AR TARGET SHEET

The following document was too large to scan as one unit, therefore, it has been broken down into sections.

EDMC#:	0061343
SECTION:	3 OF 4
DOCUMENT #:	RPP-13774, Rev 002
TITLE:	SST System Closure Plan

ADDENDUM C-2

SIMULATED GROUNDWATER CONCENTRATIONS AND RESULTANT ESTIMATED RISK AND HAZARD INDEX FOR SELECTED CONSTITUENTS IN WMA C

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1.0 URANIUM

Table 1-1. Simulated Peak Concentrations and Arrival Times for Uranium at Various Boundaries.

Uranium Concentration (mg /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	1.2E-04	12000	7.8E-05	12000	6.3E-06
Past Tank Leaks	12000	3.2E-06	12000	2.3E-06	12000	2.8E-07
Past Ancillary Equipment Leaks	12000	5.2E-06	12000	3.4E-06	12000	2.1E-07
Residual Tank Unlimited Advection Release	12000	2.6E-04	12000	1.6E-04	12000	4.1E-06
Residual Tank Release Limited to Diffusion	12000	1.5E-05	12000	8.7E-06	12000	1.8E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	5.8E-09	12000	3.4E-09	12000	6.9E-11
Residual Ancillary Pipeline Release Limited to Diffusion	12000	4.2E-08	12000	2.4E-08	12000	3.2E-10
Post-Retrieval						
Residual Tank Unlimited Advection Release	12000	5.1E-06	12000	3.1E-06	12000	7.9E-08
Residual Tank Release Limited to Diffusion	12000	2.9E-07	12000	1.7E-07	12000	3.4E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	5.8E-09	12000	3.4E-09	12000	6.9E-11
Residual Ancillary Pipeline Release Limited to Diffusion	12000	4.2E-08	12000	2.4E-08	12000	3.2E-10

Table 1-2. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries All Pathways Farmer -- Groundwater Only.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	6.3E-03	12000	4.3E-03	12000	3.5E-04
Past Tank Leaks	12000	1.8E-04	12000	1.3E-04	12000	1.5E-05
Past Ancillary Equipment Leaks	12000	2.9E-04	12000	1.9E-04	12000	1.1E-05
Unlimited Advection Release	12000	1.4E-02	12000	8.6E-03	12000	2.2E-04
Release Limited to Diffusion	12000	8.1E-04	12000	4.8E-04	12000	9.6E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	3.2E-07	12000	1.9E-07	12000	3.8E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	2.3E-06	12000	1.3E-06	12000	1.8E-08
Post-Retrieval						
Unlimited Advection Release	12000	2.8E-04	12000	1.7E-04	12000	4.3E-06
Release Limited to Diffusion	12000	1.6E-05	12000	9.3E-06	12000	1.9E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	3.2E-07	12000	1.9E-07	12000	3.8E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	2.3E-06	12000	1.3E-06	12000	1.8E-08

Table 1-3. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries Native American -- Groundwater Only.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	1.6E-02	12000	1.1E-02	12000	8.5E-04
Past Tank Leaks	12000	4.4E-04	12000	3.1E-04	12000	3.8E-05
Past Ancillary Equipment Leaks	12000	7.1E-04	12000	4.7E-04	12000	2.8E-05
Unlimited Advection Release	12000	3.5E-02	12000	2.1E-02	12000	5.5E-04
Release Limited to Diffusion	12000	2.0E-03	12000	1.2E-03	12000	2.4E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	7.9E-07	12000	4.6E-07	12000	9.3E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	5.7E-06	12000	3.2E-06	12000	4.3E-08
Post-Retrieval						
Unlimited Advection Release	12000	6.8E-04	12000	4.1E-04	12000	1.1E-05
Release Limited to Diffusion	12000	3.9E-05	12000	2.3E-05	12000	4.6E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	7.9E-07	12000	4.6E-07	12000	9.3E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	5.7E-06	12000	3.2E-06	12000	4.3E-08

Table 1-4. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries HSRAM Industrial.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	1.9E-03	12000	1.3E-03	12000	1.0E-04
Past Tank Leaks	12000	5.3E-05	12000	3.8E-05	12000	4.6E-06
Past Ancillary Equipment Leaks	12000	8.6E-05	12000	5.7E-05	12000	3.4E-06
Unlimited Advection Release	12000	4.3E-03	12000	2.6E-03	12000	6.7E-05
Release Limited to Diffusion	12000	2.5E-04	12000	1.4E-04	12000	2.9E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	9.6E-08	12000	5.7E-08	12000	1.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	7.0E-07	12000	3.9E-07	12000	5.3E-09
Post-Retrieval						
Unlimited Advection Release	12000	8.4E-05	12000	5.1E-05	12000	1.3E-06
Release Limited to Diffusion	12000	4.8E-06	12000	2.8E-06	12000	5.6E-08
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	9.6E-08	12000	5.7E-08	12000	1.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	7.0E-07	12000	3.9E-07	12000	5.3E-09

Table 1-5. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries HSRAM Recreational -- Groundwater Only.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	2.4E-04	12000	1.6E-04	12000	1.3E-05
Past Tank Leaks	12000	6.6E-06	12000	4.7E-06	12000	5.7E-07
Past Ancillary Equipment Leaks	12000	1.1E-05	12000	7.1E-06	12000	4.2E-07
Unlimited Advection Release	12000	5.3E-04	12000	3.2E-04	12000	8.3E-06
Release Limited to Diffusion	12000	3.0E-05	12000	1.8E-05	12000	3.6E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	1.2E-08	12000	7.0E-09	12000	1.4E-10
Residual Ancillary Pipeline Release Limited to Diffusion	12000	8.6E-08	12000	4.8E-08	12000	6.5E-10
Post-Retrieval						
Unlimited Advection Release	12000	1.0E-05	12000	6.2E-06	12000	1.6E-07
Release Limited to Diffusion	12000	5.9E-07	12000	3.5E-07	12000	7.0E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	1.2E-08	12000	7.0E-09	12000	1.4E-10
Residual Ancillary Pipeline Release Limited to Diffusion	12000	8.6E-08	12000	4.8E-08	12000	6.5E-10

