. If background samples are less than nineteen, then a lower average coverage and/or a lower confidence level would result.

Analytical results were reviewed under the aegis of the RCRA quality-control (QC) program. The QC program that supports the sampling and analysis of groundwater from the LERF is described in the PNNL comprehensive groundwater-monitoring report (Hartman and Dresel 1997). For the LERF, verified and validated groundwater-monitoring data (from upgradient well 299-E26-11) except for TOC and TOX, were used to establish the background value for each dangerous constituent of concern using Equation (1).

The reasonableness of the assumed log-normal (or normal) distributions was tested using the Lilliefors test for normality of data. The test results indicated that all of the dangerous constituents of concern can be reasonably approximated by log-normal (or normal) distributions, except for nitrate. On further evaluation there appear to be two concentration groups. Concentrations of earlier nitrate data (collected from June 1991 to April 1992, four data points) range from 4,900 μg/L to 6,100 μg/L. The range of the recent data (from July 1992 to January 1996, six data points) is from 7,400 μg/L to 8,200 μg/L. Because the earlier nitrate data are not representative of the current conditions, they are not used in the background value derivation. A statistical goodness-of-fit test is not performed for nitrate data because of insufficient data (six data points); however, upper tolerance limits (for a log-normal, normal, and non-parametric distribution) were calculated and evaluated. These limits (normal = 8,700 μg/L, log-normal = 8,800 μg/L, and non-parametric = 8,200 μg/L) are fairly comparable. Hence, an upper-tolerance limit based on a log-normal distribution is proposed as the background value for nitrate. As more monitoring data are collected, this value will be re-evaluated.

TOX data analyzed during the period from January 1992 through October 1993 were flagged with "Y" (suspect) because of audit concerns. These data were eliminated from further statistical evaluation because the validity of such data is in doubt. In addition, the majority of the TOC and TOX data (from upgradient well) were essentially nondetects. These data were either reported with a "U" qualifier, indicating that data were below the method detection limit (MDL), or reported with a "L" qualifier, indicating that data were between the MDL and the contractually required detection limit. Furthermore, analytical laboratories and the MDLs have changed several times over time (from June 1991 to January 1997). It is not appropriate to

use these essentially not-detected TOC and TOX data to calculate the background values using Equation (1) because the lack of estimates of background variability precludes the determination of the upper-tolerance limits.

To overcome this problem, the limit of quantitation (LOQ) will be used as a surrogate background value for TOC and similarly for TOX. The LOQ is defined as the level above which quantitative results may be obtained with a specified degree of confidence (Keith 1991). It is determined by using field-blanks data. Note that the field blanks are QC samples that are introduced into a process to monitor the performance of the system. The use of field blanks to calculate LOQ is preferred over the use of laboratory blanks because field blanks provide a measure of the errors in the entire sampling and analysis system. Methods to calculate LOQ are described in detail in Schmid et al. (1991b).

Based on above discussions, the following background values are proposed for the LERF and are presented in Table 4.2. The necessary summary statistics and k values are also provided. It should be noted that the means and standard deviations shown in Table 4.2 are expressed in respective log unit of measurement (common logarithm).

Background values (i.e., upper tolerance limits) will be compared with individual sample results obtained from downgradient compliance wells semiannually. If an initial exceedance(s) occurs, then an upper prediction limit calculated from background data (see Section 4.7.3) will be calculated and compared to re-samples from well(s) which exceed the tolerance limit (i.e., confirmation sampling). In addition, background values will also be used to track the encroachment of upgradient sources of contaminant plumes. In order to assure that the background database contains independent and representative measurements, new data will be added that are determined to belong to the same background population. Background values (listed in Table 4.2) and the statistical approach will be evaluated and updated periodically to reflect these additions. If changes in groundwater flow directions result in changes in definition of upgradient well(s) or changes in site conditions, then background values will be re-established. If statistical evaluation methods are no longer effective to achieve its goals (see discussions in Section 4.7.1) caused by changing site conditions, then a new statistical approach will be proposed.

4.7.3 Confirmation Sampling

Tolerance limits have a built-in failure rate of (1 - P)%; for example, one would expect 1 in every 20 samples to be outside of the upper 95% tolerance limit just by chance. Verification re-sampling is necessary to decrease the chance of a false-positive decision because of either the built-in failure rate or the effects of gross errors in sampling or analysis. This is the best currently available approach to balance false-positive and false-negative decisions in groundwater-monitoring applications (Gibbons 1994, page 15). In case of an initial exceedance, a verification sampling is needed to determine if the exceedance is an artifact caused by an error in sampling, analysis, or statistical evaluation or natural variation in the groundwater. Recent EPA guidance (1992) encourages the use of re-sampling as a means to reduce the facility-wide false-positive rate.

Table 4.2. Proposed Background Values[a] for the LERF

Constituent of Concern	Number of Background Samples	Transformed Mean	Transformed Standard Deviation	Multiplier (K)	Upper Tolerance Limit
Tritium	14	3.267	0.0746	2.614	2,900 pCi/L
Nitrate[b]	6	3.8796	0.0174	3.711	8,800 µg/L
Gross Alpha	12	0.333	0.162	2.736	5.97 pCi/L
Gross Beta	12	0.7431	0.1324	2.736	12.74 pCi/L
TOC[c]	NA	NA	NA	NA	LOQ
TOX[c]	NA	NA	NA	NA	LOQ

(a) Background values are defined as the upper 95% tolerance limit with 95% confidence.
(b) Nitrate data collected from 1/21/92 to 1/3/96 were used. Earlier nitrate data were not unrepresentative of current conditions.
(c) Most recently calculated LOQ will be the surrogate background value.

As described in Section 4.7.1, a two-phase testing strategy is proposed for the LERF. The second-stage confirmation sampling is applicable to instance(s) where an initial exceedance(s) occurred. Each well that triggers the upper tolerance limit is re-sampled for only those constituents that triggered the limit and is retested using an upper prediction limit established from background (upgradient) data.

A prediction interval is a statistical interval constructed to include a specified number of future observations (or the average of several future observations) from a population or distribution with a specified probability. That is, after sampling background well(s) for some time and measuring the concentration of an analyte, the data can be used to construct an interval that will contain the next analyte sample or samples (assuming the distribution has not changed). If concentrations of future observation(s) (or their mean) at a compliance-point well are above the upper prediction limit, then evidence of contamination is indicated. The formula to calculate an upper parametric-prediction limit for a single future observation (appropriate for a normal distribution) is provided in EPA (1989, pp. 5-24 to 5-28) and is stated below:

$$\bar{x} + t_{(n-1,k,1-\alpha)} * s * \sqrt{1 + \frac{1}{n}} \qquad (3)$$

where $\bar{x}$ and s are the mean and standard deviation for the background well data; n is the number of observations in the background data; k is the number of future comparisons (e.g., the product of the number of

monitoring wells and the number of constituents); and $t_{(n-1, k, 1-\alpha)}$ is the Bonferroni t-value, which is equivalent to the usual t-value at the $(1 - \alpha/k)$ level with $(n - 1)$ degrees of freedom. If data can be approximated by a log-normal distribution, then one should:

- Transform the original data into log units;
- Obtain estimates of mean and standard deviation of the log-transformed variable;
- Calculate the upper prediction limit using Equation (3); and
- Back-transform (anti-log) the calculated upper prediction limit into original unit.

When the parametric assumptions of a normal-based (or a log normal-based) prediction limit cannot be justified, then a non-parametric prediction interval may be considered. A non-parametric upper prediction limit typically is constructed by estimating the limit to be the maximum observed value of the set of background samples. If there are too few background measurements to achieve an adequate site-wide false positive rate using the non-parametric approach, Poisson prediction limits are a suitable replacement. The formula used to compute the Poisson prediction limit can be found in EPA (1992, pages 35-38) and in ASTM (1996, page 11).

Note that Equation (3) assumes that the future multiple comparisons (i.e., verification-sampling events) are independent. This is not true in the context of upgradient versus downgradient comparisons where each new monitoring measurement is compared to the same upgradient background limit. If background-sample sizes of $n = 20$ or more, then a prediction limit based on Bonferroni-adjusted t-value yields similar results to those obtained by the multivariate t-statistic that accounts for the correlation among repeated comparisons (Gibbons 1994, page 25).

The use of Bonferroni t-value to control the overall site-wide false-positive rate is not recommended when the number of future comparisons is large. In such an instance, it does so at the expense of the false-negative rate (i.e., failure to detect contamination when present). This is not acceptable. Conversely, control of the false-negative rate at the expense of the false-positive rate is also unacceptable. The best currently available approach to balancing false positive- and false-negative rates in groundwater-monitoring applications is the use of verification re-sampling (Gibbons 1994, page 15).

Confirmation retesting can be accomplished by taking a specific number of additional, independent samples from well(s) where a specific constituent triggers the initial exceedance. Because more independent data are added to the overall testing procedure, retesting of additional samples, in general, will make the statistical test more powerful and result in a more reliable determination of possible contamination. The objectives for the verification sampling, therefore, are to ensure: (1) quick identification and confirmation of contamination exceeding the background value, if any, and (2) the statistical independence of successive resamples from any well where initial exceedance has occurred. The performance of the statistical retesting strategy depends substantially on obtaining independent verification samples from the triggering well. These re-samples, therefore, must be separated enough by time so that the well could be recharged and restabilized.

Based on the results of simulation study described by Gibbons (1994, pages 18-32), it is proposed to accomplish confirmation retesting by adopting a plan in which both of two resamples must exceed the prediction limit for a statistically significant increase (over background) to be declared. Specifically, the verification sampling will be conducted as follows. If the initial sample result exceeds the upper tolerance limit (i.e., the first stage), then a re-sample is obtained from each of the triggering well(s) and analyzed for the constituent in question. If that measurement is less than the prediction limit (e.g., calculated using appropriate table from Gibbons) or less than the maximum observed background value, then no further sampling is necessary. A statistically significant result will be declared only if both re-sample results are larger than the upper prediction limit.

For constituents of concern, upper prediction limits cannot be calculated at the present time because the number of future comparisons (k) and the number of observations in the background database (n) at that time cannot be specified in advance. Recommended confidence levels (1- α)% for the two-staged retesting strategies are provided in EPA (1992, page 70). A 90% confidence level for the upper prediction limit and a 95% coverage for the tolerance limit is deemed appropriate for the LERF at the present time. One should refer to the table that provides parametric retest strategies (see EPA 1992, page 70), however, or refer to the appropriate tables provided in Gibbons (1994, pages 24- 31), or to the formulas provided in ASTM (1996, pages 10-11), to find the best combination of confidence level and coverage ratio at the time when actual exceedance has occurred because the number of background samples would be different than that was used in Table 4.2.

4.7.4 Non-Detects

Non-detects will be handled using the recommendations stated in the EPA guidance documents (1989 and 1992). In general, non-detects will be less of a problem in using a nonparametric method to evaluate compliance data. If a parametric statistical method is used, then the handling of non-detects will depend on the percentage of detected values. Basically, a substitution method (use two of the detection limits to replace non-detects) will be used if less than 15% of all samples are non-detects. If the percent of non-detects is between 15% to 50%, then either Cohen's method (requires either normal or log-normal data) or Aitchison's adjustments will be used. Detailed descriptions of these methods can be found in EPA (1989 and 1992). When more than 50% of the sample values are non-detects, then the Poisson model may be used to derive a Poisson tolerance limit and a Poisson prediction limit (EPA 1992, pp. 35 - 40). If background data are essentially non-detects, then most recent LOQ will be used as the upper tolerance limit and upper prediction limit.

4.7.5 Outliers

An "outlier" is an observation that does not conform to the pattern established by other observations in the data set. Possible reasons for its occurrence include contaminated sampling equipment, inconsistent sampling or analytical procedure, data transcribing error, and true but extreme measurements. Statistical

methods such as Grubbs' method (Grubbs 1969) for testing of outliers and/or the box-and-whisker plot (Ostle and Malone 1988) may be used. Once an observation is found to be an outlier, then the following action can be taken:

- If the error can be identified and the correct value can be recovered through the data review process (see Section 5.1), then replace the outlier value with the corrected value.
- If the error can be documented but the correct value cannot be recovered, then the outlier should be deleted. Describe this deletion in the statistical report.
- If no error can be documented, then assume that the value is a valid measurement; however, obtain another sample to confirm the high value, if necessary.

4.8 Determining the Rate and Direction of Groundwater Flow

Depth to water will be measured in the four LERF groundwater-monitoring wells during sampling and as part of the site-wide water-table elevation model. Maps produced from the site-wide model will be used to interpret the direction of groundwater flow and to derive the water-table gradient for the LERF. The gradient, in turn, will be used with estimated values of hydraulic conductivity and effective porosity to calculate flow rate using the Darcy equation.

4.9 Continuation of Monitoring Compliance at the LERF

The general groundwater-flow direction is from west to east in the vicinity of the 200 East Area; artificial recharge due to the B Pond system perturbs the general trend. The resulting groundwater mound creates flow direction in the vicinity of the LERF that is currently opposite the general west-to-east flow directions. The inferred flow is from east to west beneath the LERF. As the influence of the groundwater mound diminishes with distance, the general west-to-east flow prevails. As discharge volumes continue to decline in the future, the perturbation in groundwater-flow direction discussed above will subside. In addition, the water table continues to decline beneath the facility in response to a decline in the groundwater mound beneath B-Pond.

Because groundwater elevations in the Central Plateau were not well documented before nuclear process operations at the Hanford Site, it is generally unknown at what elevation groundwater will stabilize. It is possible that the uppermost aquifer beneath the LERF will not reside in the Hanford formation or in remnants of the Ringold Formation. The next water-bearing interval occurs in the sediments of the Rattlesnake Ridge Interbed. This aquifer system exists under confined conditions between the Elephant Mountain and Pomona Members of the Saddle Mountain Basalt Formation.

The Hanford formation eventually will yield only negligible quantities of groundwater for representative samples. The LERF groundwater-monitoring network will then cease to fulfill its intended function. A replacement or alternate monitoring system will have to consider the changing hydrogeologic conditions beneath the facility. Monitoring efficiency studies will also address an expected groundwater flow reversal

that may precede the effective loss of water in the groundwater-monitoring network. Activities that will take place to obtain the necessary information to maintain compliance include:

- semi-annual groundwater elevation measurements from the LERF network and from wells in the vicinity of the facility
- monitoring efficiency modeling for the current network based on current flow conditions
- modeling of groundwater flow throughout the 200 East Area to predict possible future flow conditions
- combining modeling results to determine network efficiency and modification requirements for the network

It would not be prudent, therefore, to recommend specific countermeasures to correct the monitoring network because it is fully functional at this time. Projections of when the groundwater elevation beneath the LERF will reach a level where the network cannot fulfill regulatory requirements are not exact. The effective life-span of the network has exceeded earlier projections of water-level decline in LERF monitoring network wells (Wurstner and Freshley 1994) (Figure 3.9). There is a strong probability that the network will lose one well by 2000. Two wells out of the network might not provide representative samples in six years.

Because the methodology available for monitoring compliance at this facility at some arbitrary future time cannot be assumed, it is more reasonable to recommend a monitoring system close to the time when the groundwater network is no longer compliant.

5.0 Data Management and Reporting

This section describes data-management practices and reporting requirements for the regulated unit.

5.1 Data Storage and Retrieval

All contract analytical laboratory results are submitted by the laboratory in electronic form and are loaded into the HEIS database. Parameters measured in the field either are entered into HEIS manually or through electronic transfer. Data from the HEIS database may be downloaded to smaller databases, such as the Geosciences Data Analysis Toolkit (GeoDAT) for data validation, data reduction, and trend analysis.

Record copies of data are stored at the laboratory until the contract is terminated, then sent to PNNL for storage. Field records are stored at PNNL.

5.2 Data Verification and Validation

Verification and validation of groundwater chemistry and water-level data is or will be performed according to WHC-CM-7-8, Section 2.6 (WHC 1992) or an equivalent PNNL procedure. Data are flagged if quality control is suspect. Data are also screened for completeness and representativeness by a project scientist assigned to the regulated unit. Data are compared to historical and spatial trends. Suspect data are investigated through the data-review process and are flagged in the database.

5.3 Reporting

The results of the statistical evaluation will be submitted to Ecology in the form of RCRA quarterly reports and the groundwater annual monitoring report. The statistical results might include a list of groundwater parameters analyzed, detection and/or quantitation limits, and background values. If a statistically significant increase (after the confirmation resampling evaluation process) in one or more of the constituents of concern is determined, then the following steps will be taken:

- Notify Ecology in writing within 7 days of the finding with a report indicating which chemical parameters or dangerous-waste constituents have shown statistically significant increases over the background values, and which points of compliance (wells) are involved.

- Submit an application for a permit modification to establish a compliance-monitoring program to Ecology in 90 days.

In case of a false positive claim, the following procedures will be taken:

- Notify Ecology in writing within 7 days of the finding (i.e., exceedance) that a false-positive claim will be made.

- Submit a report to Ecology within 90 days. This report should demonstrate that a source other than the LERF caused the contamination or that the detection resulted from an error in sampling, analysis, or evaluation or natural variation in groundwater.

- Submit an application for a permit modification, if necessary, to make appropriate changes to the detection-monitoring program within 90 days.

- Continue to monitor in accordance with the detection-monitoring program.

6.0 Compliance-Monitoring Program

A compliance-monitoring program that satisfies requirements set forth in WAC 173-303-645 (10) will be established for the LEFF if groundwater sampling during detection-level monitoring reveals statistically significant increases (or pH decreases) over background concentrations for groundwater. If compliance monitoring is required, then the DQO process will be used to guide the selection of constituents of concern, sampling and analysis, statistical methods, etc. If other groundwater constituents indicative of migrating waste products are identified, then the list of groundwater parameters will be revised to include such constituents. In the compliance monitoring programs, the constituents of concern will be compared to concentration limits [maximum contaminant levels (MCLs)]. A revised groundwater-monitoring plan will be prepared and submitted to Ecology for approval.

7.0 Corrective-Action Program

If, at a point of compliance (a well), dangerous constituents of concern are measured in the groundwater at concentrations that exceed the applicable groundwater-concentration limit, Ecology must be notified in 7 days, and an application to modify the permit to include a corrective-action plan must be sent to Ecology within 90 days. After concurrence from Ecology, a corrective-action level-monitoring program will be established. The development of a corrective-action level-monitoring program will be initiated by integration of RCRA/CERCLA programs. A description of the groundwater-monitoring plan that will be used to assess the effectiveness of the corrective/remedial action measures will be prepared and submitted to Ecology when the need for corrective action is first identified.

8.0 References

Public Laws

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Code of Federal Regulations

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40 CFR 264, Code of Federal Regulations, Title 40, Part 264. *Standards for Owners of Hazardous Waste Treatment, Storage, and Disposal Facilities.*

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Appendix A

Well Construction Diagrams for the LERF Groundwater-Monitoring Network

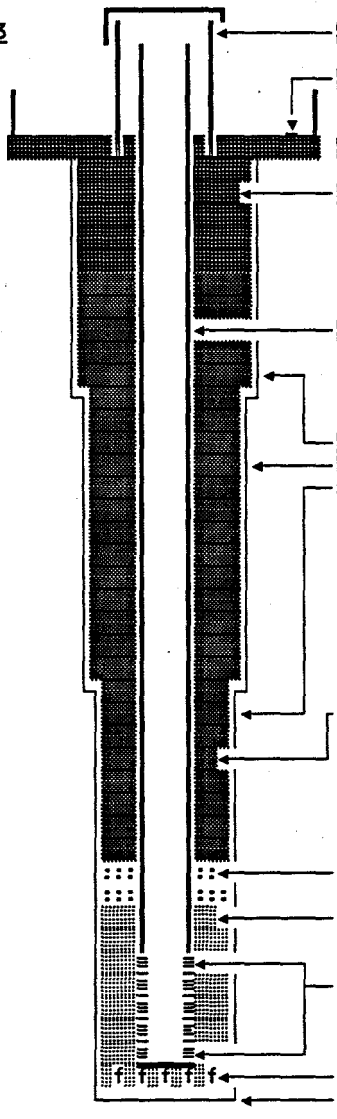
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Drive barrel Method: Hard tool	WELL NUMBER: 299-E26-9	TEMPORARY WELL NO: LF-2
Drilling Fluid Used: 200E Potable water	Additives Used: None	Hanford Coordinates: N/S N 44,779.9	E/W W 46,960.4
Driller's Name: M Thorenson	WA State Lic Nr: Not documented	State NAD83 N 137,133.40m	E 575,576.37m
Drilling Company: Kaiser Engineers	Company Location: Hanford	Coordinates: N 449,961	E 2,248,250
Date Started: 09Jul90	Date Complete: 10Aug90	Start Card #: Not documented	T___ R___ S___
		Elevation Ground surface: 599.89 (Brass cap)	

Depth to water: 195.2-ft Aug90
(Ground surface) 197.4-ft 14Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0↔10: Sandy GRAVEL
10↔25: Muddy sandy GRAVEL
25↔35: Sandy GRAVEL
35↔40: Gravelly SAND
40↔42: Muddy SAND
42↔45: Gravelly SAND
45↔50: Sandy GRAVEL
50↔55: Muddy sandy GRAVEL
55↔70: Sandy GRAVEL
70↔75: Muddy sandy GRAVEL
75↔100: Sandy GRAVEL
100↔105: Muddy sandy GRAVEL
105↔115: Sandy GRAVEL
115↔120: Muddy sandy GRAVEL
120↔125: Gravelly SAND
125↔145: Sandy GRAVEL
145↔150: Muddy sandy GRAVEL
150↔155: Sandy GRAVEL
155↔180: Muddy sandy GRAVEL
180↔201: Sandy GRAVEL
201↔202.5: BASALT



Elevation of reference point: [602.89-ft] (top of casing)
Height of reference point above ground surface [3.00-ft]
Depth of surface seal [0.0↔18.6-ft]
Type of surface seal: Cement grout, 3.2↔18.6-ft 4-ftx4-ftx6-in concrete pad extends 3.2-ft into annulus
4-in ID stainless steel casing, ~+1.0↔190.3-ft
Hole diameter,
0.0↔59.8-ft, 13-in nominal
59.8↔157.5-ft, 11-in nominal
157.5↔202.5-ft, 9-in nominal
Bentonite crumbles, 18.6↔182.9-ft, 8↔20-mesh
¼-in bentonite pellets, 182.9↔186.5-ft
Silica sand pack, 186.5↔201.0-ft, 20↔40-mesh
4-in ID T304 stainless steel screen, w/channel pack 190.3↔200.9-ft, #10-slot
Fill, 201.0↔202.5-ft
Borehole drilled depth: [202.5-ft]

Drawing By: RKL/2E26-09.ASB
Date : 17Sep93
Reference :

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E26-9

WELL DESIGNATION	:	299-E26-9
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	LERF
HANFORD COORDINATES	:	N 44,779.9 W 46,960.4 [200E-18Sep90]
LAMBERT COORDINATES	:	N 449,961 E 2,248,250 [HANCONV]
		N 137,133.40m E 575,576.37m [NAD83-18Sep90]
DATE DRILLED	:	Aug90
DEPTH DRILLED (GS)	:	202.5-ft
MEASURED DEPTH (GS)	:	201.6-ft, 25Jan93
DEPTH TO WATER (GS)	:	195.2-ft, 01Aug90;
		197.4-ft, 14Jun93
CASING DIAMETER	:	4-in stainless steel, ~+1.0↔190.3-ft;
		6-in stainless steel, +3.0↔~0.5-ft
ELEV TOP CASING	:	602.89-ft, [200E-18Sep90]
ELEV GROUND SURFACE	:	599.89-ft, Brass cap [200E-18Sep90]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	190.3↔200.9-ft, 4-in #10-slot stainless steel;
		with channel pack
COMMENTS	:	FIELD INSPECTION, 25Jan93;
		6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable
		capped and locked, brass cap in pad with well ID.
		Not in radiation zone. DTW=200.3-ft, DTB=204.6-ft (TOC)
		OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LERF quarterly water level measurement, 01Feb91↔14Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling,
		PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar, intake @ 199.2-ft (GS)
MAINTENANCE	:	

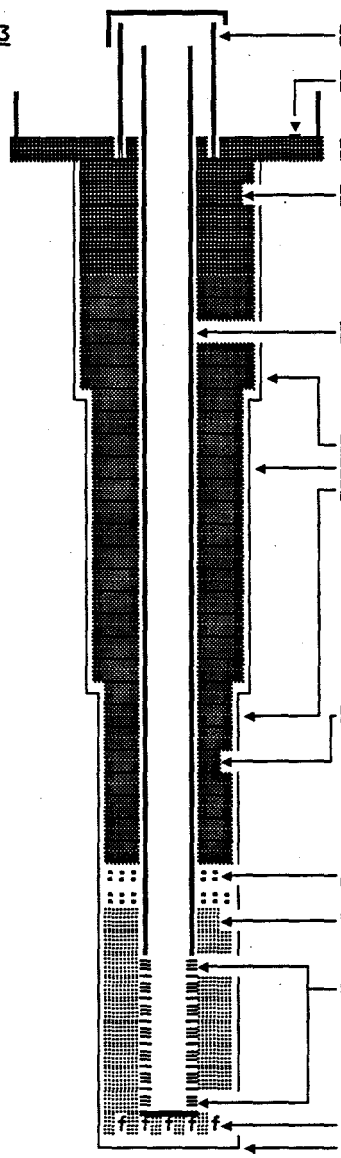
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Not documented	WELL NUMBER: 299-E26-10
Drilling 200E	Additives	TEMPORARY WELL NO: LERF-3
Fluid Used: Potable water	Used: None	Hanford Coordinates: N/S N 44,420.1 E/W W 46,919.3
Driller's Name: L Watkins	WA State Lic Nr: Not documented	State NAD83 N 137,023.76m E 575,589.23m
Drilling Company: Kaiser Engineers	Company Location: Hanford	Coordinates: N 449,602 E 2,248,292
Date Started: 20Jul90	Date Complete: 28Aug90	Start Card #: Not documented T___ R___ S___
		Elevation Ground surface: 598.49-ft (Brass cap)

Depth to water: 193.3-ft Sep90
(Ground surface) 196.0-ft 14Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0↔5: Graveely muddy SAND
5↔24: Sandy GRAVEL
24↔30: Sl gravelly SAND
30↔35: Gravelly SAND
35↔100: Muddy sandy GRAVEL
100↔105: GRAVEL
105↔110: Muddy sandy GRAVEL
110↔130: Sandy GRAVEL
130↔135: Muddy sandy GRAVEL
135↔145: Sandy GRAVEL
145↔150: Muddy sandy GRAVEL
150↔155: Sandy GRAVEL
155↔160: Muddy sandy GRAVEL
160↔165: Sandy GRAVEL
165↔204.3: Muddy sandy GRAVEL
204.3↔206.6: BASALT



Elevation of reference point: [601.47-ft] (top of casing)
Height of reference point above ground surface [2.98-ft]
Depth of surface seal [2.7↔20.4-ft]
Type of surface seal:
Cement grout, 2.7↔20.4-ft
4x4-ft x 6-in concrete pad extends 2.7-ft into annulus
4-in ID stainless steel casing, ~+1.0↔190.5-ft
Hole diameter,
0.0↔59.8-ft, 13-in nominal
59.8↔169.7-ft, 11-in nominal
169.7↔206.6-ft, 9-in nominal
Bentonite crumbles, 20.4↔183.9-ft, 8↔20-mesh
½-in Volclay bentonite tablets, 183.9↔187.4-ft
Silica sand pack, 187.4↔206.1-ft, 20↔40-mesh
4-in T304 stainless steel screen w/channel pack 190.5↔206.1-ft
Fill, 206.1↔206.6-ft
Borehole drilled depth: [206.6-ft]

Drawing By: RKL/2E26-10.ASB
Date : 17Sep93
Reference :

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E26-10

WELL DESIGNATION	:	299-E26-10
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	LERF
HANFORD COORDINATES	:	N 44,420.1 W 46,919.3 [200E-18Sep90]
LAMBERT COORDINATES	:	N 449,602 E 2,248,292 [HANCONV]
		N 137,023.76m E 575,589.23m [NAD83-18Sep90]
DATE DRILLED	:	Aug90
DEPTH DRILLED (GS)	:	206.6-ft
MEASURED DEPTH (GS)	:	206.7-ft, 27Aug93
DEPTH TO WATER (GS)	:	193.3-ft, 04Sep90;
		196.0-ft, 14Jun93
CASING DIAMETER	:	4-in stainless steel, ~+1.0↔190.5-ft;
		6-in stainless steel, +3.0↔~0.5-ft
ELEV TOP CASING	:	601.47-ft, [200E-18Sep90]
ELEV GROUND SURFACE	:	598.49-ft, Brass cap [200E-18Sep90]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	190.5↔206.1-ft, 4-in #10-slot stainless steel;
		with channel pack
COMMENTS	:	FIELD INSPECTION, 27Aug93;
		4 and 6-in stainless steel casing.
		4-ft by 4-ft concrete pad, 4 posts, 1 removable.
		Capped and locked, brass cap in pad with well ID.
		Not in radiation zone.
		OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LERF quarterly water level measurement, 01Feb91↔14Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling,
		PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar, intake @ 201.2-ft (GS)
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Potable water 200E
Driller's Name: L Watkins
Drilling Company: Kaiser Engineers
Date Started: 21Jun90

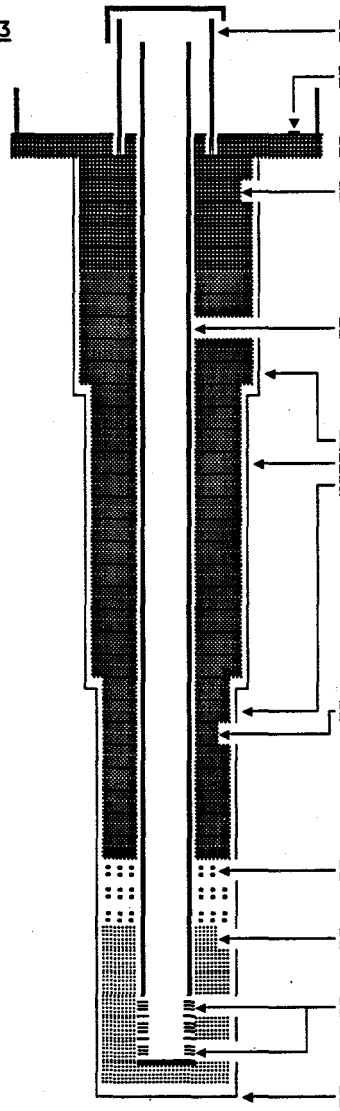
Sample Drive barrel Method: Hard tool
Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 20Aug90

WELL NUMBER: 299-E26-11
TEMPORARY WELL NO: LF-4
Hanford Coordinates: N/S N 44,779.2 E/W W 44,979.2
State NAD83 N 137,134.88m E 576,180.17m
Coordinates: N 449,966 E 2,250,231
Start Card #: Not documented T___ R___ S___
Elevation Ground surface: 596.72-ft (Brass cap)

Depth to water: 189.9-ft Aug90
(Ground surface) 191.3-ft 14Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0-24: Sandy GRAVEL
24-40: GRAVEL
40-53: Sandy GRAVEL
53-54: Muddy SAND
54-55: Gravelly SAND
55-60: Gravelly SAND
60-65: Sandy GRAVEL
65-70: Muddy sandy GRAVEL
70-80: Sandy GRAVEL
80-85: Muddy sandy GRAVEL
85-90: Sandy GRAVEL
90-100: Muddy sandy GRAVEL
100-105: Sandy GRAVEL
105-110: GRAVEL
110-135: Sandy GRAVEL
135-140: GRAVEL
140-145: Sandy GRAVEL
145-155: GRAVEL
155-160: Muddy sandy GRAVEL
160-165: Sandy GRAVEL
165-193: Muddy sandy GRAVEL
193-198: Sl gravelly sandy MUD
198-206.2: BASALT



Elevation of reference point: [599.68-ft] (top of casing)
Height of reference point above ground surface [2.96-ft]
Depth of surface seal [3.0-15.8-ft]
Type of surface seal: Cement grout 3.0-15.8-ft, 4x4-ft x 6-in concrete pad extending 3.0-ft into annulus
4-in ID stainless steel casing, ~+1.0-200.2-ft
Hole diameter,
0.0-61.5-ft, 13-in nominal
61.5-166.6-ft, 11-in nominal
166.7-206.2-ft, 9-in nominal
Bentonite crumbles, 15.8-188.0-ft, 8-20-mesh
¾-in bentonite hole plug, 188-195.9-ft
Silica sand pack,
195.9-197.0-ft, 40-60-mesh
197.0-206.0-ft, 20-40-mesh
4-in T304, stainless steel screen w/channel pack 200.2-205.8-ft
Borehole drilled depth: [206.2-ft]

Drawing By: RKL/2E26-11.ASB
Date : 17Sep93
Reference :

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E26-11

WELL DESIGNATION	:	299-E26-11
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	LERF
HANFORD COORDINATES	:	N 44,779.2 W 44,979.2 [200E-18Sep90]
LAMBERT COORDINATES	:	N 449,966 E 2,250,231 [HANCONV]
		N 137,134.88m E 576,180.17m [NAD83-18Sep90]
DATE DRILLED	:	Aug90
DEPTH DRILLED (GS)	:	206.2-ft
MEASURED DEPTH (GS)	:	206.2-ft, 27Aug93
DEPTH TO WATER (GS)	:	189.9-ft, 13Aug90;
		191.3-ft, 14Jun93
CASING DIAMETER	:	4-in stainless steel, ~+1.0↔200.2-ft;
		6-in stainless steel, +3.0↔~0.5-ft
ELEV TOP CASING	:	599.68-ft, [200E-18Sep90]
ELEV GROUND SURFACE	:	596.72-ft, Brass cap [200E-18Sep90]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	200.2↔205.8-ft, 4-in #10-slot stainless steel;
		with channel pack
COMMENTS	:	FIELD INSPECTION, 27Aug93;
		4 and 6-in stainless steel casing.
		4-ft by 4-ft concrete pad, 4 posts, 1 removable.
		Capped and locked, brass cap in pad with well ID.
		Not in radiation zone.
		OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LERF quarterly water level measurement, 01Feb91↔14Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling,
		PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar, intake @ 203.2-ft (GS)
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Potable water
Driller's Name: D Garcia
Drilling Company: Kaiser Engineers
Date Started: 21Jun90

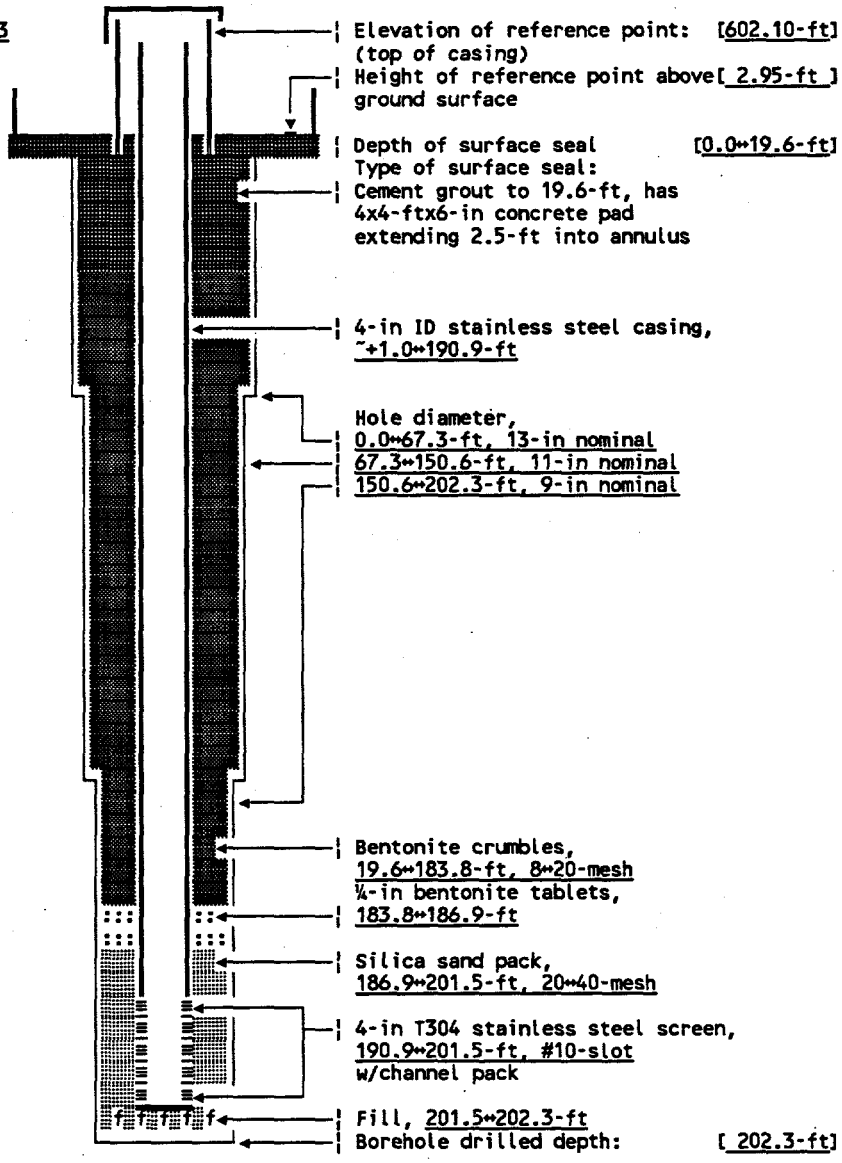
Sample Drive barrel Method: Hard tool
Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 01Aug90

WELL NUMBER: 299-E35-2
TEMPORARY WELL NO: LF-1
Hanford Coordinates: N/S N 45,179.9 E/W W 46,959.4
State NAD83 N 137,255.30m E 575,576.34m
Coordinates: N 450,361 E 2,248,250
Start Card #: Not documented T___ R___ S___
Elevation Ground surface: 599.15-ft (Brass cap)

Depth to water: 193.9-ft Aug90
(Ground surface)196.6-ft 14Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0↔10: Muddy sandy GRAVEL
10↔15: Sandy GRAVEL
15↔20: GRAVEL
25↔39: Sandy GRAVEL
39↔44: Sandy MUD<>muddy SAND
44↔60: Sandy GRAVEL
60↔65: GRAVEL
65↔94: Muddy sandy GRAVEL
94↔96: Sl muddy gravelly SAND
96↔105: Sandy GRAVEL
105↔198: Muddy sandy GRAVEL
198↔200.1: Gravelly sandy MUD
200.1↔202.3: BASALT



Drawing By: RKL/2E35-02.ASB
Date : 13Sep93
Reference : WHC-MR-0235

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E35-2

WELL DESIGNATION	:	299-E35-2
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	LERF
HANFORD COORDINATES	:	N 45,179.9 W 46,959.4 [200E-18Sep90]
LAMBERT COORDINATES	:	N 450,361 E 2,248,250 [HANCONV]
		N 137,255.30m E 575,576.34m [NAD83-18Sep90]
DATE DRILLED	:	Aug90
DEPTH DRILLED (GS)	:	202.3-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	193.9-ft, 02Aug90;
		196.6-ft, 14Jun93
CASING DIAMETER	:	4-in stainless steel, ~+1.0↔190.9-ft;
		6-in stainless steel, +3.0↔~0.5-ft
ELEV TOP CASING	:	602.10-ft, [200E-18Sep90]
ELEV GROUND SURFACE	:	599.15-ft, Brass cap [200E-18Sep90]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	190.9↔201.5-ft, 4-in #10-slot stainless steel;
		with channel pack
COMMENTS	:	FIELD INSPECTION,
		OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LERF quarterly water level measurement, 01Feb91↔14Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling
PUMP TYPE	:	Hydrostar, intake @ 202.6-ft (TOC)
MAINTENANCE	:	

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5.7 INTERIM STATUS GROUNDWATER MONITORING PLAN FOR THE 200 EAST AREA LIQUID EFFLUENT TREATMENT FACILITY, WHC-SD-EN-AP-024, REVISION 1.

3/2003

SUPPORTING DOCUMENT

1. Total Pages 126

2. Title	3. Number	4. Rev. No.
Interim Status Ground Water Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility	WHC-SD- EN-AP-024	1

5. Key Words

ground water monitoring
LERF/Liquid Effluent Retention Facility
242-A Evaporator/Crystallizer

6. Author

J. S. Schmid
Name (Type or Print)

J. S. Schmid
Signature

81231/WTW23
Organization/Charge Code

7. Abstract

This document presents a ground water monitoring plan for the 200 East Area Liquid Effluent Retention Facility (LERF), which will be constructed adjacent to the northeast corner of the 200 East Area of the Hanford Site in southeastern Washington State. The LERF will be used for temporary storage of liquid waste from the 242-A Evaporator/Crystallizer. An interim-status plan is required to determine existing ground water quality at the construction site and to provide means to detect any future ground water contamination caused by containment failure of the LERF.

This document summarizes the available data on the vicinity and presents a plan to develop a ground water monitoring system around the facility. The plan is to install four new monitoring wells, one upgradient and three downgradient. These wells will be used to monitor ground water levels and water quality immediately adjacent to the LERF site, prior to and after construction and use of the facility.

V. Birkland 4/4/91

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1.0 INTRODUCTION

This document presents a ground water monitoring plan for a proposed facility, the Liquid Effluent Retention Facility (LERF). The LERF is to be located immediately east of the 200 East Area on the Hanford Site in southeastern Washington (Figures 1-1 and 1-2). The proposed facility is composed of four contiguous, interim-storage basins designed to receive 242-A Evaporator/Crystallizer process condensate.

Figure 1-1. Map Showing the Locations of the Hanford Site and the 200 Areas.

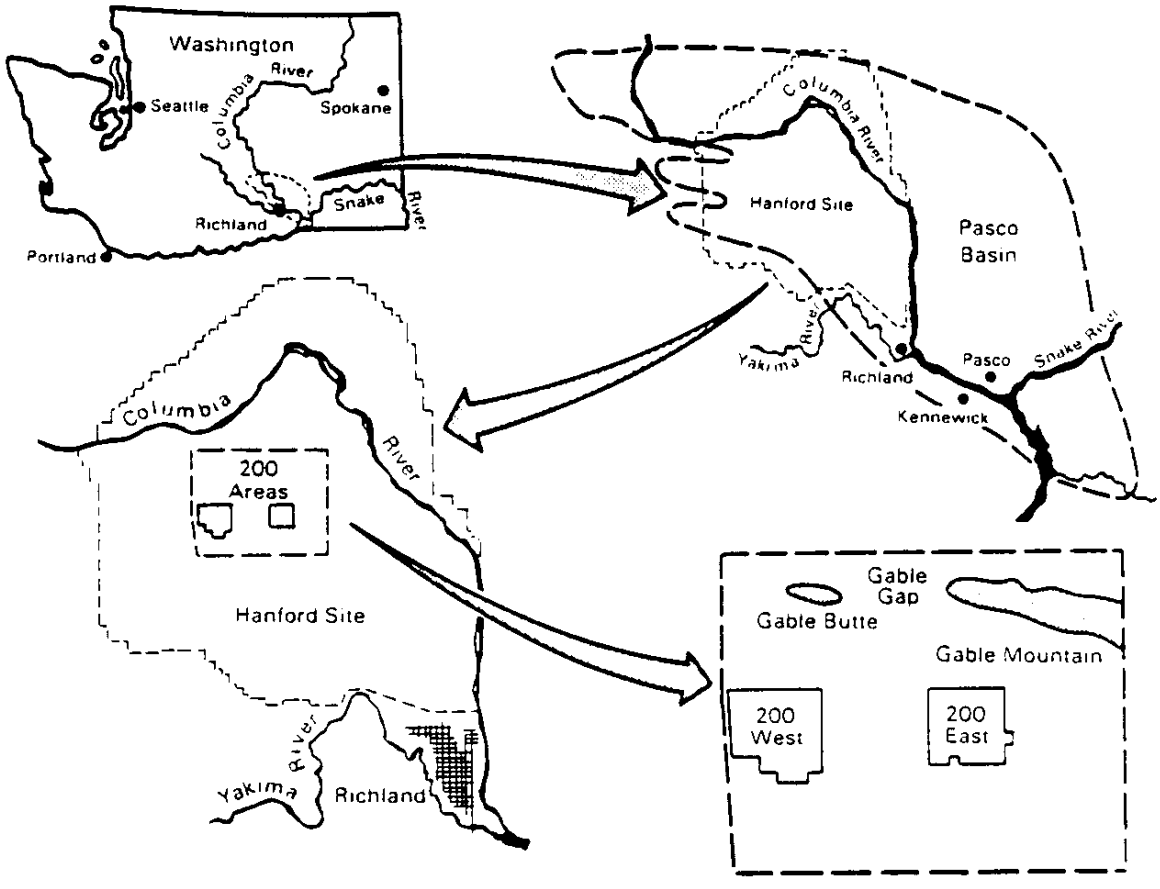
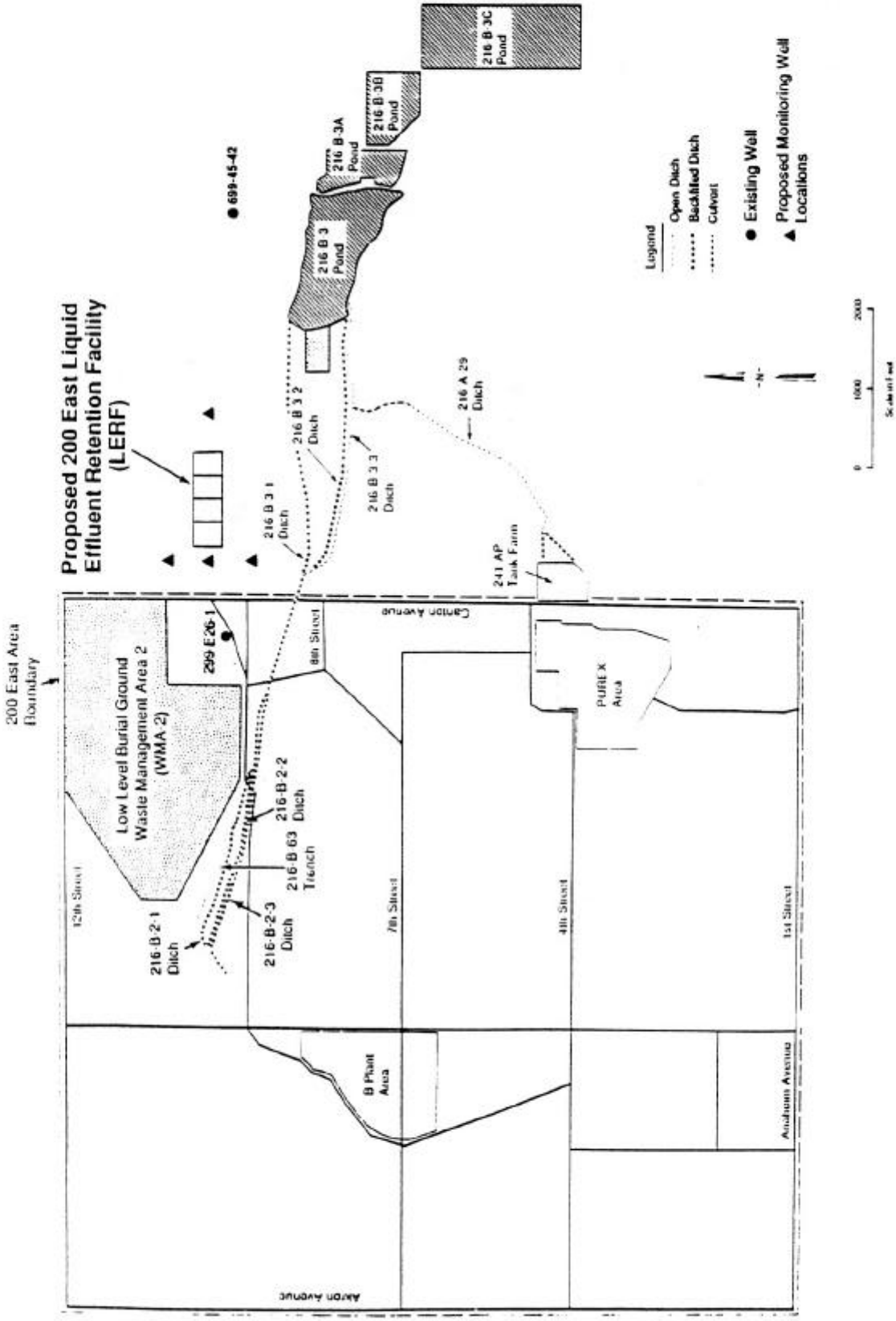


Figure 1-2. 200 East Area Map Showing the Proposed LERF and Nearby Facilities.



This ground water monitoring plan is based on requirements for interim-status facilities, as defined by the Resource Conservation and Recovery Act of 1976 (RCRA) and amended by the Hazardous and Solid Waste Amendments of 1984. These regulations are promulgated by the U.S. Environmental Protection Agency (EPA) in 40 CFR 265, Subpart F, and by the Washington Department of Ecology (Ecology) in Washington Administrative Code (WAC) 173-303-400.

This plan presents a ground water monitoring program for the proposed LERF. The program is designed to determine the impact of the LERF on the quality of the ground water in the uppermost aquifer beneath the facility [40 CFR 265.90(a)]. Specific objectives include the following:

- describe an initial ground water monitoring program to determine existing ground water quality, and to indicate whether any hazardous constituents migrate from the site to the ground water during future operations of the LERF

- describe an initial hydrogeologic characterization plan.

The ground water monitoring system and hydrogeologic characterization activities presented in this plan constitute an initial program. Hydrogeologic data, ground water chemistry data, and other information will be interpreted and evaluated before the initiation of any additional hydrogeologic characterization and well installation activities that might be deemed necessary.

2.0 BACKGROUND

The U.S. Department of Energy's (DOE) Hanford Site has been used for more than four decades for nuclear reactor operations, nuclear fuel processing, radioactive waste management, and related activities. The fuel reprocessing and radioactive waste management facilities in the 200 East and 200 West areas are currently operated by Westinghouse Hanford Company (Westinghouse Hanford).

2.1 FACILITY DESCRIPTION

The proposed LERF will be composed of four contiguous, lined, surface impoundments (basins) that will be constructed to the east of the 200 East Area of the Hanford Site (see Figure 1-2). The design of the basins is fully described by WHC (1990a). Each basin will have a nominal capacity of 6.5M gal. For leak detection and containment, each basin will have a double liner with a leachate collection system installed between the two liners.

The basins will be constructed partly abovegrade and partly belowgrade, and each will be supplied with a floating cover. In addition, a leak detection system will be installed for the waste transfer piping associated with the basins. Prior to construction of the basins, land surface will be graded to 593 ft above mean sea level.

Each basin will be approximately 270 ft wide by 330 ft long. Basin dimensions allow 3 ft of freeboard when the basins are filled to nominal capacity. This will result in a maximum fluid depth of 21 ft. Design service life of the basins is 30 yr.

2.2 WASTE CHARACTERISTICS

The waste characteristics of the effluent stream that will be associated with 200 East Area LERF are described. Historical information on the stream and the facilities that hosted it is obtained from the Waste Information Data System (WIDS) general summary reports (provided as Appendix A) and Geary (1990). The WIDS database is controlled and maintained by Westinghouse Hanford.

The 242-A Evaporator, located in the 200 East Area, is a facility designed for the treatment of mixed waste. Process condensate from the facility has been disposed to the 216-A-37-1 Crib via the 207-A Retention Basins since March 1977 (Smith and Kasper 1983). The evaporator was shut down and placed on temporary standby status in April 1989, pending construction of a waste disposal alternative to supplant use of the soil column crib.

The 242-A Evaporator is the primary concentrator for Hanford Site wastes that are stored and treated in underground, double-shell tanks. The wastes are processed in different batches according to their classification by total organic content, transuranic content, and effects on the evaporation process. The process condensate consists primarily of condensed water from boiloff in the evaporator. Contaminants consist chiefly of volatile organics that boil off with the water and radionuclides that are entrained in the vapors (WHC 1990c).

Sampling data were obtained during operations with four separate evaporator feeds. Key constituents from each feed mode are shown in Table 2-1 (WHC 1990c).

Table 2-1. Effluent Stream Sampling Data, 242-A Evaporator Process Condensate.

Key Constituents	Detection Limit[a]	Detection/ Analyses	Sample Concentration 90% CI[a]	Detection Limit[a]	Detection/ Analyses	Sample Concentration 90% CI[a]
	3/88 to 05/88, During CRW Feed			10/89 to 03/90, During Inactive Mode		
acetone	10	5/5	2,540	No Data		
aluminum	NA	5/5	1,290			
1-butanol	NA	5/5	75,100			
	08/85 to 02/88, During Linked Feed			01/88 to 03/89, During ASF Feed		
acetone	10	11/11	1,690	10	9/9	1,270
aluminum	NA	11/12	765	NA	9/10	1,150
2-butanone	10	07/12	58	10	9/10	44[b]
1-butanol	NA	10/10	589[b]	NA	9/9	46,400
	07/88, During Saltwell Feed					
acetone	10	4/4	1,040			
aluminum	NA	4/4	633			
	1977 to 1988, During Routine Operation[c]					
hydrogen-3	5,000	83/NA	6,300,000			
strontium-90	30	46/NA	760			
ruthenium-106	600	5/NA	3,500			
cesium-137	80	47/NA	540			

ASF = ammonia scrubber feed.
CI = confidence interval.
CRW = cladding removal waste feed.
NA = not available.
[a]Units: chemical--parts per billion
radionuclides--picocurie per liter.
[b]Concentrations below Group A or Group C study guideline; values given for purposes of comparison.
[c]Disposal of effluent to the 216-A-37-1 Crib began in 1983; thus, this data set includes some samples taken prior to 1983.

NOTES:

Group A--Current and proposed primary and secondary drinking water standards, also known as maximum contaminant levels and derived concentration guides.

Group C--Constituent-specific land disposal restriction limits, extraction procedure toxicity limits, and toxic characteristic leaching procedure limits.

2.3 GEOLOGY

This section provides background information on the geology of the Hanford Site, the 200 Areas, and the proposed LERF site to support the preparation of the ground water monitoring program. The geology of the Columbia Plateau, and particularly the Pasco Basin, has been studied in detail for DOE as part of the siting studies for a deep geologic repository for nuclear waste. The *Consultation Draft, Site Characterization Plan* (DOE 1988) summarizes much of the information known about the Hanford Site, especially near the 200 West Area where the candidate repository site was located. Studies have also been done as part of the nuclear power plant licensing efforts, including those for the Washington Public Power Supply System (Supply System 1981) and the Skagit/Hanford Project (PSPL 1982). More detailed information is available in the following reports:

- structural geology and tectonics - Caggiano and Duncan (1983), Reidel et al. (1982), and Reidel and Hooper (1989)
- basalt stratigraphy and chemistry - Swanson et al. (1979) and Reidel et al. (1982)
- sedimentary units interfingered with and overlying the basalts - Bjornstad (1984, 1985); Fecht et al. (1985); Myers/Price et al. (1979); Myers and Price (1981); and Graham et al. (1984). Tallman et al. (1979) is the only in-depth study of the geology of the 200 Areas.

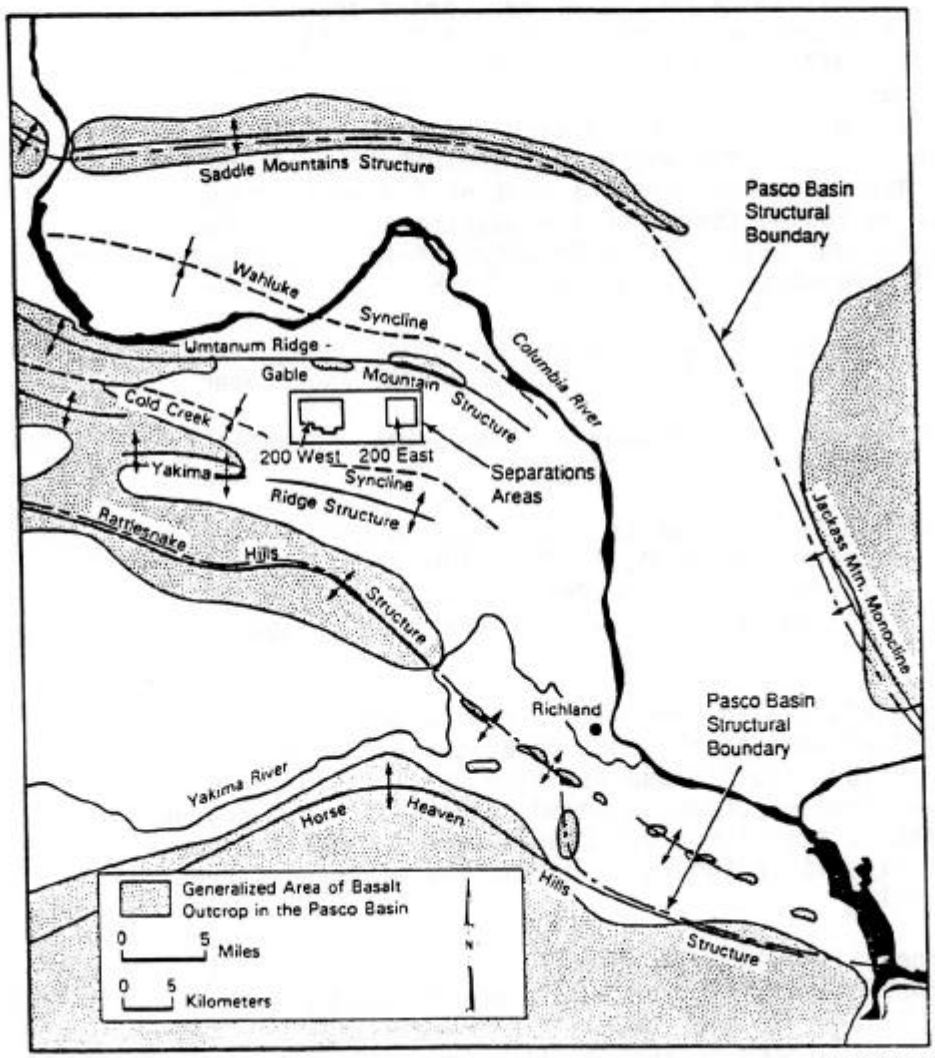
The Hanford Site lies within the Columbia Plateau, which is generally characterized by a thick sequence of tholeiitic basalt flows called the Columbia River Basalt Group (Swanson et al. 1979). These flows have been folded and faulted creating broad structural and topographic basins separated by asymmetric anticlinal structures (i.e., ridges). The Hanford Site lies specifically within the Pasco Basin, one of these structural basins (Figure 2-1).

Principal geologic units within the Pasco Basin include, in ascending order, the Columbia River Basalt Group (Miocene), the Ringold Formation (Miocene-Pliocene), and the Hanford formation (Pleistocene). A regionally discontinuous veneer of recent alluvium, colluvium, and/or eolian sediments overlies the principal geologic units.

2.3.1 200 Areas

The surface topography of the 200 Areas is primarily the result of Pleistocene cataclysmic flooding and Holocene eolian activity. Cataclysmic flooding, which ended about 13,000 yr ago (Mullineaux et al. 1978), created Cold Creek bar (Bretz et al. 1956), a prominent flood feature within the 200 Areas (Figure 2-2). The last cataclysmic flood(s) covered the 200 Areas with a blanket of coarse-grained deposits that become finer grained to the south. The northern boundary of the Cold Creek bar is defined by an erosional channel running east-southeast, which formed during waning stages of flooding as floodwaters drained from the basin (Bjornstad et al. 1987).

Figure 2-1. Location Map of the Hanford Site Showing Major Structures Within the Pasco Basin.



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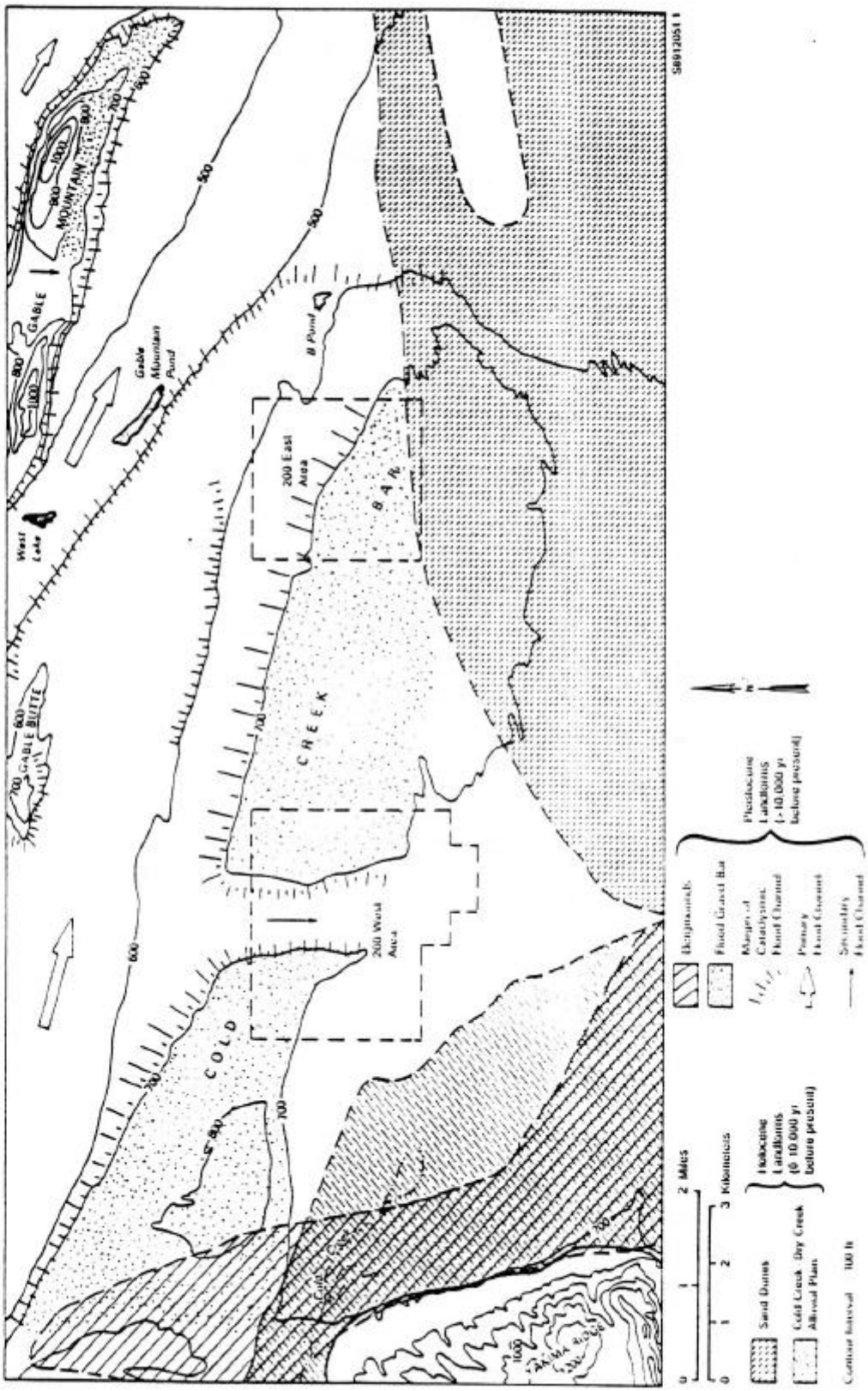
Since the end of the Pleistocene, winds have reworked the surface of the glaciofluvial sediments locally, depositing a thin veneer of eolian sand in places. Holocene sand dunes are present along the southern boundary of the 200 East Area (Figure 2-2). Holocene alluvium, associated with the Cold Creek-Dry Creek alluvial plain, was deposited less than 1 mi southwest of the 200 West Area (Figure 2-2). The 200 Areas lie within the Cold Creek syncline, which is bounded on the north by the Umtanum Ridge-Gable Mountain anticline and on the south by the Yakima Ridge anticline (Figure 2-1). In the 200 Areas, the top of the basalt generally dips gently (<5 degrees) to the south-southwest, except in the southwest corner of the 200 West Area, where beds are nearly horizontal along the axis of the Cold Creek syncline.

Figure 2-2. Geomorphic Features Surrounding the 200 Areas.



The generalized stratigraphy of the 200 Areas is shown in Figure 2-3. Bedrock is composed of basalt flows and sedimentary interbeds, which belong to the Columbia River Basalt Group and Ellensburg Formation, respectively. The uppermost basalt flow in the 200 Areas is generally the Elephant Mountain Member, which acts as a confining layer to the underlying Rattlesnake Ridge interbed. Overlying Columbia River basalt is the fluvial-lacustrine Ringold Formation, consisting of variably mixed and interbedded layers of gravel, sand, silt, and clay). The thickness of the Ringold Formation ranges from 0 ft in the northern part of the 200 East Area to about 500 ft in the southwest portion of the 200 West Area near the axis of the Cold Creek syncline (DOE 1988; Tallman et al. 1979).

The Ringold Formation has been locally subdivided into four stratigraphic units: basal, lower, middle, and upper. The basal Ringold unit consists of silty sandy gravel overlain by a fining upward sequence of sand and silt. Overlying the basal Ringold is the lower Ringold unit, another fine-grained unit consisting of mostly sand and silt. Sediments of the lower Ringold and upper basal Ringold units have been recognized locally as a potential confining layer (Graham et al. 1981).

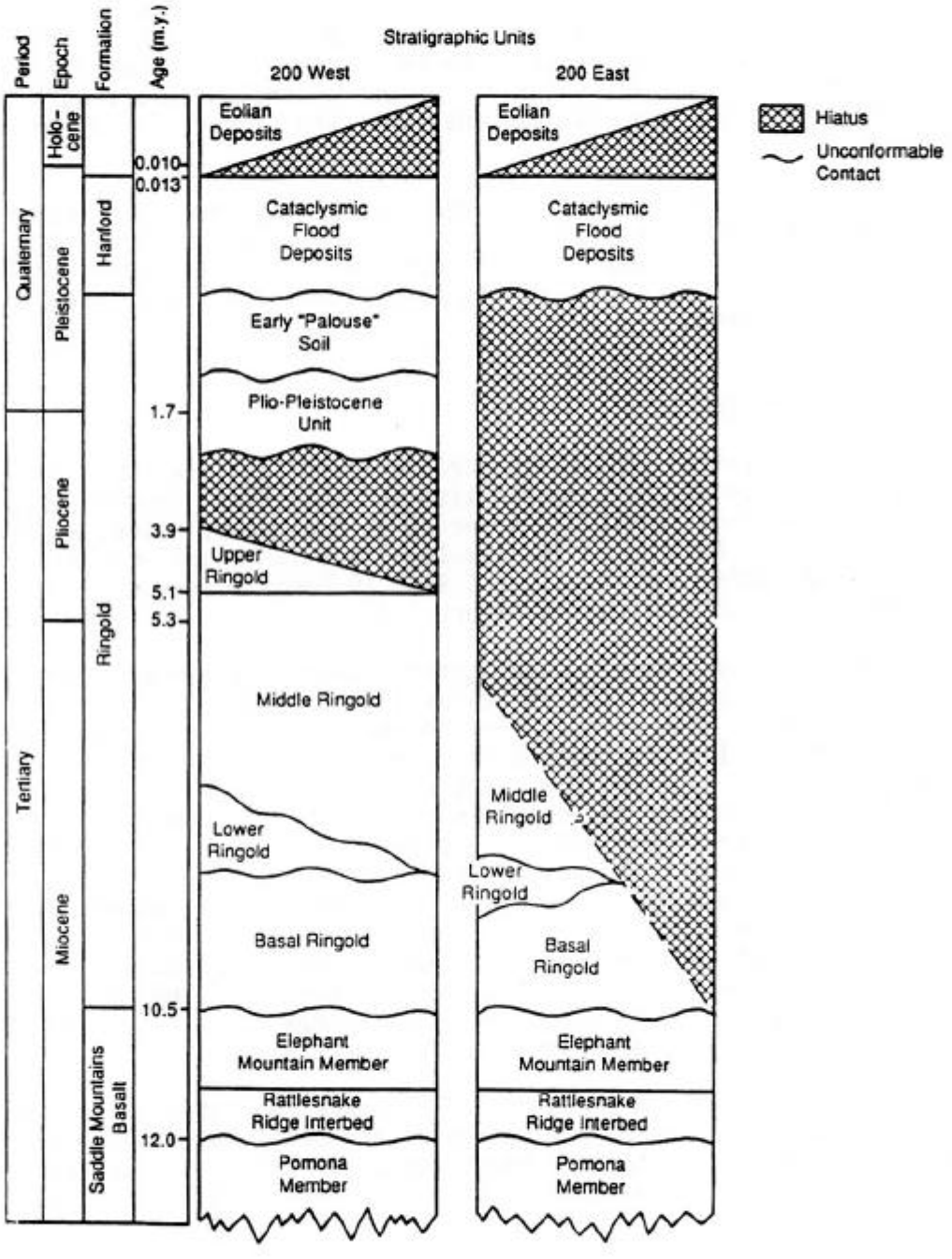
The middle Ringold unit is the thickest of the Ringold units in the vicinity of the 200 Areas. Its predominant texture consists of well-rounded sandy gravel with some sand and silty-sand lenses. The gravels typically range from pebble to cobble in size; however, boulders are locally common (Tallman et al. 1979). Because of their textures and the similarity of their gravel lithologies, the coarse-grained basal and middle Ringold units are difficult to distinguish unless separated by the fine-grained sediments of the upper basal Ringold unit or the lower Ringold unit. The uppermost unit, the upper Ringold, is another sequence of thinly bedded silt and, well-sorted sand (DOE 1988; Tallman et al. 1979). Not all of the units of the Ringold Formation are present throughout the 200 Areas. Erosion by the ancestral Columbia River and later cataclysmic flooding during the Pleistocene Epoch have removed some or all of the Ringold Formation in some areas (DOE 1988: Tallman et al. 1979). All four units are currently identified only in the western and southern portion of the 200 West Area while little or no Ringold is present in the northeastern part of the 200 East Area (Last et al. 1989; Tallman et al. 1979).

A well-developed calcrete belonging to the Plio-Pleistocene unit is found on the uppermost surface of the eroded Ringold sediments in the 200 West Area (Bjornstad 1984; Last et al. 1989). In places, the Plio-Pleistocene unit is overlain by as much as 30 ft of early "Palouse" soil, an eolian deposit of fine-grained sand. Both of these units are present over most of the 200 West Area, but they have apparently been eroded from beneath the 200 East Area.

The cataclysmic flooding that eroded the Ringold Formation also deposited a sequence of relatively unconsolidated silt, sand, and gravel informally called the Hanford formation. At least four major flood events occurred in the Pasco Basin during the Pleistocene (Fecht et al. 1985). Near flood channels (e.g., in the northern 200 East Area), the Hanford formation consists predominantly of coarse gravel and sand (Pasco gravels facies), while to the south and west, slack-water type deposits of sand and silt (Touchet bed facies) lie between or beneath coarse-grained flood deposits (Last et al. 1989). Within much of the southern portion of the 200 Areas, the Hanford formation consists predominantly of sand. Thickness of the formation ranges

from approximately 70 ft in part of the 200 West Area to a maximum of about 350 ft east of the 200 East Area (Tallman et al. 1979).

Figure 2-3. Generalized Geologic Columns for the 200 Areas.



The contact between the Hanford and Ringold formations is commonly a transition upward from more indurated deposits containing a variety of lithologies (Ringold Formation) to very weakly cemented or unconsolidated sediments with a higher proportion of basaltic clasts (Hanford formations). The textures of the Pasco gravels and the middle Ringold unit are similar, although the difference in gravel lithologies can sometimes be used to distinguish between the two. However, in some places, basalt-rich gravel layers have been found in the middle Ringold unit, and if the middle Ringold unit and Pasco gravels are not separated by the upper Ringold unit, the Plio-Pleistocene unit, and/or the early Palouse soil, they can be difficult to distinguish. This is particularly true where considerable reworking and incorporation of the Ringold sediments into the Hanford formation has occurred.

Graham et al. (1984) indicate the possibility that the Elephant Mountain Member has been completely eroded near the northeast corner of the 200 East Area, with partial erosion over a larger area. This may have resulted in the Hanford formation directly overlying the Rattlesnake Ridge interbed northeast of the 200 East Area.

2.3.2 Proposed LERF Site

There are limited subsurface stratigraphic data available for the immediate vicinity of the proposed site for the LERF. However, site geology can be inferred from conditions observed at two nearby sites, which are Waste Management Area 2 (WMA-2) of the low-level burial grounds described by Last and Bjornstad (1989) and the 216-B-3 Pond (B Pond) described by Luttrell et al. (1989), located as shown in Figure 1-2.

At WMA-2, only a single stratigraphic unit, the Hanford formation, is present above the basalt. It is believed that the Ringold Formation was entirely eroded in that area by Pleistocene cataclysmic floods (Last and Bjornstad 1989). The uppermost basalt unit is the Elephant Mountain Member, except just to the north of WMA-2 where an erosional window through the Elephant Mountain Member may exist as suggested by Graham et al. (1984) and where Last and Bjornstad (1989) have shown that a depression in the surface of the basalt does exist. The possibility of an erosional window is significant because such a window may allow hydraulic communication between the unconfined aquifer of the Hanford formation and the confined aquifer of the Rattlesnake Ridge interbed, which underlies the Elephant Mountain Member. Nevertheless, an erosional window at this location has not been confirmed by drilling, nor is there evidence to suggest that any such window would extend to the southeast as far as the proposed site for the LERF.

The sediments at WMA-2 consist of sequences of muddy sandy gravel, gravelly sand, and/or sand. Thickness of the sediments ranges from approximately 160 ft at the northeast corner of WMA-2 and increases southward to approximately 250 ft near the west margin of the LERF site (Last and Bjornstad 1989).

Geologic data from the vicinity of B Pond also show that the surface of the Elephant Mountain Member generally dips to the south. North of the pond at well 699-45-42, thickness of the overlying sediments is 190 ft. South of the pond at well 699-42-42, thickness is approximately 295 ft. Luttrell et

al. (1989) state that there is no evidence of an erosional window through the Elephant Mountain Member in the vicinity of the pond. The lowermost suprabasalt sediments beneath B Pond may represent the Ringold Formation, but the Hanford-Ringold contact is indistinct. According to Jensen et al. (1989), the lower 20 ft of the suprabasalt sediments in the vicinity of the 241-C Tank Farm, approximately 2,000 ft southwest of the LERF site, may represent middle Ringold unit.

Information on the geology beneath the proposed LERF site is described by summarizing well log data collected from well installations that are nearest to the site. Generally, a 1,000-ft radius is used to identify wells that are to be used for predicting existing geology. There are no wells that meet that criterion at the LERF site.

Figure 2-4 shows the locations of the wells used to construct the cross sections in Figures 2-5 and 2-6. The cross sections illustrate the stratigraphy beneath the LERF site based on data from drilling and geologic logs.

The thickness of the suprabasalt sediments are estimated to range between 160 to 240 ft, and these sediments likely consist of coarse grain deposits ranging from muddy to sandy gravel. The Ringold Formation may be absent. The basalt flow is believed to be the Elephant Mountain Member, although no chemical analyses of the basalt are available.

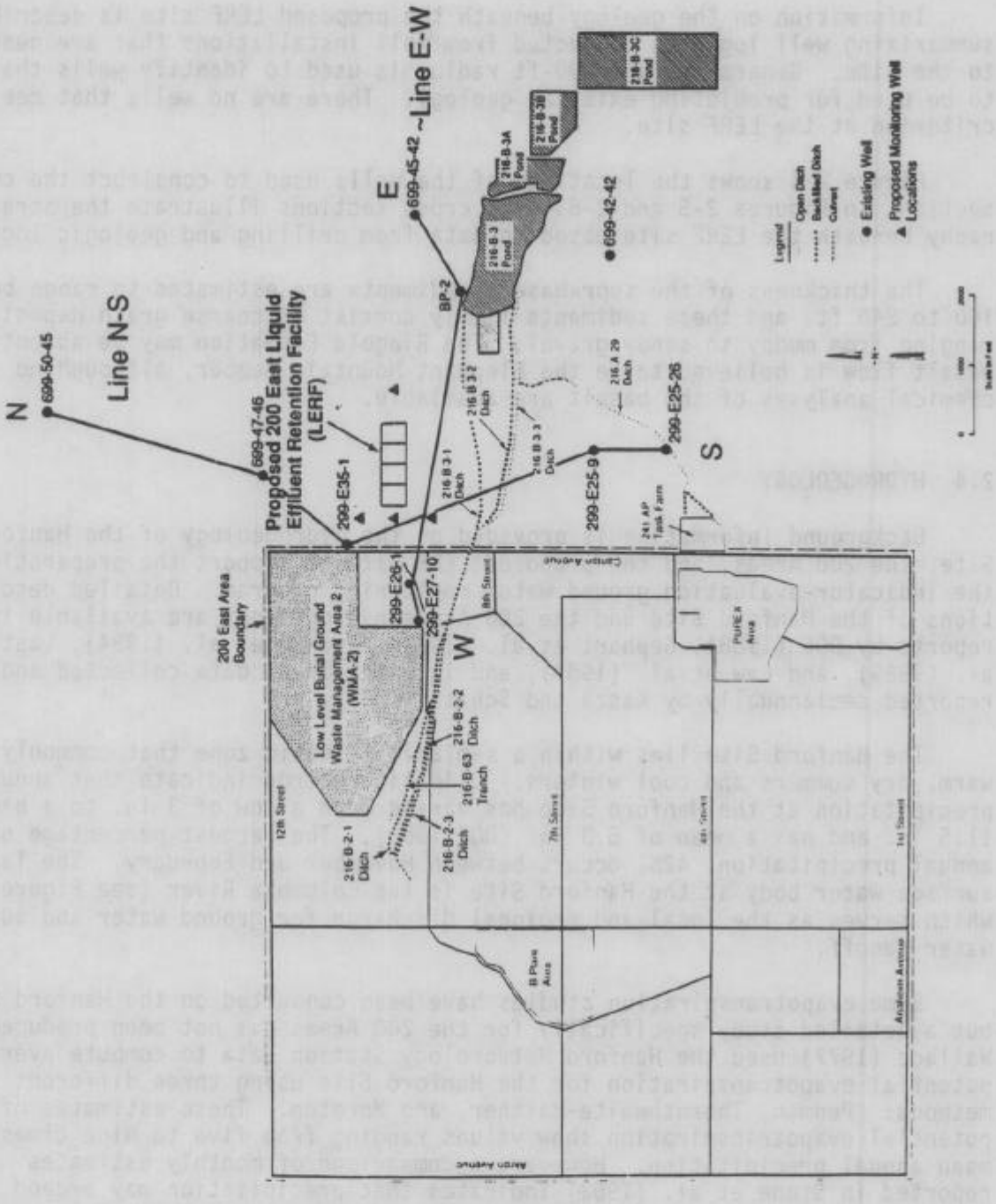
2.4 HYDROGEOLOGY

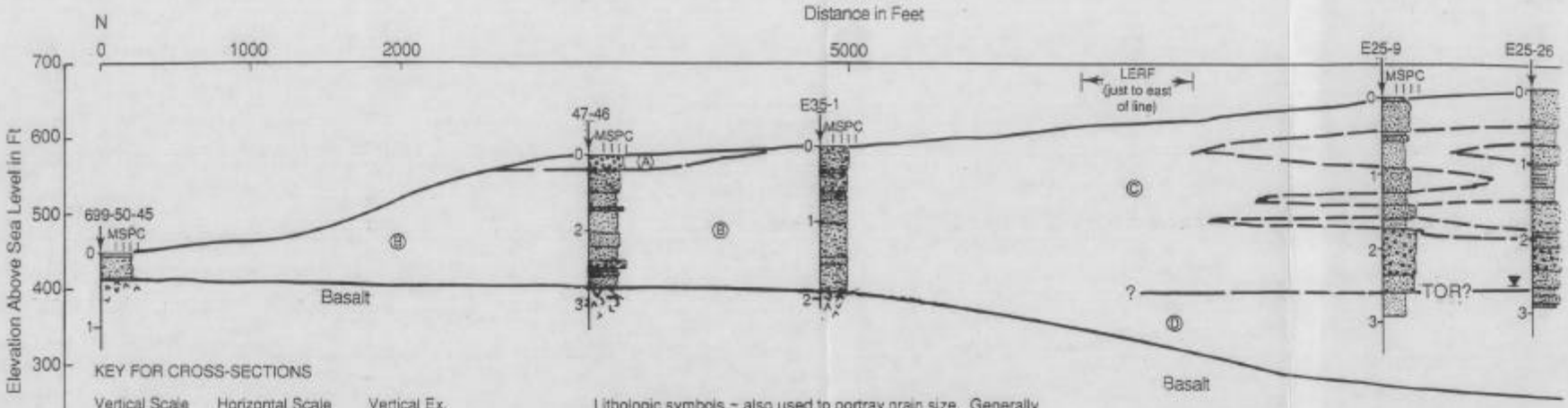
Background information is provided on the hydrogeology of the Hanford Site, the 200 Areas, and the proposed LERF site to support the preparation of the indicator-evaluation ground water monitoring program. Detailed descriptions of the Hanford Site and the 200 Areas hydrogeology are available in reports by DOE (1988), Gephart et al. (1979), Graham et al. (1984), Last et al. (1989), and Law et al. (1987), and in water level data collected and reported semiannually by Kasza and Schatz (1989).

The Hanford Site lies within a semiarid climatic zone that commonly has warm, dry summers and cool winters. Climatic records indicate that annual precipitation at the Hanford Site has varied from a low of 3 in. to a high of 11.5 in. and has a mean of 6.3 in. (DOE 1988). The largest percentage of annual precipitation, 42%, occurs between November and February. The largest surface water body at the Hanford Site is the Columbia River (see Figure 1-1), which serves as the local and regional discharge for ground water and surface water runoff.

Some evapotranspiration studies have been conducted on the Hanford Site, but a detailed study specifically for the 200 Areas has not been produced. Wallace (1977) used the Hanford Meteorology Station data to compute average potential evapotranspiration for the Hanford Site using three different methods: Penman, Thornthwaite-Maither, and Moreton. These estimates of potential evapotranspiration show values ranging from five to nine times the mean annual precipitation. However, a comparison of monthly estimates reported in Stone et al. (1983) indicates that precipitation may exceed potential evapotranspiration for the months of November through February and may be available for ground water recharge.

Figure 2-4. Locations of Wells Near the LERF Site.





KEY FOR CROSS-SECTIONS

Vertical Scale	Horizontal Scale	Vertical Ex.
100 ft	500 ft	5X

Grain size scale ~ refers to dominant grain size of sizes in interval. Read by referencing relief in column to scale.

MSPC

- M - Muds (clay & silt)
- S - Sands
- P - Pebble gravel
- C- Cobble to boulder gravel

Lithologic symbols ~ also used to portray grain size. Generally symbols will match size portrayed by size scale. In addition, symbols are used to indicate the subordinate grain sizes present.

- Cobbles & Boulders
- Pebble Gravel
- Sand
- Muds
- Basalts

Other Symbols

- Top of Ringold (TOR) Formation
- Top of Basalt and ground surface
- Sediment facies contact
- Water Table, 1989

DISCUSSION OF CROSS-SECTION, Notes refer to letters on cross-section.

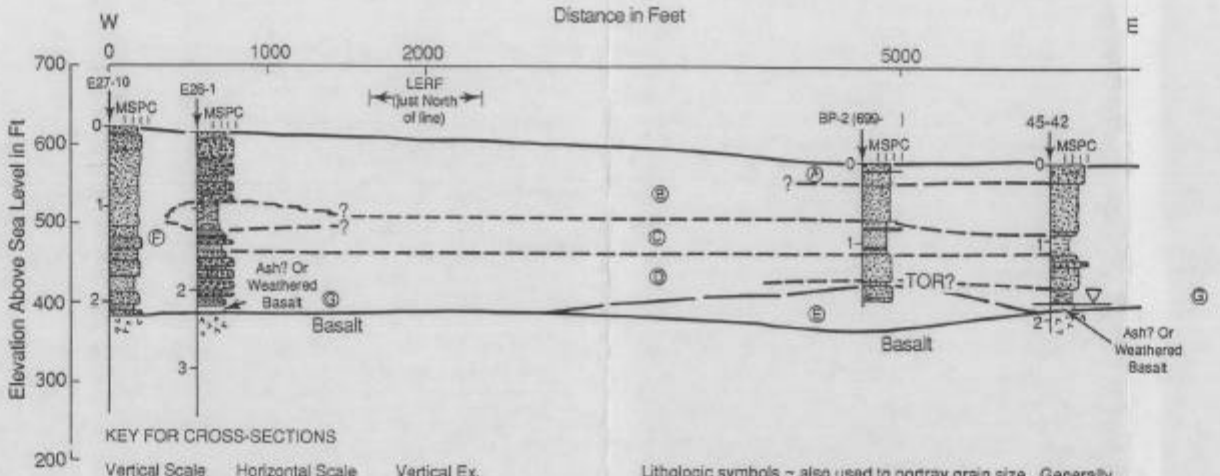
A) Part of interval A seen in E-W section?

B) Correlations in these areas are difficult to determine. Best that can be really be said is that the Hanford here is very gravelly.

C) Correlations also difficult through here. However, there is an explanation for this. Hanford strata become more gravelly to the north as one approaches the main floodway tracts. To the south, more distance from the floodway tracts, sand content increases. The area between E35-1 and E25-9 (i.e., the LERF area) is where this transition begins.

D) Somewhere in this area, the Ringold Formation is pinching out beneath the Hanford formation and the top of Basalt. The apparent absence of laterally continuous impermeable zones in the Hanford in this area suggests significant vertical communication between the Hanford and Ringold is likely. Note: If contaminants are to enter the Ringold in the area, there is a high potential that they could then migrate down-dip in the Ringold into the Cold Creek sycline, resulting in placement of contaminants below confining layers found elsewhere.

Figure 2-5. North-South Cross Section Illustrating Stratigraphy Under LERF Site.



KEY FOR CROSS-SECTIONS

Vertical Scale	Horizontal Scale	Vertical Ex.
100 ft	500 ft	5X

Grain size scale ~ refers to dominant grain size or sizes in interval. Read by referencing relief in column to scale.

MSPC

M - Muds (clay & silt)
S - Sands
P - Pebble gravel
C- Cobble to boulder gravel

Lithologic symbols ~ also used to portray grain size. Generally symbols will match size portrayed by size scale. In addition, symbols are used to indicate the subordinate grain sizes present.

Cobbles & Boulders
Pebble Gravel
Sand
Muds
Basalts

Other Symbols

- Top of Ringold (TOR) Formation
- Top of Basalt and ground surface
- Sediment facies contact
- Water Table, 1989

DISCUSSION OF CROSS-SECTION, Notes refer to letters on cross-section.

A) Upper Pebble to cobble gravel of unkown extent. May correlate to A, in N-S section.

B) Gravel-dominated strata.

C) Sand and mixed sand and mud in middle of Hanford. Correlation of this interval to anything in the N-S section is not clear. There is no corresponding middle fine interval in the N-S line.