Table 1-6. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries HSRAM Residential -- Groundwater Only.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	1.3E-02	12000	9.0E-03	12000	7.3E-04
Past Tank Leaks	12000	3.7E-04	12000	2.7E-04	12000	3.2E-05
Past Ancillary Equipment Leaks	12000	6.0E-04	12000	4.0E-04	12000	2.4E-05
Unlimited Advection Release	12000	3.0E-02	12000	1.8E-02	12000	4.7E-04
Release Limited to Diffusion	12000	1.7E-03	12000	1.0E-03	12000	2.0E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	6.7E-07	12000	4.0E-07	12000	8.0E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	4.9E-06	12000	2.7E-06	12000	3.7E-08
Post-Retrieval						
Unlimited Advection Release	12000	5.8E-04	12000	3.5E-04	12000	9.1E-06
Release Limited to Diffusion	12000	3.3E-05	12000	2.0E-05	12000	3.9E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	6.7E-07	12000	4.0E-07	12000	8.0E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	4.9E-06	12000	2.7E-06	12000	3.7E-08

Table 1-7. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries HSRAM Agricultural -- Groundwater Only.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	1.4E-02	12000	9.2E-03	12000	7.4E-04
Past Tank Leaks	12000	3.8E-04	12000	2.7E-04	12000	3.3E-05
Past Ancillary Equipment Leaks	12000	6.1E-04	12000	4.1E-04	12000	2.4E-05
Unlimited Advection Release	12000	3.1E-02	12000	1.9E-02	12000	4.8E-04
Release Limited to Diffusion	12000	1.7E-03	12000	1.0E-03	12000	2.1E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	6.8E-07	12000	4.0E-07	12000	8.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	5.0E-06	12000	2.8E-06	12000	3.8E-08
Post-Retrieval						
Unlimited Advection Release	12000	5.9E-04	12000	3.6E-04	12000	9.3E-06
Release Limited to Diffusion	12000	3.4E-05	12000	2.0E-05	12000	4.0E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	6.8E-07	12000	4.0E-07	12000	8.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	5.0E-06	12000	2.8E-06	12000	3.8E-08

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2.0 TECHNETIUM-99

Table 2-1. Simulated Peak Concentrations and Arrival Times for Technetium 99 at Various Boundaries.

Technetium-99 Concentration (pCi /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	4.2E+02	2107	6.6E+01	2324	2.2E+01
Past Tank Leaks	2092	1.6E+02	2117	2.5E+01	2333	8.5E+00
Past Ancillary Equipment Leaks	2117	3.5E+02	2141	5.6E+01	2355	2.0E+01
Residual Tank Unlimited Advection Release	4653	9.6E+03	4676	1.5E+03	4883	5.6E+02
Residual Tank Release Limited to Diffusion	5614	3.0E+03	5637	4.7E+02	5839	1.8E+02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E+00	5637	2.1E-01	5839	7.7E-02
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.4E+00	4925	1.1E+00	5130	4.2E-01
Post-Retrieval						
Residual Tank Unlimited Advection Release	4653	2.1E+02	4676	3.3E+01	4883	1.2E+01
Residual Tank Release Limited to Diffusion	5614	6.6E+01	5637	1.0E+01	5839	3.8E+00
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E+00	5637	2.1E-01	5839	7.7E-02
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.4E+00	4925	1.1E+00	5130	4.2E-01

Table 2-2. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries All Pathways Farmer -- Groundwater Only.

Technetium-99 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.9E-04	2107	4.6E-05	2324	1.5E-05
Past Tank Leaks	2092	1.1E-04	2117	1.7E-05	2333	5.9E-06
Past Ancillary Equipment Leaks	2117	2.5E-04	2141	3.9E-05	2355	1.4E-05
Unlimited Advection Release	4653	6.7E-03	4676	1.1E-03	4883	3.9E-04
Release Limited to Diffusion	5614	2.1E-03	5637	3.3E-04	5839	1.2E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.3E-07	5637	1.4E-07	5839	5.4E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.2E-06	4925	8.0E-07	5130	3.0E-07
Post-Retrieval						
Unlimited Advection Release	4653	1.5E-04	4676	2.3E-05	4883	8.3E-06
Release Limited to Diffusion	5614	4.6E-05	5637	7.1E-06	5839	2.6E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.3E-07	5637	1.4E-07	5839	5.4E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.2E-06	4925	8.0E-07	5130	3.0E-07

Table 2-3. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries Native American -- Groundwater Only.

Technetium-99 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.0E-03	2107	3.2E-04	2324	1.1E-04
Past Tank Leaks	2092	7.6E-04	2117	1.2E-04	2333	4.1E-05
Past Ancillary Equipment Leaks	2117	1.7E-03	2141	2.7E-04	2355	9.8E-05
Unlimited Advection Release	4653	4.7E-02	4676	7.3E-03	4883	2.7E-03
Release Limited to Diffusion	5614	1.5E-02	5637	2.3E-03	5839	8.6E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.5E-06	5637	1.0E-06	5839	3.7E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.6E-05	4925	5.6E-06	5130	2.1E-06
Post-Retrieval						
Unlimited Advection Release	4653	1.0E-03	4676	1.6E-04	4883	5.8E-05
Release Limited to Diffusion	5614	3.2E-04	5637	5.0E-05	5839	1.8E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.5E-06	5637	1.0E-06	5839	3.7E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.6E-05	4925	5.6E-06	5130	2.1E-06

Table 2-4. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries HSRAM Industrial.

Technetium-99 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.7E-06	2107	9.1E-07	2324	3.0E-07
Past Tank Leaks	2092	2.1E-06	2117	3.4E-07	2333	1.2E-07
Past Ancillary Equipment Leaks	2117	4.9E-06	2141	7.7E-07	2355	2.8E-07
Unlimited Advection Release	4653	1.3E-04	4676	2.1E-05	4883	7.7E-06
Release Limited to Diffusion	5614	4.2E-05	5637	6.5E-06	5839	2.4E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.8E-08	5637	2.9E-09	5839	1.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.0E-07	4925	1.6E-08	5130	5.8E-09
Post-Retrieval						
Unlimited Advection Release	4653	2.9E-06	4676	4.5E-07	4883	1.7E-07
Release Limited to Diffusion	5614	9.0E-07	5637	1.4E-07	5839	5.2E-08
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.8E-08	5637	2.9E-09	5839	1.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.0E-07	4925	1.6E-08	5130	5.8E-09

Table 2-5. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries HSRAM Recreational Groundwater Only.

Technetium-99 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	4.8E-07	2107	7.7E-08	2324	2.6E-08
Past Tank Leaks	2092	1.8E-07	2117	2.9E-08	2333	9.9E-09
Past Ancillary Equipment Leaks	2117	4.1E-07	2141	6.5E-08	2355	2.3E-08
Unlimited Advection Release	4653	1.1E-05	4676	1.8E-06	4883	6.4E-07
Release Limited to Diffusion	5614	3.5E-06	5637	5.5E-07	5839	2.0E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-09	5637	2.4E-10	5839	8.9E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.6E-09	4925	1.3E-09	5130	4.9E-10
Post-Retrieval						
Unlimited Advection Release	4653	2.4E-07	4676	3.8E-08	4883	1.4E-08
Release Limited to Diffusion	5614	7.6E-08	5637	1.2E-08	5839	4.4E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-09	5637	2.4E-10	5839	8.9E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.6E-09	4925	1.3E-09	5130	4.9E-10

Table 2-6. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries HSRAM Residential Groundwater Only.