D) Lower coarse/gravel interval.

E) Erosional remnant of Ringold Formation thickens to S and SE. Pinches out to N and W.

F) Correlations between E27-10 and E26-1 difficult to determine because of described abundance of pebbles in E26-1. The geologic log for E26-1 may be of limited use because of drilling date.

G) These two intervals, referred to as ash or gravelly ash, probably are in reality weathered basalt top.

Figure 2-6. East-West Cross Section Illustrating Stratigraphy Under LERF Site.

Within the Hanford Site, natural recharge rates have been estimated to range from near zero to more than 4 in. annually, depending on surface conditions (Gee 1987, Routson et al. 1988). Small recharge rates occur where fine-textured sediments and deep-rooted plants occur (e.g., in undisturbed portions of the 200 Areas). The larger values are associated with areas having a coarse gravelly surface and no vegetative cover.

Ground water beneath the Hanford Site occurs under unconfined, semi-confined, and confined conditions. The unconfined aquifer is contained primarily within the lower portion of the Hanford formation and the middle unit of the Ringold Formation (Graham et al. 1981). The base of the unconfined aquifer is the basalt surface, or, where present, the clays and silts of the lower and basal Ringold units (Figure 2-3). Where these fine-grained sediments occur, they represent a semiconfining layer for the coarse-grained facies of the basal Ringold unit (DOE 1988). Confined aquifers beneath the Hanford Site include sedimentary interbeds and interflow zones that occur between dense basalt flows of the Columbia River Basalt Group.

Major sources of natural recharge to the unconfined aquifer are rainfall and runoff from areas of high-relief bordering the Hanford Site, ephemeral streams in the Cold Creek and Dry Creek valleys, and localized areas where river water is induced into ground water as temporary bank storage during high stages of the Yakima or Columbia rivers (Graham et al. 1981). Discharge from the unconfined aquifer is primarily to the Columbia River.

2.4.1 200 Areas

As more characterization efforts are undertaken on the Hanford Site, the understanding of the geologic framework and its relation to the hydrogeologic system will continue to be developed and refined. This document does not attempt to integrate all that is known of the hydrogeologic system within the 200 Areas. Instead, this discussion is limited to the hydrologic properties of the uppermost portion of the unconfined aquifer contained in the Hanford and Ringold formations.

The unconfined aquifer receives artificial recharge from liquid waste disposal areas. This artificial recharge is estimated to be 10 times greater than natural recharge (Graham et al. 1981). Graham et al. (1981) estimated natural recharge from the Cold Creek valley to the 200 Areas to be approximately 1.3×10^6 gal/d. The total volume of liquid effluents discharged to radioactive disposal facilities in the 200 Areas in 1988 was approximately 2.4×10^{10} gal (Coony and Thomas 1989), or a rate of approximately 6.6×10^7 gal/d.

The major sources of artificial recharge in the central Hanford Site have been three waste ponds designated U Pond, Gable Mountain Pond, and B Pond. All are located near or in the 200 Areas. These areas of artificial recharge have had a major effect on ground water flow within the unconfined aquifer. The U Pond, located in the 200 West Area, and Gable Mountain Pond, located north of the 200 East Area, were decommissioned in 1984 and 1987, respectively.

The depth to water within the unconfined aquifer in the 200 Areas ranges from approximately 190 ft beneath the former U Pond to approximately 340 ft west of the 200 East Area. The saturated thickness of the unconfined aquifer ranges from 0 ft at the north edge of the 200 East Area to more than 250 ft in the northwest part of the 200 West Area. Current and historical water table data are presented in Figures 2-7 and 2-8.

Ground water elevation contours for January 1989 for the unconfined aquifer in the 200 Areas are shown in Figure 2-8 (Kasza and Schatz 1989). The regional flow direction in the 200 Areas is generally from west to east, but is affected by two ground water mounds that have resulted from discharges to U Pond and B Pond. Ground water flow beneath the 200 West Area is generally toward the north and the east, away from the mound created by past discharges to U Pond. As this mound dissipates, the horizontal hydraulic gradient is expected to decrease and shift to the east. The horizontal hydraulic gradient in the 200 West Area is relatively high, ranging from 4 to 1.5 ft/1,000 ft. Downward vertical hydraulic gradients are expected to be present within the unconfined aquifer in portions of the 200 West Area as a result of the U Pond ground water mound (Graham et al. 1981).

A comparison of the hindcast water table map of the Hanford Site for January 1944 (ERDA 1975) and the 200 Areas water table maps for January 1989 (Kasza and Schatz 1989) indicates that the natural water table elevation in the 200 West Area was 65 ft lower in 1944. The hindcast map indicates that the direction of regional flow was toward the east, and the natural hydraulic gradient was on the order of 1 ft/1,000 ft in the 200 West Area.

Ground water flow beneath the 200 East Area is more complex because of the convergence of flow from the west (local ground water flow system) and east (B Pond artificial recharge effects). This convergence of flow and other hydrogeologic conditions have caused ground water within the unconfined aquifer to diverge with a component flowing northward between Gable Butte and Gable Mountain and another component flowing southeast toward the Columbia River. This convergence and divergence of ground water flow is evident on the water table map (Figure 2-8). In addition, the high transmissivity beneath most of the 200 East Area results in very small hydraulic gradients. Flow directions may change temporarily because of changing rates of waste water discharged to B Pond and other disposal sites. Therefore, it is often difficult to define flow direction from water table maps of the 200 East Area. However, contaminant plume maps of the 200 Areas can indicate long-term trends in ground water flow directions (Serkowski et al. 1988). These plume maps indicate a north-northwest direction of flow in the extreme north-central portion of the 200 East Area and a south-to-southeast direction of flow in the southeast portion of the 200 East Area.

Principal geologic units (Figure 2-3) controlling ground water flow in the 200 Areas (in ascending order) are the Elephant Mountain Member, which acts as a lower confining layer in most areas; the Ringold Formation, which contains both semiconfined and unconfined aquifer components; and the Hanford formation. Basalt of the Elephant Mountain Member is assumed to be the base of the unconfined or uppermost aquifer near the 200 East Area. However, two studies by Graham et al. (1984) and Jensen (1987) indicate possible aquifer intercommunication between the unconfined aquifer and the confined Rattlesnake Ridge aquifer near the 200 East Area. The Elephant Mountain Member has possibly been removed by erosion near the vicinity of the northeast corner of

the 200 East Area, providing a means for aquifer intercommuncation. A zone of downward hydraulic gradient occurs between the unconfined aquifer and the uppermost confined Rattlesnake Ridge aquifer beneath B Pond (Graham et al. 1984, Jensen 1987, Kasza and Schatz 1989).

The Ringold Formation exhibits a variety of hydrologic characteristics, including hydraulic conditions ranging from locally confined to unconfined. In the southern portion of the 200 East Area and much of the 200 West Area, the coarse-grained facies of the basal Ringold unit are locally confined by the overlying lower and fine-grained basal Ringold units (Last et al. 1989). In other areas, the fine-grained basal and lower Ringold units are missing, and the coarse-grained basal/middle Ringold units contain the unconfined aquifer. In the northeastern portion of the 200 East Area, the Ringold Formation is completely removed by erosion; here, the unconfined aquifer lies within the Hanford formation, which directly overlies the basalt (Tallman et al. 1979).

Lithologies in the unconfined aquifer exhibit widely varying hydrogeologic properties (Table 2-2). Values given are generalizations; in some locations hydraulic properties may lie outside the ranges given.

Table 2-2. Hydraulic Properties in the 200 Areas.

Interval tested	Hydraulic conductivity, ft/d	Effective storativity	Porosity, %
Hanford formation	2,000 to 10,000	0.07	30
Middle Ringold Unit	9 to 230	NA	NA
Lower Ringold Unit	1 to 12	0.002	10

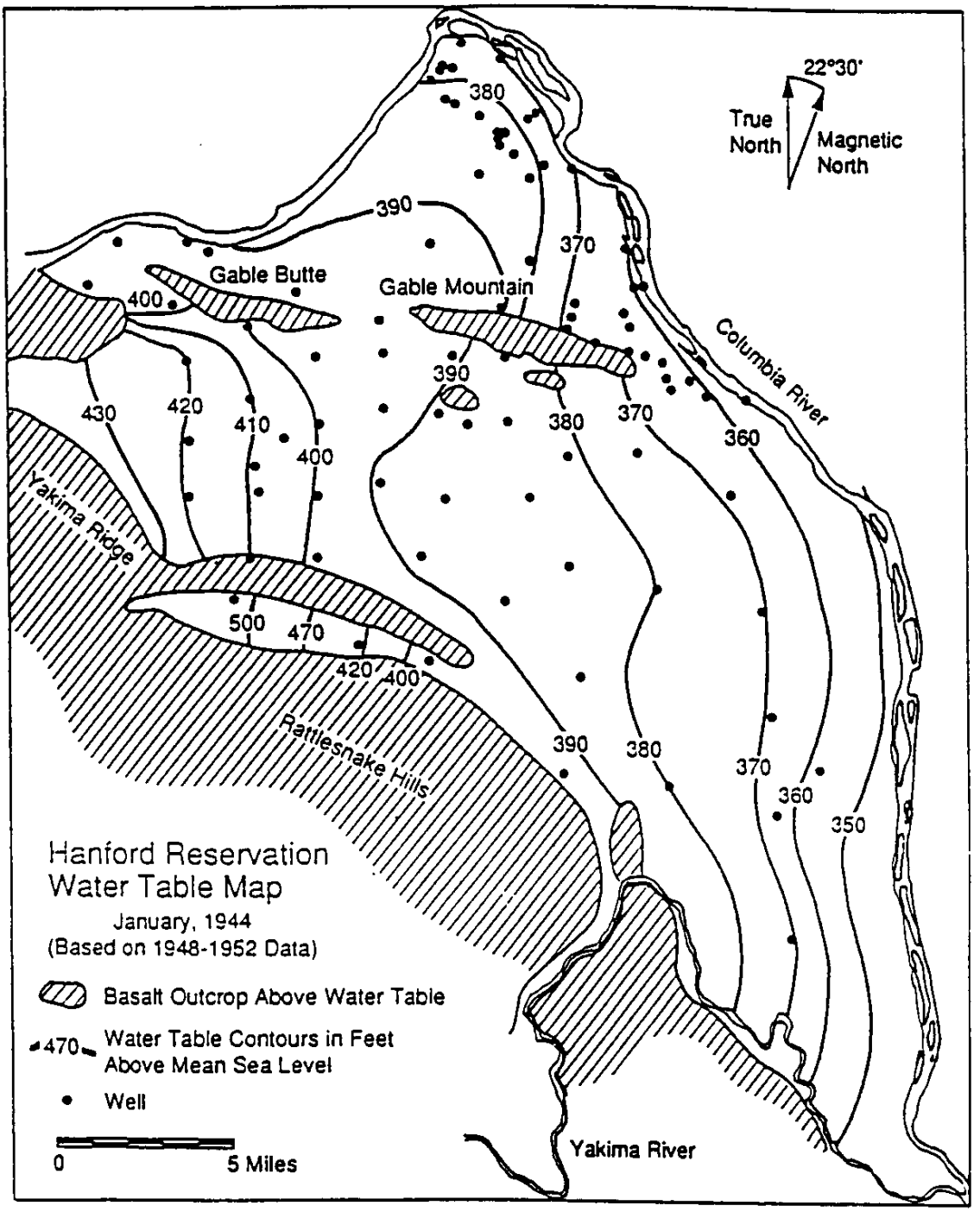
NA = not available.
Source: Graham et al. 1981.

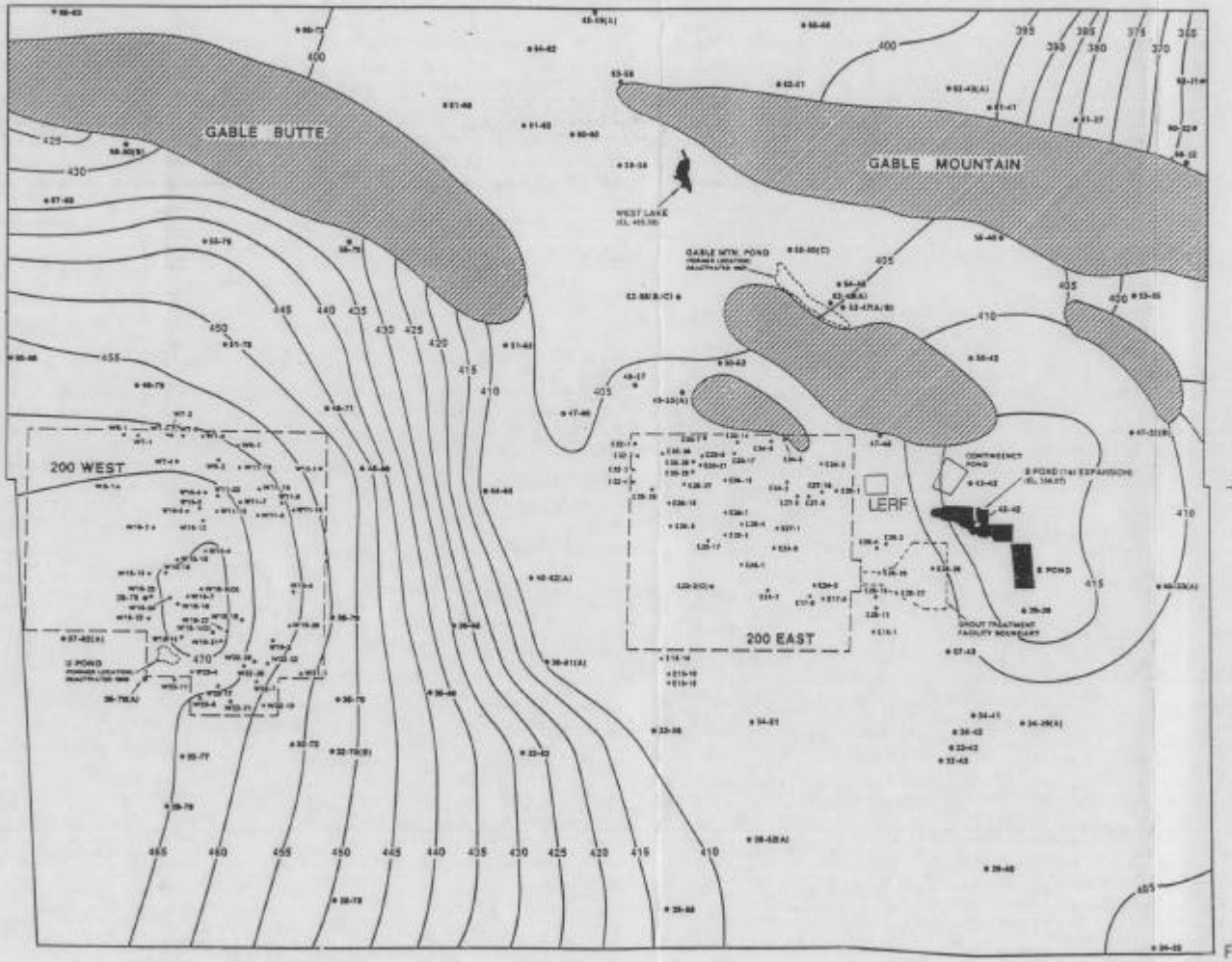
In the 200 West Area, the unconfined aquifer occurs primarily within the middle Ringold unit, which is compacted and often partially cemented. Transmissivities range from 300 to 5,400 ft^2 (Graham et al. 1981). In the 200 East Area, the aquifer is in either the unconsolidated Hanford formation, the middle Ringold unit, or both, leading to a wide range of transmissivities (i.e., from 5 to 135,000 ft^2/d). Transmissivities generally increase from west to east across the 200 Areas as a result of thinning of the Ringold Formation.

The measured storativity values for the unconfined aquifer range from 0.0002 to 0.07; the lower values are associated with the lower Ringold unit, and the higher values with the Hanford formation.

The effective porosity of the sediments in the unconfined aquifer ranges from 10 to 30% (Graham et al. 1981). The lower value corresponds to sediments contained within the lower Ringold unit, and the upper range approaches the total porosity of the sediments contained within the Hanford formation.

Figure 2-7. Hindcast Water Table Map of the Hanford Site, January 1944 (ERDA 1975).





S8912051.1

Figure 2-8. Water Table Map for the Separations Areas, January 1989 (after Kasza and Schatz 1989).

The chemical composition of the water in the unconfined aquifer ranges between calcium-bicarbonate, sodium-bicarbonate, and calcium-sulfate types (Graham et al. 1981). Calcium-bicarbonate is the most prevalent constituent in the ground water. However, there is considerable variability in chemical composition of the ground water beneath the 200 Areas.

Discontinuous perched water tables occur in localized areas in the 200 West Area, often lying on top of a calcrete horizon in the Plio-Pleistocene unit or above markedly finer-grained sediments in the upper Ringold unit, early Palouse soil, and Hanford formation. The lateral extent of these perched water tables has not been defined in detail, but they are believed to be discontinuous and found only near areas where large quantities of water were disposed to waste facilities.

2.4.2 Proposed LERF Site

The hydrogeology of the proposed LERF site (like the geology) must be inferred from nearby monitoring facilities.

Last and Bjornstad (1989) have shown that beneath WMA-2 of the low-level burial grounds, a single hydrogeologic unit, the Hanford formation, overlies the Elephant Mountain Member of the Saddle Mountains Basalt, and that the Ringold Formation is missing. Their evidence suggests that the basalt is laterally continuous in that area, except perhaps to the north of WMA-2 in the vicinity of a paleotopographic depression in the basalt surface, where an erosional window may allow hydraulic communication between the unconfined aquifer of the Hanford formation and the confined aquifer of the Rattlesnake Ridge interbed. The unconfined aquifer is relatively thin at WMA-2 because the confining basalt surface rises toward the north. Saturated thickness ranges from 0 ft near the northern boundary of WMA-2 to about 30 ft at the southern boundary. Measured hydraulic conductivities (based on five wells) ranged from 1,400 to 6,700 ft/d, and mean effective porosity was estimated to be 10%.

Luttrell et al. (1989) have shown that the uppermost aquifer at the B Pond location is contained in unconsolidated to slightly consolidated sandy gravel to silty sandy gravel, and that the base of the aquifer may be the top of a clay-rich unit overlying the basalt. If the clay-rich unit is not laterally extensive, the Elephant Mountain Member represents the base of the aquifer. A ground water mound exists beneath B Pond because of water infiltration at the pond, and saturated thickness of the unconfined aquifer ranges from about 30 to over 70 ft.

To the west of B Pond and at the WMA-2 site, ground water flow is generally to the west, because of the influence of the ground water mound beneath B Pond. Ground water flow at the LERF site, therefore, is toward the west, and hydraulic gradient based on water elevation contours seen in Figure 2-8 is probably 1 ft/1,000 ft or less. If discharge to B Pond is discontinued and the mound is allowed to dissipate, the flow direction would be expected to reverse and become easterly (Figure 2-7). No evidence of perched water table conditions was reported for either B Pond or WMA-2, so none is expected at the LERF site.

3.0 INDICATOR EVALUATION MONITORING PROGRAM

This plan has been developed in accordance with RCRA, as described in 40 CFR 265, Subpart F, and with Ecology requirements as described in WAC 173-303-400, to establish an interim-status indicator evaluation ground water monitoring program for the 200 East Area LERF and, if necessary, to initiate a ground water quality assessment program. All work outlined in this plan will be conducted under *Procedures for Ground-Water Investigations* (PNL 1989a) and the *RCRA Ground-Water Monitoring Project's Quality Assurance Project Plan* (PNL 1989b). Additionally, all onsite personnel must meet Occupational Safety and Health Administration medical, monitoring, and training requirements in accordance with 29 CFR 1910.120.

3.1 OBJECTIVES

The objectives are to establish a drilling and ground water monitoring program that will:

- characterize the stratigraphy and horizontal ground water flow directions beneath the LERF site; the focus will be on the uppermost confined aquifer
- determine background ground water quality
- provide means to detect any future ground water contamination from the LERF.

3.2 APPROACH

Four new monitoring wells will be installed around the LERF. These wells will provide information on the geology, hydrology, and water quality of ground water from the upper portion of the unconfined aquifer. This initial phase of characterization and ground water monitoring focuses on the uppermost portion of the aquifer. Results from this phase will be used to determine the need for wells that would penetrate and monitor deeper than the upper 20 ft of the aquifer.

Subsurface soil samples will be collected during drilling at each location. These samples will be described and classified in the field. Selected samples will be submitted to the laboratory for analyses to determine various physical and chemical parameters.

Ground water samples may be collected after reaching the water table if these samples are necessary for disposal of purge water during aquifer testing and well development. These samples may be analyzed for contamination indicator parameters before aquifer testing or well development. Aquifer tests, if conducted, are useful for providing estimates of hydraulic properties of materials beneath the site.

Water samples will be collected and analyzed quarterly from the new monitoring wells. The first year of sample analyses will be used to establish the background water quality for each well. Statistical evaluation of subsequent analyses compared with these background concentrations will provide an indication whether hazardous constituents from the facilities are significantly affecting the ground water.

Historical ground water quality data exist for well 299-E26-1, downgradient from the LERF and from well 699-45-42, upgradient from the LERF (see well locations in Figure 1-2). These wells provide the closest available upgradient and downgradient water quality. The wells are too distant to be incorporated as part of the monitoring network for the LERF, but the water quality from these wells serves as a starting point in the evaluation of background water quality. Construction and lithologic information for these wells is provided in Appendix B, and the water chemistry data are presented in Appendix C.

3.3 GROUND WATER MONITORING SYSTEM

This section defines the uppermost confined aquifer that will be monitored, the location and justification of the monitoring wells, how the new wells will be installed, the frequency of sampling, and ground water constituents to be analyzed.

3.3.1 Uppermost Aquifer

The uppermost aquifer at the LERF site is contained within the suprabasalt sediments and is assumed to extend from the water table to the top of the Elephant Mountain Member of the Saddle Mountains Basalt. Hydrogeologic characterization activities are designed to obtain information on hydraulic and ground water flow characteristics for the uppermost aquifer.

3.3.2 Installation of New Characterization/Monitoring Wells

Four new monitoring wells will be installed around the LERF. These wells will (1) provide hydraulic data to help determine the ground water flow direction beneath the site, (2) provide upgradient and downgradient ground water quality information from the upper portion of the unconfined aquifer, (3) evaluate the hydraulic properties of the aquifer, and (4) provide geologic information on the conditions that affect contaminant migration and ground water flow.

3.3.3 Justifications for Locations of New Wells

As a minimum, one upgradient and three downgradient ground water monitoring wells will be placed around the LERF site according to the requirements of 40 CFR 265. The primary objective of this configuration is to determine the ground water quality upgradient and downgradient of the site. The well placements were based on preliminary information and professional judgement.

3.3.3.1 Background (Upgradient) Well. The upgradient well will be located 400 ft east (the assumed upgradient direction) of the LERF, as shown in Figure 3-1. The location is close enough to provide information regarding upgradient water quality, but far enough away from the easternmost basin to be unaffected by any major leakage from that basin and consequent plume spreading in the vadose zone.

3.3.3.2 Detection (Downgradient) Wells. The three downgradient wells will be located along a north-south line approximately 100 ft west of the westernmost margin of the basins site, as shown in Figure 3-1. The wells will be located at 400-ft intervals along the north-south line, with the center well aligned on the east-west axis of the basins. Well spacing was maximized to provide a wider areal coverage of the proposed site.

The estimated depth to water table is 220 to 230 ft. Basin leakage of sufficient volume to reach the water table is estimated to exhibit a lateral spread of 200 ft or more in all directions by the time the downward-migrating plume has reached the water table. This estimated 200-ft spread is based on observations at a site 2,500 ft south of the LERF site.

Based on the assumption that the ground water flow in this vicinity is due west, the three downgradient wells are located in the flow path of the upgradient well. Water elevations from wells in the region provide the estimation of the westward flow as shown in Figure 3-2. Detailed water table elevations for the immediate vicinity of the LERF will be available after installation of the new wells.

3.3.3.3 Construction Details. As suggested in Chapter 2, the uppermost aquifer is presently defined as the lower (approximately) 30 ft of the suprabasalt sediments (i.e., no basalt above the water table), and that the Elephant Mountain Member is intact in the vicinity of the basin site (i.e., no erosional window to the Rattlesnake Ridge interbed).

Two of the four wells will be drilled to a maximum of 25 ft below the water table. This overdrilling will be done in an attempt to locate the top of basalt. Overdrilling will be done at the upgradient well. Drilling will cease if the top of basalt is encountered or the well has been advanced 25 ft below the water table, whichever occurs first. Overdrilling will also be attempted at the northernmost downgradient well. If basalt is encountered within 15 ft of the water table, an alternate well will be drilled up to 25 ft below the water table or the top of basalt, whichever occurs first.

The purpose of the overdrilling is to obtain hydrogeologic information about the top of basalt. Previous studies have indicated an erosional feature in the basalt that may create intercommunication between the uppermost aquifer and the confined aquifer.

Figure 3-1. New Monitoring Well Locations for the Proposed LERF Site.

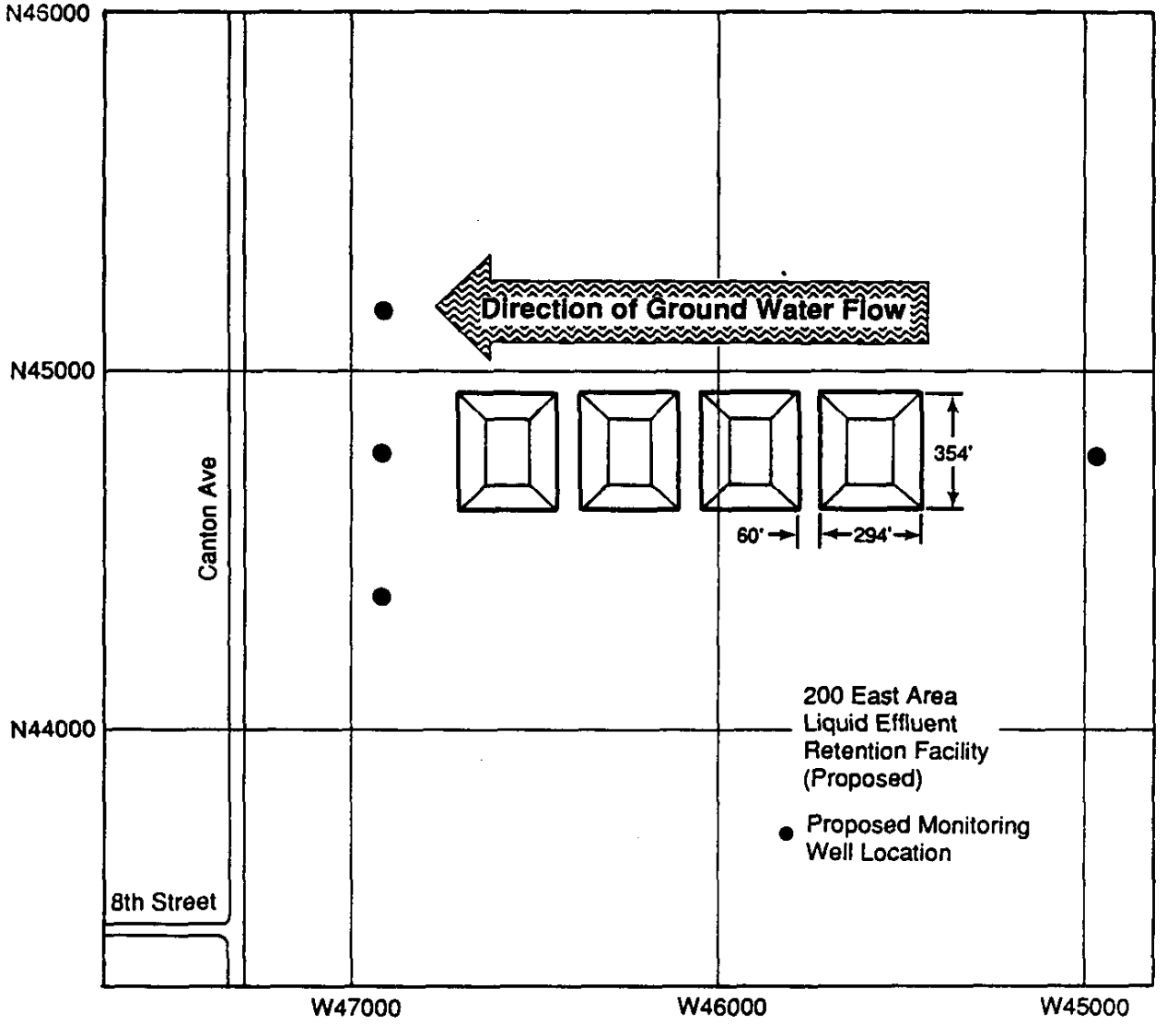
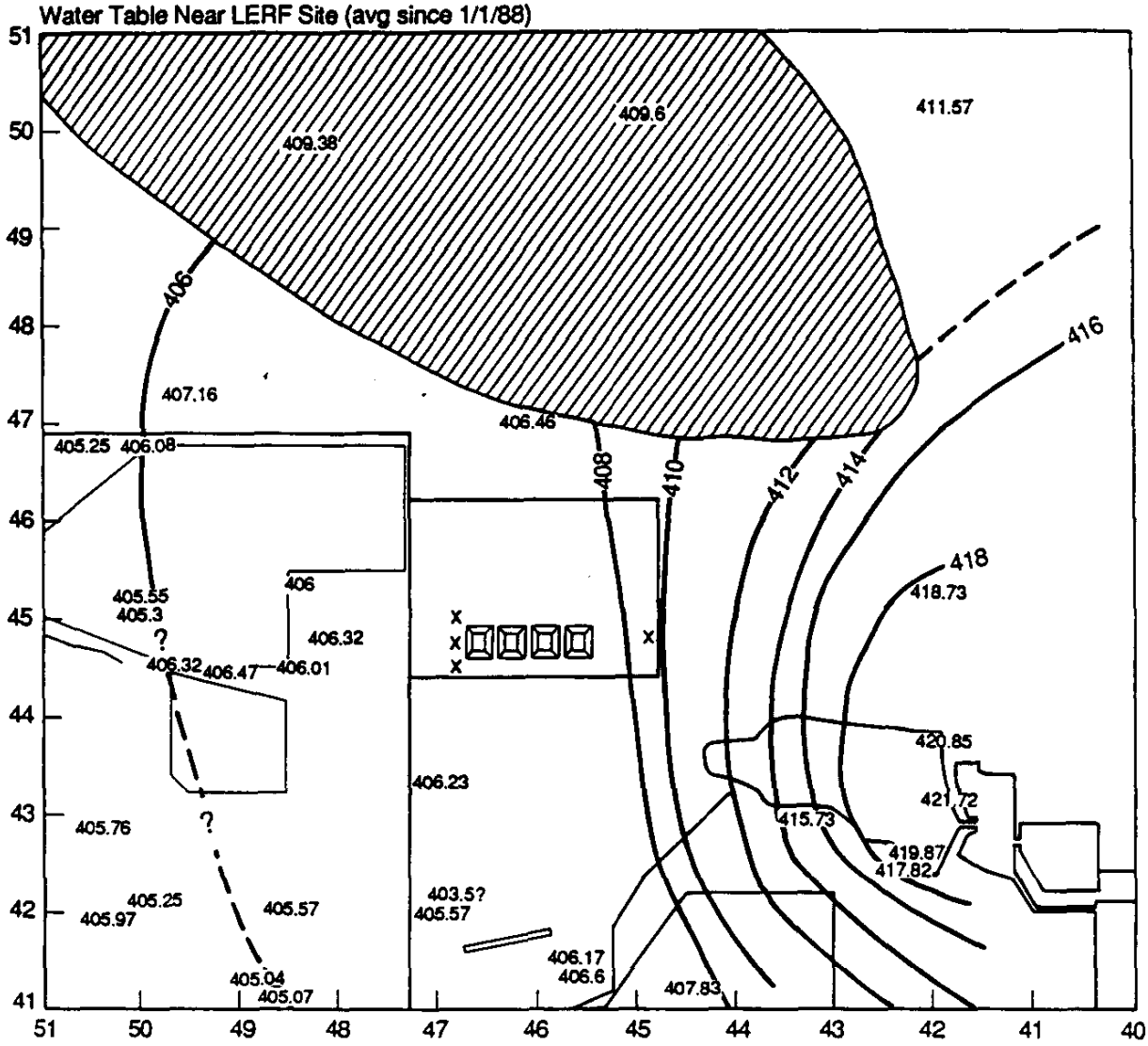


Figure 3-2. Estimation of the Westward Ground Water Flow.



Date: 12-15-1989

Solid line indicates high confidence contour.
Dashed line indicates inferred contour.

The wells are expected to have a total depth of 250 ft, and the lower 20 ft of each well will be screened, with 5 ft of the screened interval above water level measured at the time of well construction. All overdrilled wells that are advanced more than 15 ft into the aquifer will be backfilled to within 15 ft of the aquifer in accordance with the drilling specifications for ground water monitoring wells (WHC 1990b). The approximate location coordinates for each of the wells are:

Upgradient (background) well

North -- N44780 West -- W44975

Downgradient (detection) wells

North -- N45180	West -- W46920
N44780	W46920
N44380	W46920

Data sheets, as shown in Figure 3-3, will be completed and provided in the borehole data report.

3.3.4 Drilling and Well Installation

The cable-tool method of drilling will most likely be used. If another method of drilling is chosen, it will have the same advantages as the cable-tool method. These advantages include (1) drill cuttings being easily contained (important in contaminated material), (2) representative geologic samples can be collected, (3) moisture samples can be collected from above the water table, (4) disturbance to the borehole wall is minimized, and (5) a straight, plumb borehole being produced. Regardless of drilling methods, the well will meet current construction standards.

Drill cuttings will be routinely monitored for radiation and hazardous material. Where contamination is suspected, all drill cuttings will be collected until analytical results conclude that the material is not a dangerous waste. If contamination is detected, the drilling will stop until it has been determined what course of action to take. Contaminated cuttings will be handled, transported, and disposed of according to Westinghouse Hanford procedures.

To help prevent introduction of contaminants into the borehole, the drill rigs and peripheral equipment (such as drill tools, cables, and temporary casing) will be steam cleaned before arriving onsite, moving to a new site, and beginning construction of the next well. During drilling in the zone to be sampled, the addition of water to the borehole will be kept to a minimum or avoided. This will minimize well development pumping after wells are completed and minimize the changes of driving any vadose zone contaminants into the ground water.

Figure 3-3. Example Ground Water Monitoring Well Data Sheet.

1. LOCATION: (Provide general location and coordinates.)

2. TEMPORARY CASING SIZE AND SCHEDULE:

3. APPROXIMATE WELL DEPTH: (As listed in item 6 below)

4. SPECIAL INSTRUCTIONS: (Include details such as well specification, desired order that wells are to be drilled, perched water zones, estimated number of split-spoon samples, critical start and completion dates, and any other pertinent information that may impact drilling.)

5. APPLICABLE DOCUMENTS: (Include ground water monitoring plans and work plans).

6. WELL NUMBERS, LOCATIONS, DEPTH, TYPE, AND SCREEN LENGTHS:

Temporary Well Number	Facility	Coordinates	Depth	Design Type	Screen Length

Temporary carbon-steel casing with a minimum diameter of 8 in. will be driven to total depth as each borehole is advanced. The temporary casing will be telescoped so that no more than 150 ft of any one size of casing will be in contact with the formation. This will facilitate pulling the temporary casing out of the borehole and enable any zones of contamination or perched water to be sealed off during construction of the borehole. After the borehole has been drilled to its total depth, the final well casing and screen will be installed and the temporary carbon steel casing will be removed as the filter pack and annular seal materials are placed in the annular space.

3.3.5 Well Construction

A schematic diagram of a completed well is presented in Figure 3-4. Guidance concerning geologic sampling and inspection of well construction is provided by Last and Liikala (1987) and the procedures for ground water investigations are presented by Pacific Northwest Laboratory (PNL) (1989a). The WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells" and WHC (1990b) are used as guidance for the well design and construction materials. Quality assurance (QA) requirements of the QA project plan (PNL 1989b) also apply.

The final wells will be constructed of 4-in-ID pipe and a screen made of stainless steel, fiberglass, or other inert materials. Final screens will be 20 ft in length. The screens will extend downward so about 15 ft of screen is below the water table and 5 ft is above the water table.

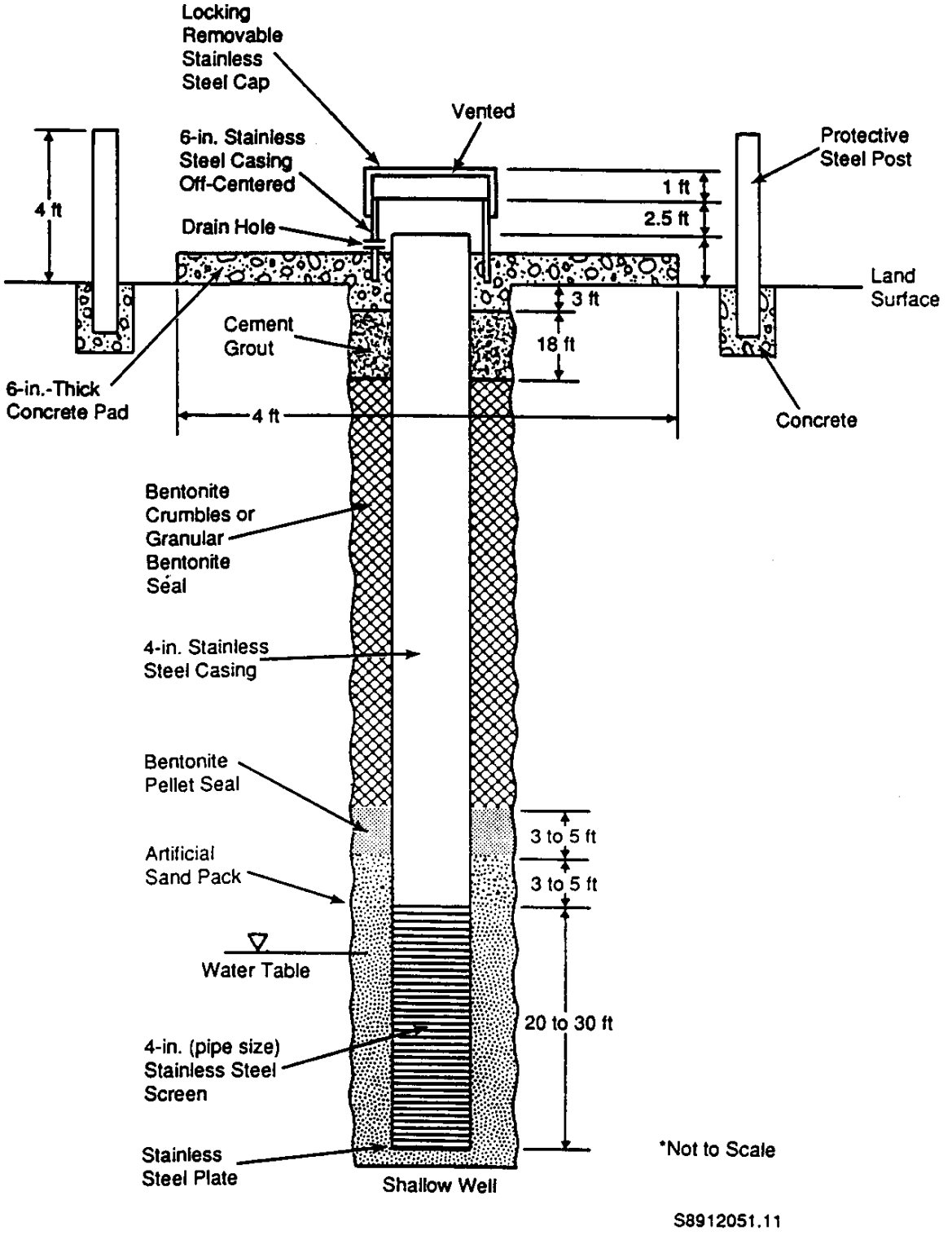
Screen slot sizes will be selected in the field after sieve analysis of the sediments has been performed. The site geologist will determine the filter pack size and screen slot size based on guidelines outlined by Last and Liikala (1987). Sand filter packs will be placed in the annulus between the 8-in. telescoping screen (if used) or the temporary 8-in-diameter casing and the permanent 4-in-diameter casing and screen as the temporary casing is withdrawn. If a telescoping screen is used during tests, it will be left in the hole. The sand filter pack will be placed from approximately 1 to 3 ft below to 3 to 5 ft above the top of the screen.

A 2- to 3-ft-thick bentonite pellet seal will be placed on top of the sand pack. The annulus above the bentonite pellet seal to 18 ft below ground surface will be filled with dry granular bentonite. Cement grout will then be installed to within 2 ft of the ground surface. The well casing will extend 1 to 2 ft above ground surface and will be protected by an outer steel casing and a locking cap. The protective casing will be set into the ground and cemented in place with a 4- by 4-ft by 6-in. concrete pad. A brass survey marker will be placed in the concrete pad and all protective casings will be permanently marked with well identification numbers.

3.3.6 Well Development

All wells will be developed following completion. Wells will be developed by the surge and bail technique, overpumping, or other reasonable techniques deemed necessary until turbidity is less than 5 NTU and sediment content is less than 8 mg/L. If the water cannot be developed to a turbidity of less than 5 NTU, an explanation will be provided and documented by the site hydrogeologist.

Figure 3-4. Schematic Diagram of a Completed Ground Water Monitoring Well.



Other hydrochemical indicators, such as total iron and drilling fluid tracers, may be monitored to assess the adequacy of development pumping for trace constituent sampling.

All ground water discharged from the wells during development will be disposed of in accordance with Westinghouse Hanford guidelines and procedures. If it is necessary, a ground water sample will be collected and analyzed before development begins. The results could be used to determine the handling and disposal of purge water.

3.3.7 Surveying

After monitoring well installation is completed, all wells will be surveyed for location and elevation by qualified surveyors. The elevation of the top of the casing and a brass marker in the concrete pad will be determined within 0.04 ft. A mark will be placed on the casing to indicate the location that was surveyed. The areal location will be determined to the nearest 0.5 ft. All measurements will be referenced to a common datum (preferably a Hanford Site datum).

3.3.8 Monitoring Parameters

Ground water samples will be collected at least once each quarter to test constituents (Table 3-1) in conformance with 40 CFR 265, Subpart F.

While there are several other radioactive and organic constituents indicated in the effluent stream data summaries provided in Section 2.1, they should be detected as a group by the general screening or indicator parameters such as gross alpha, gross beta, total organic carbons (TOC), and total organic halogens (TOX). If increases in these parameters are detected, then more specific analyses would be performed. In addition, constituents listed in the sampling and analysis plan (Appendix D) will be analyzed once during the first year of sampling.

3.4 HYDROGEOLOGIC CHARACTERIZATION

Hydrogeologic characterization will be conducted to describe the geologic and hydrogeologic conditions and properties that control contaminant flow paths. Work performed will follow approved procedures, in accordance with the QA project plan approved by PNL and Westinghouse Hanford (PNL 1989b) and that meets EPA guidance (Stanley and Verner 1983).

Data collection and interpretation will focus on geology, geochemistry, hydrogeology, hydrochemistry, ground water monitoring, and ground water modeling. The characterization will be performed during and after construction of the planned ground water monitoring network. Information obtained from nearby facilities will be integrated into the characterization and interpretation effort. Characterization of this site is a discovery process, and data collection in these areas may expand or decrease depending on the information obtained.

Table 3-1. Constituents Tested in Ground Water Samples.

Interim primary drinking water standards	Maximum level, mg/L
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Fluoride	1.4 to 2.4
Lead	0.05
Mercury	0.002
Nitrate (as NO_3^-)	45
Selenium	0.01
Silver	0.05
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5--TP Silvex	0.01
Radium	5 pCi/L
Gross alpha	15 pCi/L
Gross beta	4 mrem/yr
Coliform bacteria	1/100 mL

Ground water quality parameters	
Chloride	Phenols
Iron	Sodium
Manganese	Sulfate

Ground water contamination indicator parameters	
pH	TOC
Specific conductance	TOX

Site-specific Parameters (as effluent to basins becomes better defined, parameters subject to change)	
Tritium	Aluminum
Ammonium	

3.4.1 Geologic Data

Geologic samples will be collected at 5-ft intervals, at changes in lithology, and when significant changes in moisture content are observed during drilling (EPA 1986). A general description of the borehole cuttings should be recorded by the well-site geologist to obtain a continuous lithologic record. Samples will be archived for possible future analyses. A guide to subsurface data collection and documentation during cable-tool drilling is presented by Last and Liikala (1987), and the procedures for ground water investigations are presented by PNL (1989a).

No drilling fluids will be added to the borehole unless necessary and approved by the well-site geologist. This will allow detection of perched water zones and the collection of representative moisture samples with minimal impact on water chemistry. Samples will be collected for moisture content determinations in the unsaturated sediments at 5-ft intervals and at moist or wet zones.

The well-site geologist will describe the samples in the field and document the descriptions on borehole logs. Every sample will be recorded on borehole logs as collected at the drill site. The detailed lithologic descriptions of geologic samples will include color, texture, sorting, mineralogy, roundness, relative calcium carbonate concentration, consolidation, and cementation. In addition, the drilling and well construction information, and the depths where various samples were collected, will be documented on the borehole logs.

3.4.1.1 Laboratory Analyses. Geologic samples will be analyzed in the laboratory using the following methods and criteria (see Table 3-2):

- sieve particle size
- pipette/hydrometer analyses
- permeameter testing
- calcium carbonate content
- moisture content
- petrography
- x-ray diffraction
- x-ray fluorescence
- atomic absorption analysis
- bulk mass density
- hazardous chemical analysis
- radionuclide analysis.

Some of these methods may be performed on every 5-ft sample, while other methods apply to particular types of samples or sample intervals. Table 3-2 summarizes the frequency that samples could be analyzed, the limitations, and the requirements for samples to be analyzed by the various methods.

3.4.1.2 Sediment Collection and Analysis. In addition to geologic samples, sediment samples may be collected for chemical and radiologic analysis. These samples will be collected as outlined below:

- at major lithologic changes
- at perched water zones or increased soil moisture content
- at zones where contamination is suspected based on unusual soil discoloration, odor, or detection instrumentation response above background levels.

All samples will be collected and kept in refrigerated storage under the established chain-of-custody procedures. Samples obtained from zones identified in the last two bullets discussed in Section 3.4.1.2 will be submitted for analyses within the holding time for the constituent(s). Each sample may be analyzed for the constituents listed in Table 3-1.

Table 3-2. Laboratory Analyses to be Performed as Part of Hydrogeologic Characterization.

Laboratory analysis	Parameter measured	Sample requirements/ limitations	Potential uses	Sample frequency	Method of sample collection[a]
Sieving	Particle-size distribution of sand to gravel-size particles	Individual soil particles must be disaggregated and unbroken to yield accurate results	Proxy for hydraulic parameters; ground water modeling	All samples	SS, DB, HT
Hydrometer	Particle-size distribution of mud-size particles (i.e., silt and clay)	Fine grained; undisturbed/intact soils	Characterize aquitards; ground water modeling	All fine-grained intervals	SS, DB
Permeameter	Saturated hydraulic conductivity	Undisturbed/intact soils	Determine rate of ground water movement; check for aquifer tests; ground water modeling	Selected intervals	SS
Calcium carbonate	%CaO_3	Soils of fine sand or smaller particles	Aquitard identification; stratigraphic marker horizons	All samples	SS, DB, HT
Moisture content	%water	Undisturbed/intact soils	Elevate vadose water movement; aquitard identification; ground water modeling	All fine-grained intact intervals	SS, DB
Petrography	Mineral content/ concentration	Soils with sand and larger particles	Differentiate among hydrostratigraphic units	Selected samples where major geologic contacts are suspected	SS, DB, HT
X-ray diffraction	Clay mineral identification	Soils with mud-size particles	Sorptive characteristics; hydrostratigraphic unit identification	Selected fine-grained intervals	SS, DB, HT
X-ray fluorescence	Major and trace element concentrations (except sodium and magnesium)	Intact soils or soils uncontaminated with overlying material	Hydrostratigraphic unit identification; determine background levels of constituents in soil	Selected intervals where lithology changes	SS, DB, HT
Atomic absorption	Sodium and magnesium concentrations	Intact soils or soils uncontaminated with overlying material	Hydrostratigraphic unit identification; determine background levels of constituents in soils	Selected intervals where lithology changes	SS, DB, HT
Bulk mass density	Bulk porosity	Undisturbed/intact soils	Determine hydraulic parameters; ground water modeling	Selected intervals	SS
Hazardous chemicals	Concentrations of hazardous constituents in ground water	Nonturbid ground water; soil samples	Determine presence/ absence of ground water contamination	All ground water bearing zones at regular intervals	Pump from completed well
Radionuclides	Concentrations of radionuclides in ground water	Nonturbid ground water; soil samples	Determine presence/ absence of ground water contamination	All ground water bearing zones at regular intervals	Pump from completed well

[a]SS = split-spoon drill method; DB = drive-barrel drill method; HT = hard-tool.

3.4.1.3 Borehole Logging. After each size of temporary casing has been placed and when the monitoring wells have been drilled to final depth, the borehole will be logged with a gross gamma probe. Logging will not be necessary after the 20-ft starter casing has been placed in the borehole. A procedure for geophysical well logging that is approved by Westinghouse Hanford will be used. The primary purpose of the logging will be to provide qualitative stratigraphic interpretation and correlation (Hallenburg 1984; Fetter 1988). Specifically, the gross gamma log is useful for providing an indication of the clay content of the formation. In many cases, the presence of fine-grained sedimentary layers produces a higher gamma activity than coarse-grained sediments. Another use is to identify zones of suspected contamination by gamma ray-emitting radionuclides. After completion, each well will be viewed with a downhole video camera to ensure that the well is clean and undamaged. The neutron, density, caliper, spontaneous potential, resistivity, and magnetic probes, as well as the downhole video camera, may be used in specific instances when approved by Westinghouse Hanford. Spectral gamma logging may also be performed by Westinghouse Hanford.

3.4.1.4 Data Interpretation and Presentation. All geologic and geophysical data will be interpreted to determine the stratigraphy beneath the site. These data will be presented in cross sections, fence diagrams, contour maps, and tables, as recommended by EPA (1986). Interpretations of the stratigraphy will be used in evaluating potential contaminant flow paths, in determining hydrostratigraphic units, and, if needed, to aid in locating additional monitoring wells.

The data and interpretations will be presented in an interim site characterization report and in permitting documents. The documents will include (1) descriptions of stratigraphic units, (2) results of analyses, (3) as-built diagrams of wells, and if necessary (4) recommendations for further characterization or additional monitoring wells.

3.4.2 Hydrogeologic Data

Data that will be used to characterize the hydrogeology will be collected during and after drilling of the monitoring wells. The general types and methods of data collection are discussed below. Ground water samples will be taken following the procedures discussed in the sampling and analysis plan (Appendix C), or their revised, approved, and documented equivalents.

3.4.2.1 Aquifer Testing. The purpose of aquifer testing is to determine the hydraulic characteristics of in situ geologic materials in the uppermost confined aquifer underlying the LERF. A field testing program is essential to optimize collection of hydrologic data. However, the primary purpose of installing the wells is to monitor the ground water chemistry and not for aquifer testing. Therefore, the results must be considered in this perspective.

Aquifer testing that involves pumping ground water out of the well will be conducted only if adequate means exist for disposing of the purge water at the time the wells are ready for testing. A ground water sample may be collected and analyzed before aquifer testing begins. The results may be used to determine the handling and disposal of purge water. Slug testing will most likely be used because of the purge water issue.

A bailer will be used to remove drilling fluids and coarse materials from the borehole. Pretest development by pumping will be conducted after bailing. The purpose of these tests is to develop the well. Pretest development by pumping can be used to determine the optimum discharge rate and, thus, the pump size for the constant-discharge test. If the pump has a check valve, then pretest development will consist of pumping at a low-flow rate followed by successively higher flow rate steps until full pump capacity or maximum drawdown has been achieved. If the pump is not equipped with a check valve, a surging technique will be used where the pump is alternately turned on and off followed by step pumping as described above. The constant-discharge test will not be performed until water levels have fully recovered from the development test.

A number of aquifer test methods may be used in the field testing program depending on the hydrologic parameter sought and existing hydraulic test conditions. Some test methods commonly used include bailer, development, constant-discharge, and recovery techniques. Constant-discharge tests could be conducted for up to 24 h in those cases where at least one observation well is available and drawdown is large enough (greater than 0.2 ft) to allow a quantitative analysis of the data. When available, data from the observation wells can be analyzed to yield estimates of transmissivity, storativity, and sometimes, hydraulic conductivity anisotropy. Results from constant-discharge tests can also be used to verify lateral continuity. Single well constant-discharge tests can normally be conducted for up to 8 h. Tests of 8-h duration can be used to estimate transmissivity.

A constant-discharge pumping test should be conducted in one upgradient and one downgradient well. If a constant-discharge pumping test is conducted, a temporary section of nominal 8-in. telescoping screen will be set in each of the wells before pumping. The length of the temporary screen will be similar to the screen lengths of the completed well. The screen will be open to the uppermost portion of the aquifer.

A submersible pump will be placed in the bottom portion of the screened interval. If the sediments in the test interval appear to have relatively high permeabilities (such as those characteristic of the Hanford formation), a large discharge range will be required. The largest pump that will fit in a nominal 8-in. telescoping screen (normally 40 hp) will be used in this case because it is expected that even a maximum discharge from this size pump (200 to 250 gal/min) will produce only a small drawdown (no more than 2 ft).

If sediments in the test interval have low permeabilities (such as those characteristic of the Ringold Formation), a much lower discharge rate will be required and a smaller pump can be installed. In some locations, the sediments in a test interval may be of such low permeability that a pumping test would not be possible. In these situations, a slug test may be conducted.

A slug test may be conducted in the following manner. The drive casing will be pulled back a few feet to expose the formation to the open hole. If heaving or caving formations are expected, a temporary section of telescoping screen will be set in the well before testing. The screen may be set as described for the constant-discharge pumping test. The borehole will be bailed to remove drilling fluids and debris before conducting the test.

During the slug test, the hydraulic head will be changed instantaneously by suddenly introducing or removing a cylinder of known volume. The water level recovery response will then be observed over time.

A slug test will not yield representative results if the interval is of heterogeneous materials with hydraulic conductivities ranging over several orders of magnitude. In this case, split-spoon samples may be collected and laboratory tests may be used to determine hydraulic conductivity.

One or two days of continuous water level monitoring will be conducted (if scheduling permits) before/after terminating the pumping tests. These data will be used to determine whether outside influences, such as barometric effects, will have a significant impact on the tests. If so, the data will be corrected for these effects.

The conventional analysis methods by Cooper and Jacob (1946) and Theis (1935) can be used to estimate transmissivity in the unconfined aquifer Graham et al. 1981). Modifications of these methods can be used to correct for partial penetration effects, delayed yield response, leakage effects, and borehole storage effects. Slug test methods than can be used include Hvorslev (1951), Cooper et al. (1967), and Bouwer and Rice (1976). The laboratory methods to determine hydraulic conductivity include the falling-head or constant-head permeameter tests (Klute and Dirksen 1986).

3.4.2.2 Determination of Ground Water Flow Paths. Water levels will be measured in all new wells and in all suitable nearby existing wells to determine the hydraulic head distribution used in identifying ground water flow paths. Measurements will also be made over time to evaluate temporal changes in flow paths and dynamics of the aquifer system.

3.4.2.3 Data Interpretation and Presentation. Hydrogeologic data, interpretations, and recommendations will be presented in an interim site characterization report after well installation and initial monitoring are completed. Specifically, this report will include (1) descriptions of hydrostratigraphic units, (2) water level data and water table maps, (3) test data and results of analyses, (4) as-built diagrams of wells, (5) hydrochemistry data, and if necessary, (6) recommendations for further characterization or construction of additional monitoring wells.

The data will also be used to evaluate whether the characterization was adequate and if the ground water monitoring system is appropriately designed. Recommendations will be provided for additional characterization activities or construction of additional ground water monitoring wells if necessary.

The hydrogeologic data will be integrated to form an initial conceptual model of the ground water flow system(s) in the vicinity of the LERF site. Components of the model will include the flow paths and their possible changes over time, estimates of ground water velocity, unsaturated zone conditions as they relate to the ground water monitoring system, and hydrochemical characterization.

3.5 SAMPLING AND ANALYSIS

The wells will be sampled quarterly for 1 yr and semiannually thereafter. Sampling pumps will be installed in the new wells after construction and development is complete. The depth to water will be measured before samples are collected. The wells will be purged and samples will be collected after at least three borehole volumes have been removed and when specific conductance, temperature, and pH have stabilized. In the case of wells that pump dry because of very low permeability materials, the sample will be collected after recharge.

Sample analysis, preservation, and chain-of-custody procedures in accordance with 40 CFR 265.92 are discussed in Appendix D. The QA control protocol is also given in Appendix D. The purpose of the quality control activities is to determine and document that samples were carefully collected and transferred to an analytical laboratory, that the quality of the analytical results being produced by the laboratory are defensible, and to see the corrective actions will be taken as necessary.

Under the indicator-evaluation monitoring program, ground water surface elevation data will be evaluated at least annually to determine if the existing monitoring wells are appropriately located. If the evaluation indicates that existing wells are no longer adequately located, the ground water monitoring system will be modified to bring it into compliance with 40 CFR 265.91(a).

3.6 STATISTICAL ANALYSIS OF GROUND WATER MONITORING DATA

3.6.1 Methods for Establishing Background

Quarterly samples will be collected for 1 yr from the ground water monitoring wells in conformance with 40 CFR 265.92 for analyses of the constituents listed in Section 3.4. Additional constituents may be added to this list after evaluation of the initial results. The first set of samples will be collected after the wells have been completed, developed, and had sampling pumps installed. Depths to water will be measured before the wells are purged.

After 1 yr of quarterly monitoring, background levels for indicator parameters will be determined and compared with indicator parameters from upgradient and downgradient wells semiannually in accordance with 40 CFR 265.93. The data will be analyzed to evaluate whether ground water is being affected by the LERF.

Background summary statistics (mean, variance, and coefficient of variation) will be calculated from four quarters of data from the upgradient well. The actual method that will be used for calculating summary statistics will depend on the distribution of the data and the presence of any data reported as less than the limit of detection. Replicate summary statistics will be calculated each quarter. Background comparison summary statistics will be calculated from the quarterly summary statistics.

Samples will then continue to be collected and analyzed semiannually from the background wells. The data will be evaluated to determine if trends are present, irregularities exist in the data, or ground water from the wells is affected by the subject facility. If any of these conditions are present, the data will be evaluated in relation to the hydrologic system to determine if the background levels need to be recalculated from a new set of quarterly sample data. The data will also be evaluated to determine whether the wells being used are suitable for that purpose or if different wells are required.

3.6.2 Evaluation of Data

Wells will be sampled at least twice each succeeding year after background concentrations have been established. A minimum of four replicate measurements will be obtained from each well for determining indicator parameters, and the arithmetic mean and variance will be calculated for the indicator parameters for each sample.

The Student's t-test, as presented in the *Technical Enforcement Guidance Document* (EPA 1986), will be used to determine statistically significant changes in the concentration of indicator parameters of downgradient wells as compared to initial background concentrations or values. This comparison will individually consider each of the wells in the monitoring system. For three of the indicator parameters (specific conductance, TOC, TOX), a single-tailed Student's t-test will be used to test at the 0.01 level of significance for significant increases over background. The difference test for pH will be a two-tailed Student's t-test at the overall 0.01 level of significance.

3.6.3 Reporting Requirements

A summary of the reports required for compliance with 40 CFR 265, Subpart F, is given in Table 3-3.

Table 3-3. Reports Required for Compliance with 40 CFR 265, Subpart F, for Ground Water Monitoring.

Submittal	Submittal period
First year of sampling: Concentrations of interim primary drinking water constituents, identifying those that exceed limits listed in Section 3-4.	Quarterly, according to the current schedule.
Concentration and statistical analyses of ground water contamination indicator parameters, noting significant differences in upgradient wells.	Annually, according to the current schedule.
Results of ground water surface elevation evaluation and description of response if appropriate.	Annually, according to the current schedule.

4.0 GROUND WATER QUALITY ASSESSMENT PROGRAM

Criteria requiring notification to regulatory agencies and initiation of a ground water quality assessment program are described. The notifications for compliance with 40 CFR 265, Subpart F, are presented, and the contents of the ground water quality assessment program are outlined as required in 40 CFR 265.93(a).

Ground water samples from all monitoring wells will be tested quarterly for contamination indicator parameters, interim primary drinking water constituents, secondary ground water quality parameters, and site-specific parameters for the first year of sampling. Background levels of the ground water contamination indicator parameters will be statistically established after the first year of sampling using methods in the Technical Enforcement Guidance Document (EPA 1986). Once the background for the indicator parameters has been established, subsequent samplings from the LERF monitoring network will be statistically compared to the established background values to determine if there is a significant difference. If a difference is found, the wells in question will be immediately resampled. If the results are verified, Ecology will be notified in writing within 7 d of verification. A ground water quality assessment program will then be developed and its plan sent to Ecology within 15 d following the notification. An outline of this plan follows:

- INTRODUCTION
- GROUND WATER QUALITY ASSESSMENT PROGRAM
  - Investigatory Approach
  - Hydrogeology of the Site
  - Description of Background Monitoring Network
  - Existing Data and Evaluation
  - Ground Water Quality Assessment Monitoring System
  - Ground Water Quality Sampling Schedule
  - Water Table Monitoring
  - Sampling and Analytical Methods
  - Quality Assurance
    - * Laboratory, Internal Quality Control
    - * External Quality Control
  - Data Evaluation Procedures
- REFERENCES
- APPENDIX A--Preservation Techniques, Analytical Methods Used, and Current Detection Levels for Constituents Analyzed for in the Project
- APPENDIX B--As-Built Diagrams for Background Monitoring Wells
- APPENDIX C--Monthly Water Table Elevation Maps for the Surrounding Area

The quality assessment program will include (1) number, location, and depth of wells in monitoring network, (2) sampling and analytical methods used, (3) evaluation procedures, and (4) a schedule of implementation. The quality assessment program will also provide an investigative approach to determine rate and extent of migration of hazardous waste or hazardous constituents in the ground water and their concentrations. As soon as technically feasible, these determinations will be made and a report of the findings sent to Ecology. Table 4-1 provides a schedule for reports and notifications.

Table 4-1. Reports and Notifications.

Submittal	Submittal period
Required whether or not facility might be affecting ground water	
First year of sampling only: Concentrations of interim primary drinking water standards, identifying those that exceed limits listed in Section 3.3.8.	Quarterly.
Concentration and statistical analyses of ground water contamination indicator parameters, noting significant differences in upgradient wells.	Annually, by March 30 of following year.
Results of ground water surface elevation evaluation and description of response if appropriate.	Annually, by March 30 of following year.
Required if facility might be affecting ground water	
Notification to EPA and Ecology that facility might be affecting ground water.	Within 7 d of confirmation of a statistical difference over background.
Submittal of ground water assessment plan to EPA and Ecology.	Within 15 d of the above notification.
Submittal to EPA and Ecology of written report on assessment of ground water quality, including concentrations of hazardous waste constituents and their rate and extent of migration.	Within 15 d of first determination (as soon as technically feasible).
Results of ground water quality assessment program.	Annually, by March of following year

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APPENDIX A

WASTE INFORMATION DATA SYSTEM SUMMARY REPORTS

Waste Information Data System
General Summary Report
March 14, 1990

SITE NAME: 207-A Retention Basin
ALIAS NAMES: None

SITE TYPE: Retention Basin
WASTE CATEGORY: Hazardous Waste
OPERABLE UNIT: 200-PO-5
REGULATORY AUTHORITY: Undefined

STATUS: Active
SERVICE DATES: From 1977 to the present

COORDINATES: N41220 W46890, N41220 W47105, N40900 W47105, N40900 W46890
LOCATION: 200 East Area, directly east of the 242-A Evaporator.

REFERENCE DRAWINGS: H-2-34761, H-2-69292

SITE AREA:

ELEVATIONS and DEPTHS:

Ground:	672.00	feet above MSL
Water Table:	282.00	feet below grade
Site Depth:		feet below grade

WASTE VOLUME RECEIVED: liters
CONTAMINATED SOIL VOLUME: cubic meters
OVERBURDEN SOIL VOLUME: cubic meters

SITE DESCRIPTIONS:
Retention basin consisting of six rubber-lined holding basins, each 55 ft long and 10 ft wide at the bottom and 7 ft deep. A 4-in. fill line enters each basin, and a 3-in drain line exits.

WASTE DESCRIPTION:
Since March 1977, the site has been receiving two liquid waste streams from the 242-A Evaporator: (intermittently when evaporator is used)
1) Steam condensate is sent to the three north basins and then goes to 216-A-25 Pond;
2) Process condensate is sent to the three south basins and then goes to 216-A-37-1 Crib.

COMMENTS:
In operation, the basins are alternately filled, sampled, and emptied when meeting specifications. The north basins are discharged into the Gable Mountain Pond pipeline and the south basins are discharged to the 216-A-37 Crib. The facility includes the capability of returning liquid waste for reprocessing or in-tank storage if discharge specifications are not met.

RELEASE POTENTIAL:
The basin is rubber-lined.

SITE NAME: 207-A Retention Basin

ASSOCIATED STRUCTURES:
A 4-in. fill line for each basin, ~2 ft long (inside basin structure).
Hypalon liner for 6 basins, ~16,000 sq ft.

SURVEILLANCE INFORMATION

SITE NAME: 207-A Retention Basin

SCHEDULE: Not Applicable **LAST SURVEY DATE:**

AREA POSTING: Not Applicable
POSTING TYPE: Unknown

CAVE-IN POTENTIAL:
EXISTING CAVE-INS: None

PERCENTAGE OF VEGETATION COVER:
GRASS: **DEEP ROOTED:**
OTHER: **NO COVERAGE:** 100%

Waste Information Data System
General Summary Report
March 14, 1990

SITE NAME: 216-A-37-1
ALIAS NAMES: 216-A-37 Crib

SITE TYPE: Crib
WASTE CATEGORY: Low-Level Waste
OPERABLE UNIT: 200-PO-4
REGULATORY AUTHORITY: Undefined

STATUS: Active
SERVICE DATES: From March 1977 to the present

COORDINATES: N39856 W45816, N40157 W46449 (center line of crib)
LOCATION: 200 East Area, outside of the 200 East Area perimeter fence, 2,000 ft east of the 202-A Building.

REFERENCE DRAWINGS: H-2-62876, H-2-62877

SITE AREA: 7,000.00 square feet

ELEVATIONS and DEPTHS:

Ground:	675.00	feet above MSL
Water Table:	278.00	feet below grade
Site Depth:		feet below grade

WASTE VOLUME RECEIVED: 315,000,000 liters
CONTAMINATED SOIL VOLUME: 1,800 cubic meters
OVERBURDEN SOIL VOLUME: 3,400 cubic meters

SITE DESCRIPTIONS:
Crib with a 10-in. corrugated, galvanized, perforated pipe located horizontally, 7 ft below grade. Bottom dimensions of the excavation are 700 ft by 10 ft. It is 11 ft deep. The excavation contains 5 ft (5,300 cu ft) of gravel fill, and the site has been backfilled over. The side slope is 1:1.

WASTE DESCRIPTION:
Since 3/77, the site has been receiving process condensate from the 242-A Evaporator.

COMMENTS:
Well #299-E25-19: Beta activity (excluding H-3) shows an increase over the last seven months. Limits have not been exceeded. H-3 showed a decrease from April to October 1985. The November sample was twice as high as the previous month and shows an increase since then. NO3 remains between two and four times the drinking water standards (DWS). Well #299-E25-20 shows that a decreasing trend has been exhibited in the contaminant H-3 since February 1985. NO3 remains between three and five times the DWS. - Groundwater Monitoring Compliance Report for August 1986 (9/19/86).

SITE NAME: 216-A-37-1

ENVIRONMENTAL MONITORING:
Radiological surveys of the surface are performed quarterly.

RELEASE POTENTIAL:
This unit is used as a percolation crib.

ASSOCIATED STRUCTURES:
A 4-in. SCH 40 carbon steel vent riser and vent extending from the distribution pipe to 3 ft above grade.
A 3-ft by 3-ft by 1.5-ft concrete block acting as a base for the vent riser.
Two 8-in. diameter gage wells extending from the crib bottom to 3 ft above grade.
Two 2-ft by 2-ft by 1-ft concrete pads supporting the gage wells.
One concrete distribution box, 7 ft 4 in. by 5 ft 4 in.
One membrane barrier, 16,800 sq ft, between gravel and backfill.

SURVEILLANCE INFORMATION

SITE NAME: 216-A-37-1

SCHEDULE: Quarterly **LAST SURVEY DATE:** 3/89

AREA POSTING: Underground Radioactive Matl.
POSTING TYPE: Unknown

RESULTS:
No surface contamination detected and no change in activity since the last survey, 1/89.

CORRECTIVE ACTION:
No action required.

CAVE-IN POTENTIAL:
EXISTING CAVE-INS: None

PERCENTAGE OF VEGETATION COVER:
GRASS: 85-90% **DEEP ROOTED:** 10-15%
OTHER: **NO COVERAGE:**

3/14/90

Waste Information Data System
Radionuclide Inventory
(In Curies)

Site Name: 216-A-37-1
Operable Unit: 200-PO-4
Flagit:

Bibliography: [306]

H-3:	1580.00000	Sn-113:	.00738	U-233:	
C-14:		Sb-125:		U-234:	
Na-22:		I-129:	.00394	U-235:	
Mn-54:		Cs-134:		Np-237:	
Co-58:		Cs-137:	.09590	U-238:	
Fe-59:		Ce-141:		Pu-238:	
Co-60:		Ce-144:		Pu-239:	
Ni-63:		Pm-147:	.06620	Pu-240:	
Kr-85:		Eu-152:		Pu-241:	
Sr-90:	.05530	Eu-154:		Am-241:	
Zr-95:		Eu-155:		Pu-242:	
Tc-99:		Th-232:		Am-243:	
Ru-106:	.07630	U-233:		Cm-245:	

Inventory Total U:	0.00000
Inventory Total Pu:	0.00000
Total Reported Alpha:	.00831
Total Reported Beta:	.55400
Total Reported Gamma:	

These values are decayed through: December 31, 1988

Historical Waste Analysis Results of 242-A Evaporator Process Condensate. (sheet 1 of 4)

Parameter	N[b]	MDA[c]	Method[d]	Concentration[a] (ppb) Mean	StdErr[e]	90%CILim[f]	Maximum
Cladding Removal Waste Feed							
Aluminum	5	0	NA[g]	1.14 E+03	9.66 E+01	1.29 E+03	1.47 E+03
Barium	5	4	DL	6.00 E+00	2.13 E-07	6.00 E+00	6.00 E+00
Calcium	5	0	NA	4.97 E+03	1.15 E+03	6.74 E+03	7.88 E+03
Chloride	5	3	DL	6.23 E+02	8.51 E+01	7.54 E+02	9.32 E+02
Magnesium	5	4	DL	5.42 E+01	4.20 E+00	6.06 E+01	7.10 E+01
Mercury	5	0	NA	5.26 E-01	5.87 E-02	6.16 E-01	6.90 E-01
Potassium	5	0	NA	6.03 E+02	3.20 E+01	6.52 E+02	6.74 E+02
Uranium	5	0	NA	3.88 E-01	2.42 E-01	7.59 E-01	1.35 E+00
Zinc	5	4	DL	5.00 E+00	1.51 E-07	5.00 E+00	5.00 E+00
Acetone	5	0	NA	2.10 E+03	2.89 E+02	2.54 E+03	2.57 E+03
Ammonia	5	0	NA	6.41 E+05	1.12 E+05	8.12 E+05	1.00 E+06
Benzyl alcohol	3	0	NA	1.47 E+01	1.76 E+00	1.80 E+01	1.80 E+01
Butanal	4	0	NA	4.42 E+01	1.31 E+01	6.57 E+01	7.60 E+01
1-Butanol (butyl alcohol)	5	0	NA	4.60 E+04	1.90 E+04	7.51 E+04	8.80 E+04
2-Butoxyethanol	5	0	NA	5.52 E+02	1.09 E+02	7.20 E+02	8.40 E+02
Butoxyglycol	5	0	NA	2.77 E+02	6.95 E+01	3.84 E+02	5.40 E+02
3,5-Dimethylpyridine	3	0	NA	2.07 E+01	2.03 E+00	2.45 E+01	2.40 E+01
2-Hexanone (methyl n-butyl ketone)	4	0	NA	9.25 E+00	1.11 E+00	1.11 E+01	1.10 E+01
Methyl ethyl ketone (2-Butanone)	5	0	NA	7.16 E+01	1.04 E+01	8.76 E+01	9.00 E+01
MIBK (hexone)	3	0	NA	4.33 E+00	3.33 E-01	4.96 E+00	5.00 E+00
2-Pentanone (methyl n-propyl ketone)	4	0	NA	8.75 E+00	1.25 E+00	1.08 E+01	1.20 E+01
2-Propanol	1	0	NA	3.90 E+01	NA	NA	3.90 E+01
Tetradecane	4	0	NA	1.92 E+01	3.61 E+00	2.52 E+01	2.60 E+01
Tetrahydrofuran	5	0	NA	1.50 E+01	1.48 E+00	1.73 E+01	1.80 E+01
Tributylphosphate	5	0	NA	3.59 E+03	1.28 E+03	5.55 E+03	6.80 E+03
Tridecane	4	0	NA	1.27 E+01	2.06 E+00	1.61 E+01	1.80 E+01
Unknown	3	0	NA	4.40 E+01	1.30 E+01	6.85 E+01	6.60 E+01
Alpha activity (pCi/L)	2	0	NA	2.15 E-01	6.30 E-02	4.09 E-01	2.78 E-01
Beta activity (pCi/L)	5	0	NA	3.86 E+02	1.88 E+02	6.73 E+02	1.09 E+03
Conductivity (µS)	5	0	NA	3.18 E+02	3.73 E+01	3.75 E+02	4.20 E+02
pH (dimensionless)	5	0	NA	1.05 E+01	5.10 E-02	1.06 E+01	1.07 E+01
Temperature (°C)	2	0	NA	3.33 E+01	3.40 E+00	4.38 E+01	3.67 E+01
TOC	5	0	NA	4.38 E+04	8.91 E+03	5.75 E+04	6.25 E+04
Linking Run Feed							
Aluminum	12	1	LM	5.99 E+02	1.22 E+02	7.65 E+02	1.65 E+03
Barium	12	11	DL	6.00 E+00	1.17 E-07	6.00 E+00	6.00 E+00
Cadmium	12	11	DL	2.25 E+00	2.50 E-01	2.59 E+00	5.00 E+00
Calcium	12	0	NA	2.04 E+03	3.45 E+02	2.51 E+03	4.37 E+03
Chloride	12	10	DL	5.94 E+02	6.50 E+01	6.83 E+02	1.17 E+03
Copper	12	8	LM	1.11 E+01	5.89 E+00	1.92 E+01	7.30 E+01
Fluoride	7	6	DL	2.21 E+01	2.14 E+00	2.52 E+01	3.50 E+01
Iron	12	7	DL	5.46 E+01	1.07 E+01	6.92 E+01	1.56 E+02
Magnesium	12	1	LM	5.17 E+02	3.28 E+02	9.64 E+02	4.03 E+03
Mercury	12	3	LM	2.22 E-01	3.36 E-02	2.68 E-01	4.80 E-01
Nickel	12	9	DL	1.12 E+01	7.26 E-01	1.22 E+01	1.70 E+01
Nitrate	12	8	LM	9.83 E+02	5.10 E+02	1.68 E+03	4.98 E+03
Potassium	12	1	LM	4.07 E+02	1.28 E+02	5.81 E+02	1.71 E+03
Sodium	12	1	LM	2.87 E+03	2.08 E+03	5.71 E+03	2.56 E+04
Sulfate	12	5	LM	2.04 E+03	1.10 E+03	3.54 E+03	1.30 E+04
Sulfide	12	10	DL	6.73 E+03	5.36 E+03	1.40 E+04	6.56 E+04
Uranium	12	2	MR	1.54 E-01	4.33 E-02	2.13 E-01	4.75 E-01

Historical Waste Analysis Results of 242-A Evaporator Process Condensate. (sheet 2 of 4)

Parameter	N[b]	MDA[c]	Method[d]	Mean	StdErr[e]	90%CILim[f]	Maximum
				Concentration[a] (ppb)			
Vanadium	12	11	DL	5.00 E+00	1.17 E-07	5.00 E+00	5.00 E+00
Zinc	12	6	LM	7.33 E+00	2.89 E+00	1.13 E+01	3.40 E+01
Acetone	11	0	NA	1.10 E+03	4.29 E+02	1.69 E+03	5.10 E+03
Ammonia	12	0	NA	7.55 E+04	2.25 E+04	1.06 E+05	2.50 E+05
Benzaldehyde	1	0	NA	2.30 E+01	NA	NA	2.30 E+01
Benzyl alcohol	1	0	NA	1.00 E+01	NA	NA	1.00 E+01
Butanal	4	0	NA	1.20 E+02	5.25 E+01	2.06 E+02	2.30 E+02
1-Butanol (butyl alcohol)	10	0	NA	3.99 E+02	1.37 E+02	5.89 E+02	1.13 E+03
Butoxydiglycol	1	0	NA	1.10 E+01	NA	NA	1.10 E+01
2-Butoxyethanol	10	0	NA	4.82 E+02	1.08 E+02	6.33 E+02	9.20 E+02
Butoxyglycol	6	0	NA	8.48 E+01	1.36 E+01	1.05 E+02	1.30 E+02
Dodecane	2	0	NA	4.30 E+01	3.00 E+00	5.22 E+01	4.60 E+01
Ethoxytriethylene glycol	1	0	NA	1.50 E+02	NA	NA	1.50 E+02
Heptadecane	1	0	NA	1.80 E+01	NA	NA	1.80 E+01
Hexadecane	1	0	NA	1.70 E+01	NA	NA	1.70 E+01
Hexanoic acid	1	0	NA	7.00 E+01	NA	NA	7.00 E+01
2-Hexanone (methyl n-butyl ketone)	5	0	NA	1.12 E+01	2.60 E+00	1.52 E+01	2.00 E+01
Methyl ethyl ketone (2-Butanone)	12	5	LM	4.17 E+01	1.21 E+01	5.83 E+01	1.20 E+02
Methoxydiglycol	1	0	NA	2.80 E+01	NA	NA	2.80 E+01
Methoxytriglycol	1	0	NA	3.70 E+02	NA	NA	3.70 E+02
MIBK (hexone)[g]	7	1	DL	1.46 E+01	8.95 E+00	2.75 E+01	6.80 E+01
N-Nitrosodimethylamine	12	11	DL	1.39 E+01	3.92 E+00	1.93 E+01	5.70 E+01
Pentadecane	1	0	NA	2.00 E+01	NA	NA	2.00 E+01
2-Pentanone (methyl n-propyl ketone)	4	0	NA	9.75 E+00	9.46 E-01	1.13 E+01	1.10 E+01
Phenol	12	11	DL	1.19 E+01	1.92 E+00	1.45 E+01	3.30 E+01
2-Propanol	2	0	NA	1.60 E+01	6.00 E+00	3.45 E+01	2.20 E+01
Pyridine	12	11	DL	5.04 E+02	4.17 E+00	5.10 E+02	5.50 E+02
Tetradecane	9	0	NA	1.16 E+02	5.17 E+01	1.88 E+02	4.40 E+02
Tetrahydrofuran	6	0	NA	1.98 E+01	2.94 E+00	2.42 E+01	3.00 E+01
Tributylphosphate	11	0	NA	3.30 E+03	1.81 E+03	5.79 E+03	2.06 E+04
Tridecane	9	0	NA	1.01 E+02	4.51 E+01	1.64 E+02	3.50 E+02
Triglyme	1	0	NA	9.00 E+01	NA	NA	9.00 E+01
Alpha activity (pCi/L)	10	0	LM	7.52 E-01	1.55 E-01	9.69 E-01	1.62 E+00
Beta activity (pCi/L)[h]	12	1	DL	1.29 E+03	4.51 E+02	1.90 E+03	4.34 E+03
Conductivity (µS)	12	0	NA	1.56 E+02	3.44 E+01	2.03 E+02	4.70 E+02
pH (dimensionless)	12	0	NA	9.42 E+00	2.19 E-01	9.72 E+00	1.04 E+01
Temperature (°C)	7	0	NA	2.66 E+01	3.12 E+00	3.11 E+01	3.90 E+01
TOC	12	1	LM	1.76 E+04	5.42 E+03	2.50 E+04	5.61 E+04
Ammonia Scrubber Feed							
Aluminum	10	1	LM	9.44 E+02	1.44 E+02	1.15 E+03	1.77 E+03
Arsenic (EP toxic)	2	2	NA	<5.00 E+01	0.00 E+00	<5.00 E+01	<5.00 E+01
Barium	10	8	DL	6.30 E+00	2.13 E-01	6.60 E+00	8.00 E+00
Barium (EP toxic)	2	0	NA	2.31 E+02	5.00 E-01	2.33 E+02	2.32 E+02
Boron	4	3	DL	1.07 E+01	7.50 E-01	1.20 E+01	1.30 E+01
Cadmium (EP toxic)	2	2	NA	<1.00 E+01	0.00 E+00	<1.00 E+01	<1.00 E+01
Calcium	10	0	NA	3.46 E+03	6.91 E+02	4.42 E+03	8.32 E+03
Chloride	10	7	DL	7.00 E+02	1.79 E+02	9.48 E+02	2.30 E+03
Chromium (EP toxic)	2	2	NA	<5.00 E+01	0.00 E+00	<5.00 E+01	<5.00 E+01
Copper	10	9	DL	1.02 E+01	2.00 E-01	1.05 E+01	1.20 E+01
Fluoride[h]	10	4	DL	1.47 E+02	1.03 E+02	2.91 E+02	1.07 E+03
Iron	10	6	LM	2.77 E+01	5.65 E+00	3.55 E+01	6.70 E+01
Lead (EP toxic)	2	2	NA	<5.00 E+01	0.00 E+00	<5.00 E+01	<5.00 E+01

Historical Waste Analysis Results of 242-A Evaporator Process Condensate. (sheet 3 of 4)

Parameter	N[b]	MDA[c]	Method[d]	Mean	StdErr[e]	90%CILim[f]	Maximum
				Concentration[a] (ppb)			
Magnesium	10	8	DL	1.20 E+02	6.98 E+01	2.17 E+02	7.48 E+02
Manganese	10	9	DL	5.00 E+00	1.01 E-07	5.00 E+00	5.00 E+00
Mercury	10	4	LM	1.79 E-01	5.11 E-02	2.50 E-01	5.60 E-01
Mercury (EP toxic)	2	2	NA	<1.00 E+01	0.00 E+00	<1.00 E+01	<1.00 E+01
Nickel	10	9	DL	1.04 E+01	4.00 E-01	1.10 E+01	1.40 E+01
Postassium	10	0	NA	5.11 E+03	2.02 E+03	7.92 E+03	1.57 E+04
Selenium (EP toxic)	2	2	NA	<5.00 E+01	0.00 E+00	<5.00 E+01	<5.00 E+01
Silicon	4	0	NA	6.72 E+03	9.11 E+02	8.22 E+03	9.40 E+03
Silver (EP toxic)	2	2	NA	5.00 E+01	0.00 E+00	<5.00 E+01	<5.00 E+01
Sodium	10	0	NA	4.02 E+03	3.25 E+03	8.55 E+03	3.32 E+04
Strontium	10	6	DL	1.85 E+00	1.81 E+01	2.10 E+01	3.00 E+01
Sulfate	10	0	NA	2.01 E+03	2.75 E+02	2.40 E+03	3.90 E+03
Uranium	10	4	MR	5.43 E-01	2.42 E-01	8.80 E-01	2.03 E+00
Vanadium	10	7	DL	5.50 E+00	2.69 E-01	5.87 E+00	7.00 E+00
Zinc	10	5	LM	6.33 E+00	1.49 E+00	8.41 E+00	1.70 E+01
Acetone	9	0	NA	1.03 E+03	1.70 E+02	1.27 E+03	2.16 E+03
Ammonia	10	0	NA	8.20 E+05	1.82 E+05	1.07 E+06	2.19 E+06
Benzyl alcohol[h]	8	4	DL	1.19 E+01	1.09 E+00	1.34 E+01	1.70 E+01
Butanal	3	0	NA	8.67 E+00	2.33 E+00	1.31 E+01	1.30 E+01
1-Butanol (butyl alcohol)	9	0	NA	2.84 E+04	1.29 E+04	4.64 E+04	1.21 E+05
Butoxydiglycol	1	0	NA	2.70 E+01	NA	NA	2.70 E+01
2-Butoxyethanol	6	0	NA	2.89 E+02	7.74 E+01	4.03 E+02	4.90 E+02
Butoxyglycol	6	0	NA	1.88 E+02	4.48 E+01	2.54 E+02	3.60 E+02
Butoxytriethyleneglycol	1	0	NA	3.50 E+01	NA	NA	3.50 E+01
Ethanol	1	0	NA	2.00 E+00	NA	NA	2.00 E+00
2-Hexanone (methyl n-butyl alcohol)	6	3	DL	3.20 E+01	1.31 E+01	5.13 E+01	7.90 E+01
Methyl ethyl ketone (2-Butanone)	10	1	LM	3.38 E+01	7.56 E+00	4.43 E+01	9.30 E+01
2-Methylnonane	2	0	NA	1.55 E+01	1.50 E+00	2.01 E+01	1.70 E+01
2-Propanol	3	0	NA	1.90 E+01	4.51 E+00	2.75 E+01	2.40 E+01
Tetradecane	6	0	NA	1.40 E+01	2.62 E+00	1.79 E+01	2.50 E+01
Tetrahydrofuran	9	0	NA	2.92 E+01	7.85 E+00	4.02 E+01	8.10 E+01
Tributylphosphate	13	2	LM	3.95 E+03	9.39 E+02	5.22 E+03	1.01 E+04
Tridecane	6	0	NA	1.27 E+01	3.57 E+00	1.79 E+01	2.80 E+01
Unknown	9	0	NA	2.88 E+02	1.29 E+02	4.69 E+02	1.13 E+03
Unknown aliphatic HC	1	0	NA	1.20 E+01	NA	NA	1.20 E+01
Alpha activity (pCi/L)	8	6	DL	3.72 E-01	1.05 E-01	5.20 E-01	1.01 E+00
Beta activity (pCi/L)	10	0	NA	4.11 E+03	1.41 E+03	6.07 E+03	1.25 E+04
Conductivity (µS)	10	0	NA	3.19 E+02	4.49 E+01	3.82 E+02	5.90 E+02
pH (dimensionless)	10	0	NA	1.05 E+01	2.31 E-01	1.08 E+01	1.13 E+01
TDS	2	0	NA	2.25 E+04	1.50 E+03	2.71 E+04	2.40 E+04
Temperature (°C)	6	0	NA	2.76 E+01	2.31 E+00	3.10 E+01	3.49 E+01
TOC	10	0	NA	2.70 E+04	6.87 E+03	3.66 E+04	7.85 E+04
Salt well feed							
Aluminum	4	0	NA	5.93 E+02	2.43 E+01	6.33 E+02	6.42 E+02
Calcium	4	0	NA	3.65 E+02	3.43 E+01	4.21 E+02	4.47 E+02
Mercury	4	0	NA	1.83 E-01	1.97 E-02	2.15 E-01	2.30 E-01
Nickel	4	3	DL	1.07 E+01	7.50 E-01	1.20 E+01	1.30 E+01
Potassium	4	0	NA	4.81 E+03	2.62 E+02	5.24 E+03	5.28 E+03
Sodium	4	0	NA	1.74 E+03	4.27 E+02	2.44 E+03	2.73 E+03
Zinc	4	1	DL	1.55 E+01	9.51 E+00	3.11 E+01	4.40 E+01
Acetone	4	0	NA	8.00 E+02	1.49 E+02	1.04 E+03	1.20 E+03
Ammonia	4	0	NA	7.97 E+04	8.04 E+03	9.29 E+04	8.89 E+04
Benzyl alcohol	1	0	NA	1.10 E+01	NA	NA	1.10 E+01
Butanal	3	0	NA	3.10 E+01	7.23 E+00	4.46 E+01	4.30 E+01

Historical Waste Analysis Results of 242-A Evaporator Process Condensate. (sheet 4 of 4)

Parameter	N[b]	MDA[c]	Method[d]	Concentration[a] (ppb) Mean	StdErr[e]	90%CILim[f]	Maximum
1-Butanol (butyl alcohol)	4	0	NA	3.90 E+02	6.43 E+01	4.95 E+02	5.25 E+02
2-Butoxyethanol	4	0	NA	7.17 E+01	1.22 E+01	9.17 E+01	9.80 E+01
Butoxyglycol	4	0	NA	7.02 E+02	4.99 E+01	7.83 E+02	8.06 E+02
Ethoxytriethylene glycol	3	0	NA	8.20 E+01	2.57 E+01	1.30 E+02	1.20 E+02
2-Hexanone (methyl n-butyl ketone)	4	0	NA	6.25 E+00	1.31 E+00	8.40 E+00	1.00 E+01
Methoxydiglycol	1	0	NA	5.20 E+01	NA	NA	5.20 E+01
Methoxytriglycol	1	0	NA	6.50 E+01	NA	NA	6.50 E+01
Methyl ethyl ketone (2-Butanone)	4	0	NA	3.25 E+01	3.84 E+00	3.88 E+01	4.40 E+01
MIBK (hexone)	1	0	NA	8.00 E+00	NA	NA	8.00 E+00
2-Propanol	4	0	NA	2.35 E+01	5.55 E+00	3.26 E+01	3.40 E+01
Tetradecane	4	0	NA	1.38 E+02	6.60 E+01	2.46 E+02	3.20 E+02
Tetrahydrofuran	4	0	NA	1.07 E+02	2.74 E+01	1.52 E+02	1.70 E+02
Tributylphosphate	4	0	NA	3.64 E+03	9.53 E+02	5.21 E+03	6.15 E+03
Tridecane	4	0	NA	1.45 E+02	6.52 E+01	2.52 E+02	3.00 E+02
Unknown	4	0	NA	4.47 E+01	2.46 E+00	4.88 E+01	5.10 E+01
Beta activity (pCi/L)	4	0	NA	1.27 E+03	1.36 E+02	1.50 E+03	1.61 E+03
Conductivity (µS)	4	0	NA	8.32 E+01	2.17 E+00	8.68 E+01	8.70 E+01
pH (dimensionless)	4	0	NA	1.01 E+01	4.75 E-02	1.01 E+01	1.01 E+01
TOC	4	0	NA	2.36 E+04	2.22 E+03	2.72 E+04	2.97 E+04
TOX (as Cl)	4	3	DL	1.15 E+01	7.98 E+00	2.46 E+01	3.50 E+01

[a] Concentration in ppb (parts per billion) except where noted.
[b] N - Number of samples analyzed.
[c] MDA - Number of samples with results below the detection limit.
[d] Method - Replacement method for results below the detection limit:
DL -- replacement by detection limit
LM -- replacement by lognormal plotting position
MR -- replacement by normal plotting position
[e] StdErr - Standard error.
[f] 90%CILim - 90% confidence internal limit. Defined as upper limit of one-tailed 90% confidence interval.
[g] NA - Not applicable.
[h] At least one reported measurement is less than the reported detection limit for data set.