Technetium-99 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.4E-04	2107	2.2E-05	2324	7.4E-06
Past Tank Leaks	2092	5.2E-05	2117	8.3E-06	2333	2.9E-06
Past Ancillary Equipment Leaks	2117	1.2E-04	2141	1.9E-05	2355	6.7E-06
Unlimited Advection Release	4653	3.2E-03	4676	5.1E-04	4883	1.9E-04
Release Limited to Diffusion	5614	1.0E-03	5637	1.6E-04	5839	5.9E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.5E-07	5637	7.0E-08	5839	2.6E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.5E-06	4925	3.8E-07	5130	1.4E-07
Post-Retrieval						
Unlimited Advection Release	4653	7.0E-05	4676	1.1E-05	4883	4.0E-06
Release Limited to Diffusion	5614	2.2E-05	5637	3.4E-06	5839	1.3E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.5E-07	5637	7.0E-08	5839	2.6E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.5E-06	4925	3.8E-07	5130	1.4E-07

Table 2-7. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries HSRAM Agricultural Groundwater Only.

Technetium-99 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.0E-04	2107	3.1E-05	2324	1.0E-05
Past Tank Leaks	2092	7.3E-05	2117	1.2E-05	2333	4.0E-06
Past Ancillary Equipment Leaks	2117	1.7E-04	2141	2.6E-05	2355	9.5E-06
Unlimited Advection Release	4653	4.6E-03	4676	7.1E-04	4883	2.6E-04
Release Limited to Diffusion	5614	1.4E-03	5637	2.2E-04	5839	8.3E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.3E-07	5637	9.8E-08	5839	3.6E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.5E-06	4925	5.4E-07	5130	2.0E-07
Post-Retrieval						
Unlimited Advection Release	4653	9.8E-05	4676	1.5E-05	4883	5.7E-06
Release Limited to Diffusion	5614	3.1E-05	5637	4.8E-06	5839	1.8E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.3E-07	5637	9.8E-08	5839	3.6E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.5E-06	4925	5.4E-07	5130	2.0E-07

Table 2-8. Simulated Peak Dose and Arrival Times for Technetium-99 at Various Boundaries All Pathways Farmer -- Groundwater Only.

Technetium-99 (Dose)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Dose (mrem/yr)	Time	Dose (mrem/yr)	Time	Dose (mrem/yr)
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	7.3E-01	2107	1.2E-01	2324	3.9E-02
Past Tank Leaks	2092	2.7E-01	2117	4.3E-02	2333	1.5E-02
Past Ancillary Equipment Leaks	2117	6.2E-01	2141	9.8E-02	2355	3.5E-02
Unlimited Advection Release	4653	1.7E+01	4676	2.6E+00	4883	9.7E-01
Release Limited to Diffusion	5614	5.3E+00	5637	8.3E-01	5839	3.1E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-03	5637	3.6E-04	5839	1.3E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-02	4925	2.0E-03	5130	7.4E-04
Post-Retrieval						
Unlimited Advection Release	4653	3.7E-01	4676	5.7E-02	4883	2.1E-02
Release Limited to Diffusion	5614	1.2E-01	5637	1.8E-02	5839	6.7E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-03	5637	3.6E-04	5839	1.3E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-02	4925	2.0E-03	5130	7.4E-04

Table 2-9. Simulated Peak Dose and Arrival Times for Technetium-99 at Various Boundaries Native American -- Groundwater Only.

Technetium-99 (Dose)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Dose (mrem/yr)	Time	Dose (mrem/yr)	Time	Dose (mrem/yr)
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.8E+00	2107	2.8E-01	2324	9.3E-02
Past Tank Leaks	2092	6.6E-01	2117	1.0E-01	2333	3.6E-02
Past Ancillary Equipment Leaks	2117	1.5E+00	2141	2.4E-01	2355	8.5E-02
Unlimited Advection Release	4653	4.1E+01	4676	6.4E+00	4883	2.3E+00
Release Limited to Diffusion	5614	1.3E+01	5637	2.0E+00	5839	7.4E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.6E-03	5637	8.8E-04	5839	3.3E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.2E-02	4925	4.9E-03	5130	1.8E-03
Post-Retrieval						
Unlimited Advection Release	4653	8.8E-01	4676	1.4E-01	4883	5.1E-02
Release Limited to Diffusion	5614	2.8E-01	5637	4.3E-02	5839	1.6E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.6E-03	5637	8.8E-04	5839	3.3E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.2E-02	4925	4.9E-03	5130	1.8E-03

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3.0 CHROMIUM

Table 3-1. Simulated Peak Concentrations and Arrival Times for Chromium at Various Boundaries.

Chromium Concentration (mg /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	6.4E-03	2107	1.0E-03	2324	3.4E-04
Past Tank Leaks	2092	7.9E-04	2117	1.3E-04	2333	4.3E-05
Past Ancillary Equipment Leaks	2117	3.3E-03	2141	5.2E-04	2355	1.9E-04
Residual Tank Unlimited Advection Release	4653	1.6E-01	4676	2.4E-02	4883	8.9E-03
Residual Tank Release Limited to Diffusion	5614	4.9E-02	5637	7.6E-03	5839	2.8E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.1E-05	5637	3.3E-06	5839	1.2E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.2E-04	4925	1.8E-05	5130	6.7E-06
Post-Retrieval						
Residual Tank Unlimited Advection Release	4653	3.3E-03	4676	5.2E-04	4883	1.9E-04
Residual Tank Release Limited to Diffusion	5614	1.0E-03	5637	1.6E-04	5839	6.0E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.1E-05	5637	3.3E-06	5839	1.2E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.2E-04	4925	1.8E-05	5130	6.7E-06

Table 3-2. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries All Pathways Farmer -- Groundwater Only.

Chromium (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.7E-07	2107	9.0E-08	2324	3.0E-08
Past Tank Leaks	2092	7.0E-08	2117	1.1E-08	2333	3.9E-09
Past Ancillary Equipment Leaks	2117	2.9E-07	2141	4.7E-08	2355	1.7E-08
Unlimited Advection Release	4653	1.4E-05	4676	2.2E-06	4883	7.9E-07
Release Limited to Diffusion	5614	4.4E-06	5637	6.8E-07	5839	2.5E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.9E-09	5637	2.9E-10	5839	1.1E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-08	4925	1.6E-09	5130	6.0E-10
Post-Retrieval						
Unlimited Advection Release	4653	2.9E-07	4676	4.6E-08	4883	1.7E-08
Release Limited to Diffusion	5614	9.3E-08	5637	1.4E-08	5839	5.4E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.9E-09	5637	2.9E-10	5839	1.1E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-08	4925	1.6E-09	5130	6.0E-10

Table 3-3. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

All Pathways Farmer -- Groundwater Only.

Chromium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	7.1E-02	2107	1.1E-02	2324	3.8E-03
Past Tank Leaks	2092	8.8E-03	2117	1.4E-03	2333	4.8E-04
Past Ancillary Equipment Leaks	2117	3.7E-02	2141	5.8E-03	2355	2.1E-03
Unlimited Advection Release	4653	1.7E+00	4676	2.7E-01	4883	9.9E-02
Release Limited to Diffusion	5614	5.4E-01	5637	8.5E-02	5839	3.1E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-04	5637	3.7E-05	5839	1.4E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-03	4925	2.0E-04	5130	7.5E-05
Post-Retrieval						
Unlimited Advection Release	4653	3.7E-02	4676	5.7E-03	4883	2.1E-03
Release Limited to Diffusion	5614	1.2E-02	5637	1.8E-03	5839	6.7E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-04	5637	3.7E-05	5839	1.4E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-03	4925	2.0E-04	5130	7.5E-05

Table 3-3. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries Native American -- Groundwater Only.

Chromium (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	4.8E-04	2107	7.7E-05	2324	2.6E-05
Past Tank Leaks	2092	6.0E-05	2117	9.4E-06	2333	3.3E-06
Past Ancillary Equipment Leaks	2117	2.5E-04	2141	3.9E-05	2355	1.4E-05
Unlimited Advection Release	4653	1.2E-02	4676	1.8E-03	4883	6.7E-04
Release Limited to Diffusion	5614	3.7E-03	5637	5.8E-04	5839	2.1E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.6E-06	5637	2.5E-07	5839	9.2E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.9E-06	4925	1.4E-06	5130	5.1E-07
Post-Retrieval						
Unlimited Advection Release	4653	2.5E-04	4676	3.9E-05	4883	1.4E-05
Release Limited to Diffusion	5614	7.9E-05	5637	1.2E-05	5839	4.5E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.6E-06	5637	2.5E-07	5839	9.2E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.9E-06	4925	1.4E-06	5130	5.1E-07

Table 3-5. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

Native American -- Groundwater Only.

Chromium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.2E+00	2107	8.2E-01	2324	2.7E-01
Past Tank Leaks	2092	6.4E-01	2117	1.0E-01	2333	3.5E-02
Past Ancillary Equipment Leaks	2117	2.7E+00	2141	4.2E-01	2355	1.5E-01
Unlimited Advection Release	4653	1.3E+02	4676	2.0E+01	4883	7.2E+00
Release Limited to Diffusion	5614	3.9E+01	5637	6.2E+00	5839	2.3E+00
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.7E-02	5637	2.7E-03	5839	9.8E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	9.5E-02	4925	1.5E-02	5130	5.4E-03
Post-Retrieval						
Unlimited Advection Release	4653	2.7E+00	4676	4.2E-01	4883	1.5E-01
Release Limited to Diffusion	5614	8.4E-01	5637	1.3E-01	5839	4.9E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.7E-02	5637	2.7E-03	5839	9.8E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	9.5E-02	4925	1.5E-02	5130	5.4E-03

Table 3-4. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries HSRAM Industrial.

Chromium (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.7E-07	2107	2.8E-08	2324	9.2E-09
Past Tank Leaks	2092	2.1E-08	2117	3.4E-09	2333	1.2E-09
Past Ancillary Equipment Leaks	2117	8.9E-08	2141	1.4E-08	2355	5.1E-09
Unlimited Advection Release	4653	4.2E-06	4676	6.6E-07	4883	2.4E-07
Release Limited to Diffusion	5614	1.3E-06	5637	2.1E-07	5839	7.6E-08
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.7E-10	5637	8.9E-11	5839	3.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.2E-09	4925	4.9E-10	5130	1.8E-10
Post-Retrieval						
Unlimited Advection Release	4653	8.9E-08	4676	1.4E-08	4883	5.1E-09
Release Limited to Diffusion	5614	2.8E-08	5637	4.4E-09	5839	1.6E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.7E-10	5637	8.9E-11	5839	3.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.2E-09	4925	4.9E-10	5130	1.8E-10

Table 3-7. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

HSRAM Industrial.

Chromium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.8E-02	2107	4.4E-03	2324	1.5E-03
Past Tank Leaks	2092	3.4E-03	2117	5.4E-04	2333	1.9E-04
Past Ancillary Equipment Leaks	2117	1.4E-02	2141	2.3E-03	2355	8.1E-04
Unlimited Advection Release	4653	6.7E-01	4676	1.0E-01	4883	3.9E-02
Release Limited to Diffusion	5614	2.1E-01	5637	3.3E-02	5839	1.2E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.1E-05	5637	1.4E-05	5839	5.3E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.1E-04	4925	7.9E-05	5130	2.9E-05
Post-Retrieval						
Unlimited Advection Release	4653	1.4E-02	4676	2.2E-03	4883	8.2E-04
Release Limited to Diffusion	5614	4.5E-03	5637	7.0E-04	5839	2.6E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.1E-05	5637	1.4E-05	5839	5.3E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.1E-04	4925	7.9E-05	5130	2.9E-05

Table 3-8. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries HSRAM Recreational -- Groundwater Only.

Chromium (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	6.8E-09	2107	1.1E-09	2324	3.6E-10
Past Tank Leaks	2092	8.5E-10	2117	1.3E-10	2333	4.6E-11
Past Ancillary Equipment Leaks	2117	3.5E-09	2141	5.6E-10	2355	2.0E-10
Unlimited Advection Release	4653	1.7E-07	4676	2.6E-08	4883	9.6E-09
Release Limited to Diffusion	5614	5.2E-08	5637	8.2E-09	5839	3.0E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-11	5637	3.5E-12	5839	1.3E-12
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-10	4925	1.9E-11	5130	7.2E-12
Post-Retrieval						
Unlimited Advection Release	4653	3.5E-09	4676	5.5E-10	4883	2.0E-10
Release Limited to Diffusion	5614	1.1E-09	5637	1.8E-10	5839	6.5E-11
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-11	5637	3.5E-12	5839	1.3E-12
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-10	4925	1.9E-11	5130	7.2E-12

Table 3-9. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

HSRAM Recreational -- Groundwater Only.