(Geary 1990, p. 3-3 to 3-9)

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APPENDIX B

GEOLOGIC AND WELL CONSTRUCTION DIAGRAMS

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Rodda
Drilling Company: Bach Drilling
Date Started: 28Apr48

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 25May48

WELL NUMBER: 299-E26-1
TEMPORARY WELL NO: 361-B-11
Hanford Coordinates: N/S N 44,774 E/W W 48,025
State Coordinates: N 449,953 E 2,247,185
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 615.5 Estimated

Depth to water: 205.5 ft Jun89
(Ground Surface)

GENERALIZED STRATIGRAPHY — Driller's Log

0-2: Sandy LOAM
2-15: SAND and GRAVEL
15-30: GRAVEL and BOULDERS
30-40: SAND, GRAVEL and BOULDERS
40-45: SAND
45-60: SAND, GRAVEL and BOULDERS
60-65: SAND and GRAVEL
65-80: SAND, GRAVEL and BOULDERS
80-85: Coarse SAND and GRAVEL
85-95: SAND, GRAVEL and BOULDERS
95-131: SAND and CLAY
131-138: Coarse SAND and fine GRAVEL
138-140: Hard fine SAND
140-145: SAND, GRAVEL and BOULDERS
145-155: SAND
155-165: SAND and GRAVEL
165-175: SAND, GRAVEL and BOULDERS
175-180: SAND and GRAVEL
180-185: GRAVEL and BOULDERS
185-190: Fine SAND
190-195: SAND and GRAVEL
195-201: SAND, GRAVEL and BOULDERS
201-205: SAND and GRAVEL
205-209: SAND
209-210: SAND, GRAVEL and BOULDERS
210-218: SAND
218-225: Coarse SAND and fine GRAVEL
225-231: Red-brown volcanic ASH
231-240: Dark BED ROCK
240-245: Black SAND and fine ground ROCK
245-248: BASALT

Elevation of reference point: [617.25 ft]
(top of casing)
Height of reference point above ground surface [1.75 ft]

Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]

I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
Depth top of perforations: [217 ft]
5 holes/ft
Depth bottom of perforations: [227 ft]
Depth bottom of casing: [229 ft]
Depth bottom of borehole: [248 ft]

Drawing By: RKL\2#E26-01.ASB Date: 02May90

Reference: Field Inspection Report, 07Feb90
Golder 8831752\14114

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Baker
Drilling Company: Not documented
Date Started: 03Jun48

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 23Jun48

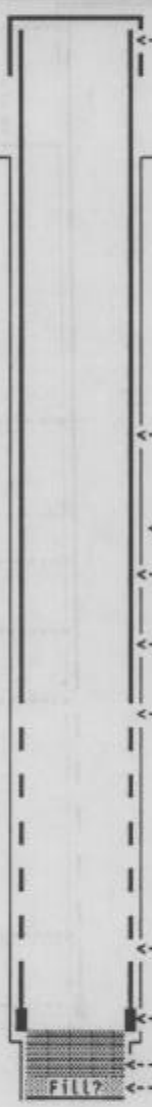
WELL NUMBER: 699-45-42
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 45,274 E/W W 42,099
State Coordinates: N 450,468 E 2,253,110
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: 159 ft Jun89 TOC*
*TOC = Top of casing

GENERALIZED STRATIGRAPHY — Driller's Log

0-16: SAND and BOULDERS
16-30: BOULDERS
30-35: SAND and GRAVEL
35-40: SAND
40-55: SAND and small GRAVEL
55-90: SAND, GRAVEL with some CLAY
90-95: SAND with some CLAY
95-120: SAND and SILT
120-125: SAND, GRAVEL and SILT
125-126: SAND and GRAVEL
126-132: BOULDERS
132-140: SAND and SILT
140-141: SAND and BOULDERS
141-143: GRAVEL and BOULDERS
143-145: SAND and GRAVEL
145-150: SAND and BOULDERS
150-160: SAND and coarse GRAVEL
160-165: SAND, CLAY and GRAVEL
165-180: SAND and a lot of CLAY
180-189: Volcanic ASH
189-190: Volcanic ASH and ROCK
190-195: Volcanic ASH and BASALT
195 : Black BASALT

NOTE: Remediation Nov75 by Bultena. Cleaned well to 193 ft and installed cement plug to 188 ft.



Elevation of reference point: (top of casing) [577.33 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
Depth top of perforations: [158 ft]
6 holes/ft
Depth bottom of perforations: [180 ft]
Depth bottom of casing: [187 ft]
Cement plug 188-193 ft
Depth bottom of borehole: [195 ft]

Drawing By: RKL\6#45-42.ASB Date: 02May90
Reference: Golder 8831752\14114

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APPENDIX C

WATER-CHEMISTRY DATA LISTINGS AND SUMMARIES

This appendix presents all water-chemistry data available from the existing wells in the vicinity of the 200 East Area Liquid Effluent Retention Facility. The results of the analyses of the ground water from these wells are listed in Table C-1. Less than flags indicate levels below detection limits.

Regulatory agency guidelines are based on the following:

- U.S. Environmental Protection Agency (EPA) - maximum contaminant levels given in 40 CFR 141 (July 1987) *National Primary Drinking Water Regulations* as amended by 52 FR 25690.
- EPA - *Proposed Maximum Containment Goals* in 50 FR 46936.
- U.S. Department of Energy (DOE) - DOE derived concentration guides, DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (DOE 1990).

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 1 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
2-E26-1	3/30/87	Cesium-137	PCI/L		6.20	20.00	200.00	EPAR
2-E26-1	3/30/87	Cobalt-60	PCI/L			22.50	100.00	EPAR
2-E26-1	3/30/87	Nitrate	PPB	<	500.00	500.00	45000.00	EPA
2-E26-1	3/30/87	Ruthenium-106	PCI/L	<	17.60	172.50	30.00	EPAR
2-E26-1	3/30/87	Tritium	PCI/L		10300.00	500.00	20000.00	EPA
2-E26-1	6/16/87	1,1,1-trichloroethane	PPB	<	10.00	5.00	200.00	EPA
2-E26-1	6/16/87	1,1,2-trichloroethane	PPB	<	10.00	5.00		
2-E26-1	6/16/87	1,2,3,4-tetrachlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,2,3,5-tetrachlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,2,3-trichlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,2,4,5-tetrachlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,2,4-trichlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,2-dichlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,3,5-trichlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,3-dichlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Alkalinity			94200.00	20000.00		
2-E26-1	6/16/87	Aluminum, filtered	PPB	<	150.00	150.00		
2-E26-1	6/16/87	Ammonium ion	PPB		63.00	50.00		
2-E26-1	6/16/87	Antimony, filtered	PPB	<	100.00	100.00		
2-E26-1	6/16/87	Arsenic, filtered	PPB	<	5.00	5.00	50.00	EPA
2-E26-1	6/16/87	Barium, filtered	PPB		23.00	6.00	1000.00	EPA
2-E26-1	6/16/87	Beryllium, filtered	PPB	<	5.00	5.00		
2-E26-1	6/16/87	Cadmium, filtered	PPB	<	2.00	2.00	10.00	EPA
2-E26-1	6/16/87	Calcium, filtered	PPB		29000.00	50.00		
2-E26-1	6/16/87	Carbon Tetrachloride by GC/MS	PPB	<	10.00	5.00	5.00	EPA
2-E26-1	6/16/87	Chloride	PPB		6900.00	500.00	250000.00	EPAS
2-E26-1	6/16/87	Chloroform	PPB	<	10.00	5.00	100.00	EPA
2-E26-1	6/16/87	Chromium, filtered	PPB	<	10.00	10.00	50.00	EPA
2-E26-1	6/16/87	Copper, filtered	PPB	<	10.00	10.00	1300.00	EPAP
2-E26-1	6/16/87	Cyanide	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Fluoride	PPB	<	500.00	500.00	4000.00	EPA
2-E26-1	6/16/87	Gross alpha	PCI/L		1.09	4.00	15.00	EPA
2-E26-1	6/16/87	Gross beta	PCI/L		9.14	8.00	50.00	EPA
2-E26-1	6/16/87	Hexachlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Hexachlorophene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Hydrazine, Low Detection Level	PPB	<	30.00	30.00		
2-E26-1	6/16/87	Iron, filtered	PPB	<	50.00	30.00	300.00	EPAS
2-E26-1	6/16/87	Kerosene	PPB	<	10000.00	10000.00		
2-E26-1	6/16/87	Lead, filtered	PPB	<	5.00	5.00	50.00	EPA
2-E26-1	6/16/87	Magnesium, filtered	PPB		8820.00	50.00		
2-E26-1	6/16/87	Manganese, filtered	PPB	<	5.00	5.00	50.00	EPAS
2-E26-1	6/16/87	Mercury, filtered	PPB	<	0.10	0.10	2.00	EPA
2-E26-1	6/16/87	Methyl ethyl ketone	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Methylene Chloride	PPB	<	10.00	5.00		
2-E26-1	6/16/87	Naphthalene	PPB	<	10.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 2 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
2-E26-1	6/16/87	Nickel, filtered	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Nitrate	PPB		5090.00	500.00	45000.00	EPA
2-E26-1	6/16/87	Osmium, filtered	PPB	<	300.00	300.00		
2-E26-1	6/16/87	Pentachlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Phenol	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Phosphate	PPB	<	1000.00	1000.00		
2-E26-1	6/16/87	Potassium, filtered	PPB		5880.00	100.00		
2-E26-1	6/16/87	Selenium, filtered	PPB	<	5.00	5.00	10.00	EPA
2-E26-1	6/16/87	Silver, filtered	PPB	<	10.00	10.00	50.00	EPA
2-E26-1	6/16/87	Sodium, filtered	PPB		9450.00	200.00		
2-E26-1	6/16/87	Strontium, filtered	PPB	<	300.00	10.00		
2-E26-1	6/16/87	Sulfate	PPB		29900.00	500.00	250000.00	EPAS
2-E26-1	6/16/87	Tetrachloroethylene	PPB	<	10.00	5.00		
2-E26-1	6/16/87	Total Organic Halogen, Low Det. Level	PPB	<	6.30	10.00		
2-E26-1	6/16/87	Total organic carbon	PPB	<	382.00	2000.00		
2-E26-1	6/16/87	Trichloroethylene	PPB	<	10.00	5.00	5.00	EPA
2-E26-1	6/16/87	Tritium	PCI/L		16600.00	500.00	20000.00	EPA
2-E26-1	6/16/87	Vanadium, filtered	PPB		11.00	5.00		
2-E26-1	6/16/87	Xylene-m	PPB	<	10.00	5.00	440.00	EPAP
2-E26-1	6/16/87	Xylene-o,p	PPB	<	10.00	5.00	440.00	EPAP
2-E26-1	6/16/87	Zinc, filtered	PPB	<	5.00	5.00	5000.00	EPAS
2-E26-1	6/16/87	p-Dichlorobenzene	PPB	<	10.00	10.00	75.00	EPA
2-E26-1	6/16/87	pH, Laboratory Measurement			7.72	0.01	8.50	EPAS
2-E26-1	8/05/87	Cesium-137	PCI/L	<	3.52	20.00	200.00	EPAR
2-E26-1	8/05/87	Cobalt-60	PCI/L	<	1.02	22.50	100.00	EPAR
2-E26-1	8/05/87	Ruthenium-106	PCI/L	<	2.77	172.50	30.00	EPAR
2-E26-1	8/05/87	Tritium	PCI/L		17200.00	500.00	20000.00	EPA
2-E26-1	3/01/88	Nitrate, High Detection Level	PPB	<	2500.00	2500.00	45000.00	EPA
2-E26-1	3/01/88	Tritium	PCI/L		16700.00	500.00	20000.00	EPA
2-E26-1	8/29/88	Iodine-129 (Drinking Water Standard)	PCI/L		0.28	1.00	1.00	EPAR
2-E26-1	8/29/88	Nitrate, High Detection Level	PPB	<	2500.00	2500.00	45000.00	EPA
2-E26-1	8/29/88	Tritium	PCI/L		15200.00	500.00	20000.00	EPA
2-E26-1	11/07/88	Alkalinity			75100.00	20000.00		
2-E26-1	11/07/88	Ammonium ion	PPB	<	50.00	50.00		
2-E26-1	11/07/88	Chloride	PPB		6100.00	500.00	250000.00	EPAS
2-E26-1	11/07/88	Cyanide	PPB	<	10.00	10.00		
2-E26-1	11/07/88	Fluoride	PPB	<	500.00	500.00	4000.00	EPA
2-E26-1	11/07/88	Nitrate	PPB	<	500.00	500.00	45000.00	EPA
2-E26-1	11/07/88	Phosphate	PPB	<	1000.00	1000.00		
2-E26-1	11/07/88	Specific conductance	UMHO		173.00	1.00	700.00	WDOE
2-E26-1	11/07/88	Sulfate	PPB		18900.00	500.00	250000.00	EPAS
2-E26-1	11/07/88	Total carbon	PPB		16100.00	1000.00		
2-E26-1	11/07/88	Total organic carbon	PPB	<	300.00	2000.00		
2-E26-1	11/07/88	pH, Field Measurement			8.30	0.10	8.50	EPAS
2-E26-1	11/07/88	pH, Laboratory Measurement			8.30	0.01	8.50	EPAS

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 3 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
2-E26-1	6/06/89	Iodine-129 (Drinking Water Standard)	PCI/L		0.40	1.00	1.00	EPAR
2-E26-1	6/06/89	Nitrate, High Detection Level	PPB	<	2500.00	2500.00	45000.00	EPA
2-E26-1	6/06/89	Tritium	PCI/L		12700.00	500.00	20000.00	EPA
6-45-42	2/28/87	Cesium-137	PCI/L	<	3.85	20.00	200.00	EPAR
6-45-42	2/28/87	Cobalt-60	PCI/L	<	2.10	22.50	100.00	EPAR
6-45-42	2/28/87	Nitrate	PPB		7970.00	500.00	45000.00	EPA
6-45-42	2/28/87	Ruthenium-106	PCI/L		72.00	172.50	30.00	EPAR
6-45-42	2/28/87	Tritium	PCI/L		51800.00	500.00	20000.00	EPA
6-45-42	6/11/87	Cesium-137	PCI/L	<	1.13	20.00	200.00	EPAR
6-45-42	6/11/87	Cobalt-60	PCI/L			22.50	100.00	EPAR
6-45-42	6/11/87	Nitrate	PPB		7350.00	500.00	45000.00	EPA
6-45-42	6/11/87	Ruthenium-106	PCI/L		63.40	172.50	30.00	EPAR
6-45-42	6/11/87	Tritium	PCI/L		53000.00	500.00	20000.00	EPA
6-45-42	8/04/87	Cesium-137	PCI/L	<	3.79	20.00	200.00	EPAR
6-45-42	8/04/87	Cobalt-60	PCI/L	<	1.70	22.50	100.00	EPAR
6-45-42	8/04/87	Nitrate, High Detection Level	PPB		6510.00	2500.00	45000.00	EPA
6-45-42	8/04/87	Ruthenium-106	PCI/L	<	3.01	172.50	30.00	EPAR
6-45-42	8/04/87	Tritium	PCI/L		54100.00	500.00	20000.00	EPA
6-45-42	9/15/87	Cesium-137	PCI/L	<	9.83	20.00	200.00	EPAR
6-45-42	9/15/87	Cobalt-60	PCI/L	<	2.10	22.50	100.00	EPAR
6-45-42	9/15/87	Gross alpha	PCI/L		1.71	4.00	15.00	EPA
6-45-42	9/15/87	Gross beta	PCI/L		4.01	8.00	50.00	EPA
6-45-42	9/15/87	Natural uranium	UG/L		1.85	0.73		
6-45-42	9/15/87	Plutonium-238	PCI/L		0.02	17.00	1.60	DOE
6-45-42	9/15/87	Plutonium-239/40	PCI/L	<	0.01	17.00	1.20	DOE
6-45-42	9/15/87	Ruthenium-106	PCI/L	<	72.30	172.50	30.00	EPAR
6-45-42	9/15/87	Strontium-90	PCI/L	<	0.10	5.00	8.00	EPA
6-45-42	9/15/87	Tritium	PCI/L		52600.00	500.00	20000.00	EPA
6-45-42	9/15/87	Uranium-234	PCI/L		1.14	0.10	20.00	DOE
6-45-42	9/15/87	Uranium-235	PCI/L		0.04	0.10	24.00	DOE
6-45-42	9/15/87	Uranium-238	PCI/L		0.86	0.10	24.00	DOE
6-45-42	10/14/87	Cesium-137	PCI/L	<	2.56	20.00	200.00	EPAR
6-45-42	10/14/87	Cobalt-60	PCI/L	<	4.05	22.50	100.00	EPAR
6-45-42	10/14/87	Gross alpha	PCI/L		1.81	4.00	15.00	EPA
6-45-42	10/14/87	Gross beta	PCI/L		4.75	8.00	50.00	EPA
6-45-42	10/14/87	Natural uranium	UG/L		2.54	0.73		
6-45-42	10/14/87	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	10/14/87	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	10/14/87	Ruthenium-106	PCI/L	<	5.37	172.50	30.00	EPAR
6-45-42	10/14/87	Strontium-90	PCI/L	<	0.27	5.00	8.00	EPA
6-45-42	10/14/87	Tritium	PCI/L		52900.00	500.00	20000.00	EPA
6-45-42	10/14/87	Uranium-234	PCI/L		1.07	0.10	20.00	DOE
6-45-42	10/14/87	Uranium-235	PCI/L		0.03	0.10	24.00	DOE
6-45-42	10/14/87	Uranium-238	PCI/L		0.88	0.10	24.00	DOE
6-45-42	11/15/87	1,1,1,2-tetrachlorethane	PPB	<	10.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 4 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	1,1,1-trichloroethane	PPB	<	5.00	5.00	200.00	EPA
6-45-42	11/15/87	1,1,2,2-tetrachlorethane	PPB	<	10.00	5.00		
6-45-42	11/15/87	1,1,2-trichloroethane	PPB	<	5.00	5.00		
6-45-42	11/15/87	1,1-dichloroethane	PPB	<	10.00	5.00		
6-45-42	11/15/87	1,1-dichloroethylene	PPB	<	10.00	10.00	7.00	EPA
6-45-42	11/15/87	1,2,3,4-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2,3,5-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2,3-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2,3-trichloropropane	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2,4,5-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2,4-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2-dibromo-3-chloropropane	PPB	<	10.00	10.00		EPAP
6-45-42	11/15/87	1,2-dibromoethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2-dichloroethane	PPB	<	10.00	5.00	5.00	EPA
6-45-42	11/15/87	1,2-dichloropropane	PPB	<	10.00	5.00	6.00	EPAP
6-45-42	11/15/87	1,2-diphenylhydrazine	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,3,5-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,3-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,3-dichloropropene	PPB	<	10.00	5.00		
6-45-42	11/15/87	1,4-dichloro-2-butene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,4-naphthoquinone	PPB	<	10.00	10.00		
6-45-42	11/15/87	1-chloro-2,3-epoxypropane	PPB	<	10.00	10.00		EPAP
6-45-42	11/15/87	1-naphthylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,3,4,6-tetrachlorophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,4,5-trichlorophenol	PPB	<	50.00	10.00		
6-45-42	11/15/87	2,4,6-trichlorophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,4-dichlorophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,4-dimethylphenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,4-dinitrophenol	PPB	<	50.00	10.00		
6-45-42	11/15/87	2,4-dinitrotoluene	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,6-dichlorophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,6-dinitrotoluene	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-acetylaminofluorene	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-chloroethyl vinyl ether	PPB	<	10.00	5.00		
6-45-42	11/15/87	2-chloronaphthalene	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-chlorophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-cyclohexyl-4,6-dinitrophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-methyl-2-(methylthio) propionaldehyde-	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-methylaziridine	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-methyllactonitrile	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-naphthylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-picoline	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-sec-butyl-4,6-dinitrophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	3,3'-dichlorobenzidine	PPB	<	20.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 5 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	3,3'-dimethoxybenzidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	3,3'-dimethylbenzidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	3-methylcholanthrene	PPB	<	10.00	10.00		
6-45-42	11/15/87	4,4'-methylenebis(2-chloroaniline)	PPB	<	10.00	10.00		
6-45-42	11/15/87	4,6-dinitro-o-cresol and salts	PPB	<	10.00	10.00		
6-45-42	11/15/87	4-aminobyphenyl	PPB	<	10.00	10.00		
6-45-42	11/15/87	4-bromophenyl phenyl ether	PPB	<	10.00	10.00		
6-45-42	11/15/87	5-(aminomethyl)-3-isoxazolol	PPB	<	10.00	10.00		
6-45-42	11/15/87	5-nitro-o-toluidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	7,12-dimethylbenz[a]anthracene	PPB	<	10.00	10.00		
6-45-42	11/15/87	7H-dibenzo[c,g]carbazole	PPB	<	10.00	10.00		
6-45-42	11/15/87	Acetonitrile	PPB	<	3000.00	10.00		
6-45-42	11/15/87	Acetophenone	PPB	<	10.00	10.00		
6-45-42	11/15/87	Acrolein	PPB	<	10.00	10.00		
6-45-42	11/15/87	Acrylonitrile	PPB	<	10.00	10.00		
6-45-42	11/15/87	Alkalinity			103000.00	20000.00		
6-45-42	11/15/87	Alpha,alpha-dimethylphenethylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Aluminum	PPB	<	150.00	150.00		
6-45-42	11/15/87	Aluminum, filtered	PPB	<	150.00	150.00		
6-45-42	11/15/87	Amitrole	PPB	<	10.00	10.00		
6-45-42	11/15/87	Ammonium ion	PPB	<	50.00	50.00		
6-45-42	11/15/87	Aniline	PPB	<	10.00	10.00		
6-45-42	11/15/87	Antimony, filtered	PPB	<	100.00	100.00		
6-45-42	11/15/87	Aramite	PPB	<	10.00	10.00		
6-45-42	11/15/87	Arsenic	PPB	<	5.00	5.00	50.00	EPA
6-45-42	11/15/87	Arsenic, filtered	PPB	<	5.00	5.00	50.00	EPA
6-45-42	11/15/87	Auramine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Barium	PPB		38.00	6.00	1000.00	EPA
6-45-42	11/15/87	Barium, filtered	PPB		38.00	6.00	1000.00	EPA
6-45-42	11/15/87	Benz[a]anthracene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benz[c]acridine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzene	PPB	<	5.00	5.00	5.00	EPA
6-45-42	11/15/87	Benzene, dichloromethyl	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzenethoil	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzo[a]pyrene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzo[b]fluoranthene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzo[j]fluoranthene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzyl chloride	PPB	<	10.00	10.00		
6-45-42	11/15/87	Beryllium, filtered	PPB	<	5.00	5.00		
6-45-42	11/15/87	Bis(2-chloroethoxy) methane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Bis(2-chloroethyl) ether	PPB	<	10.00	10.00		
6-45-42	11/15/87	Bis(2-chloroisopropyl)ether	PPB	<	10.00	10.00		
6-45-42	11/15/87	Bis(2-ethylhexyl) phthalate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Bis(chloromethyl) ether	PPB	<	10.00	5.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 6 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	Bromoacetone	PPB	<	10.00	5.00		
6-45-42	11/15/87	Bromoform	PPB	<	10.00	5.00	100.00	EPA
6-45-42	11/15/87	Butyl benzyl phthalate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Cadmium	PPB	<	2.00	2.00	10.00	EPA
6-45-42	11/15/87	Cadmium, filtered	PPB	<	2.00	2.00	10.00	EPA
6-45-42	11/15/87	Calcium	PPB		25200.00	50.00		
6-45-42	11/15/87	Calcium, filtered	PPB		20600.00	50.00		
6-45-42	11/15/87	Carbon Tetrachloride by GC/MS	PPB	<	5.00	5.00	5.00	EPA
6-45-42	11/15/87	Carbon disulfide	PPB	<	10.00	10.00		
6-45-42	11/15/87	Cesium-137	PCI/L		7.28	20.00	200.00	EPAR
6-45-42	11/15/87	Chloride	PPB		5960.00	500.00	250000.00	EPAS
6-45-42	11/15/87	Chlornaphazine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Chloroalkyl ethers	PPB	<	10.00	10.00		
6-45-42	11/15/87	Chlorobenzene	PPB	<	10.00	5.00	60.00	EPAP
6-45-42	11/15/87	Chloroform	PPB	<	5.00	5.00	100.00	EPA
6-45-42	11/15/87	Chloromethyl methyl ether	PPB	<	10.00	10.00		
6-45-42	11/15/87	Chromium	PPB	<	10.00	10.00	50.00	EPA
6-45-42	11/15/87	Chromium, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	11/15/87	Chrysene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Cobalt-60	PCI/L	<	20.30	22.50	100.00	EPAR
6-45-42	11/15/87	Copper	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	11/15/87	Copper, filtered	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	11/15/87	Cresols	PPB	<	10.00	10.00		
6-45-42	11/15/87	Crotonaldehyde	PPB	<	10.00	10.00		
6-45-42	11/15/87	Cyanide	PPB	<	10.00	10.00		
6-45-42	11/15/87	Di-n-butyl phthalate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Di-n-octyl phthalate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Di-n-propylnitrosamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dibenz[a,h]acridine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dibenz[a,h]anthracene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dibenz[a,j]acridine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dibenzo[a,e]pyrene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dibenzo[a,h]pyrene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dibenzo[a,i]pyrene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dibromomethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dichlorodifluoromethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Diethyl phthalate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Diethylarsine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dihydrosafrole	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dimethyl phthalate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dinitrobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dioxane	PPB	<	500.00	500.00		
6-45-42	11/15/87	Diphenylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Ethyl methacrylate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Ethyl methanesulfonate	PPB	<	10.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 7 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	Ethylene oxide	PPB	<	3000.00	10.00		
6-45-42	11/15/87	Ethyleneimine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Fluoranthene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Fluoride	PPB		634.00	500.00	4000.00	EPA
6-45-42	11/15/87	Fluoride, Low Detection Level	PPB		595.00	20.00	4000.00	EPA
6-45-42	11/15/87	Formalin	PPB	<	500.00	500.00		
6-45-42	11/15/87	Gross alpha	PCI/L		1.89	4.00	15.00	EPA
6-45-42	11/15/87	Gross alpha	PCI/L		2.09	4.00	15.00	EPA
6-45-42	11/15/87	Gross beta	PCI/L		2.95	8.00	50.00	EPA
6-45-42	11/15/87	Gross beta	PCI/L		8.07	8.00	50.00	EPA
6-45-42	11/15/87	Hexachlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hexachlorobutadiene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hexachlorocyclopentadiene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hexachloroethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hexachlorophene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hexachloropropene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hydrogen sulfide	PPB	<	10.00	10.00		
6-45-42	11/15/87	Indeno(1,2,3-cd)pyrene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Iodomethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Iron	PPB		886.00	30.00	300.00	EPAS
6-45-42	11/15/87	Iron, filtered	PPB	<	30.00	30.00	300.00	EPAS
6-45-42	11/15/87	Isosafrole	PPB	<	10.00	10.00		
6-45-42	11/15/87	Kerosene	PPB	<	10000.00	10000.00		
6-45-42	11/15/87	Lead (graphite furnace)	PPB	<	5.00	5.00	50.00	EPA
6-45-42	11/15/87	Lead, filtered	PPB	<	5.00	5.00	50.00	EPA
6-45-42	11/15/87	Magnesium	PPB		10400.00	50.00		
6-45-42	11/15/87	Magnesium, filtered	PPB		10200.00	50.00		
6-45-42	11/15/87	Maleic hydrizide	PPB	<	500.00	500.00		
6-45-42	11/15/87	Malononitrile	PPB	<	10.00	10.00		
6-45-42	11/15/87	Manganese	PPB		12.00	5.00	50.00	EPAS
6-45-42	11/15/87	Manganese, filtered	PPB		6.00	5.00	50.00	EPAS
6-45-42	11/15/87	Melphalan	PPB	<	10.00	10.00		
6-45-42	11/15/87	Mercury	PPB	<	0.10	0.10	2.00	EPA
6-45-42	11/15/87	Mercury, filtered	PPB	<	0.10	0.10	2.00	EPA
6-45-42	11/15/87	Methacrylonitrile	PPB	<	10.00	10.00		
6-45-42	11/15/87	Methanethiol	PPB	<	10.00	10.00		
6-45-42	11/15/87	Methapyrilene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Metholonyl	PPB	<	10.00	10.00		
6-45-42	11/15/87	Methyl Isobutyl Ketone	PPB	<	10.00	10.00		
6-45-42	11/15/87	Methyl bromide	PPB	<	10.00	10.00		
6-45-42	11/15/87	Methyl chloride	PPB	<	10.00	10.00		
6-45-42	11/15/87	Methyl ethyl ketone	PPB	<	10.00	10.00		
6-45-42	11/15/87	Methyl methacrylate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Methyl methanesulfonate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Methylene Chloride	PPB	<	10.00	5.00		

Table C-I. Water-Chemistry Data from Wells Near LERF Site (page 8 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	Methylthiouracil	PPB	<	10.00	10.00		
6-45-42	11/15/87	N,N-diethylhydrazine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitroso-N-methylurethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosodi-n-butylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosodiethanolamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosodiethylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosodimethylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosomethylethylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosomethylvinylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosomorpholine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosonornicotine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosopiperidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Naphthalene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Natural uranium	UG/L		1.98	0.73		
6-45-42	11/15/87	Nickel	PPB	<	10.00	10.00		
6-45-42	11/15/87	Nickel, filtered	PPB	<	10.00	10.00		
6-45-42	11/15/87	Nicotinic acid	PPB	<	100.00	100.00		
6-45-42	11/15/87	Nitrate	PPB		7470.00	500.00	45000.00	EPA
6-45-42	11/15/87	Nitrobenzine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Nitrosopyrrolidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	O,O,O-triethyl phosphorothioate	PPB	<	10.00	10.00		
6-45-42	11/15/87	O-toluidine hydrochloride	PPB	<	10.00	10.00		
6-45-42	11/15/87	P benzoquinone	PPB	<	10.00	10.00		
6-45-42	11/15/87	P-chloro-m-cresol	PPB	<	10.00	10.00		
6-45-42	11/15/87	P-chloroaniline	PPB	<	10.00	10.00		
6-45-42	11/15/87	P-dimethylaminoazobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	P-nitroaniline	PPB	<	50.00	10.00		
6-45-42	11/15/87	Pentachlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Pentachloroethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Pentachloronitrobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Pentachlorophenol	PPB	<	50.00	50.00	220.00	EPAP
6-45-42	11/15/87	Phenacetin	PPB	<	10.00	10.00		
6-45-42	11/15/87	Phenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	Phenylenediamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Phosphate	PPB	<	1000.00	1000.00		
6-45-42	11/15/87	Phthalic acid esters	PPB	<	10.00	10.00		
6-45-42	11/15/87	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	11/15/87	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	11/15/87	Potassium	PPB		4590.00	100.00		
6-45-42	11/15/87	Potassium, filtered	PPB		4390.00	100.00		
6-45-42	11/15/87	Pronamide	PPB	<	10.00	10.00		
6-45-42	11/15/87	Pyridine	PPB	<	500.00	500.00		
6-45-42	11/15/87	Radium	PCI/L	<	0.02	1.00	5.00	EPA
6-45-42	11/15/87	Reserpine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Resorcinol	PPB	<	10.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 9 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	Ruthenium-106	PCI/L	<	19.40	172.50	30.00	EPAR
6-45-42	11/15/87	Safrol	PPB	<	10.00	10.00		
6-45-42	11/15/87	Selenium	PPB	<	5.00	5.00	10.00	EPA
6-45-42	11/15/87	Selenium, filtered	PPB	<	5.00	5.00	10.00	EPA
6-45-42	11/15/87	Silver	PPB	<	10.00	10.00	50.00	EPA
6-45-42	11/15/87	Silver, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	11/15/87	Sodium	PPB		19300.00	200.00		
6-45-42	11/15/87	Sodium, filtered	PPB		18500.00	200.00		
6-45-42	11/15/87	Specific conductance	UMHO		229.00	1.00	700.00	WDOE
6-45-42	11/15/87	Strontium, filtered	PPB		193.00	10.00		
6-45-42	11/15/87	Strontium-90	PCI/L	<	0.19	5.00	8.00	EPA
6-45-42	11/15/87	Strychnine	PPB	<	50.00	50.00		
6-45-42	11/15/87	Sulfate	PPB		34800.00	500.00	250000.00	EPAS
6-45-42	11/15/87	Sym-trinitrobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Tetrachloroethylene	PPB	<	5.00	5.00		
6-45-42	11/15/87	Thiofanox	PPB	<	10.00	10.00		
6-45-42	11/15/87	Thiuram	PPB	<	10.00	10.00		
6-45-42	11/15/87	Toluene	PPB	<	5.00	5.00	2000.00	EPAP
6-45-42	11/15/87	Toluenediamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Total Organic Halogen, Low Det. Level	PPB	<	6.10	10.00		
6-45-42	11/15/87	Total carbon	PPB		21800.00	1000.00		
6-45-42	11/15/87	Total organic carbon	PPB	<	355.00	2000.00		
6-45-42	11/15/87	Trans-1,2-dichloroethene	PPB	<	10.00	5.00	70.00	EPAP
6-45-42	11/15/87	Tributylphosphoric Acid	PPB	<	10.00	10.00		
6-45-42	11/15/87	Trichloroethylene	PPB	<	5.00	5.00	5.00	EPA
6-45-42	11/15/87	Trichloromethanethiol	PPB	<	10.00	10.00		
6-45-42	11/15/87	Trichloromonofluoromethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Trichloropropane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Tris(2,3-dibromopropyl) phosphate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Tritium	PCI/L		51100.00	500.00	20000.00	EPA
6-45-42	11/15/87	Uranium-234	PCI/L		1.24	0.10	20.00	DOE
6-45-42	11/15/87	Uranium-235	PCI/L		0.03	0.10	24.00	DOE
6-45-42	11/15/87	Uranium-238	PCI/L		0.99	0.10	24.00	DOE
6-45-42	11/15/87	Vanadium	PPB		31.00	5.00		
6-45-42	11/15/87	Vanadium, filtered	PPB		32.00	5.00		
6-45-42	11/15/87	Vinyl chloride	PPB	<	10.00	10.00	2.00	EPA
6-45-42	11/15/87	Warfarin	PPB	<	10.00	10.00		
6-45-42	11/15/87	Xylene-m	PPB	<	5.00	5.00	440.00	EPAP
6-45-42	11/15/87	Xylene-o,p	PPB	<	5.00	5.00	440.00	EPAP
6-45-42	11/15/87	Zinc	PPB		8.00	5.00	5000.00	EPAS
6-45-42	11/15/87	Zinc, filtered	PPB		7.00	5.00	5000.00	EPAS
6-45-42	11/15/87	p-Dichlorobenzene	PPB	<	10.00	10.00	75.00	EPA
6-45-42	11/15/87	p-Nitrophenol	PPB	<	50.00	10.00		
6-45-42	11/15/87	pH, Field Measurement			7.60	0.10	8.50	EPAS
6-45-42	11/15/87	pH, Laboratory Measurement			8.00	0.01	8.50	EPAS