Chromium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.8E-03	2107	4.5E-04	2324	1.5E-04
Past Tank Leaks	2092	3.5E-04	2117	5.6E-05	2333	1.9E-05
Past Ancillary Equipment Leaks	2117	1.5E-03	2141	2.3E-04	2355	8.3E-05
Unlimited Advection Release	4653	6.9E-02	4676	1.1E-02	4883	4.0E-03
Release Limited to Diffusion	5614	2.2E-02	5637	3.4E-03	5839	1.3E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.4E-06	5637	1.5E-06	5839	5.4E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.3E-05	4925	8.1E-06	5130	3.0E-06
Post-Retrieval						
Unlimited Advection Release	4653	1.5E-03	4676	2.3E-04	4883	8.5E-05
Release Limited to Diffusion	5614	4.6E-04	5637	7.3E-05	5839	2.7E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.4E-06	5637	1.5E-06	5839	5.4E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.3E-05	4925	8.1E-06	5130	3.0E-06

Table 3-10. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries HSRAM Residential -- Groundwater Only.

Chromium (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	3.8E-07	2107	6.1E-08	2324	2.0E-08
Past Tank Leaks	2092	4.8E-08	2117	7.5E-09	2333	2.6E-09
Past Ancillary Equipment Leaks	2117	2.0E-07	2141	3.1E-08	2355	1.1E-08
Unlimited Advection Release	4653	9.3E-06	4676	1.5E-06	4883	5.4E-07
Release Limited to Diffusion	5614	2.9E-06	5637	4.6E-07	5839	1.7E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E-09	5637	2.0E-10	5839	7.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.1E-09	4925	1.1E-09	5130	4.0E-10
Post-Retrieval						
Unlimited Advection Release	4653	2.0E-07	4676	3.1E-08	4883	1.1E-08
Release Limited to Diffusion	5614	6.3E-08	5637	9.8E-09	5839	3.6E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E-09	5637	2.0E-10	5839	7.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.1E-09	4925	1.1E-09	5130	4.0E-10

Table 3-11. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

HSRAM Residential -- Groundwater Only.

Chromium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.5E-01	2107	2.4E-02	2324	8.1E-03
Past Tank Leaks	2092	1.9E-02	2117	3.0E-03	2333	1.0E-03
Past Ancillary Equipment Leaks	2117	7.9E-02	2141	1.3E-02	2355	4.5E-03
Unlimited Advection Release	4653	3.7E+00	4676	5.8E-01	4883	2.1E-01
Release Limited to Diffusion	5614	1.2E+00	5637	1.8E-01	5839	6.8E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.1E-04	5637	7.9E-05	5839	2.9E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.8E-03	4925	4.4E-04	5130	1.6E-04
Post-Retrieval						
Unlimited Advection Release	4653	7.9E-02	4676	1.2E-02	4883	4.6E-03
Release Limited to Diffusion	5614	2.5E-02	5637	3.9E-03	5839	1.4E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.1E-04	5637	7.9E-05	5839	2.9E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.8E-03	4925	4.4E-04	5130	1.6E-04

Table 3-12. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries HSRAM Agricultural -- Groundwater Only.

Chromium (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	3.8E-07	2107	6.1E-08	2324	2.0E-08
Past Tank Leaks	2092	4.8E-08	2117	7.5E-09	2333	2.6E-09
Past Ancillary Equipment Leaks	2117	2.0E-07	2141	3.1E-08	2355	1.1E-08
Unlimited Advection Release	4653	9.3E-06	4676	1.5E-06	4883	5.4E-07
Release Limited to Diffusion	5614	2.9E-06	5637	4.6E-07	5839	1.7E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E-09	5637	2.0E-10	5839	7.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.1E-09	4925	1.1E-09	5130	4.0E-10
Post-Retrieval						
Unlimited Advection Release	4653	2.0E-07	4676	3.1E-08	4883	1.1E-08
Release Limited to Diffusion	5614	6.3E-08	5637	9.8E-09	5839	3.6E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E-09	5637	2.0E-10	5839	7.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.1E-09	4925	1.1E-09	5130	4.0E-10

Table 3-13. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

HSRAM Agricultural -- Groundwater Only.

Chromium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.6E-01	2107	2.5E-02	2324	8.4E-03
Past Tank Leaks	2092	2.0E-02	2117	3.1E-03	2333	1.1E-03
Past Ancillary Equipment Leaks	2117	8.2E-02	2141	1.3E-02	2355	4.6E-03
Unlimited Advection Release	4653	3.8E+00	4676	6.0E-01	4883	2.2E-01
Release Limited to Diffusion	5614	1.2E+00	5637	1.9E-01	5839	7.0E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.2E-04	5637	8.2E-05	5839	3.0E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.9E-03	4925	4.5E-04	5130	1.7E-04
Post-Retrieval						
Unlimited Advection Release	4653	8.2E-02	4676	1.3E-02	4883	4.7E-03
Release Limited to Diffusion	5614	2.6E-02	5637	4.0E-03	5839	1.5E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.2E-04	5637	8.2E-05	5839	3.0E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.9E-03	4925	4.5E-04	5130	1.7E-04

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4.0 IODINE-129

Table 4-1. Simulated Peak Concentrations and Arrival Times for Iodine-129 at Various Boundaries.

Iodine-129 Concentration (pCi /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	8.2E-01	2107	1.3E-01	2324	4.4E-02
Past Tank Leaks	2092	3.0E-01	2117	4.8E-02	2333	1.6E-02
Past Ancillary Equipment Leaks	2117	6.8E-01	2141	1.1E-01	2355	3.9E-02
Residual Tank Unlimited Advection Release	4653	2.8E+01	4676	4.3E+00	4883	1.6E+00
Residual Tank Release Limited to Diffusion	5614	8.7E+00	5637	1.4E+00	5839	5.0E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.8E-03	5637	4.3E-04	5839	1.6E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.5E-02	4925	2.4E-03	5130	8.7E-04
Post-Retrieval						
Residual Tank Unlimited Advection Release	4653	4.3E-01	4676	6.7E-02	4883	2.5E-02
Residual Tank Release Limited to Diffusion	5614	1.4E-01	5637	2.1E-02	5839	7.9E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.8E-03	5637	4.3E-04	5839	1.6E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.5E-02	4925	2.4E-03	5130	8.7E-04

Table 4-2. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries All Pathways Farmer -- Groundwater Only.

Iodine-129 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.3E-05	2107	2.0E-06	2324	6.7E-07
Past Tank Leaks	2092	4.6E-06	2117	7.3E-07	2333	2.5E-07
Past Ancillary Equipment Leaks	2117	1.0E-05	2141	1.6E-06	2355	5.9E-07
Unlimited Advection Release	4653	4.2E-04	4676	6.6E-05	4883	2.4E-05
Release Limited to Diffusion	5614	1.3E-04	5637	2.1E-05	5839	7.7E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.2E-08	5637	6.6E-09	5839	2.4E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-07	4925	3.6E-08	5130	1.3E-08
Post-Retrieval						
Unlimited Advection Release	4653	6.6E-06	4676	1.0E-06	4883	3.8E-07
Release Limited to Diffusion	5614	2.1E-06	5637	3.2E-07	5839	1.2E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.2E-08	5637	6.6E-09	5839	2.4E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-07	4925	3.6E-08	5130	1.3E-08

Table 4-3. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries Native American -- Groundwater Only.

Iodine-129 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	9.0E-05	2107	1.4E-05	2324	4.8E-06
Past Tank Leaks	2092	3.3E-05	2117	5.2E-06	2333	1.8E-06
Past Ancillary Equipment Leaks	2117	7.4E-05	2141	1.2E-05	2355	4.2E-06
Unlimited Advection Release	4653	3.0E-03	4676	4.7E-04	4883	1.7E-04
Release Limited to Diffusion	5614	9.5E-04	5637	1.5E-04	5839	5.5E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.0E-07	5637	4.7E-08	5839	1.7E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.7E-06	4925	2.6E-07	5130	9.5E-08
Post-Retrieval						
Unlimited Advection Release	4653	4.7E-05	4676	7.3E-06	4883	2.7E-06
Release Limited to Diffusion	5614	1.5E-05	5637	2.3E-06	5839	8.6E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.0E-07	5637	4.7E-08	5839	1.7E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.7E-06	4925	2.6E-07	5130	9.5E-08

Table 4-4. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries HSRAM Industrial.

Iodine-129 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	6.1E-07	2107	9.7E-08	2324	3.2E-08
Past Tank Leaks	2092	2.2E-07	2117	3.5E-08	2333	1.2E-08
Past Ancillary Equipment Leaks	2117	5.1E-07	2141	8.0E-08	2355	2.9E-08
Unlimited Advection Release	4653	2.0E-05	4676	3.2E-06	4883	1.2E-06
Release Limited to Diffusion	5614	6.4E-06	5637	1.0E-06	5839	3.7E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.0E-09	5637	3.2E-10	5839	1.2E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-08	4925	1.8E-09	5130	6.5E-10
Post-Retrieval						
Unlimited Advection Release	4653	3.2E-07	4676	5.0E-08	4883	1.8E-08
Release Limited to Diffusion	5614	1.0E-07	5637	1.6E-08	5839	5.8E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.0E-09	5637	3.2E-10	5839	1.2E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-08	4925	1.8E-09	5130	6.5E-10

Table 4-5. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries HSRAM Recreational Groundwater Only.

Iodine-129 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.2E-08	2107	8.2E-09	2324	2.7E-09
Past Tank Leaks	2092	1.9E-08	2117	3.0E-09	2333	1.0E-09
Past Ancillary Equipment Leaks	2117	4.3E-08	2141	6.7E-09	2355	2.4E-09
Unlimited Advection Release	4653	1.7E-06	4676	2.7E-07	4883	9.9E-08
Release Limited to Diffusion	5614	5.4E-07	5637	8.5E-08	5839	3.1E-08
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.7E-10	5637	2.7E-11	5839	9.9E-12
Residual Ancillary Pipeline Release Limited to Diffusion	4891	9.6E-10	4925	1.5E-10	5130	5.5E-11
Post-Retrieval						
Unlimited Advection Release	4653	2.7E-08	4676	4.2E-09	4883	1.5E-09
Release Limited to Diffusion	5614	8.5E-09	5637	1.3E-09	5839	4.9E-10
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.7E-10	5637	2.7E-11	5839	9.9E-12
Residual Ancillary Pipeline Release Limited to Diffusion	4891	9.6E-10	4925	1.5E-10	5130	5.5E-11

Table 4-6. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries HSRAM Residential Groundwater Only.

Iodine-129 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	3.2E-06	2107	5.0E-07	2324	1.7E-07
Past Tank Leaks	2092	1.2E-06	2117	1.8E-07	2333	6.4E-08
Past Ancillary Equipment Leaks	2117	2.6E-06	2141	4.2E-07	2355	1.5E-07
Unlimited Advection Release	4653	1.1E-04	4676	1.7E-05	4883	6.1E-06
Release Limited to Diffusion	5614	3.3E-05	5637	5.2E-06	5839	1.9E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.1E-08	5637	1.7E-09	5839	6.1E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.9E-08	4925	9.1E-09	5130	3.4E-09
Post-Retrieval						
Unlimited Advection Release	4653	1.7E-06	4676	2.6E-07	4883	9.5E-08
Release Limited to Diffusion	5614	5.2E-07	5637	8.2E-08	5839	3.0E-08
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.1E-08	5637	1.7E-09	5839	6.1E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.9E-08	4925	9.1E-09	5130	3.4E-09

Table 4-7. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries HSRAM Agricultural Groundwater Only.

Iodine-129 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.9E-05	2107	3.1E-06	2324	1.0E-06
Past Tank Leaks	2092	7.0E-06	2117	1.1E-06	2333	3.8E-07
Past Ancillary Equipment Leaks	2117	1.6E-05	2141	2.5E-06	2355	9.0E-07
Unlimited Advection Release	4653	6.4E-04	4676	1.0E-04	4883	3.7E-05
Release Limited to Diffusion	5614	2.0E-04	5637	3.2E-05	5839	1.2E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.4E-08	5637	1.0E-08	5839	3.7E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.6E-07	4925	5.5E-08	5130	2.0E-08
Post-Retrieval						
Unlimited Advection Release	4653	1.0E-05	4676	1.6E-06	4883	5.8E-07
Release Limited to Diffusion	5614	3.2E-06	5637	4.9E-07	5839	1.8E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.4E-08	5637	1.0E-08	5839	3.7E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.6E-07	4925	5.5E-08	5130	2.0E-08

Table 4-8. Simulated Peak Dose and Arrival Times for Iodine-129 at Various Boundaries All Pathways Farmer -- Groundwater Only.