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 10 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	12/03/87	Cesium-137	PCI/L	<	5.64	20.00	200.00	EPAR
6-45-42	12/03/87	Cobalt-60	PCI/L			22.50	100.00	EPAR
6-45-42	12/03/87	Gross alpha	PCI/L		1.67	4.00	15.00	EPA
6-45-42	12/03/87	Gross beta	PCI/L		4.07	8.00	50.00	EPA
6-45-42	12/03/87	Natural uranium	UG/L		2.48	0.73		
6-45-42	12/03/87	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	12/03/87	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	12/03/87	Ruthenium-106	PCI/L	<	62.90	172.50	30.00	EPAR
6-45-42	12/03/87	Strontium-90	PCI/L	<	0.22	5.00	8.00	EPA
6-45-42	12/03/87	Tritium	PCI/L		51200.00	500.00	20000.00	EPA
6-45-42	12/03/87	Uranium-234	PCI/L		1.02	0.10	20.00	DOE
6-45-42	12/03/87	Uranium-235	PCI/L		0.03	0.10	24.00	DOE
6-45-42	12/03/87	Uranium-238	PCI/L		0.80	0.10	24.00	DOE
6-45-42	1/08/88	1,1,1,2-tetrachlorethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,1,1-trichloroethane	PPB	<	5.00	5.00	200.00	EPA
6-45-42	1/08/88	1,1,2,2-tetrachlorethane	PPB	<	10.00	5.00		
6-45-42	1/08/88	1,1,2-trichloroethane	PPB	<	5.00	5.00		
6-45-42	1/08/88	1,1-dichloroethane	PPB	<	10.00	5.00		
6-45-42	1/08/88	1,1-dichloroethylene	PPB	<	10.00	10.00	7.00	EPA
6-45-42	1/08/88	1,2,3,4-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2,3,5-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2,3-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2,3-trichloropropane	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2,4,5-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2,4-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2-dibromo-3-chloropropane	PPB	<	10.00	10.00		EPAP
6-45-42	1/08/88	1,2-dibromoethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2-dichloroethane	PPB	<	10.00	5.00	5.00	EPA
6-45-42	1/08/88	1,2-dichloropropane	PPB	<	10.00	5.00	6.00	EPAP
6-45-42	1/08/88	1,2-diphenylhydrazine	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,3,5-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,3-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,3-dichloropropene	PPB	<	10.00	5.00		
6-45-42	1/08/88	1,4-dichloro-2-butene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,4-naphthoquinone	PPB	<	10.00	10.00		
6-45-42	1/08/88	1-chloro-2,3-epoxypropane	PPB	<	10.00	10.00		EPAP
6-45-42	1/08/88	1-naphthylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,3,4,6-tetrachlorophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,4,5-trichlorophenol	PPB	<	50.00	10.00		
6-45-42	1/08/88	2,4,6-trichlorophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,4-dichlorophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,4-dimethylphenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,4-dinitrophenol	PPB	<	50.00	10.00		
6-45-42	1/08/88	2,4-dinitrotoluene	PPB	<	10.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 11 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	2,6-dichlorophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,6-dinitrotoluene	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-acetylaminofluorene	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-chloroethyl vinyl ether	PPB	<	10.00	5.00		
6-45-42	1/08/88	2-chloronaphthalene	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-chlorophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-cyclohexyl-4,6-dinitrophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-methyl-2-(methylthio) propionaldehyde-	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-methylaziridine	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-methyllactonitrile	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-naphthylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-picoline	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-sec-butyl-4,6-dinitrophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	3,3'-dichlorobenzidine	PPB	<	20.00	10.00		
6-45-42	1/08/88	3,3'-dimethoxybenzidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	3,3'-dimethylbenzidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	3-methylcholanthrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	4,4'-methylenebis(2-chloroaniline)	PPB	<	10.00	10.00		
6-45-42	1/08/88	4,6-dinitro-o-cresol and salts	PPB	<	10.00	10.00		
6-45-42	1/08/88	4-aminobyphenyl	PPB	<	10.00	10.00		
6-45-42	1/08/88	4-bromophenyl phenyl ether	PPB	<	10.00	10.00		
6-45-42	1/08/88	5-(aminomethyl)-3-isoxazolol	PPB	<	10.00	10.00		
6-45-42	1/08/88	5-nitro-o-toluidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	7,12-dimethylbenz(a)anthracene	PPB	<	10.00	10.00		
6-45-42	1/08/88	7H-dibenzo[c,g]carbazole	PPB	<	10.00	10.00		
6-45-42	1/08/88	Acetonitrile	PPB	<	3000.00	10.00		
6-45-42	1/08/88	Acetophenone	PPB	<	10.00	10.00		
6-45-42	1/08/88	Acrolein	PPB	<	10.00	10.00		
6-45-42	1/08/88	Acrylonitrile	PPB	<	10.00	10.00		
6-45-42	1/08/88	Alkalinity			101000.00	20000.00		
6-45-42	1/08/88	Alpha,alpha-dimethylphenethylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Aluminum	PPB	<	150.00	150.00		
6-45-42	1/08/88	Aluminum, filtered	PPB	<	150.00	150.00		
6-45-42	1/08/88	Amitrole	PPB	<	10.00	10.00		
6-45-42	1/08/88	Ammonium ion	PPB	<	50.00	50.00		
6-45-42	1/08/88	Aniline	PPB	<	10.00	10.00		
6-45-42	1/08/88	Antimony, filtered	PPB	<	100.00	100.00		
6-45-42	1/08/88	Aramite	PPB	<	10.00	10.00		
6-45-42	1/08/88	Arsenic	PPB	<	5.00	5.00	50.00	EPA
6-45-42	1/08/88	Arsenic, filtered	PPB		5.00	5.00	50.00	EPA
6-45-42	1/08/88	Auramine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Barium	PPB		32.00	6.00	1000.00	EPA
6-45-42	1/08/88	Barium, filtered	PPB		34.00	6.00	1000.00	EPA
6-45-42	1/08/88	Benz[a]anthracene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benz[c]acridine	PPB	<	10.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 12 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	Benzene	PPB	<	5.00	5.00	5.00	EPA
6-45-42	1/08/88	Benzene, dichloromethyl	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzenethoil	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzo[a]pyrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzo[b]fluoranthene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzo[j]fluoranthene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzyl chloride	PPB	<	10.00	10.00		
6-45-42	1/08/88	Beryllium, filtered	PPB	<	5.00	5.00		
6-45-42	1/08/88	Bis(2-chloroethoxy) methane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Bis(2-chloroethyl) ether	PPB	<	10.00	10.00		
6-45-42	1/08/88	Bis(2-chloroisopropyl)ether	PPB	<	10.00	10.00		
6-45-42	1/08/88	Bis(2-ethylhexyl) phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Bis(chloromethyl) ether	PPB	<	10.00	5.00		
6-45-42	1/08/88	Bromoacetone	PPB	<	10.00	5.00		
6-45-42	1/08/88	Bromoform	PPB	<	10.00	5.00	100.00	EPA
6-45-42	1/08/88	Butyl benzyl phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Cadmium	PPB	<	2.00	2.00	10.00	EPA
6-45-42	1/08/88	Cadmium, filtered	PPB	<	2.00	2.00	10.00	EPA
6-45-42	1/08/88	Calcium	PPB		24200.00	50.00		
6-45-42	1/08/88	Calcium, filtered	PPB		26300.00	50.00		
6-45-42	1/08/88	Carbon Tetrachloride by GC/MS	PPB	<	5.00	5.00	5.00	EPA
6-45-42	1/08/88	Carbon disulfide	PPB	<	10.00	10.00		
6-45-42	1/08/88	Cesium-137	PCI/L	<	5.22	20.00	200.00	EPAR
6-45-42	1/08/88	Chloride	PPB		5670.00	500.00	250000.00	EPAS
6-45-42	1/08/88	Chlornaphazine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Chloroalkyl ethers	PPB	<	10.00	10.00		
6-45-42	1/08/88	Chlorobenzene	PPB	<	10.00	5.00	60.00	EPAP
6-45-42	1/08/88	Chloroform	PPB	<	5.00	5.00	100.00	EPA
6-45-42	1/08/88	Chloromethyl methyl ether	PPB	<	10.00	10.00		
6-45-42	1/08/88	Chromium	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/08/88	Chromium, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/08/88	Chrysene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Cobalt-60	PCI/L	<	4.34	22.50	100.00	EPAR
6-45-42	1/08/88	Copper	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	1/08/88	Copper, filtered	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	1/08/88	Cresols	PPB	<	10.00	10.00		
6-45-42	1/08/88	Crotonaldehyde	PPB	<	10.00	10.00		
6-45-42	1/08/88	Cyanide	PPB	<	10.00	10.00		
6-45-42	1/08/88	Di-n-butyl phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Di-n-octyl phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Di-n-propylnitrosamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibenz[a,h]acridine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibenz[a,h]anthracene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibenz[a,j]acridine	PPB	<	10.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 13 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	Dibenzo[a,e]pyrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibenzo[a,h]pyrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibenzo[a,i]pyrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibromomethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dichlorodifluoromethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Diethyl phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Diethylarsine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dihydrosafrole	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dimethyl phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dinitrobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dioxane	PPB	<	500.00	500.00		
6-45-42	1/08/88	Diphenylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Ethyl methacrylate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Ethyl methanesulfonate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Ethylene oxide	PPB	<	3000.00	10.00		
6-45-42	1/08/88	Ethyleneimine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Fluoranthene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Fluoride	PPB		667.00	500.00	4000.00	EPA
6-45-42	1/08/88	Formalin	PPB	<	500.00	500.00		
6-45-42	1/08/88	Gross alpha	PCI/L		1.85	4.00	15.00	EPA
6-45-42	1/08/88	Gross beta	PCI/L		3.19	8.00	50.00	EPA
6-45-42	1/08/88	Hexachlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Hexachlorobutadiene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Hexachlorocyclopentadiene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Hexachloroethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Hexachlorophene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Hexachloropropene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Hydrogen sulfide	PPB	<	10.00	10.00		
6-45-42	1/08/88	Indeno(1,2,3-cd)pyrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Iodomethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Iron	PPB		428.00	30.00	300.00	EPAS
6-45-42	1/08/88	Iron, filtered	PPB		60.00	30.00	300.00	EPAS
6-45-42	1/08/88	Isosafrole	PPB	<	10.00	10.00		
6-45-42	1/08/88	Kerosene	PPB	<	10000.00	10000.00		
6-45-42	1/08/88	Lead (graphite furnace)	PPB	<	5.00	5.00	50.00	EPA
6-45-42	1/08/88	Lead, filtered	PPB	<	5.00	5.00	50.00	EPA
6-45-42	1/08/88	Magnesium	PPB		10100.00	50.00		
6-45-42	1/08/88	Magnesium, filtered	PPB		10500.00	50.00		
6-45-42	1/08/88	Maleic hydrizide	PPB	<	500.00	500.00		
6-45-42	1/08/88	Malononitrile	PPB	<	10.00	10.00		
6-45-42	1/08/88	Manganese	PPB	<	5.00	5.00	50.00	EPAS
6-45-42	1/08/88	Manganese, filtered	PPB		10.00	5.00	50.00	EPAS
6-45-42	1/08/88	Melphalan	PPB	<	10.00	10.00		
6-45-42	1/08/88	Mercury	PPB	<	0.10	0.10	2.00	EPA
6-45-42	1/08/88	Mercury, filtered	PPB	<	0.10	0.10	2.00	EPA

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 14 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	Methacrylonitrile	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methanethiol	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methapyrilene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Metholonyl	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl Isobutyl Ketone	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl bromide	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl chloride	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl ethyl ketone	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl methacrylate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl methanesulfonate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methylene Chloride	PPB	<	10.00	5.00		
6-45-42	1/08/88	Methylthiouracil	PPB	<	10.00	10.00		
6-45-42	1/08/88	N,N-diethylhydrazine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitroso-N-methylurethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosodi-n-butylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosodiethanolamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosodiethylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosodimethylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosomethylethylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosomethylvinylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosomorpholine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosonornicotine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosopiperidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Naphthalene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Natural uranium	UG/L		2.17	0.73		
6-45-42	1/08/88	Nickel	PPB	<	10.00	10.00		
6-45-42	1/08/88	Nickel, filtered	PPB	<	10.00	10.00		
6-45-42	1/08/88	Nicotinic acid	PPB	<	100.00	100.00		
6-45-42	1/08/88	Nitrate	PPB		8860.00	500.00	45000.00	EPA
6-45-42	1/08/88	Nitrate, High Detection Level	PPB		6910.00	2500.00	45000.00	EPA
6-45-42	1/08/88	Nitrobenzine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Nitrosopyrrolidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	O,O,O-triethyl phosphorothioate	PPB	<	10.00	10.00		
6-45-42	1/08/88	O-toluidine hydrochloride	PPB	<	10.00	10.00		
6-45-42	1/08/88	P benzoquinone	PPB	<	10.00	10.00		
6-45-42	1/08/88	P-chloro-m-cresol	PPB	<	10.00	10.00		
6-45-42	1/08/88	P-chloroaniline	PPB	<	10.00	10.00		
6-45-42	1/08/88	P-dimethylaminoazobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	P-nitroaniline	PPB	<	50.00	10.00		
6-45-42	1/08/88	Pentachlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Pentachloroethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Pentachloronitrobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Pentachlorophenol	PPB	<	50.00	50.00	220.00	EPAP
6-45-42	1/08/88	Phenacetin	PPB	<	10.00	10.00		
6-45-42	1/08/88	Phenol	PPB	<	10.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 15 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	Phenylenediamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Phosphate	PPB	<	1000.00	1000.00		
6-45-42	1/08/88	Phthalic acid esters	PPB	<	10.00	10.00		
6-45-42	1/08/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	1/08/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	1/08/88	Potassium	PPB		4420.00	100.00		
6-45-42	1/08/88	Potassium, filtered	PPB		4320.00	100.00		
6-45-42	1/08/88	Pronamide	PPB	<	10.00	10.00		
6-45-42	1/08/88	Pyridine	PPB	<	500.00	500.00		
6-45-42	1/08/88	Radium	PCI/L	<	0.04	1.00	5.00	EPA
6-45-42	1/08/88	Reserpine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Resorcinol	PPB	<	10.00	10.00		
6-45-42	1/08/88	Ruthenium-106	PCI/L	<	56.60	172.50	30.00	EPAR
6-45-42	1/08/88	Safrol	PPB	<	10.00	10.00		
6-45-42	1/08/88	Selenium	PPB	<	5.00	5.00	10.00	EPA
6-45-42	1/08/88	Selenium, filtered	PPB	<	5.00	5.00	10.00	EPA
6-45-42	1/08/88	Silver	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/08/88	Silver, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/08/88	Sodium	PPB		18800.00	200.00		
6-45-42	1/08/88	Sodium, filtered	PPB		18400.00	200.00		
6-45-42	1/08/88	Specific conductance	UMHO		219.00	1.00	700.00	WDOE
6-45-42	1/08/88	Strontium, filtered	PPB		192.00	10.00		
6-45-42	1/08/88	Strontium-90	PCI/L	<	0.02	5.00	8.00	EPA
6-45-42	1/08/88	Strychnine	PPB	<	50.00	50.00		
6-45-42	1/08/88	Sulfate	PPB		35200.00	500.00	250000.00	EPAS
6-45-42	1/08/88	Sym-trinitrobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Tetrachloroethylene	PPB	<	5.00	5.00		
6-45-42	1/08/88	Thiofanox	PPB	<	10.00	10.00		
6-45-42	1/08/88	Thiuram	PPB	<	10.00	10.00		
6-45-42	1/08/88	Toluene	PPB	<	5.00	5.00	2000.00	EPAP
6-45-42	1/08/88	Toluenediamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Total Organic Halogen, Low Det. Level	PPB	<	1.10	10.00		
6-45-42	1/08/88	Total carbon	PPB		22600.00	1000.00		
6-45-42	1/08/88	Total organic carbon	PPB	<	368.00	2000.00		
6-45-42	1/08/88	Trans-1,2-dichloroethene	PPB	<	10.00	5.00	70.00	EPAP
6-45-42	1/08/88	Tributylphosphoric Acid	PPB	<	10.00	10.00		
6-45-42	1/08/88	Trichloroethylene	PPB	<	5.00	5.00	5.00	EPA
6-45-42	1/08/88	Trichloromethanethiol	PPB	<	10.00	10.00		
6-45-42	1/08/88	Trichloromonofluoromethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Trichloropropane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Tris(2,3-dibromopropyl) phosphate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Tritium	PCI/L		52300.00	500.00	20000.00	EPA
6-45-42	1/08/88	Uranium-234	PCI/L		1.11	0.10	20.00	DOE
6-45-42	1/08/88	Uranium-235	PCI/L		0.04	0.10	24.00	DOE
6-45-42	1/08/88	Uranium-238	PCI/L		0.86	0.10	24.00	DOE

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 16 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	Vanadium	PPB		28.00	5.00		
6-45-42	1/08/88	Vanadium, filtered	PPB		30.00	5.00		
6-45-42	1/08/88	Vinyl chloride	PPB	<	10.00	10.00	2.00	EPA
6-45-42	1/08/88	Warfarin	PPB	<	10.00	10.00		
6-45-42	1/08/88	Xylene-m	PPB	<	5.00	5.00	440.00	EPAP
6-45-42	1/08/88	Xylene-o,p	PPB	<	5.00	5.00	440.00	EPAP
6-45-42	1/08/88	Zinc	PPB	<	5.00	5.00	5000.00	EPAS
6-45-42	1/08/88	Zinc, filtered	PPB	<	5.00	5.00	5000.00	EPAS
6-45-42	1/08/88	p-Dichlorobenzene	PPB	<	10.00	10.00	75.00	EPA
6-45-42	1/08/88	p-Nitrophenol	PPB	<	50.00	10.00		
6-45-42	1/08/88	pH, Field Measurement			7.50	0.10	8.50	EPAS
6-45-42	1/08/88	pH, Laboratory Measurement			7.74	0.01	8.50	EPAS
6-45-42	2/04/88	Cesium-137	PCI/L	<	3.18	20.00	200.00	EPAR
6-45-42	2/04/88	Cobalt-60	PCI/L	<	3.60	22.50	100.00	EPAR
6-45-42	2/04/88	Gross alpha	PCI/L		1.55	4.00	15.00	EPA
6-45-42	2/04/88	Gross beta	PCI/L		4.22	8.00	50.00	EPA
6-45-42	2/04/88	Natural uranium	UG/L		2.32	0.73		
6-45-42	2/04/88	Nitrate, High Detection Level	PPB		6140.00	2500.00	45000.00	EPA
6-45-42	2/04/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	2/04/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	2/04/88	Ruthenium-106	PCI/L	<	27.10	172.50	30.00	EPAR
6-45-42	2/04/88	Strontium-90	PCI/L	<	0.14	5.00	8.00	EPA
6-45-42	2/04/88	Tritium	PCI/L		50100.00	500.00	20000.00	EPA
6-45-42	2/04/88	Uranium-234	PCI/L		1.16	0.10	20.00	DOE
6-45-42	2/04/88	Uranium-235	PCI/L		0.02	0.10	24.00	DOE
6-45-42	2/04/88	Uranium-238	PCI/L		0.87	0.10	24.00	DOE
6-45-42	3/17/88	Cesium-137	PCI/L	<	1.38	20.00	200.00	EPAR
6-45-42	3/17/88	Cobalt-60	PCI/L	<	2.02	22.50	100.00	EPAR
6-45-42	3/17/88	Gross alpha	PCI/L		1.87	4.00	15.00	EPA
6-45-42	3/17/88	Gross beta	PCI/L		4.78	8.00	50.00	EPA
6-45-42	3/17/88	Natural uranium	UG/L		1.92	0.73		
6-45-42	3/17/88	Nitrate, High Detection Level	PPB		5210.00	2500.00	45000.00	EPA
6-45-42	3/17/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	3/17/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	3/17/88	Ruthenium-106	PCI/L	<	13.30	172.50	30.00	EPAR
6-45-42	3/17/88	Strontium-90	PCI/L	<	0.17	5.00	8.00	EPA
6-45-42	3/17/88	Tritium	PCI/L		49700.00	500.00	20000.00	EPA
6-45-42	3/17/88	Uranium-234	PCI/L		0.87	0.10	20.00	DOE
6-45-42	3/17/88	Uranium-235	PCI/L	<	0.01	0.10	24.00	DOE
6-45-42	3/17/88	Uranium-238	PCI/L		0.57	0.10	24.00	DOE
6-45-42	4/07/88	Cesium-137	PCI/L	<	2.05	20.00	200.00	EPAR
6-45-42	4/07/88	Cobalt-60	PCI/L	<	0.56	22.50	100.00	EPAR
6-45-42	4/07/88	Gross alpha	PCI/L		2.62	4.00	15.00	EPA
6-45-42	4/07/88	Gross beta	PCI/L		5.78	8.00	50.00	EPA
6-45-42	4/07/88	Natural uranium	UG/L		1.88	0.73		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 17 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	4/07/88	Nitrate, High Detection Level	PPB		5960.00	2500.00	45000.00	EPA
6-45-42	4/07/88	Plutonium-238	PCI/L	<	0.01	17.00	1.60	DOE
6-45-42	4/07/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	4/07/88	Ruthenium-106	PCI/L	<	29.20	172.50	30.00	EPAR
6-45-42	4/07/88	Strontium-90	PCI/L	<	0.27	5.00	8.00	EPA
6-45-42	4/07/88	Tritium	PCI/L		50200.00	500.00	20000.00	EPA
6-45-42	4/07/88	Uranium-234	PCI/L		0.94	0.10	20.00	DOE
6-45-42	4/07/88	Uranium-235	PCI/L		0.02	0.10	24.00	DOE
6-45-42	4/07/88	Uranium-238	PCI/L		0.79	0.10	24.00	DOE
6-45-42	5/04/88	Cesium-137	PCI/L	<	2.76	20.00	200.00	EPAR
6-45-42	5/04/88	Cobalt-60	PCI/L	<	6.92	22.50	100.00	EPAR
6-45-42	5/04/88	Gross alpha	PCI/L		1.48	4.00	15.00	EPA
6-45-42	5/04/88	Gross beta	PCI/L		4.04	8.00	50.00	EPA
6-45-42	5/04/88	Natural uranium	UG/L		2.07	0.73		
6-45-42	5/04/88	Nitrate, High Detection Level	PPB		6610.00	2500.00	45000.00	EPA
6-45-42	5/04/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	5/04/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	5/04/88	Ruthenium-106	PCI/L	<	21.60	172.50	30.00	EPAR
6-45-42	5/04/88	Strontium-90	PCI/L	<	0.06	5.00	8.00	EPA
6-45-42	5/04/88	Tritium	PCI/L		49400.00	500.00	20000.00	EPA
6-45-42	5/04/88	Uranium-234	PCI/L		1.08	0.10	20.00	DOE
6-45-42	5/04/88	Uranium-235	PCI/L		0.03	0.10	24.00	DOE
6-45-42	5/04/88	Uranium-238	PCI/L		0.82	0.10	24.00	DOE
6-45-42	6/06/88	Cesium-137	PCI/L	<	2.32	20.00	200.00	EPAR
6-45-42	6/06/88	Cobalt-60	PCI/L	<	4.27	22.50	100.00	EPAR
6-45-42	6/06/88	Gross alpha	PCI/L		2.23	4.00	15.00	EPA
6-45-42	6/06/88	Gross beta	PCI/L		6.29	8.00	50.00	EPA
6-45-42	6/06/88	Natural uranium	UG/L		2.03	0.73		
6-45-42	6/06/88	Nitrate, High Detection Level	PPB		7730.00	2500.00	45000.00	EPA
6-45-42	6/06/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	6/06/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	6/06/88	Ruthenium-106	PCI/L	<	2.79	172.50	30.00	EPAR
6-45-42	6/06/88	Strontium-90	PCI/L	<	0.41	5.00	8.00	EPA
6-45-42	6/06/88	Tritium	PCI/L		50200.00	500.00	20000.00	EPA
6-45-42	6/06/88	Uranium-234	PCI/L		1.08	0.10	20.00	DOE
6-45-42	6/06/88	Uranium-235	PCI/L		0.06	0.10	24.00	DOE
6-45-42	6/06/88	Uranium-238	PCI/L		0.89	0.10	24.00	DOE
6-45-42	6/15/88	1,1,1,2-tetrachlorethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,1,1-trichloroethane	PPB	<	5.00	5.00	200.00	EPA
6-45-42	6/15/88	1,1,2,2-tetrachlorethane	PPB	<	10.00	5.00		
6-45-42	6/15/88	1,1,2-trichloroethane	PPB	<	5.00	5.00		
6-45-42	6/15/88	1,1-dichloroethane	PPB	<	10.00	5.00		
6-45-42	6/15/88	1,1-dichloroethylene	PPB	<	10.00	10.00	7.00	EPA
6-45-42	6/15/88	1,2,3,4-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2,3,5-tetrachlorobenzene	PPB	<	10.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 18 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	6/15/88	1,2,3-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2,3-trichloropropane	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2,4,5-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2,4-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2-dibromo-3-chloropropane	PPB	<	10.00	10.00		EPAP
6-45-42	6/15/88	1,2-dibromoethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2-dichloroethane	PPB	<	10.00	5.00	5.00	EPA
6-45-42	6/15/88	1,2-dichloropropane	PPB	<	10.00	5.00	6.00	EPAP
6-45-42	6/15/88	1,3,5-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,3-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,3-dichloropropene	PPB	<	10.00	5.00		
6-45-42	6/15/88	1,4-dichloro-2-butene	PPB	<	10.00	10.00		
6-45-42	6/15/88	2-chloroethyl vinyl ether	PPB	<	10.00	5.00		
6-45-42	6/15/88	Acetonitrile	PPB	<	3000.00	10.00		
6-45-42	6/15/88	Acrolein	PPB	<	10.00	10.00		
6-45-42	6/15/88	Acrylonitrile	PPB	<	10.00	10.00		
6-45-42	6/15/88	Alkalinity			103000.00	20000.00		
6-45-42	6/15/88	Aluminum, filtered	PPB	<	150.00	150.00		
6-45-42	6/15/88	Ammonium ion	PPB	<	50.00	50.00		
6-45-42	6/15/88	Antimony, filtered	PPB	<	100.00	100.00		
6-45-42	6/15/88	Arsenic, filtered	PPB		6.00	5.00	50.00	EPA
6-45-42	6/15/88	Barium, filtered	PPB		35.00	6.00	1000.00	EPA
6-45-42	6/15/88	Benzene	PPB	<	5.00	5.00	5.00	EPA
6-45-42	6/15/88	Beryllium, filtered	PPB	<	5.00	5.00		
6-45-42	6/15/88	Bis(chloromethyl) ether	PPB	<	10.00	5.00		
6-45-42	6/15/88	Bromoacetone	PPB	<	10.00	5.00		
6-45-42	6/15/88	Bromoform	PPB	<	10.00	5.00	100.00	EPA
6-45-42	6/15/88	Cadmium, filtered	PPB	<	2.00	2.00	10.00	EPA
6-45-42	6/15/88	Calcium, filtered	PPB		26900.00	50.00		
6-45-42	6/15/88	Carbon Tetrachloride by GC/MS	PPB	<	5.00	5.00	5.00	EPA
6-45-42	6/15/88	Carbon disulfide	PPB	<	10.00	10.00		
6-45-42	6/15/88	Chloride	PPB		5650.00	500.00	250000.00	EPAS
6-45-42	6/15/88	Chlorobenzene	PPB	<	10.00	5.00	60.00	EPAP
6-45-42	6/15/88	Chloroform	PPB	<	5.00	5.00	100.00	EPA
6-45-42	6/15/88	Chloromethyl methyl ether	PPB	<	10.00	10.00		
6-45-42	6/15/88	Chromium, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	6/15/88	Copper, filtered	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	6/15/88	Crotonaldehyde	PPB	<	10.00	10.00		
6-45-42	6/15/88	Cyanide	PPB		151.00	10.00		
6-45-42	6/15/88	Dibromomethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	Dichlorodifluoromethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	Diethylarsine	PPB	<	10.00	10.00		
6-45-42	6/15/88	Dioxane	PPB	<	500.00	500.00		
6-45-42	6/15/88	Ethyl methacrylate	PPB	<	10.00	10.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 19 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	6/15/88	Ethylene oxide	PPB	<	3000.00	10.00		
6-45-42	6/15/88	Fluoride	PPB		1200.00	500.00	4000.00	EPA
6-45-42	6/15/88	Fluoride, Low Detection Level	PPB		488.00	20.00	4000.00	EPA
6-45-42	6/15/88	Formalin	PPB	<	500.00	500.00		
6-45-42	6/15/88	Gross alpha	PCI/L		1.77	4.00	15.00	EPA
6-45-42	6/15/88	Gross beta	PCI/L		7.25	8.00	50.00	EPA
6-45-42	6/15/88	Hexachlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	Hexachlorophene	PPB	<	10.00	10.00		
6-45-42	6/15/88	Hydrogen sulfide	PPB	<	10.00	10.00		
6-45-42	6/15/88	Iodomethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	Iron, filtered	PPB		53.00	30.00	300.00	EPAS
6-45-42	6/15/88	Kerosene	PPB	<	10000.00	10000.00		
6-45-42	6/15/88	Lead, filtered	PPB	<	5.00	5.00	50.00	EPA
6-45-42	6/15/88	Magnesium, filtered	PPB		10800.00	50.00		
6-45-42	6/15/88	Manganese, filtered	PPB		7.00	5.00	50.00	EPAS
6-45-42	6/15/88	Mercury, filtered	PPB	<	0.10	0.10	2.00	EPA
6-45-42	6/15/88	Methacrylonitrile	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methanethiol	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methyl Isobutyl Ketone	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methyl bromide	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methyl chloride	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methyl ethyl ketone	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methyl methacrylate	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methylene Chloride	PPB	<	10.00	5.00		
6-45-42	6/15/88	N,N-diethylhydrazine	PPB	<	10.00	10.00		
6-45-42	6/15/88	Naphthalene	PPB	<	10.00	10.00		
6-45-42	6/15/88	Nickel, filtered	PPB	<	10.00	10.00		
6-45-42	6/15/88	Nitrate	PPB		7270.00	500.00	45000.00	EPA
6-45-42	6/15/88	Pentachlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	Pentachloroethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	Phenol	PPB	<	1000.00	1000.00		
6-45-42	6/15/88	Phosphate	PPB		3920.00	100.00		
6-45-42	6/15/88	Potassium, filtered	PPB	<	500.00	500.00		
6-45-42	6/15/88	Pyridine	PPB	<	5.00	5.00	10.00	EPA
6-45-42	6/15/88	Selenium, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	6/15/88	Silver, filtered	PPB		17300.00	200.00		
6-45-42	6/15/88	Sodium, filtered	PPB		196.00	10.00		
6-45-42	6/15/88	Strontium, filtered	PPB		34200.00	500.00	250000.00	EPAS
6-45-42	6/15/88	Sulfate	PPB	<	5.00	5.00		
6-45-42	6/15/88	Tetrachloroethylene	PPB	<	5.00	5.00	2000.00	EPAP
6-45-42	6/15/88	Toluene	PPB	<	5.55	10.00		
6-45-42	6/15/88	Total Organic Halogen, Low Det. Level	PPB		23300.00	1000.00		
6-45-42	6/15/88	Total carbon	PPB	<	622.00	2000.00		
6-45-42	6/15/88	Total organic carbon	PPB	<	10.00	5.00	70.00	EPAP
6-45-42	6/15/88	Trans-1,2-dichloroethene						

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 20 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	6/15/88	Tributylphosphoric Acid	PPB	<	10.00	10.00		
6-45-42	6/15/88	Trichloroethylene	PPB	<	5.00	5.00	5.00	EPA
6-45-42	6/15/88	Trichloromethanethiol	PPB	<	10.00	10.00		
6-45-42	6/15/88	Trichloromonofluoromethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	Trichloropropane	PPB	<	10.00	10.00		
6-45-42	6/15/88	Vanadium, filtered	PPB		34.00	5.00		
6-45-42	6/15/88	Vinyl chloride	PPB	<	10.00	10.00	2.00	EPA
6-45-42	6/15/88	Xylene-m	PPB	<	5.00	5.00	440.00	EPAP
6-45-42	6/15/88	Xylene-o,p	PPB	<	5.00	5.00	440.00	EPAP
6-45-42	6/15/88	Zinc, filtered	PPB	<	5.00	5.00	5000.00	EPAS
6-45-42	6/15/88	p-Dichlorobenzene	PPB	<	10.00	10.00	75.00	EPA
6-45-42	6/15/88	pH, Laboratory Measurement			7.90	0.01	8.50	EPAS
6-45-42	8/12/88	Cesium-137	PCI/L	<	6.14	20.00	200.00	EPAR
6-45-42	8/12/88	Cobalt-60	PCI/L	<	0.17	22.50	100.00	EPAR
6-45-42	8/12/88	Gross alpha	PCI/L		1.89	4.00	15.00	EPA
6-45-42	8/12/88	Gross beta	PCI/L		4.50	8.00	50.00	EPA
6-45-42	8/12/88	Natural uranium	UG/L		2.10	0.73		
6-45-42	8/12/88	Nitrate, High Detection Level	PPB		5170.00	2500.00	45000.00	EPA
6-45-42	8/12/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	8/12/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	8/12/88	Ruthenium-106	PCI/L	<	10.70	172.50	30.00	EPAR
6-45-42	8/12/88	Strontium-90	PCI/L	<	0.17	5.00	8.00	EPA
6-45-42	8/12/88	Tritium	PCI/L		46000.00	500.00	20000.00	EPA
6-45-42	8/12/88	Uranium-234	PCI/L		1.02	0.10	20.00	DOE
6-45-42	8/12/88	Uranium-235	PCI/L		0.04	0.10	24.00	DOE
6-45-42	8/12/88	Uranium-238	PCI/L		0.82	0.10	24.00	DOE
6-45-42	8/15/88	Alkalinity			101000.00	20000.00		
6-45-42	8/15/88	Aluminum, filtered	PPB	<	150.00	150.00		
6-45-42	8/15/88	Antimony, filtered	PPB	<	100.00	100.00		
6-45-42	8/15/88	Barium, filtered	PPB		16.00	6.00	1000.00	EPA
6-45-42	8/15/88	Beryllium, filtered	PPB	<	5.00	5.00		
6-45-42	8/15/88	Cadmium, filtered	PPB	<	2.00	2.00	10.00	EPA
6-45-42	8/15/88	Calcium, filtered	PPB		29700.00	50.00		
6-45-42	8/15/88	Cesium-137	PCI/L	<	0.11	20.00	200.00	EPAR
6-45-42	8/15/88	Chloride	PPB		4830.00	500.00	250000.00	EPAS
6-45-42	8/15/88	Chromium, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	8/15/88	Cobalt-60	PCI/L	<	3.76	22.50	100.00	EPAR
6-45-42	8/15/88	Copper, filtered	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	8/15/88	Cyanide	PPB	<	10.00	10.00		
6-45-42	8/15/88	Fluoride	PPB	<	500.00	500.00	4000.00	EPA
6-45-42	8/15/88	Fluoride, Low Detection Level	PPB		550.00	20.00	4000.00	EPA
6-45-42	8/15/88	Gross alpha	PCI/L		0.43	4.00	15.00	EPA
6-45-42	8/15/88	Gross beta	PCI/L		5.81	8.00	50.00	EPA
6-45-42	8/15/88	Iron, filtered	PPB	<	30.00	30.00	300.00	EPAS
6-45-42	8/15/88	Magnesium, filtered	PPB		10400.00	50.00		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 21 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	8/15/88	Manganese, filtered	PPB	<	5.00	5.00	50.00	EPAS
6-45-42	8/15/88	Natural uranium	UG/L		2.82	0.73		
6-45-42	8/15/88	Nickel, filtered	PPB	<	10.00	10.00		
6-45-42	8/15/88	Nitrate	PPB		6650.00	500.00	45000.00	EPA
6-45-42	8/15/88	Nitrate, High Detection Level	PPB		6870.00	2500.00	45000.00	EPA
6-45-42	8/15/88	Phosphate	PPB	<	1000.00	1000.00		
6-45-42	8/15/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	8/15/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	8/15/88	Potassium, filtered	PPB		4460.00	100.00		
6-45-42	8/15/88	Ruthenium-106	PCI/L	<	12.60	172.50	30.00	EPAR
6-45-42	8/15/88	Silver, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	8/15/88	Sodium, filtered	PPB		18000.00	200.00		
6-45-42	8/15/88	Specific conductance	UMHO		262.00	1.00	700.00	WDOE
6-45-42	8/15/88	Strontium, filtered	PPB		183.00	10.00		
6-45-42	8/15/88	Strontium-90	PCI/L	<	0.22	5.00	8.00	EPA
6-45-42	8/15/88	Sulfate	PPB		30900.00	500.00	250000.00	EPAS
6-45-42	8/15/88	Total carbon	PPB		23900.00	1000.00		
6-45-42	8/15/88	Total organic carbon	PPB	<	480.00	2000.00		
6-45-42	8/15/88	Tritium	PCI/L		45600.00	500.00	20000.00	EPA
6-45-42	8/15/88	Uranium-234	PCI/L		1.01	0.10	20.00	DOE
6-45-42	8/15/88	Uranium-235	PCI/L		0.06	0.10	24.00	DOE
6-45-42	8/15/88	Uranium-238	PCI/L		0.73	0.10	24.00	DOE
6-45-42	8/15/88	Vanadium, filtered	PPB		20.00	5.00		
6-45-42	8/15/88	Zinc, filtered	PPB		82.00	5.00	5000.00	EPAS
6-45-42	8/15/88	pH, Field Measurement			7.80	0.10	8.50	EPAS
6-45-42	8/15/88	pH, Laboratory Measurement			7.90	0.01	8.50	EPAS
6-45-42	9/09/88	Cesium-137	PCI/L	<	1.83	20.00	200.00	EPAR
6-45-42	9/09/88	Cobalt-60	PCI/L	<	1.32	22.50	100.00	EPAR
6-45-42	9/09/88	Gross alpha	PCI/L		1.07	4.00	15.00	EPA
6-45-42	9/09/88	Gross beta	PCI/L		4.38	8.00	50.00	EPA
6-45-42	9/09/88	Natural uranium	UG/L		2.13	0.73		
6-45-42	9/09/88	Nitrate, High Detection Level	PPB		6700.00	2500.00	45000.00	EPA
6-45-42	9/09/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	9/09/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	9/09/88	Ruthenium-106	PCI/L	<	28.10	172.50	30.00	EPAR
6-45-42	9/09/88	Strontium-90	PCI/L	<	0.37	5.00	8.00	EPA
6-45-42	9/09/88	Tritium	PCI/L		47100.00	500.00	20000.00	EPA
6-45-42	9/09/88	Uranium-234	PCI/L		1.02	0.10	20.00	DOE
6-45-42	9/09/88	Uranium-235	PCI/L		0.02	0.10	24.00	DOE
6-45-42	9/09/88	Uranium-238	PCI/L		0.70	0.10	24.00	DOE
6-45-42	10/06/88	Cesium-137	PCI/L	<	1.56	20.00	200.00	EPAR
6-45-42	10/06/88	Cobalt-60	PCI/L	<	0.39	22.50	100.00	EPAR
6-45-42	10/06/88	Gross alpha	PCI/L		1.61	4.00	15.00	EPA
6-45-42	10/06/88	Gross beta	PCI/L		4.17	8.00	50.00	EPA
6-45-42	10/06/88	Natural uranium	UG/L		2.28	0.73		

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 22 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	10/06/88	Nitrate, High Detection Level	PPB		6560.00	2500.00	45000.00	EPA
6-45-42	10/06/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	10/06/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	10/06/88	Ruthenium-106	PCI/L	<	14.10	172.50	30.00	EPAR
6-45-42	10/06/88	Strontium-90	PCI/L	<	0.06	5.00	8.00	EPA
6-45-42	10/06/88	Tritium	PCI/L		49500.00	500.00	20000.00	EPA
6-45-42	10/06/88	Uranium-234	PCI/L		1.00	0.10	20.00	DOE
6-45-42	10/06/88	Uranium-235	PCI/L		0.07	0.10	24.00	DOE
6-45-42	10/06/88	Uranium-238	PCI/L		0.79	0.10	24.00	DOE
6-45-42	10/31/88	Cesium-137	PCI/L	<	6.07	20.00	200.00	EPAR
6-45-42	10/31/88	Cobalt-60	PCI/L	<	4.26	22.50	100.00	EPAR
6-45-42	10/31/88	Gross alpha	PCI/L		1.66	4.00	15.00	EPA
6-45-42	10/31/88	Gross beta	PCI/L		3.18	8.00	50.00	EPA
6-45-42	10/31/88	Natural uranium	UG/L		2.16	0.73		
6-45-42	10/31/88	Nitrate, High Detection Level	PPB		6400.00	2500.00	45000.00	EPA
6-45-42	10/31/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	10/31/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	10/31/88	Ruthenium-106	PCI/L	<	20.20	172.50	30.00	EPAR
6-45-42	10/31/88	Strontium-90	PCI/L	<	0.30	5.00	8.00	EPA
6-45-42	10/31/88	Tritium	PCI/L		46300.00	500.00	20000.00	EPA
6-45-42	10/31/88	Uranium-234	PCI/L		0.85	0.10	20.00	DOE
6-45-42	10/31/88	Uranium-235	PCI/L		0.02	0.10	24.00	DOE
6-45-42	10/31/88	Uranium-238	PCI/L		0.53	0.10	24.00	DOE
6-45-42	12/13/88	Cesium-137	PCI/L	<	5.65	20.00	200.00	EPAR
6-45-42	12/13/88	Cobalt-60	PCI/L	<	1.37	22.50	100.00	EPAR
6-45-42	12/13/88	Gross alpha	PCI/L		1.23	4.00	15.00	EPA
6-45-42	12/13/88	Gross beta	PCI/L		4.44	8.00	50.00	EPA
6-45-42	12/13/88	Natural uranium	UG/L		2.20	0.73		
6-45-42	12/13/88	Nitrate, High Detection Level	PPB		7100.00	2500.00	45000.00	EPA
6-45-42	12/13/88	Plutonium-238	PCI/L	<	0.01	17.00	1.60	DOE
6-45-42	12/13/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	12/13/88	Ruthenium-106	PCI/L	<	6.03	172.50	30.00	EPAR
6-45-42	12/13/88	Strontium-90	PCI/L	<	0.22	5.00	8.00	EPA
6-45-42	12/13/88	Tritium	PCI/L		48000.00	500.00	20000.00	EPA
6-45-42	12/13/88	Uranium-234	PCI/L		0.85	0.10	20.00	DOE
6-45-42	12/13/88	Uranium-235	PCI/L		0.03	0.10	24.00	DOE
6-45-42	12/13/88	Uranium-238	PCI/L		0.67	0.10	24.00	DOE
6-45-42	1/13/89	Cesium-137	PCI/L	<	2.47	20.00	200.00	EPAR
6-45-42	1/13/89	Cobalt-60	PCI/L	<	2.27	22.50	100.00	EPAR
6-45-42	1/13/89	Gross alpha	PCI/L		2.52	4.00	15.00	EPA
6-45-42	1/13/89	Gross beta	PCI/L		3.50	8.00	50.00	EPA
6-45-42	1/13/89	Natural uranium	UG/L		2.51	0.73		
6-45-42	1/13/89	Nitrate, High Detection Level	PPB		7000.00	2500.00	45000.00	EPA
6-45-42	1/13/89	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	1/13/89	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 23 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/13/89	Ruthenium-106	PCI/L	<	11.80	172.50	30.00	EPAR
6-45-42	1/13/89	Strontium-90	PCI/L	<	0.35	5.00	8.00	EPA
6-45-42	1/13/89	Tritium	PCI/L		44500.00	500.00	20000.00	EPA
6-45-42	1/13/89	Uranium-234	PCI/L		1.13	0.10	20.00	DOE
6-45-42	1/13/89	Uranium-235	PCI/L		0.03	0.10	24.00	DOE
6-45-42	1/13/89	Uranium-238	PCI/L		0.86	0.10	24.00	DOE
6-45-42	1/16/89	Alkalinity			102000.00	20000.00		
6-45-42	1/16/89	Aluminum, filtered	PPB	<	150.00	150.00		
6-45-42	1/16/89	Antimony, filtered	PPB	<	100.00	100.00		
6-45-42	1/16/89	Barium, filtered	PPB		34.00	6.00	1000.00	EPA
6-45-42	1/16/89	Beryllium, filtered	PPB	<	5.00	5.00		
6-45-42	1/16/89	Boron, filtered	PPB		14.00	10.00		
6-45-42	1/16/89	Bromide	PPB	<	1000.00	1000.00		
6-45-42	1/16/89	Cadmium, filtered	PPB	<	2.00	2.00	10.00	EPA
6-45-42	1/16/89	Calcium, filtered	PPB		26600.00	50.00		
6-45-42	1/16/89	Chloride	PPB		5400.00	500.00	250000.00	EPAS
6-45-42	1/16/89	Chromium, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/16/89	Cobalt, filtered	PPB	<	20.00	20.00		
6-45-42	1/16/89	Copper, filtered	PPB		12.00	10.00	1300.00	EPAP
6-45-42	1/16/89	Cyanide	PPB	<	10.00	10.00		
6-45-42	1/16/89	Fluoride	PPB	<	500.00	500.00	4000.00	EPA
6-45-42	1/16/89	Iron, filtered	PPB	<	30.00	30.00	300.00	EPAS
6-45-42	1/16/89	Lithium, filtered	PPB	<	10.00	10.00		
6-45-42	1/16/89	Magnesium, filtered	PPB		10200.00	50.00		
6-45-42	1/16/89	Manganese, filtered	PPB	<	5.00	5.00	50.00	EPAS
6-45-42	1/16/89	Molybdenum, filtered	PPB	<	40.00	40.00		
6-45-42	1/16/89	Nickel, filtered	PPB	<	10.00	10.00		
6-45-42	1/16/89	Nitrate	PPB		6900.00	500.00	45000.00	EPA
6-45-42	1/16/89	Nitrite	PPB	<	1000.00	1000.00		
6-45-42	1/16/89	Phosphate	PPB	<	1000.00	1000.00		
6-45-42	1/16/89	Potassium, filtered	PPB		4530.00	100.00		
6-45-42	1/16/89	Silicon, filtered	PPB		21700.00	50.00		
6-45-42	1/16/89	Silver, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/16/89	Sodium, filtered	PPB		19300.00	200.00		
6-45-42	1/16/89	Specific conductance	UMHO		292.00	1.00	700.00	WDOE
6-45-42	1/16/89	Strontium, filtered	PPB		198.00	10.00		
6-45-42	1/16/89	Sulfate	PPB		36000.00	500.00	250000.00	EPAS
6-45-42	1/16/89	Tin, filtered	PPB	<	30.00	30.00		
6-45-42	1/16/89	Titanium, filtered	PPB	<	60.00	60.00		
6-45-42	1/16/89	Total carbon	PPB		22000.00	1000.00		
6-45-42	1/16/89	Total organic carbon	PPB	<	400.00	2000.00		
6-45-42	1/16/89	Vanadium, filtered	PPB		27.00	5.00		
6-45-42	1/16/89	Zinc, filtered	PPB		10.00	5.00	5000.00	EPAS
6-45-42	1/16/89	Zirconium, filtered	PPB	<	50.00	50.00		
6-45-42	1/16/89	pH, Field Measurement			7.70	0.10	8.50	EPAS

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 24 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/16/89	pH, Laboratory Measurement			8.00	0.01	8.50	EPAS
6-45-42	2/08/89	Alpha, High Detection Level	PCI/L		1.81	4.00	15.00	EPA
6-45-42	2/08/89	Cesium-137	PCI/L	<	3.13	20.00	200.00	EPAR
6-45-42	2/08/89	Cobalt-60	PCI/L	<	2.35	22.50	100.00	EPAR
6-45-42	2/08/89	Gross beta	PCI/L		2.95	8.00	50.00	EPA
6-45-42	2/08/89	Natural uranium	UG/L		2.47	0.73		
6-45-42	2/08/89	Nitrate, High Detection Level	PPB		7100.00	2500.00	45000.00	EPA
6-45-42	2/08/89	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	2/08/89	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	2/08/89	Ruthenium-106	PCI/L	<	30.10	172.50	30.00	EPAR
6-45-42	2/08/89	Strontium-90	PCI/L	<	0.17	5.00	8.00	EPA
6-45-42	2/08/89	Tritium	PCI/L		42500.00	500.00	20000.00	EPA
6-45-42	2/08/89	Uranium-234	PCI/L		1.19	0.10	20.00	DOE
6-45-42	2/08/89	Uranium-235	PCI/L		0.02	0.10	24.00	DOE
6-45-42	2/08/89	Uranium-238	PCI/L		1.19	0.10	24.00	DOE
6-45-42	3/02/89	Alpha, High Detection Level	PCI/L	<	0.04	4.00	15.00	EPA
6-45-42	3/02/89	Cesium-137	PCI/L	<	1.77	20.00	200.00	EPAR
6-45-42	3/02/89	Cobalt-60	PCI/L	<	2.46	22.50	100.00	EPAR
6-45-42	3/02/89	Gross beta	PCI/L		2.85	8.00	50.00	EPA
6-45-42	3/02/89	Natural uranium	UG/L		2.68	0.73		
6-45-42	3/02/89	Nitrate, High Detection Level	PPB		6500.00	2500.00	45000.00	EPA
6-45-42	3/02/89	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	3/02/89	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	3/02/89	Ruthenium-106	PCI/L	<	20.80	172.50	30.00	EPAR
6-45-42	3/02/89	Strontium-90	PCI/L	<	0.18	5.00	8.00	EPA
6-45-42	3/02/89	Tritium	PCI/L		39100.00	500.00	20000.00	EPA
6-45-42	3/02/89	Uranium-234	PCI/L		1.27	0.10	20.00	DOE
6-45-42	3/02/89	Uranium-235	PCI/L	<		0.10	24.00	DOE
6-45-42	3/02/89	Uranium-238	PCI/L		0.93	0.10	24.00	DOE
6-45-42	10/09/89	Alpha, High Detection Level	PCI/L		3.00	4.00	15.00	EPA
6-45-42	10/09/89	Cesium-137	PCI/L	<	3.60	20.00	200.00	EPAR
6-45-42	10/09/89	Cobalt-60	PCI/L	<	0.83	22.50	100.00	EPAR
6-45-42	10/09/89	Gross beta	PCI/L		5.19	8.00	50.00	EPA
6-45-42	10/09/89	Natural uranium	UG/L		2.14	0.73		
6-45-42	10/09/89	Nitrate, High Detection Level	PPB		6000.00	2500.00	45000.00	EPA
6-45-42	10/09/89	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	10/09/89	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	10/09/89	Ruthenium-106	PCI/L	<	1.04	172.50	30.00	EPAR
6-45-42	10/09/89	Strontium-90	PCI/L	<	0.24	5.00	8.00	EPA
6-45-42	10/09/89	Tritium	PCI/L		41400.00	500.00	20000.00	EPA
6-45-42	10/09/89	Uranium-234	PCI/L		0.93	0.10	20.00	DOE
6-45-42	10/09/89	Uranium-235	PCI/L	<		0.10	24.00	DOE
6-45-42	10/09/89	Uranium-238	PCI/L		0.75	0.10	24.00	DOE

APPENDIX D

SAMPLING AND ANALYSIS PLAN

APPENDIX D

SAMPLING AND ANALYSIS PLAN

This appendix introduces the procedures that will be used for sample collection (including well evaluation and sample withdrawal methods); chain of custody; analytical methods, including sample preservation, shipment, and chemical analysis; and quality assurance/quality control (Tables D-1 and D-2).