Iodine-129 (Dose)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Dose (mrem/yr)	Time	Dose (mrem/yr)	Time	Dose (mrem/yr)
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	4.3E-01	2107	6.9E-02	2324	2.3E-02
Past Tank Leaks	2092	1.6E-01	2117	2.5E-02	2333	8.7E-03
Past Ancillary Equipment Leaks	2117	3.6E-01	2141	5.7E-02	2355	2.0E-02
Unlimited Advection Release	4653	1.5E+01	4676	2.3E+00	4883	8.3E-01
Release Limited to Diffusion	5614	4.6E+00	5637	7.1E-01	5839	2.6E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-03	5637	2.3E-04	5839	8.4E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.1E-03	4925	1.2E-03	5130	4.6E-04
Post-Retrieval						
Unlimited Advection Release	4653	2.3E-01	4676	3.5E-02	4883	1.3E-02
Release Limited to Diffusion	5614	7.1E-02	5637	1.1E-02	5839	4.1E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-03	5637	2.3E-04	5839	8.4E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.1E-03	4925	1.2E-03	5130	4.6E-04

Table 4-9. Simulated Peak Dose and Arrival Times for Iodine-129 at Various Boundaries Native American -- Groundwater Only.

Iodine-129 (Dose)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Dose (mrem/yr)	Time	Dose (mrem/yr)	Time	Dose (mrem/yr)
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.0E+00	2107	1.6E-01	2324	5.4E-02
Past Tank Leaks	2092	3.7E-01	2117	5.8E-02	2333	2.0E-02
Past Ancillary Equipment Leaks	2117	8.4E-01	2141	1.3E-01	2355	4.7E-02
Unlimited Advection Release	4653	3.4E+01	4676	5.3E+00	4883	1.9E+00
Release Limited to Diffusion	5614	1.1E+01	5637	1.7E+00	5839	6.2E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.4E-03	5637	5.3E-04	5839	2.0E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.9E-02	4925	2.9E-03	5130	1.1E-03
Post-Retrieval						
Unlimited Advection Release	4653	5.3E-01	4676	8.3E-02	4883	3.0E-02
Release Limited to Diffusion	5614	1.7E-01	5637	2.6E-02	5839	9.6E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.4E-03	5637	5.3E-04	5839	2.0E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.9E-02	4925	2.9E-03	5130	1.1E-03

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5.0 NITRATE

Table 5-1. Simulated Peak Concentrations and Arrival Times for Nitrate at Various Boundaries.

Nitrate Concentration (mg /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	6.6E-01	2107	1.1E-01	2324	3.5E-02
Past Tank Leaks	2092	2.5E-02	2117	4.0E-03	2333	1.4E-03
Past Ancillary Equipment Leaks	2117	2.4E-01	2141	3.9E-02	2355	1.4E-02
Residual Tank Unlimited Advection Release	4653	1.1E+01	4676	1.7E+00	4883	6.4E-01
Residual Tank Release Limited to Diffusion	5614	3.5E+00	5637	5.5E-01	5839	2.0E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-03	5637	2.3E-04	5839	8.6E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.3E-03	4925	1.3E-03	5130	4.7E-04
Post-Retrieval						
Residual Tank Unlimited Advection Release	4653	2.3E-01	4676	3.6E-02	4883	1.3E-02
Residual Tank Release Limited to Diffusion	5614	7.3E-02	5637	1.1E-02	5839	4.2E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-03	5637	2.3E-04	5839	8.6E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.3E-03	4925	1.3E-03	5130	4.7E-04

Table 5-2. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries All Pathways Farmer -- Groundwater Only.

Nitrate (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	8.9E-03	2107	1.4E-03	2324	4.7E-04
Past Tank Leaks	2092	3.4E-04	2117	5.4E-05	2333	1.9E-05
Past Ancillary Equipment Leaks	2117	3.3E-03	2141	5.2E-04	2355	1.9E-04
Unlimited Advection Release	4653	1.5E-01	4676	2.3E-02	4883	8.6E-03
Release Limited to Diffusion	5614	4.7E-02	5637	7.4E-03	5839	2.7E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.0E-05	5637	3.1E-06	5839	1.2E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-04	4925	1.7E-05	5130	6.4E-06
Post-Retrieval						
Unlimited Advection Release	4653	3.1E-03	4676	4.9E-04	4883	1.8E-04
Release Limited to Diffusion	5614	9.9E-04	5637	1.5E-04	5839	5.7E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.0E-05	5637	3.1E-06	5839	1.2E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-04	4925	1.7E-05	5130	6.4E-06

Table 5-3. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries Native American -- Groundwater Only.

Nitrate (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.8E-02	2107	2.9E-03	2324	9.7E-04
Past Tank Leaks	2092	7.0E-04	2117	1.1E-04	2333	3.8E-05
Past Ancillary Equipment Leaks	2117	6.7E-03	2141	1.1E-03	2355	3.8E-04
Unlimited Advection Release	4653	3.1E-01	4676	4.8E-02	4883	1.8E-02
Release Limited to Diffusion	5614	9.6E-02	5637	1.5E-02	5839	5.6E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.1E-05	5637	6.4E-06	5839	2.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.3E-04	4925	3.5E-05	5130	1.3E-05
Post-Retrieval						
Unlimited Advection Release	4653	6.4E-03	4676	1.0E-03	4883	3.7E-04
Release Limited to Diffusion	5614	2.0E-03	5637	3.2E-04	5839	1.2E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.1E-05	5637	6.4E-06	5839	2.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.3E-04	4925	3.5E-05	5130	1.3E-05

Table 5-4. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries HSRAM Industrial.

Nitrate (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	4.1E-03	2107	6.5E-04	2324	2.2E-04
Past Tank Leaks	2092	1.6E-04	2117	2.5E-05	2333	8.6E-06
Past Ancillary Equipment Leaks	2117	1.5E-03	2141	2.4E-04	2355	8.6E-05
Unlimited Advection Release	4653	6.9E-02	4676	1.1E-02	4883	4.0E-03
Release Limited to Diffusion	5614	2.2E-02	5637	3.4E-03	5839	1.2E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.2E-06	5637	1.4E-06	5839	5.3E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.1E-05	4925	7.9E-06	5130	2.9E-06
Post-Retrieval						
Unlimited Advection Release	4653	1.4E-03	4676	2.3E-04	4883	8.3E-05
Release Limited to Diffusion	5614	4.5E-04	5637	7.1E-05	5839	2.6E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.2E-06	5637	1.4E-06	5839	5.3E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.1E-05	4925	7.9E-06	5130	2.9E-06

Table 5-5. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries HSRAM Recreational -- Groundwater Only.