All sampling activities are currently performed under contract by Pacific Northwest Laboratory (PNL).

SAMPLE COLLECTION PROCEDURES

The procedures for ground water sample collection, water level measurements, and field measurements are contained in *Procedures for Ground-Water Investigations* (PNL 1989a). Specific applicable procedures include the following:

- GC-1--"Ground-Water Sample Collection Procedure"
- GC-2--"In-Line Sample Filtration Procedure"
- GC-3--"Disposal of Purge Water from Monitoring Wells"
- FA-1--"Temperature Measurement Procedure"
- FA-2--"Calibration of Conductivity Meter and Measurement of Field Conductivity"
- FA-3--"Calibration of pH Meter and Measurement of Field pH"
- WL-1--"Water-Level Measurement Procedure"
- WL-2--"Procedure for Standardizing Steel Tapes"
- AD-1--"Change Control Procedure"
- AD-2--"Ground-Water Sample Chain of Custody"
- AD-4--"Sediment Sample Chain of Custody"
- DO-1--"Collection and Documentation of Borehole Samples and Well Construction Data"
- DO-2--"Split-Barrel Auger Sediment Sampling."

CHAIN-OF-CUSTODY PROCEDURES

Chain-of-custody procedures are contained in *Procedures for Ground-Water Investigations* (PNL 1989a). The specific applicable procedure is AD-2, "Ground-Water Sample Chain-of-Custody Procedure." The history of the custody of each sample will be documented according to this procedure.

QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance

Quality assurance (QA) will be conducted in accordance with the PNL QA manual. A QA plan describing the manner in which specific QA requirements are to be met has been prepared in accordance with that manual (PNL 1989b).

Quality Control

The purpose of quality control (QC) is to determine and document the quality of the analytical results being produced by the laboratory and to bring potential problems with analyses to attention for corrective actions as needed. The QC effort has two main components (1) routine internal checks performed by the contract laboratory and (2) external checks conducted by PNL. The scope of these efforts is described in the following sections.

Internal Quality Control. Internal QC includes general practices applicable to a wide range of analyses as well as specific procedures stipulated for particular analyses. The QC and QA programs are documented in QC and QA manuals. A quarterly QC report will be provided to PNL that includes blank, matrix, spike, and surrogate data.

External Quality Control. Pacific Northwest Laboratory will use interlaboratory comparisons, replicate, blank, and blind samples to evaluate the accuracy of results. The purpose and scope of each of these are as follows.

Interlaboratory comparisons using field samples are conducted to determine if the results obtained are comparable to those obtained from other laboratories. Comparisons are currently being conducted for anions, selected volatile organic constituents, metals, cyanide, gross alpha, gross beta, and tritium. Each month, replicate samples from selected wells are delivered to four different PNL laboratories. The results from these PNL laboratories are then compared to the results of the contract laboratory. Samples sent to PNL laboratories are from the same sampling set as those to be analyzed in duplicate by the contract laboratory.

Replicate analyses of field samples are conducted to establish how much variability might be expected in the laboratory measurements performed on nearly identical samples and as a check for gross errors. Blanks for a wide range of analyses are submitted to the contract laboratory monthly to check for container or laboratory contamination.

Trip (transport) blanks or transfer blanks are submitted to determine whether environmental conditions encountered during collection and transportation of samples have affected the results obtained by analysis. One set of trip blanks and transfer blanks are submitted each sample period per sample area at a rate of at least one for 1 to 20 wells. These blanks are analyzed for volatile organic constituents.

Blind samples are submitted to estimate the bias of analytical laboratory procedures and to determine when this bias exceeds control limits. Blink standard samples prepared by PNL containing metals, anions, herbicides, pesticides, and volatile organic compounds have been submitted quarterly since January 1986. Most blind samples are now prepared with materials supplied by the U.S. Environmental Protection Agency (EPA), including the previous list of analytes plus ammonium ion, cyanide, semivolatile compounds, PCBs, and an expanded number of pesticides and volatile organic compounds. Samples containing constituents not available in EPA performance samples are prepared from high-quality chemicals. These include constituents from the enhanced thiourea and phosphorous pesticides group analyses, plus ethylene glycol, sulfide, perchlorate, and hydrazine dioxin (TCDD).

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Table D-1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 1 of 4)

CONSTITUENT	COLLECTION AND PRESERVATION[a,b]	ANALYSIS METHODS[c]	DETECTION LIMIT, PPB[d]
Metals Analyzed by the Inductively Coupled Plasma Method--Unfiltered/Filtered			
beryllium	P, HNO_3 to pH<2	SW-846,[e] #6010	3
strontium			10
zinc			5
calcium			50
barium			6
cadmium			5
chromium			10
silver			10
sodium			200
nickel			10
copper			10
vanadium			5
antimony			100
aluminum			150
manganese			5
potassium			100
iron			30
magnesium			50
boron			10
cobalt			20
lithium			10
molybdenum			40
silicon			50
tin			30
titanium			60
zirconium			50
Metals - Unfiltered/Filtered			
arsenic	P, HNO_3 to pH<2	SW-846, #7060	5
mercury	G, HNO_3 to pH<2	SW-846, #7470	0.1
selenium	P, HNO_3 to pH<2	SW-846, #7740	5
lead	P, HNO_3 to pH<2	SW-846, #7421	5
Anions by Ion Chromatography			
nitrate	P, none		500
sulfate			500
fluoride			500

Table D-1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 2 of 4)

CONSTITUENT	COLLECTION AND PRESERVATION[a,b]	ANALYSIS METHODS[c]	DETECTION LIMIT, PPB[d]
chloride		(f)	500
phosphate			1000
bromide			1000
nitrite			1000
Pesticides			
endrin	G, none	SW-846, #8080	0.1
methoxychlor			3
toxaphene			1
lindane (four isomers)			0.1
Herbicides			
2,4-D	G, none	SW-846, #8150	2
2,4-5-TP silvex			2
2,4,5-T			2
Volatile Organic Analyses (VOA)			
carbon tetra-chloride	G, no headspace	SW-846, #8240	5
benzene			5
methyl ethyl ketone			10
toluene			5
1,1,1-trichloro-ethane			5
1,1,2-trichloro-ethane			5
trichloroethylene			5
tetrachloroethylene			5
xylene-o,p			5
chloroform			5
1,1-dichloroethane			5
1,2-dichloroethane			5
trans-1,2-dichloroethylene			5
methylene chloride			5
vinyl chloride			10
xylene-m			5

Table D-1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 3 of 4)

CONSTITUENT	COLLECTION AND PRESERVATION[a,b]	ANALYSIS METHODS[c]	DETECTION LIMIT, PPB[d]
methyl isobutyl ketone			10
acetone by VOA			10
tetrahydrofuran			10
p-dichlorobenzene			5
Radiological			
radium	P, HNO_3 to pH<2	SW-846, #9315[g]	1 pCi/L
gross alpha	P, HNO_3 to pH<2	SW-846, #9310	4 pCi/L
gross beta	P, HNO_3 to pH<2	SW-846, #9310	8 pCi/L
tritium	P, none	ASTM D2476-81	500 pCi/L
uranium	P, HNO_3 to pH<2	ASTM D2907-83[h]	0.5 pCi/L
gamma scan	P, HNO_3 to pH<2	(i)	
technetium-99	P, HNO_3 to pH<2	(j)	15 pCi/L
iodine-129 (LDL)	P, none	(k)	1 pCi/L
strontium-90	P, HNO_3 to pH<2	(l)	5 pCi/L
plutonium-239/240	P, HNO_3 to pH<2	ASTM D3865-82	17 pCi/L
Other			
coliform bacteria	P, none	SW-846, #9131[m]	2.2[n]
coliform, MFT	P, none	SW-846, 9132[o]	1/100 mL
temperature	field measurement	(p)	--
conductivity, laboratory	P, none	(p)	1 µohm
pH, laboratory measurement	P, none	(p)	0.01
total organic halogen, low detection level	G, H_2SO_4 to pH<2 No headspace	SW-846, #9020	10
total organic carbon	G, HCl or H_2SO_4 to pH<2	SW-846, #9060	2000
total carbon	G, none	SW-846, #9060	2000
ammonium ion	P, H_2SO_4 to pH<2	ASTM D1426-D[q]	50
phenol	G, none	SW-846, #8040	10
cyanide	P, NaOH to pH>12	SW-846, #9010	10
hydrazine	G, HCl	ASTM D1385	30
total dissolved solids	P, none	Std. Methods 209B[r]	5000

Table D-1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 4 of 4)

[a]P, plastic; G, glass.
[b]All samples will be cooled to 4°C upon collection.
[c]Constituents grouped together are analyzed by the same method.
[d]Detection limit units except where indicated.
[e]EPA 1986.
[f]Analytical method adapted from Method 300.0, EPA 1984.
[g]The method also references ASTM 1988 and Krieger and Whittaker 1980.
[h]Method A/B, adopted from *Techniques of Water Resources Investigations of the U.S. Geological Survey*, as amended, U.S. Government Printing Office, Washington, D.C. and from NCRP 1985.
[i]Method 901, from Krieger and Whittaker 1980 and Volchok and dePlanque 1983.
[j]Method from procedures manual.
[k]Adapted from Method E-I-02, Volchok and dePlanque 1983.
[l]Method 905, Krieger and Whittaker 1980.
[m]Multiple tube fermentation.
[n]Most probable number.
[o]Membrane filter technique.
[p]PNL 1989.
[q]By ion selective electrode.
[r]APHA 1985.

Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists[a]. (Sheet 1 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
Metals Analyzed by the Inductively Coupled Plasma Method			
thallium	P, HNO_3 to pH<2	SW-846, #7840	5
Thiourea Group--Enhanced Additions			
thiourea	G, none	SW-846, #8330 (modified)	200
1-acetyl-2-thiourea			200
1-(o-chlorophenyl) thiourea			200
diethylstilbestrol			200
ethylenethiourea			200
1-naphthyl-2-thiourea			200
N-phenylthiourea			500
Pesticides--Enhanced Additions			
aldrin	G, none	SW-846, #8080	0.1
chlordane			1
4,4'DDD[f]			0.1
4,4'DDE[g]			0.1
4,4'DDT[h]			0.1
endosulfan I			0.1
endosulfan II			0.1
endosulfan sulfate			0.5
heptachlor			0.1
heptachlor epoxide			0.1
kepone			1
dieldrin			0.1
chlorobenzilate			300
Phosphorous Pesticides			
carbophenothion			2
tetraethylpyro-phosphate			2
disulfoton			2

Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists[a]. (Sheet 2 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
dimethoate	G, none	SW-846, #8140	2
methyl parathion			2
parathion			2
phorate			2
Direct Aqueous Injection			
paraldehyde			10,000
acrylamide			10,000
allyl alcohol			10,500
3-chloropropionitrile			10,000
ethyl carbamate	G, none	GC/FID[i]	10,000
ethyl cyanide			10,000
ethylene glycol			10,000
isobutyl alcohol			10,000
N-propylamine			10,000
2-propyn-1-ol			10,000
1-butanol			10,000
2-propanol			10,000
ethanol			10,000
monobutylphosphate			10,000
dibutylphosphate			10,000
ethylene glycol			10,000
1-butynol			10,000
Dioxins			
PCDDs[j]	G, none	SW-846, #8280	0.01
PCDFs[k]			0.01
2,3,7,8 TCDD[l]			0.01
Volatile Organic Analyses--Enhanced Additions			
dioxane			500
pryidine			5
acrolein			10
acrylonitrile			10
bis(chloromethyl) ether			5
bromoacetone			5

Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists[a]. (Sheet 3 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
methyl bromide			10
carbon disulfide			10
chlorobenzene			5
2-chloroethyl vinyl ether			5
methyl chloride			10
chloromethyl methyl ether	G, no headspace	SW-846, #8240	10
crotonaldehyde			10
1,2-dibromo-3-chloropropane			10
1,2-dibromoethane			10
dibromomethane			10
1,4-dichloro-2-butene			10
dichlorodifluoromethane			10
1,1-dichloro ethylene			10
1,2-dichloropropane			5
N-N-diethylhydrazine			10
1,1-dimethylhydrazine			10
1,2-dimethylhydrazine			10
iodomethane			10
methacrylonitrile			10
methanethiol			10
pentachloroethane			10
1,1,1,2-tetrachlorethane			10
1,1,2,2-tetrachlorethane			5
bromoform			5
trichlorometh-anethiol			10
trichloromonofluoromethane			10
1,2,3-trichloropropane			10
acetonitrile			10
formalin	G, no headspace	SW-846, #8240	500
ethylene oxide			10

Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists[a]. (Sheet 4 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
ethyl methacrylate			10
ethylbenzene			5
styrene			5
chlorobromodimethane			5
dibromochloromethane			5
2-hexanone			50
allyl chloride			100
chloroethane			10
propionitrile			5
vinyl acetate			5
SEMIVOLATILE ORGANIC ANALYSIS (Acid/Base/Neutral)			
1,2-dichlorobenzene	G, none	SW-846, #8270	10
1,3-dichlorobenzene			10
p-dichlorobenzene			10
hexachlorobenzene			10
pentachlorobenzene			10
1,2,4,5-tetrachlorobenzene			10
1,2,4-trichlorobenzene			10
hexachlorophene			10
naphthalene			10
1,2,3-trichlorobenzene			10
phenol			10
1,3,5-trichlorobenzene			10
1,2,3,4-tetrachlorobenzene			10
1,2,3,5-tetrachlorobenzene			10
kerosene			10,000
chlorobenzene by ABN			10
cresols			10
pentachlorophenol			50

Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists[a]. (Sheet 5 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
	G, none	SW-846, #8270	
tributylphospahte			10
strychnine			50
maleic hydrizide			500
nicotinic acid			100
acetophenone			10
warfarin			10
2-acetylamino-fluorene			10
4-aminobyphenyl			10
5-(aminomethyl)-3-isoxazolol			10
amitrole			10
aniline			10
aramite			10
auramine			10
benz[c]acridine			10
benz[a]anthracene			10
benzene, dichloromethyl			10
benzenethoil			10
benzidine			10
benzo[b]fluor-anthene			10
benzo[j]fluor-anthene			10
p benzoquinone			10
benzyl chloride			10
bis(2-chloroethoxy) methane			10
bis(2-choroethyl) ether			10
bis(2-ethylhexyl) phthalate			10
4-bromophenyl phenyl ether			10
butyl benzyl phthalate			10
2-sec-butyl-4, 6-dinitrophenol			10
chloroalkyl ethers			10
p-chloroaniline			20
p-chlorom-cresol			20

Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists[a]. (Sheet 6 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
1-chloro-2, 3-epoxypropane			10
2-chloronaphthalene			10
2-chlorophenol			10
chrysene			10
2-cyclohexyl-4, 6-dinitrophenol			10
dibenz[a,h]acridine			10
dibenz[a,j]acridine			10
dibenz[a,h] anthracene			10
7H-dibenzo[c,g] carbazole			10
dibenzo[a,e]pyrene			10
dibenzo[a,h]pyrene			10
dibenzo[a,i]pyrene			10
di-n-butyl phthalate			10
3,3'-dichloro-benzidine			20
2,4-dichlorophenol			10
2,6-dichlorophenol			10
diethyl phthalate			10
dihydrosafrole			10
3,3'-dimethoxy-benzidine			10
p-dimethylamino-azobenzene			10
7,12-dimethylbenz [a]anthracene			10
3,3'-dimethyl-benzidine			10
thiofanox			10
alpha, alpha-dimethylphen-ethylamine			10
dimethyl phthalate			10
dinitrobenzene			10
4,6-dinitro-o-cresol and salts			50
2,4-dinitrophenol			50
2,4-dinitrotoluene			10
2,6-dinitrotoluene			10

Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists[a]. (Sheet 7 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
di-n-octyl phthalate			10
diphenylamine			10
1,2-diphenyl-hydrazine			10
di-n-propylnitro-samine			10
ethyleneimine			10
ethyl methanesul-fonate			10
fluoranthene			10
hexachlorobutadiene			10
hexachlorocyclo-pentadeine			10
hexachloroethane			10
indeno(1,2,3-cd) pyrene			10
isosafrole			10
malononitrile			10
melphalan			10
methapyrilene			10
metholonyl			10
2-methylaziridine			10
3-methylcholan-threne			10
4,4′-methylenebis (2-chloroaniline)			10
2-methyllactoni-trile			10
methyl methacrylate			10
methyl methanesul-fonate			10
2-methyl-2-(methylthio) propionaldehyde-			10
methylthiouracil			10
1,4-naphthoquinone			10
1-naphthylamine			10
2-naphthylamine			10
p-nitroaniline			10
nitrobenzine			10
p-nitrophenol			50
N-nitrosodi-n-butylamine			10
			10

Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists[a]. (Sheet 8 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
N-nitrosodiethanolamine			10
N-nitrosodiethylamine			10
N-nitrosodimethylamine			10
N-nitrosomethylethylamine			10
N-nitroso-n-methylurethane			10
N-nitrosomethylvinylamine			10
N-nitrosomorpholine			10
N-nitrosonornicotine			10
N-nitrosopiperidine			10
nitrosopyrrolidine			10
pentachloronitrobenzene			10
phenacetin			10
phenylenediamine			10
phthalic acid esters			10
2-picoline			10
pronamide			10
reserpine			10
resorcinol			10
safrol			10
2,3,4,6-tetrachlorophenol			10
thiuram			10
toluenediamine			10
O-toluidine hydrochloride			10
2,4,5-trichlorophenol			10
O,O,O-triethyl phosphorothioate			10
sym-trinitrobenzene			10
tris(2,3-dibromopropyl) phosphate			10
benzo[a]pyrene			10
chlornaphazine			10

Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists[a]. (Sheet 9 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
bis(2-choroiso-propyl)ether			10
hexachloropropene			10
isophorone			10
acenaphthene			10
fluorene			10
anthracene			10
pyrene			10
o-nitrophenol			10
2-methylnaphthalene			10
phenanthrene			10
benzyl alcohol			10
benzo(k)fluor-anthene			10
benzo(ghi)perylene			10
dinoseb			10
diallate			10
N-nitrosodiphenyl-amine			10
dibenzofuran			10
acenaphthylene			10
bis (1-chloro-1-methylethyl) ether			10
0,0-diethyl-0, 2-pyrazinyl phosorothionate			10
isodrin			10
o-nitroaniline (2-nitroaniline)			50
m-nitroaniline (3-nitroaniline)			50
4-nitroquinoline-1-oxide			10
acetone by ABN			10
OTHER			
polychlorinated biphenyls	G, none	SW-846, #8080	1
perchlorate	P, none	70-IC[m]	500

Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists[a]. (Sheet 10 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
sulfide	P, NaOH/zinc acetate	SW-846, #9030	1000
citrus red no. 2	G, none	AOAC #34.015B[n]	1000

[a]WAC 173-303-9905, "Dangerous Waste Constituent List"; and 40 CFR 264, Appendix IX, "Ground-Water Monitoring List."
[b]P, plastic; G, glass.
[c]All samples will be cooled to 4°C upon collection.
[d]Constituents grouped together are analyzed by the same method.
[e]Detection limit units except where indicated.
[f]DDD = dichlorodiphenyldichloroethane.
[g]DDE = dichlorodiphenyldichloroethylene.
[h]DDT = dichlorodiphenyltrichloroethane.
[i]Direct aqueous injection.
[j]PCDD = polychlorinated dibenzo-p-dioxin.
[k]PCDF = polychlorinated dibenzofuran.
[l]TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin.
[m]Analytical method adapted from Method 300.0, EPA 1984.
[n]AOAC 1980.

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Chapter 6.0 Procedures to Prevent Hazards

6.0 PROCEDURES TO PREVENT HAZARDS [F] 6.3

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Circumvention of Statute

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6.0 PROCEDURES TO PREVENT HAZARDS [F]

This chapter discusses security; inspection schedules; preparedness and prevention requirements; preventive procedures, structures, and equipment; and prevention of reaction of ignitable, reactive, and incompatible waste at LERF and ETF.

6.1 SECURITY [F-1]

Refer to Permit Attachment 33, § 6.1, Security.

6.1.1 Waiver [F-1b]

Waiver of the security procedures and equipment requirements for LERF and ETF are not requested, therefore; WAC 173-303-310(1)(a) and (b) are not applicable to LERF and ETF.

6.2 INSPECTION PLAN [F-2]

This section describes the method and schedule for inspections of LERF and ETF. The purpose of inspections is to help ensure that situations do not exist that might cause or lead to the release of dangerous and/or mixed waste that could pose a threat to human health and the environment. Abnormal conditions identified by an inspection will be corrected on a schedule that prevents hazards to workers, the public, and the environment.

6.2.1 General Inspection Requirements [F-2a and F-2a(4)]

The content and frequency of inspections are described in this section. Inspection records are retained at the ETF, or other approved locations, for a minimum of 5 years.

In certain areas of the ETF, many inspections are performed remotely to maintain ALARA exposure. Monitoring instruments are connected to audible alarms and visual indicators track alarm status. The monitoring system provides trending of selected monitoring data, graphics, and equipment summary displays.

A preventive maintenance recall system is employed to direct preventive maintenance activities at the LERF and the ETF. Equipment requiring maintenance is checked as indicated by the maintenance history and the manufacturer's recommendations. The preventive maintenance of certain equipment might not be possible if the LERF or the ETF is in an operational mode. Thus, the preventive maintenance could be performed slightly earlier or later than planned to minimize impact on operations.

Instrumentation at ETF is calibrated regularly to ensure accuracy and reliability. All process control instrumentation is calibrated on a schedule depending on previous calibration experience. An instrument calibration and recall system is employed to manage calibrations.

6.2.1.1 Types of Problems

Key components of the LERF inspection program include the following areas:

- Structural integrity of the basins
- Catch basin secondary containment system integrity
- Evidence of release from basins
- Safety, communications, and emergency equipment

Key components of the ETF inspection program include the following areas:

- Condition of tanks and ancillary piping

- Condition of containers
- Condition of the process control equipment
- Condition of emergency equipment
- Condition of secondary containment

Tables 6.1 and 6.2 provide a description of ETF items to be inspected.

6.2.1.2 Frequency of Inspections [F-2a(3)]

The frequency of inspections is based on the rate of possible deterioration of equipment and the probability of a threat to human health or the environment.

While in operation, the LERF is inspected weekly. The LERF also is inspected for run-on, run-off, cover integrity, and erosion problems after significant precipitation events. The ETF is inspected as indicated in Tables 6.1 and 6.2.

6.2.2 Specific Process Inspection Requirements [F-2d]

The following sections describe the specific process inspections performed at LERF and ETF.

6.2.2.1 Container Inspections [F-2d(1)]

Containers are used at the ETF to store solidified secondary waste, such as the powder waste from the thin film dryer and maintenance and operations waste. When containers are being held in container storage areas, the following inspection schedule is maintained:

- Daily visual inspection of container storage area for leaks, spills, accumulated liquids, and open or improperly sealed containers
- Weekly visual inspection of container labels to ensure labels are not obscured, removed, or otherwise unreadable
- Weekly visual inspection for deterioration of containers, containment systems, or cracks in protective coating or foundations caused by corrosion, mishandling, or other factors

Following the inspections, an inspection datasheet is signed and dated by the inspector and supervisor.

6.2.2.2 Tank Inspections [F-2d(2)]

A description of the tank systems and ancillary equipment at the ETF is given in Chapter 4.0. Inspections and frequencies are given in Tables 6.1 and 6.2. This section includes a brief discussion of the inspections.

6.2.2.2.1 Overfill Protection. Tanks that have the possibility of being overfilled have level instrumentation that alarms before the tanks reach overflow. High tank level alarms annunciate in the control room, allowing operating personnel to take immediate action to stop the vessels from overfilling. These alarms are monitored continuously in the control room during solution transfers.

6.2.2.2.2 Visual Inspections. Visual inspections of tanks and secondary containments are performed to check for leaks, signs of corrosion or damage, and malfunctioning equipment. Inspections are performed on tanks, secondary containment within the ETF surge tank and verification tank, and associated secondary containment.

6.2.2.2.3 Secondary Containment Leak Detectors. The surge tank and verification tank secondary containment systems have sloped floors that drain solution to sumps equipped with leak detectors that alarm in the control room. These alarms are monitored continuously in the control room. If an alarm is

activated, further investigation is performed to determine if the source is a tank leak or other solution (i.e., precipitation).

6.2.2.2.4 Integrity Assessments. The initial integrity assessment was issued in 1995 (Chapter 4.0). Consistent with the recommendations of the integrity assessment, a periodic integrity assessment program was developed for the ETF tanks and is discussed in detail in Chapter 4.0, §4.4.2.

6.2.2.2.5 Effluent Treatment Facility Piping. The ETF employs an extensive piping system. During inspections at the ETF, any aboveground piping is inspected visually for signs of leakage and for general structural integrity. During the visual inspection, particular attention is paid to valves and fittings for signs of cracking, deformation, and leakage.

6.2.2.3 Surface Impoundments [F-2d(6)] and Condition Assessment [F-2d(6)(a)]

The following describes the surface impoundment inspections performed at LERF.

6.2.2.3.1 Overtopping Control [F-2d(6)(a)(1)]. Under current operating conditions, 1.34 meters of freeboard is maintained at each LERF basin, which corresponds to a normal operating level of 6.1 meters, or 24.6 million liters. Level indicators at each basin are monitored to confirm that this level is not exceeded.

Before an aqueous waste is transferred into a basin, administrative controls are implemented to ensure overtopping will not occur during the transfer. The volume of feed to be transferred is compared to the available volume in the receiving basin. The transfer is not initiated unless there is sufficient volume available in the receiving basin or a cut-off level is established. The transfer into the basin would be stopped when this cut-off level is reached.

The LERF basins also are provided with floating very low-density polyethylene covers that are designed and constructed to prevent overtopping by the introduction of precipitation and dust into the basins. Overtopping and flow control also are discussed in Chapter 4.0.

6.2.2.3.2 Impoundment Contents [F-2d(6)(a)(2)]. The LERF basins are inspected weekly to assess whether the contents are escaping from a basin. Level indicators are inspected weekly to check for unaccountable change in the level of the basins.

6.2.2.3.3 Leak Detection [F-2d(6)(a)(3)]. The leachate detection, collection, and removal system is described in Chapter 4.0. The leachate collection sump pump is activated automatically when the liquid level in the leachate sump reaches a preset level. A flowmeter and totalizer measure the amount of leachate removed. An inspection is performed weekly where the totalizer reading and basin level reading are used to determine the leak rate per wetted surface area. The leak rate is compared to previous rates to see if leakage has increased.

The LERF employs a double-walled transfer piping between 242-A Evaporator and LERF and between LERF and ETF. The WAC 173-303-650 regulations do not require a discussion of piping for surface impoundments. However, for the purposes of comprehensive coverage of the LERF, inspections and integrity assessments are performed on the piping system. Aqueous waste (e.g., process condensate) is transferred from the 242-A Evaporator to the LERF via a buried pipeline. Likewise, aqueous waste is transferred to the ETF via buried pipelines. At the LERF dikes, aboveground piping serves to transfer waste from one basin to another.

The buried pipelines normally are continuously monitored during transfers by a leak detection system (Chapter 4.0). The alarms on the leak detection system are monitored in the ETF control rooms. As an alternative to continuous leak detection, the transfer lines can be inspected daily during transfers by opening the secondary containment drain lines at the LERF catch basins (for 242-A Evaporator transfers

to LERF) and the surge tank (for LERF transfers to ETF) to inspect for leakage. During the routine inspections at LERF, the aboveground piping system is inspected for signs of leakage and for general structural integrity. During the visual inspection, particular attention is paid to valves and fittings for signs of cracking, deformation, and leakage.

6.2.2.3.4 Dike Erosion [F-2d(6)(a)(4)]. The LERF basins and dikes are visually inspected weekly and after storms for severe erosion or other signs of deterioration in the dikes from precipitation, wind, burrowing mammals, or vegetation.

6.2.2.3.5 Structural Integrity [F-2d(6)(b)]. A written certification attesting to the structural integrity of the basin dikes, signed by a qualified, registered professional engineer, is provided in Chapter 4.0.

6.2.2.3.6 Container Inspection [F-2b(1)]. Normal operation of the LERF does not involve the storage of dangerous waste in containers. Therefore, the inspection requirements of this section normally are not applicable to the LERF. Any containerized RCRA-regulated waste that might be generated at LERF will be brought to the ETF and managed in accordance with WAC 173-303-200(1) and is discussed in Section 6.2.2.1.

6.2.3 Inspection Log [F-2b and 2c]

Observations made and deficiencies noted during an inspection are recorded on inspection log sheets (also called turnover sheets). On completion, the log sheet includes the inspector's printed name, signature, date, and time; the log sheet is submitted for review and approval by ETF/LERF management or their designee, as required by operating procedures. Once approved, the log sheet is kept in LERF and ETF files. Inspection records are retained at the ETF, or other approved locations, for a minimum of 5 years. The inspection records are used to help determine any necessary corrective actions. Problems identified during the inspections are prioritized and addressed in a timely fashion to mitigate health risks to workers, maintain integrity of the TSD units, and prevent hazards to public health and the environment.

If while performing an inspection, a leak or spill is discovered, facility operations responds per the emergency response procedures action is taken to stop the leak and determine the cause. The waste is removed from the secondary containment in a timely manner that prevents harm to human health and the environment.

6.2.4 Storage of Ignitable or Reactive Wastes [F-2d(3)]

The LERF could receive an aqueous waste that is designated reactive or ignitable. Any aqueous waste exhibiting these characteristics is managed (e.g., through blending in LERF) such that the waste no longer exhibits the reactive or ignitable characteristics.

Though unlikely, the ETF secondary waste might have the characteristics of being reactive or ignitable. A qualified inspector performs annual fire inspections of the ETF using a checklist developed specifically for facilities that handle dangerous and/or mixed waste.

6.3 PREPAREDNESS AND PREVENTION REQUIREMENTS [F-3]

The following sections document the preparedness and prevention measures taken at LERF and ETF.

6.3.1 Equipment Requirements [F-3a]

The following sections describe the internal and external communications systems and the emergency equipment required that could be activated by the LERF/200 Area ETF BED. Hanford Facility-wide equipment is identified in Permit Attachment 4, *Hanford Emergency Management Plan*, (DOE/RL-94-02).

6.3.1.1 Internal Communications

When operators are present at the LERF, the operators carry mobile (hand-held) two-way radios to maintain contact with ETF personnel. The operators at LERF are informed of emergencies (e.g., building and/or area evacuations, take-cover events, high airborne contamination, fire, and/or explosion), and are provided with emergency instructions by several systems. These systems include the mobile two-way radios, and the telephone in the LERF instrument building.

The ETF is equipped with an internal communication system to provide immediate emergency instruction to personnel. The onsite communication system at the ETF includes telephones, mobile two-way radios, a public address system, and alarm systems. The telephone and radio systems provide for intraplant communication as well as external communication. Provisions are made to respond appropriately to various emergencies, including the following alarm-activated emergencies: building evacuations, fire and/or explosion, loss of essential services, loss of ventilation, discharges, and high airborne contamination. Chapter 7.0 provides additional information on the response activities.

Immediate emergency instruction to personnel is provided by a public address system via speaker horns and ceiling-mounted speakers located throughout the building. The public address system is coupled to building telephone systems to provide telephone accessed voice paging. The ETF alarms are annunciated via elements of the public address system. The general telephone system carries various communication signals (e.g., telephone, crash alarm), is linked to the Hanford Site integrated voice data telecommunications system.

6.3.1.2 External Communications [F-3a(2)]

The LERF and its operators are equipped with devices for summoning emergency assistance from the Hanford Fire Department, the Hazardous Materials Response Team, and/or Hanford patrol, as necessary. External communication to summon emergency assistance is made by a telephone communication system or hand held radio as described in Permit Attachment 4, *Hanford Emergency Management Plan*, (DOE/RL-94-02). The LERF telephone is available in the instrumentation building.

- For ETF, fire alarm pull boxes and telephones are used as external communication systems, as described in Permit Attachment 4, *Hanford Emergency Management Plan*, (DOE/RL-94-02), are provided at numerous locations throughout the ETF.

6.3.1.3 Emergency Equipment [F-3a(3)]

The LERF and ETF rely primarily on the Hanford Fire Department to respond to fires and other emergencies as described in Permit Attachment 4, *Hanford Emergency Management Plan*, (DOE/RL-94-02). The Hanford Fire Department is capable of providing rapid response to fires within the 200 East Area. All LERF and ETF operators are familiar with the LERF and ETF contingency plans (Chapter 7.0) and are trained in the use of emergency pumping of LERF/200 Area ETF systems, fire, and communications equipment.

Portable fire extinguishers, fire control equipment, spill control equipment, and decontamination equipment is available at various locations in the ETF.

Fire control equipment is available at the ETF and could include the following:

- Fire extinguishers (all-utility use, dry chemical), good for use on small fires
- Automatic fire suppression systems installed in the ETF control room and electrical room
- Fire alarm pull boxes
- A water spray system is installed in the operating and administrative portions of the ETF.

Respirators, hazardous material protective gear, and special work procedure clothing for ETF personnel are kept in the change room at the ETF. Safety showers are located in convenient locations in the ETF. Portable emergency eyewashes are used at the ETF. Water for these devices is supplied from the ETF sanitary water system.

6.3.1.4 Water for Fire Control [F-3a(4)]

A water main is not provided to the LERF. Water for fire control is supplied by the Hanford Fire Department trucks for fires requiring high water volume and pressure as described in Permit Attachment 4, *Hanford Emergency Management Plan*, (DOE/RL-94-02).

The ETF is serviced by two 12-inch raw water lines that are tied into the 200 East Area raw water distribution grid. These lines provide a looped configuration that supplies two independent sources of raw water for fire protection and raw water uses. Connections from the ETF raw water system supply fire hydrants and the wet-pipe sprinkler system.

In the event that water pressure is lost, the Hanford Fire Department is equipped with fire engines to provide needed water.

6.3.2 Aisle Space Requirement [F-3b]

The operation of the LERF does not involve aisle space. Nevertheless, the LERF and the individual basins are easily accessible to emergency response personnel and vehicles. A 6.1-meter-wide service road runs along the base of the basin area on the east, south, and west sides within the operational security fence.

Aisle spacing at ETF is sufficient to allow the movement of personnel and fire protection equipment in and around the containers. This storage arrangement also meets the requirements of the National Fire Protection Association and the Life Safety Code (NFPA 1996) for the protection of personnel and the environment. A minimum 0.76-meter aisle space is maintained between rows of containers as required by WAC 173-303-630(5)(c).

6.4 PREVENTIVE PROCEDURES, STRUCTURES, AND EQUIPMENT [F-4]

The following sections describe preventive procedures, structures, and equipment.

6.4.1 Unloading Operations, Spill Prevention, and Control [F-4a]

Underground pipelines that transfer aqueous waste to and from the LERF are encased in a secondary pipe. If a leak is detected in a pipeline, flow in the pipeline will be stopped and the cause of the leak investigated and remediated.

If it is required to transfer aqueous waste from one LERF basin to another, submersible pumps are located in risers at the northwest corner of a basin. Valves are closed or opened depending on the direction of the fluid transfer. Pumps are started, providing a cumulative flow of between 2,000 and 3,000 liters per minute into another basin.

The ETF Load-In Station is monitored continuously during tank-filling operations and filling is stopped immediately if leaks occur. Care is taken to ensure that even minor leaks are cleaned up immediately and disposed of in accordance with approved management procedures. Any spill that is determined to be a dangerous waste will be managed according to the requirements of WAC 173-303.

6.4.2 Run-Off [F-4b]

The LERF is constructed and operated to ensure that all aqueous waste is contained within the basins. The basins are designed and operated to prevent overtopping (Section 6.2.2.3.1). Furthermore, the basins are provided with very low-density polyethylene floating covers to prevent the introduction of precipitation into the basins. The basins also are graded to ensure that all precipitation outside the basins is directed away from the surface impoundments.

The basins are constructed so that the top of the basin dikes are approximately 3 meters above grade. The exterior side slopes of the basins have a 2.25 (horizontal) to 1 (vertical) slope. Run-on of precipitation to the basins from the surrounding area is not possible because the surrounding area slopes away from the LERF.

Dangerous waste and hazardous chemical handling areas at the ETF are designed to contain spills, leaks, and wash water, thereby preventing run-off and subsequent releases. All dangerous and/or mixed waste loading and unloading areas are provided with secondary containment structures as described in Chapter 4.0.

6.4.3 Water Supplies [F-4c]

The LERF uses operating practices, structures, and equipment to prevent the contamination of natural water supplies (i.e., groundwater and surface water). The LERF is monitored closely during operation to detect abnormal conditions (e.g., leaks), and regularly inspected to detect equipment and structural deteriorations that could allow possible water supply contamination. The basins are provided with a leachate collection system that is designed to contain any leachate generated. These systems, in conjunction with the double-composite liner system and underlying low permeable clay liner, ensure that should a release occur, the release will be fully contained within the basin configuration and, therefore, water supplies will be protected. Chapter 7.0 provides information on procedures that are implemented if a release is detected at the LERF.

There are no drinking water wells near the ETF. Therefore, a release would not immediately contaminate drinking water supplies. The ETF uses operating practices, structures, and equipment to prevent the contamination of natural water supplies (i.e., groundwater and surface water). The ETF is monitored during operation to detect abnormal conditions, and is inspected regularly to detect equipment and structural deteriorations that could allow spills to the environment. Areas in contact with dangerous and/or mixed waste are monitored continuously during operation through a series of level and pressure indicators, leak detection alarms, equipment failure alarms, and control panel readouts. In addition, the ETF is inspected regularly for the presence of leaks or other off normal conditions wherever possible (in all areas that can be safely entered).

In addition to detailed operating practices, structures and equipment are used at the ETF to prevent contamination of water supplies. The structures and equipment designed to prevent contamination of water supplies are the same as the structures and equipment used to prevent run-off from dangerous and/or mixed waste handling areas.

6.4.4 Equipment and Power Failure [F-4d]

The storage function of the LERF is not affected by loss of power and a temporary loss of power would not pose a threat to the environment. Loss of electrical power would not cause the storage of the waste to be jeopardized. For process condensate transferred from the 242-A Evaporator, appropriate valving procedures are followed to ensure a smooth restart of the flow to the LERF in the event of a power failure at the 242-A Evaporator.

The ETF does not have a standby power source. Power to selected lighting, computers, and process controls is configured with an uninterruptible power supply. During partial loss of normal power, the effected pumps and subsystems will be shut down. Complete loss of power to the ETF shuts down the entire ETF except for the instruments in the control room connected to the uninterruptible power supply. Redundant pumps allow the process to continue to operate when only one component is out of service.

When power at the ETF is lost, the valves assume a fail-safe position to allow the process to remain in a safe shutdown mode until restoration of power. This action allows the operators to perform equipment surveys during shutdown and to confirm that there are no safety issues because the ETF is shut down. Because a power failure would also shutoff flow into the ETF, there will not be any increase in volume in any of the holdup basins, tanks, or other systems.

A combination of reliability, redundancy, maintenance, and repair features are used in the ETF equipment and systems to minimize random failure of equipment. For crucial systems such as ventilation filters, redundant trains are provided to mitigate equipment and system failure. Spare parts are maintained for essential production and safety equipment.

6.4.5 Personnel Exposure [F-4e]

At the LERF and ETF, operating practices, structures, and equipment are used to prevent undue exposure of personnel to dangerous and/or mixed waste. Protective clothing and equipment are used by all personnel handling waste. All operations are conducted so that exposure to dangerous and/or mixed waste and hazardous materials are maintained ALARA.

Protective clothing and equipment are prescribed for personnel handling chemicals or dangerous waste. Before the start of any operation that could expose personnel to the risk of injury or illness, a review of the operation is performed to ensure that the nature of hazards that might be encountered is considered and appropriate protective gear is selected. Personnel are instructed to wear personal protective equipment in accordance with training, posting, and instructions.

A change trailer at LERF is located between basins 42 and 43. In addition, the change trailer has an operations office for working with procedures. Exits within the change trailer are clearly marked. A storage building is located within the perimeter fence, northwest of the basins. The LERF storage building also is provided with separate storage areas for clean and contaminated equipment. A decontamination shower and decontamination building is located at the 272-AW Building, approximately 1.6 kilometers from the LERF or at the ETF.

The ETF has eyewash stations and safety showers in convenient locations for use by personnel. The following structures and equipment were incorporated into the ETF design to minimize personnel exposure.

- Offices, control room, clean- and soiled-clothes storage areas, change rooms, and the lunchroom are situated to minimize casual exposure of personnel.
- Building exit pathways are located to provide rapid egress in emergency evacuations.
- Emergency lighting devices are located strategically throughout the ETF.
- Audio and/or visual alarms are provided for all room air samplers, area alarms, and liquid monitors. Visual readouts for these alarm systems are located in less contaminated areas to minimize exposure to personnel.
- Areas for decontaminating and maintaining equipment are provided in contaminated areas to limit the spread of contamination to uncontaminated areas such as the control room.
- Instrument interlock systems automatically return process operations to a safe condition if an unsafe condition should occur.

- The ETF ventilation systems are designed to provide airflow from uncontaminated zones to progressively more contaminated zones.

Whenever possible, exposures to hazards are controlled by accepted engineering and/or administrative controls. Protective gear is used where effective engineering or administrative controls are not feasible.

6.5 PREVENTION OF REACTION OF IGNITABLE, REACTIVE, AND INCOMPATIBLE WASTE [F-5 through F-5b]

Typically, aqueous waste managed at the LERF or ETF does not display the characteristics of reactivity or ignitability. Any aqueous waste streams exhibiting these characteristics are blended or mixed at LERF to a concentration where the waste no longer exhibits reactive or ignitable characteristics.

Incompatible aqueous waste is not expected to be stored or treated at the LERF or ETF (Chapter 3.0). Therefore, the requirements of WAC 173-303-806(4)(a) are not applicable.

Table 6.1. Visual Inspection Schedule for the ETF

Item	Inspection	Frequency	Inspected by
Main Treatment Train			
Surge tank system	Inspect area for leaks. Note any unusual noises or vibration from the system pumps. Inspect secondary containment system for signs of deterioration.	Daily	Process operator
Rough filter	Inspect for leaks.	Daily*	Process operator
Ultraviolet oxidation system	Inspect module for leaks. Inspect peroxide storage tank, ancillary equipment for leaks.	Daily*	Process operator
pH adjustment tank	Inspect tank and ancillary equipment for leaks.	Daily*	Process operator
H_2O_2 decomposer	Inspect tank and ancillary equipment for leaks.	Daily*	Process operator
Fine filter	Inspect module for leaks.	Daily*	Process operator
Degasification system	Inspect module for leaks. Note any unusual noises or vibration from the degasification blower.	Daily*	Process operator
Reverse osmosis system	Inspect tanks and ancillary equipment for leaks. Note any unusual noises or vibration from the system pumps.	Daily*	Process operator
Polishers	Inspect tanks and ancillary equipment for leaks.	Daily*	Process operator
Effluent pH adjustment tank	Inspect tank and ancillary equipment for leaks.	Daily*	Process operator
Verification tanks	Inspect tanks and ancillary equipment for leaks. Note any unusual noises or vibration from the system pumps. Inspect secondary containment system for signs of deterioration.	Daily	Process operator
Secondary Treatment Train			
Secondary waste receiving tank	Inspect tank and ancillary equipment for leaks.	Daily	Process operator
ETF evaporator	Inspect tank and equipment for leaks. Note any unusual noises or vibration from the system pumps or compressor.	Daily*	Process operator
Concentrate tank	Inspect tank and ancillary equipment for leaks.	Daily*	Process operator
Thin film dryer	Inspect tanks and ancillary equipment for leaks (viewed through camera). Note any unusual noises or vibration from the system pumps or blower.	Daily*	Process operator
Container handling	Inspect area for spills, leaks, accumulated liquids.	Daily	Process operator
Container handling	Inspect for deterioration of containers and secondary containment, including corrosion and cracks in	Weekly	Process operator

Item	Inspection	Frequency	Inspected by
	secondary containment foundation and coating. Inspect container labels to ensure that they are readable.		
Resin dewatering	Inspect module for leaks. Note any unusual noises or vibration from the system pumps or blower.	Daily*	Process operator
Support Systems			
Vessel ventilation system	Inspect filters (HEPA and pre-filters), check vessel off-gas pressures, system flow, and discharge temperatures.	Daily	Process operator
Sump tank system	Inspect sump trenches for unexpected liquids, which indicate spills or leaks from process equipment.	Daily	Process operator
Safety Systems			
Eye wash stations	Check status; check for adequate pressure.	Monthly	Process operator
Safety showers	Check status; check for adequate pressure.	Monthly	Process operator
Emergency Systems			
Fire extinguishers	Check for adequate charge.	Monthly	Process operator
Emergency lighting	Test operability.	Monthly	Process operator
Processing Area			
Uninterruptible power supply	Check output voltage and visually inspect battery pack for corrosion and leakage. Check indicator lights for fault conditions.	Annually	Electrician/ process operator
* Stated inspection frequency to be performed only during ETF operations. HEPA – High efficiency particulate air			

Table 6.2. Inspection Plan for Instrumentation Monitoring

Item	Inspection	Frequency	Inspected by
Main Treatment Train			
Leak detector LAH-20B009	Monitor for leakage in the surge tank drainage sump.	Continuously	Computer Process Operator
Level alarm LAH-60A013	Monitor surge tank level to prevent overflow.	Continuously	Computer Process Operator
Level alarm LAHL-60C-111	Monitor liquid levels in the pH adjustment tank to prevent overflow.	Continuously	Computer Process Operator
Level alarm LAHL-60F-101	Monitor liquid levels in the first RO feed tank to prevent overflow.	Continuously	Computer Process Operator
Level alarm LAHL-60F-201	Monitor liquid levels in the second RO feed tank to prevent overflow.	Continuously	Computer Process Operator
Level alarms LAHL-60F-211	Monitor liquid levels in the effluent pH adjustment tank to prevent overflow.	Continuously	Computer Process Operator
Level transmitter LAHX-60H001A/B/C	Monitor liquid level in verification tanks to prevent overflow.	Continuously	Computer Process Operator
Leak detector LAH-20B010	Monitor for leakage in the verification tank drainage sump.	Continuously	Computer Process Operator
Secondary Treatment Train			
Level alarm LAHL-60I-001A/B	Monitor liquid levels in secondary waste receiver tanks A and B to prevent overflow.	Continuously	Computer Process Operator
Level alarm LAHL-60J-001A/B	Monitor liquid levels in concentrate tanks A and B to prevent overflow.	Continuously	Computer Process Operator
Level alarm LAHL-60I-107	Monitor liquid levels in the evaporator tank to prevent overflow.	Continuously	Computer Process Operator
Level alarm LAHL-60J-036	Monitor liquid levels in the spray condenser tank to prevent overflow.	Continuously	Computer Process Operator
Level alarm LAHL-60I-108	Monitor liquid levels in the distillate flash tank to prevent overflow.	Continuously	Computer Process Operator
Level alarm LAH-60I-119	Monitor liquid levels in the entrainment separator tank to prevent overflow.	Continuously	Computer Process Operator
Level transmitter LAH-20B001	Monitor liquid level in sump tank No. 1 to prevent overflow.	Continuously	Computer Process Operator
Level transmitter LAH-20B002	Monitor liquid level in sump tank No. 2 to prevent overflow.	Continuously	Computer Process Operator
Leak detector LAH-20B003	Monitor for leakage to sump No. 1.	Continuously*	Computer Process Operator
Leak detector LAH-20B005	Monitor for leakage to sump No. 2.	Continuously*	Computer Process Operator
Leak detector	Monitor for leakage from pipeline between ETF and load-in station.	Continuously*	Computer Process Operator
Leak detector	Monitor for leakage from pipeline between ETF and LERF.	Continuously*	Computer Process Operator
Leak detector	Monitor for leakage from pipeline between LERF and the 242-A Evaporator.	Continuously*	Computer Process Operator
* In the event of a malfunction of one of the electronic leak detectors, daily visual inspections will be performed while the facilities are in operation.			

Chapter 7.0 Contingency Plan

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OFFICIAL USE ONLY

May be exempt from public release under the Freedom of Information Act
(5 U.S.C. 552)Exemption number(s) and category: Exemption 2
Circumvention of Statute
Department of Energy review required before public release

Chapter 8.0 Personnel Training

8.0 PERSONNEL TRAINING [H] 8.1

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8.0 PERSONNEL TRAINING [H]

This chapter discusses personnel training requirements based on WAC 173-303 and the Hanford Facility RCRA Permit (Permit). In accordance with WAC 173-303-806(4)(a)(xii), the *Hanford Facility Dangerous Waste Part B Permit Application* must contain two items: (1) *an outline of both the introductory and continuing training programs by owners or operators to prepare persons to operate or maintain the TSD facility in a safe manner as required to demonstrate compliance with WAC 173-303-330" and (2) "a brief description of how training will be designed to meet actual job tasks in accordance with the requirements in WAC 173-303-330(1)(d)*. Permit Condition II.C (Personnel Training) contains training requirements applicable to Hanford Facility personnel and non-Facility personnel.

Compliance with these requirements at the Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility is contained in Permit Attachment 33, Chapter 8.0 and this chapter. This chapter supplements Permit Attachment 33, Chapter 8.0.

8.1 OUTLINE OF INTRODUCTORY AND CONTINUING TRAINING PROGRAMS

The introductory and continuing training programs are designed to prepare personnel to manage and maintain the TSD unit in a safe, effective, and environmentally sound manner. In addition to preparing personnel to manage and maintain TSD units under normal conditions, the training programs ensure that personnel are prepared to respond in a prompt and effective manner should abnormal or emergency conditions occur. Emergency response training is consistent with the description of actions contained in Chapter 7.0, Contingency Plan. The introductory and continuing training programs contain the following objectives:

- Teach Hanford Facility personnel to perform their duties in a way that ensures the Hanford Facility's compliance with WAC 173-303
- Teach Hanford Facility personnel dangerous waste management procedures (including implementation of the contingency plan) relevant to the job titles/positions in which they are employed, and
- Ensure Hanford Facility personnel can respond effectively to emergencies.

8.1.1 Introductory Training

Introductory training includes general Hanford Facility training and TSD unit-specific training. General Hanford Facility training is described in Permit Attachment 33, Section 8.1, and is provided in accordance with Permit Condition II.C.2. TSD unit-specific training is provided to Hanford Facility personnel allowing those personnel to work unescorted, and in some cases is required for escorted access. Hanford Facility personnel cannot perform a task for which they are not properly trained, except to gain required experience while under the direct supervision of a supervisor or coworker who is properly trained. Hanford Facility personnel must be trained within 6 months after their employment at or assignment to the Hanford Facility, or to a new job title/position at the Hanford Facility, whichever is later.

<u>General Hanford Facility training:</u> Refer to description in Permit Attachment 33, Section 8.1.

<u>Contingency Plan training:</u> Hanford Facility personnel receive training on applicable portions of Permit Attachment 4, *Hanford Emergency Management Plan* (DOE/RL-94-02) in general Hanford Facility training. In addition, Hanford Facility personnel receive training on content of the description of actions contained in Chapter 7.0, Contingency Plan to be able to respond effectively to emergencies.

Emergency Coordinator training: Hanford Facility personnel who perform emergency coordinator duties in WAC 173-303-360 (e.g., Building Emergency Director) in the Hanford Incident Command System receive training on implementation of the contingency plan and fulfilling the position within the Hanford Incident Command System. These Hanford Facility personnel must also become thoroughly familiar with applicable contingency plan documentation, operations, activities, location, and properties of all waste handled, location of all records, and the unit/building layout.

Operations training: Dangerous waste management operations training (e.g., waste designation training, shippers training) is determined on a unit-by-unit basis and considers the type of waste management unit (e.g., container management unit) and the type of activities performed at the waste management unit (e.g., sampling). For example, training provided for management of dangerous waste in containers is different than the training provided for management of dangerous waste in a tank system. Common training required for compliance within similar waste management units can be provided in general training and supplemented at the TSD unit. Training provided for TSD unit-specific operations is identified in the training plan documentation based on: (1) whether a general training course exists, (2) the training needs to ensure waste management unit compliance with WAC 173-303, and (3) training commitments agreed to with Ecology.

8.1.2 Continuing Training

Continuing training meets the requirements for WAC 173-303-330(1)(b) and includes general Hanford Facility training and TSD unit-specific training.

General Hanford Facility training: Annual refresher training is provided for general Hanford Facility training. Refer to description in Permit Attachment 33, Section 8.1.

Contingency plan training: Annual refresher training is provided for contingency plan training. Refer to description above in Section 8.1.1.

Emergency coordinator training: Annual refresher training is provided for emergency coordinator training. Refer to description above in Section 8.1.1.

Operations training: Refresher training occurs on many frequencies (i.e., annual, every other year, and every 3 years) for operations training. When justified, some training will not contain a refresher course and will be identified as a one-time only training course. The TSD unit-specific training plan documentation will specify the frequency for each training course. Refer to description above in Section 8.1.1.

8.2 DESCRIPTION OF TRAINING DESIGN

Proper design of a training program ensures personnel who perform duties on the Hanford Facility related to WAC 173-303-330(1)(d) are trained to perform their duties in compliance with WAC 173-303. Actual job tasks, referred to as duties, are used to determine training requirements. The first step taken to ensure Hanford Facility personnel have received the proper training is to determine and document the waste management duties by job title/position. The second step compares waste management duties to general waste management unit training curriculum. If general waste management unit training curriculum does not address the waste management duties, the training curriculum is supplemented and/or on-the-job training is provided. The third step summarizes the content of a training course necessary to ensure that the training provided to each job title/position addresses associated waste management duties. The last step is to assign training curriculum to Hanford Facility personnel based on the previous evaluation. The training plan documentation contains this process.

Waste management duties include those specified in Section 8.1 as well as those contained in WAC 173-303-330(1)(d). Training elements of WAC 173-303-330(1)(d) applicable to the Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility operations include the following:

Surface Impoundment (Liquid Effluent Retention Facility)

- Procedures for using, inspecting, repairing, and replacing emergency and monitoring equipment
- Key parameters for automatic waste feed cut-off systems
- Communications or alarm systems
- Response to fires or explosions
- Response to groundwater contamination incident
- Shutdown of operations

Tank system (200 Area Effluent Treatment Facility)

- Procedures for using, inspecting, repairing, and replacing emergency and monitoring equipment
- Key parameters for automatic waste feed cut-off systems
- Communications or alarm systems
- Response to fires or explosions
- Shutdown of operations

Containers (200 Area Effluent Treatment Facility)

- Procedures for using, inspecting, repairing, and replacing emergency and monitoring equipment
- Communications or alarm systems
- Response to fires or explosions

Hanford Facility personnel who perform these duties receive training pertaining to their duties. The training plan documentation described in Section 8.3 contains specific information regarding the types of training Hanford Facility personnel receive based on the outline in Section 8.1.

8.3 DESCRIPTION OF TRAINING PLAN

In accordance with Permit Condition II.C.3, the unit-specific portion of the *Hanford Facility Dangerous Waste Permit Application* must contain a description of the training plan. Training plan documentation is maintained outside of the *Hanford Facility Dangerous Waste Part B Permit Application* and the Permit. Therefore, changes made to the training plan documentation are not subject to the Permit modification process. However, the training plan documentation is prepared to comply with WAC 173-303-330(2).

Documentation prepared to meet the training plan consists of hard copy and/or electronic media as provided by Permit Condition II.C.1. The training plan documentation consists of one or more documents and/or a training database with all the components identified in the core document.

A description of how training plan documentation meets the three items in WAC 173-303-330(2) is as follows:

1. -330(2)(a): *The job title, job description, and name of the employee filling each job. The job description must include requisite skills, education, other qualifications, and duties for each position.*

   Description: The specific Hanford Facility personnel job title/position is correlated to the waste management duties. Waste management duties relating to WAC 173-303 are correlated to training courses to ensure training properly is assigned.

   Only names of Hanford Facility personnel who carry out job duties relating to TSD unit waste management operations at the Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility are maintained. Names are maintained within the training plan documentation. A list of

Hanford Facility personnel assigned to the Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility is available upon request.

Information on requisite skills, education, and other qualifications for job titles/positions are addressed by providing a reference where this information is maintained (e.g., human resources). Specific information concerning job title, requisite skills, education, and other qualifications for personnel can be provided upon request.

2. -330(2)(b): *A written description of the type and amount of both introductory and continuing training required for each position.*

   Description: In addition to the outline provided in Section 8.1, training courses developed to comply with the introductory and continuing training programs are identified and described in the training plan documentation. The type and amount of training is specified in the training plan documentation as shown in Table 8.1.

3. -330(2)(c): *Records documenting that personnel have received and completed the training required by this section. The Department may require, on a case-by-case basis, that training records include employee initials or signature to verify that training was received.*

   Description: Training records are maintained consistent with Permit Attachment 33, Section 8.4.

Table 8.1. 200 Area Liquid Waste Processing Facilities Training Matrix

	Training Category*						
Permit Attachment 33, Chapter 8, Training	General Hanford Facility Training	Contingency Plan Training	Emergency Coordinator Training	Operations Training			
200 Area Liquid Waste Processing Facilities DWTP implementing category	Orientation Program	Emergency Response (contingency plan)	Emergency Coordinator Training	General Waste Management	Container Management	Tank System Management	Surface Impoundment
JOB TITLE/POSITION							
Nuclear Chemical Operator (NCO)	X	X		X	X	X	X
Hazardous Waste Coordinator (HWC)	X				X		
Operations Technical Advisor (OTA)	X	X	X		X		
Shift Operations Manager (SOM)	X	X	X		X		
Environmental Compliance Officer	X			X			
Resident Waste Service Provider	X			X	X		
Non-Resident Waste Service Provider	X			X	X		
Non-Resident Sampler	X			X			X

* Refer to the 200 Area Liquid Waste Processing Facilities Dangerous Waste Training Plan for a complete description of coursework in each training category. The 200 Area Liquid Waste Processing Facilities Dangerous Waste Training Plan addresses the 200 Area Effluent Treatment Facility and the Liquid Effluent Retention Facility.

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Chapter 11.0 Closure and Financial Assurance

11.0 CLOSURE AND FINANCIAL ASSURANCE [I] ..... Att 34.11.1

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11.2 CLOSURE PERFORMANCE STANDARD [I-1a] ..... Att 34.11.1
11.2.1 Closure Standards for Metal Surfaces, Rubber, Tanks, and Concrete ..... Att 34.11.1
11.2.2 Closure Standards for Internal and External Piping ..... Att 34.11.2
11.2.3 Closure Standards for Ancillary Equipment ..... Att 34.11.2
11.2.4 Closure Standards for Underlying Soils ..... Att 34.11.2

11.3 CLOSURE ACTIVITIES [I-1b] ..... Att 34.11.3
11.3.1 General Closure Activities ..... Att 34.11.3
11.3.2 Constituents of Concern for Closure for the Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility ..... Att 34.11.3
11.3.3 Removing Dangerous Waste [I-1b(2)] ..... Att 34.11.3
11.3.4 Decontaminating Structures, Equipment, and Soils [I-1b(3)] ..... Att 34.11.3

11.4 MAXIMUM WASTE INVENTORY [I-1c] ..... Att 34.11.8

11.5 CLOSURE OF CONTAINERS, TANKS, AND SURFACE IMPOUNDMENTS [I-1d] ..... Att 34.11.8
11.5.1 Closure of Containers [I-1d(1)] ..... Att 34.11.8
11.5.2 Closure of Tanks [I-1d(2)] ..... Att 34.11.8
11.5.3 Closure of Surface Impoundments [I-1d(4)] ..... Att 34.11.8

11.6 SCHEDULE FOR CLOSURE [I-1f] ..... Att 34.11.8

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11.0 CLOSURE AND FINANCIAL ASSURANCE [I]

This chapter describes the planned activities and performance standards for closing LERF and ETF.

11.1 CLOSURE PLAN/FINANCIAL ASSURANCE FOR CLOSURE [I-1]

The LERF and ETF will be clean closed with respect to dangerous waste contamination that resulted from operation as TSD units, with closure of LERF occurring first. To facilitate closure, the LERF retention basins are being viewed as consisting of seven components: the covers and primary liner, drainage layer system/bentonite carpet liner, secondary liner, soil bentonite, internal and/or external piping, ancillary equipment, and concrete basins. To facilitate closure of ETF, ETF is being viewed as consisting of six components: tanks, internal and/or external piping, ancillary equipment, concrete floors/dikes/ encasements, structures, and soil directly beneath the structure. It is anticipated that closure of LERF and ETF will begin after the projected 30-year active life of LERF and ETF. If it is determined that clean closure is not possible, the closure plan will be modified to address required postclosure activities.

Uncontaminated structures will be left for future use or disassembled, dismantled, and removed for disposal. Uncontaminated equipment and structures could include aqueous makeup, HVAC and piping, steam condensate and cooling water piping, and the control room and office areas.

Clean closure requires decontamination or removal and disposal of all dangerous waste, waste residues, contaminated equipment, soil, or other material established in accordance with the clean closure performance standards of WAC 173-303-610(2). This and future closure plan revisions will provide for compliance with these performance standards.

11.2 CLOSURE PERFORMANCE STANDARD [I-1a]

Clean closure, as provided for in this plan, and in accordance with WAC 173-303-610(2), will eliminate future maintenance and will be protective of human health and the environment by removing or reducing chemical contamination at LERF and ETF to levels that eliminate the threat of contaminant escape to the environment.

After closure, the appearance of the land where the LERF and ETF are located will be consistent with the appearance and future use of its surrounding land areas. This plan proposes to leave clean structures and equipment in place after closure for potential use in future operations. This need will be evaluated at the time of closure.

11.2.1 Closure Standards for Metal Surfaces, Rubber, Tanks, and Concrete

This closure plan proposes use of a 'clean debris surface' (defined in the following paragraph) as the clean closure performance standard for the metal surfaces, rubber (i.e., basin covers, liners, etc.), tanks, and concrete that will remain after closure. This approach is consistent with Ecology guidance (Ecology 1994a) for achievement of clean closure. Additionally, adherence to this guidance ensures that all residues have been removed as required by WAC 173-303-640 for clean closure of the ETF tank systems. The ETF verification tanks will be considered "clean" if the delisting limits were not exceeded for the effluent in the tanks. If the delisting limits were exceeded, closure activities will be as described in Section 11.3.4.3.

The clean debris surface standard is verified visually. "A clean debris surface means the surface, when viewed without magnification, shall be free of all visible contaminated soil and hazardous waste except residual staining from soil and waste consisting of light shadows, slight streaks, or minor discolorations and soil and waste in cracks, crevices, and pits may be present provided that such staining and waste and

soil in cracks, crevices, and pits shall be limited to no more than 5% of each square inch of surface area" (40 CFR 268.45). When a physical extraction method is used on concrete, the performance standard is based on removal of the contaminated layer of debris. The physical extraction performance standard for concrete is removal of 0.6 centimeter of the surface layer and treatment to a clean debris surface. Inspections to verify achievement of a clean debris surface will be performed and documented.

11.2.2 Closure Standards for Internal and External Piping

The internal and external piping of both LERF and ETF will be flushed and drained as part of closure. For piping where the contaminated surfaces can be inspected, an inspection will be performed to see if the piping meets the clean debris surface standard in 40 CFR 268.45 incorporated by reference and can be declared non-dangerous in accordance with WAC 173-303-071(3)(qq). If it is not possible to inspect the contaminated surfaces or meet the clean debris surface performance standard, the particular piping of concern will be removed, designated, and disposed of accordingly.

Dangerous and/or mixed-waste materials generated during closure activities will be managed in accordance with WAC 173-303-610(5). Removal of any dangerous wastes or dangerous constituents during partial or final closure will be handled in accordance with applicable requirements of WAC 173-303-610(5).

11.2.3 Closure Standards for Ancillary Equipment

Ancillary equipment is defined as pumps and other miscellaneous equipment not otherwise specified in this closure plan. Ancillary equipment will be removed and disposed.

11.2.4 Closure Standards for Underlying Soils

The LERF retention basins have a leachate collection system for leaks or spills that channels the liquid to drains or sumps. The collected liquid is pumped back into the basins, thereby preventing spills from reaching the soil. The soil only could be contaminated if the secondary liner had failed. To determine if failure occurred, the primary liner will be inspected for leaks, holes, or punctures and the drainage gravel and bentonite carpet liner underneath the primary liner will be sampled and analyzed for contamination. If the drainage gravel analytical results determine that the constituents of concern are at or below agreed to regulatory cleanup levels (i.e., Hanford Site soil background levels (DOE-RL 1993) and/or residential exposure assumptions), the gravel will be considered clean for closure. Only if contamination is found in the drainage gravel/bentonite carpet liner will the secondary liner surfaces be inspected for leaks, holes, or punctures, which (if existing) could have provided a pathway to soil for contamination (refer to Chapter 4.0, Figure 4-3 for basin diagram). If no leaks, holes, or punctures are found in the primary liner or if the drainage gravel/bentonite carpet liner is found not to be contaminated, the soil will be considered to be clean closed. However, if leaks, holes, or punctures are found in the primary liner or the gravel is contaminated, the secondary liner surfaces will be inspected. If no leaks, holes, or punctures are found in the secondary liner surfaces, the soil will be considered clean closed. If such leaks, holes, or punctures are identified, potential soil contamination will be investigated. Soil will be sampled and analyzed for constituents of concerns. If the soil analytical results determine that, the constituents of concern are at or below agreed to regulatory cleanup levels, the soil will be considered clean closed.

Clean closure of soil under the ETF will be accomplished by demonstrating that the coated concrete floor kept contaminants from reaching the soil. The coated concrete floor provided secondary containment for all the tanks and process piping. Unless inspections identify potential through-thickness cracks indicating containment failure and a subsequent potential for soil contamination from TSD unit operations, the soil will be considered clean closed. However, if inspections identify such cracks and there have been documented spills in the vicinity, potential soil contamination will be investigated. Soils will be sampled and analyzed for constituents of concern. If the soil analytical results determine that the constituents of concern are at or below agreed to regulatory clean up levels, the soil will be considered clean closed. The

Hanford Facility RCRA Permit Condition II.K defines regulatory cleanup levels. If verification sampling is required, a sampling analysis plan will be prepared before closure in a manner consistent with Ecology guidance (Ecology 1994a) for achievement of clean closure.

11.3 CLOSURE ACTIVITIES [I-1b]

The LERF and ETF were designed for a 30-year active life. At the time of closure, the closure plan will be modified as necessary to reflect current regulation or informational revisions. If it is determined that clean closure is not possible, the closure plan will be modified to address required postclosure activities.

11.3.1 General Closure Activities

The approach to LERF closure is to dispose of accumulated basin aqueous waste by processing the waste through ETF. Primary basin liners and covers will be decontaminated or disposed of as appropriate. Any remaining solids (residue) within basins will be removed, designated, and disposed of accordingly. Piping associated with LERF closure is intended to be decontaminated and left in place. Rinsate generated during decontamination also will be disposed of through ETF. Sampling will assess whether contamination beneath the primary liner has occurred. Contamination, if present, will be managed in compliance with regulatory requirements.

The approach to ETF closure is to process any aqueous waste through the effluent treatment system. Any containerized dangerous waste and/or mixed waste will be transferred to other TSD units. All structures and equipment will be decontaminated and/or disposed. Piping associated with ETF closure is intended to be decontaminated and left in place. Contamination, if present, will be managed in compliance with regulatory requirements.

Equipment or materials used in performing closure activities will be decontaminated or disposed at a permitted facility.

11.3.2 Constituents of Concern for Closure for the Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility

Using the list of dangerous waste numbers in the Part A, (Chapter 1.0) process knowledge and the risk to human health and the environment, the constituents of concern for closure will be determined through the data quality objective process.

11.3.3 Removing Dangerous Waste [I-1b(2)]

At the start of LERF closure, aqueous waste will be transferred sequentially from each basin to ETF for treatment. At a treatment rate of about 284 liters per minute, it will take approximately 60 days to empty a full basin. Basin covers will remain in place to prevent possible wind dispersion of waste until all basin waste has been removed.

All of the aqueous waste inventory at the ETF will be processed before closure. Any residue remaining in piping, equipment, or the LERF liner will be removed to an appropriate disposal unit. All containerized waste will be dispositioned. All secondary waste in containers will be transferred to an appropriate TSD unit.

11.3.4 Decontaminating Structures, Equipment, and Soils [I-1b(3)]

This section discusses the activities necessary to implement a clean closure strategy for the LERF and ETF. Before closure activities begin, any waste inventory stored will be removed. After the waste inventory is removed, clean closure of the LERF covers and primary liner, drainage layer/leachate collection system/bentonite carpet liner, secondary liner, soil bentonite, the internal piping, ancillary equipment, and the concrete catch basins will be accomplished by decontaminating the components as

necessary, and demonstrating that clean closure performance standards are met (Section 11.1.1). To facilitate closure of ETF, tanks, internal piping, external piping, ancillary equipment, concrete floors/dikes/encasements, structures, and soil directly beneath the structure will be decontaminated, as necessary, to demonstrate that the clean closure performance standards are met.

Removal and disposal of most of the components will be determined at time of closure. Clean closure of the soil will be accomplished by demonstrating that the concrete kept contaminants from reaching the soil.

11.3.4.1 Covers and Liners

After all pumpable waste has been removed from a given basin at LERF; the cover for that basin will be removed. The cover either will be decontaminated or disposed of appropriately. If the cover is disposed of, the cover will be cut up within the basin and loaded into a lined dump truck for transport and disposal. If the covers are to be reused, an initial decontamination effort will be made by spraying the underside of the cover while in place over a basin. The intent of preremoval spraying is to minimize subsequent decontamination efforts and to use the basin as a wash water catchment. Each cover will be inspected visually for physical damage in the same manner as the primary liners. Visible signs of damage to the cover will be repaired as specified by the cover manufacturer. The cover decontamination procedure will be to position a cover into its basin and wash the cover. Any openings, such as for vents, will be sealed temporarily so that rinsate cannot seep through. The method and degree of washing will be the same as necessary for the respective basin liner. The generated rinsate will be transferred from the basin to the ETF or appropriate TSD unit.

The primary liner will be inspected visually for physical damage and surveyed before any decontamination efforts. Physical damage will be defined as tears, holes, or punctures such that the liner would not hold water. A description and location of any physical damage found will be noted in an inspection record. Visible signs of damage to the liner will be repaired per procedures specified by the manufacturer before decontamination to prevent liquid solutions from driving potential contamination down into the drainage gravel. The purpose of the inspection will be twofold: to identify and map any physical damage in the primary liner that might have allowed contaminants a pathway to the drainage gravel below; and to identify areas that potentially are contaminated with dangerous waste or dangerous waste residues. The inspection standard for the liner will be a clean debris surface as defined in Section 11.1.1.1. The inspection of the liner for a clean debris surface will be documented on an inspection record. Those areas already meeting the standard can be clean closed as is, based on Ecology acceptance of the completed record.

Those potentially contaminated areas will undergo decontamination to meet the clean closure standard of a clean debris surface. Plastic surfaces indicated by visual examination as being potentially contaminated will be decontaminated through use of physical extraction technologies such as high-pressure steam and water sprays coupled with a detergent wash.

Achievement of a clean debris surface will be documented on an inspection record. Decontamination rinsate will be transferred directly to the ETF or transferred to another basin before ultimate disposal. If it is not possible to meet the clean closure performance standard, or there is no further need for the liner, the primary liner could be removed, designated, and disposed of accordingly. The inspections for a clean debris surface will be documented on an inspection record.

11.3.4.2 Drainage Layer/Bentonite Carpet Liner/Secondary Liner

Assessment of contamination beneath the LERF's primary liner will be performed within each basin by sampling the drainage gravel. Biased rather than random location selection will be used to increase the probability of detecting leachate contamination. Sampling points will be chosen where physical damage was noted during the inspection of the primary liner or areas where the underlying material porosity and

permeability and the hydraulic head would most likely drive any leachate. The leakage rate through the liner would increase toward the bottom of the liner as hydraulic head increases. Any leakage that did occur in the sloped sides could be expected to travel down slope through the geotextile between the primary and secondary liner until reaching the bottom of the liner. Therefore, the most likely area of contamination would be the drainage gravel.

Gravel samples will be collected by removing the bentonite carpet liner and making an incision in the geotextile. Sampling will be performed in accordance with existing procedures at the time of sampling. Special care will be needed in sampling for volatiles. To aid in ensuring sample integrity, the initial removal of gravel to create the gravel profile will not be done unless the samples can be collected immediately.

Sample collection will occur immediately after profile exposure. If no constituents of concern are found above soil closure performance standards (Section 11.1.1), no further analysis will be done. If the initial sample analysis indicates liner leakage, analysis of the bottom sample will be performed to determine the depth of contamination. Additional gravel samples from different locations will be taken to determine the spatial extent of contamination.

A visual assessment of the underlying basin integrity will be made at the bottom of each sampled location and wherever else gravel is removed. If the basin is perceived to be damaged such that leakage could have occurred beneath the secondary liner, an amendment to the closure plan will be submitted to allow time for additional sampling and possible gravel removal. Sampling beneath the secondary liner, if necessary, will be attempted in accordance with sampling procedures for beneath the primary liner. Sampling beneath the secondary liner has not been extensively addressed because of the remote probability of its occurrence. The drainage gravel will be the preferred flow path even if minor leaks exist in the secondary liner. The secondary liner is resting on a soil/bentonite bed, which would tend to seal any punctures in the secondary liner as hydraulic head built up.

Sampling and disposal objectives will be determined at the time of closure activities through the data quality objectives process.

11.3.4.3 Tanks

After all pumpable waste has been removed from the tanks at ETF, the interior of the tanks, including the internal components such as the agitator, will be washed down by adding or spraying with steam, a water-soluble cleaner, or other approved method. The tanks will be emptied and the interiors visually examined.

After rinsing, the tanks will be inspected visually for compliance with the performance standard. Visual inspection might be made remotely using a camera or other device that allows verification of meeting the standard. If any areas are found not meeting the clean debris surface performance standard, these areas will be decontaminated in-place. Per the debris rule, only removal of contaminants from the surface layer is necessary for metal surfaces. Contamination will be removed from the surface layer using either high-pressure water blasting (a physical extraction method) or by hand or remote wiping, washing, brushing, or scrubbing using an approved cleaner, and rinsing with water or by other appropriate methods.

The outside of the tanks also will be inspected for compliance to the performance standard. Any areas found not to meet this performance standard will be decontaminated in-place. Contamination will be removed from the surface layer using any of the methods described for internal tank decontamination or another appropriate method. Before using decontamination solutions on the outside of the tanks, the floor will be inspected for cracks or other openings that could provide a pathway to soil. This inspection will be performed as described in Section 11.1.4.6 in conjunction with mapping of potential through-thickness cracks. Any such cracks will be mapped. The cracks will be sealed before beginning treatment or other

engineered containment devices (e.g., portable catch basins, liners) will be used to collect and contain solutions.

Decontamination residues will be collected, designated, and managed as appropriate. If it is not possible to meet the clean closure performance standard, contaminated portions of the tanks could be removed, designated, and disposed of accordingly. The inspections for a clean debris surface will be documented on an inspection record.

11.3.4.4 Internal and External Piping and Ancillary Equipment

The internal piping and ancillary equipment for both LERF and ETF will be flushed and drained as part of closure. For piping where the contaminated surfaces can be inspected, an inspection will be performed to see if the piping meets the clean debris surface standard in 40 CFR 268.45 and can be declared non-dangerous. If it is not possible to meet the clean debris surface standard or the piping cannot be inspected, portions of the internal piping will be removed, designated, and disposed of accordingly.

External piping (transfer lines) and ancillary equipment associated with LERF and ETF consist of below grade and above grade piping. Below grade piping, will be dispositioned at closure consistent with the practices for below grade piping in the 200 Areas at the time of closure. For above grade piping, it will be dispositioned consistent with the provisions for internal piping.

Rinsate from the external piping and LERF internal piping will be processed through ETF. Rinsate from closure of the ETF that cannot be treated at ETF will be managed in accordance with WAC 173-303-610(5). Detail regarding the process for rinsing any internal and external piping and ancillary equipment will be provided in the closure plan in accordance with WAC 173-303-610(3)(a)(v) upon modification as stated in Section 11.6.

Dangerous and/or mixed-waste materials generated during closure activities will be managed in accordance with WAC 173-303-610(5). Removal of any dangerous wastes or dangerous constituents during partial or final closure will be handled in accordance with applicable requirements of WAC 173-303-610(5).

11.3.4.5 Concrete

At LERF, the concrete catch basins are located at the northeast corner of each retention basin, where inlet pipes, leachate risers, and transfer pipe risers emerge for the basin. The concrete catch basin is curbed, and coated with a chemical resistant epoxy sealant. The concrete catch basin is sloped so that any leaks or spills from the piping or connections will drain into the basin. At the ETF, the coated concrete floor and berm provides secondary containment for all the tanks and process piping.

At LERF and ETF, all concrete will be inspected visually and surveyed before any decontamination. The purpose of the inspection will be twofold: to identify and map any cracks in the concrete that might have allowed contaminants a pathway to the soil below (Section 11.1.2.3.), and to identify areas that potentially are contaminated with dangerous waste or dangerous waste residues. The inspection standard will be a clean debris surface as defined in Section 11.1.1. The inspection of the concrete for a clean debris surface will be documented on an inspection record. Those areas already meeting the standard can be clean closed as is.

Those potentially contaminated areas will undergo decontamination to meet the clean closure standard of a clean debris surface. The concrete will be washed down, the rinsate collected, designated, and disposed of accordingly. The concrete will be reinspected for a clean debris surface. Concrete surfaces indicated by visual examination, as still being potentially contaminated will have the surface layer removed to a depth of 0.6 centimeter by scabbling or other approved methods. This will not threaten the environment, even if potential through-thickness cracks had been found during the inspection, because concrete

decontamination (scabbling) will not employ liquid solutions that could enter cracks and because scabbling residues will be vacuumed away from cracks as any residue is generated.

Achievement of a clean debris surface will be documented on an inspection record. Decontamination residues will be collected, designated, and managed as appropriate.

11.3.4.6 Structures

If contaminated with either dangerous or mixed waste constituents, the ETF structures will be decontaminated and/or disassembled, if necessary, packaged, and disposed of in accordance with existing land disposal restrictions (WAC 173-303-140).

Closure steps could include the following activities.

- Containerize (as necessary and practicable) and remove any remaining waste.
- Review operating records for spillage incidents and visually inspect storage area surfaces for evidence of contamination or for cracks that could harbor contamination or allow the escape of decontamination solutions. Inspect storage area surfaces for visible evidence of contamination (e.g., discoloration, material degradation, wetness, and odor). If contamination is evident, the affected area(s) will be decontaminated.
- Decontaminate ETF walls and floors to minimize the potential for loose contamination and facilitate any required surveys and/or chemical field screening. The structures could be cleaned by water rinse or high-pressure, low-volume steam cleaning coupled with a detergent wash. After decontamination, the walls and floors will be compared to closure performance standards.
- Collect rinsate and manage as dangerous waste for appropriate disposal.
- Secure (lock) personnel entries into building and post doors with appropriate warning signs.

Clean closure of structures will occur in accordance with WAC 173-303-610. Remediation of soil contamination beneath or around containment buildings will be performed in conjunction with soil closure requirements.

11.3.4.7 Underlying Soils

Clean closure of soil under LERF's secondary liner will be accomplished by demonstrating that the liners and leak detection system kept contaminants from reaching the soil. The secondary liner provided secondary containment for the LERF basins. Unless inspections identify potential leaks, punctures, cracks, or tears indicating containment failure and a subsequent potential for soil contamination from TSD unit operations, the soil will be considered clean closed. However, if inspections identify such leaks, punctures, etc., potential soil contamination will be investigated.

Clean closure of soil under ETF will be accomplished by demonstrating that the coated concrete floor kept contaminants from reaching the soil. The coated concrete floor and bermed area provided secondary containment for all the tanks and process piping. Unless inspections identify potential through-thickness cracks indicating containment failure and a subsequent potential for soil contamination from TSD unit operations, the soil will be considered clean closed. However, if inspections identify such cracks and there have been documented spills in the vicinity, potential soil contamination will be investigated.

Where it is possible visually to inspect directly beneath the tanks, a visual inspection will be performed. Where it is not possible visually to inspect beneath the tanks, an evaluation of the tank integrity will be made. The condition of the tank will be evaluated to determine if there was any potential for leakage. If no cracks, severe corrosion, or evidence of leaks is observed, it will be reasoned that mixed or dangerous waste solutions could not have penetrated to the soil directly below the tank.

External piping (transfer lines) between the 242-A Evaporator and LERF and LERF and ETF are double-lined with a leak detection system. If records indicate that no leaks from the primary piping occurred, the soil will be considered clean with respect to RCRA closure.

11.4 MAXIMUM WASTE INVENTORY [I-1c]

The maximum waste inventory for ETF/LERF is in Chapter 1.0.

11.5 CLOSURE OF CONTAINERS, TANKS, AND SURFACE IMPOUNDMENTS [I-1d]

The following sections cover closure of containers, closure of tanks, and closure of surface impoundments.

11.5.1 Closure of Containers [I-1d(1)]

Containers at ETF will be used to contain dangerous waste in the event of a spill, unexpected release, or equipment failure. Containers will be used to accumulate nonradioactive dangerous waste and/or mixed waste. Any containers used to contain dangerous and/or mixed waste at the ETF will be disposed of in the appropriate manner. Containers of dangerous and/or mixed waste will not be left in the ETF after closure.

11.5.2 Closure of Tanks [I-1d(2)]

Clean closure of ETF will consist of the removal and disposal of all dangerous waste and the decontamination and/or removal and disposal of contaminated equipment, including tanks. The ETF was designed to incorporate removable components. This design facilitates closure by allowing complete removal of equipment contaminated with dangerous and mixed waste.

11.5.3 Closure of Surface Impoundments [I-1d(4)]

At closure, all of LERF that received regulated waste will be closed in accordance with the requirements of WAC 173-303-650(6)(a)(i). All equipment, structures, and other material associated with closure of LERF will be decontaminated or removed in accordance with WAC 173-303-610(2). All basin waste and decontamination rinsate will be transferred to ETF. Sampling and testing will be conducted.

11.6 SCHEDULE FOR CLOSURE [I-1f]

Closure of LERF and ETF is not anticipated to occur within the next 30 years. The actual year of closure will depend on the time required for current waste to be processed and what role the LERF and ETF will play in processing additional waste generated during future activities in the 200 Areas. Other factors affecting the year of closure include changes in operational requirements, lifetime extension upgrades, and unforeseen factors. When a definite closure date is established, a revised closure plan will be submitted to Ecology.

The activities required to complete closure are planned to be accomplished within 180 days in accordance with WAC 173-303-610(4)(b). Should a modified schedule be necessary, a revised schedule will be presented and agreed to before closure in accordance with WAC 173-303-610(4)(c).

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