Nitrate (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.0E-04	2107	8.0E-05	2324	2.7E-05
Past Tank Leaks	2092	1.9E-05	2117	3.1E-06	2333	1.1E-06
Past Ancillary Equipment Leaks	2117	1.9E-04	2141	2.9E-05	2355	1.1E-05
Unlimited Advection Release	4653	8.5E-03	4676	1.3E-03	4883	4.9E-04
Release Limited to Diffusion	5614	2.7E-03	5637	4.2E-04	5839	1.5E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.1E-06	5637	1.8E-07	5839	6.5E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	6.3E-06	4925	9.8E-07	5130	3.6E-07
Post-Retrieval						
Unlimited Advection Release	4653	1.8E-04	4676	2.8E-05	4883	1.0E-05
Release Limited to Diffusion	5614	5.6E-05	5637	8.7E-06	5839	3.2E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.1E-06	5637	1.8E-07	5839	6.5E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	6.3E-06	4925	9.8E-07	5130	3.6E-07

Table 5-6. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries HSRAM Residential -- Groundwater Only.

Nitrate (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.6E-02	2107	4.2E-03	2324	1.4E-03
Past Tank Leaks	2092	1.0E-03	2117	1.6E-04	2333	5.5E-05
Past Ancillary Equipment Leaks	2117	9.7E-03	2141	1.5E-03	2355	5.5E-04
Unlimited Advection Release	4653	4.4E-01	4676	6.9E-02	4883	2.5E-02
Release Limited to Diffusion	5614	1.4E-01	5637	2.2E-02	5839	8.0E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.9E-05	5637	9.2E-06	5839	3.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.3E-04	4925	5.1E-05	5130	1.9E-05
Post-Retrieval						
Unlimited Advection Release	4653	9.3E-03	4676	1.4E-03	4883	5.3E-04
Release Limited to Diffusion	5614	2.9E-03	5637	4.6E-04	5839	1.7E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.9E-05	5637	9.2E-06	5839	3.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.3E-04	4925	5.1E-05	5130	1.9E-05

Table 5-7. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries HSRAM Agricultural -- Groundwater Only.

Nitrate (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.6E-02	2107	4.2E-03	2324	1.4E-03
Past Tank Leaks	2092	1.0E-03	2117	1.6E-04	2333	5.5E-05
Past Ancillary Equipment Leaks	2117	9.7E-03	2141	1.5E-03	2355	5.5E-04
Unlimited Advection Release	4653	4.4E-01	4676	6.9E-02	4883	2.5E-02
Release Limited to Diffusion	5614	1.4E-01	5637	2.2E-02	5839	8.0E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.9E-05	5637	9.2E-06	5839	3.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.3E-04	4925	5.1E-05	5130	1.9E-05
Post-Retrieval						
Unlimited Advection Release	4653	9.3E-03	4676	1.4E-03	4883	5.3E-04
Release Limited to Diffusion	5614	2.9E-03	5637	4.6E-04	5839	1.7E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.9E-05	5637	9.2E-06	5839	3.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.3E-04	4925	5.1E-05	5130	1.9E-05

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6.0 NITRITE

Table 6-1. Simulated Peak Concentrations and Arrival Times for Nitrite at Various Boundaries.

Nitrite Concentration (mg /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.6E-01	2107	4.2E-02	2324	1.4E-02
Past Tank Leaks	2092	2.2E-02	2117	3.4E-03	2333	1.2E-03
Past Ancillary Equipment Leaks	2117	1.2E-01	2141	2.0E-02	2355	7.0E-03
Residual Tank Unlimited Advection Release	4653	5.3E+00	4676	8.2E-01	4883	3.0E-01
Residual Tank Release Limited to Diffusion	5614	1.7E+00	5637	2.6E-01	5839	9.6E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.9E-04	5637	1.1E-04	5839	4.0E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.8E-03	4925	5.9E-04	5130	2.2E-04
Post-Retrieval						
Residual Tank Unlimited Advection Release	4653	1.1E-01	4676	1.7E-02	4883	6.2E-03
Residual Tank Release Limited to Diffusion	5614	3.4E-02	5637	5.3E-03	5839	2.0E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.9E-04	5637	1.1E-04	5839	4.0E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.8E-03	4925	5.9E-04	5130	2.2E-04

Table 6-2. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries All Pathways Farmer -- Groundwater Only.

Nitrite (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.7E-02	2107	9.0E-03	2324	3.0E-03
Past Tank Leaks	2092	4.7E-03	2117	7.4E-04	2333	2.6E-04
Past Ancillary Equipment Leaks	2117	2.7E-02	2141	4.2E-03	2355	1.5E-03
Unlimited Advection Release	4653	1.1E+00	4676	1.8E-01	4883	6.6E-02
Release Limited to Diffusion	5614	3.6E-01	5637	5.6E-02	5839	2.1E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-04	5637	2.3E-05	5839	8.6E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.3E-04	4925	1.3E-04	5130	4.7E-05
Post-Retrieval						
Unlimited Advection Release	4653	2.3E-02	4676	3.6E-03	4883	1.3E-03
Release Limited to Diffusion	5614	7.3E-03	5637	1.1E-03	5839	4.2E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-04	5637	2.3E-05	5839	8.6E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.3E-04	4925	1.3E-04	5130	4.7E-05

Table 6-3. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries Native American -- Groundwater Only.

Nitrite (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.2E-01	2107	1.8E-02	2324	6.1E-03
Past Tank Leaks	2092	9.5E-03	2117	1.5E-03	2333	5.2E-04
Past Ancillary Equipment Leaks	2117	5.4E-02	2141	8.6E-03	2355	3.1E-03
Unlimited Advection Release	4653	2.3E+00	4676	3.6E-01	4883	1.3E-01
Release Limited to Diffusion	5614	7.3E-01	5637	1.1E-01	5839	4.2E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.0E-04	5637	4.7E-05	5839	1.7E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.7E-03	4925	2.6E-04	5130	9.6E-05
Post-Retrieval						
Unlimited Advection Release	4653	4.7E-02	4676	7.4E-03	4883	2.7E-03
Release Limited to Diffusion	5614	1.5E-02	5637	2.3E-03	5839	8.6E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.0E-04	5637	4.7E-05	5839	1.7E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.7E-03	4925	2.6E-04	5130	9.6E-05

Table 6-4. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries HSRAM Industrial.

Nitrite (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.6E-02	2107	4.1E-03	2324	1.4E-03
Past Tank Leaks	2092	2.1E-03	2117	3.4E-04	2333	1.2E-04
Past Ancillary Equipment Leaks	2117	1.2E-02	2141	1.9E-03	2355	6.9E-04
Unlimited Advection Release	4653	5.2E-01	4676	8.1E-02	4883	3.0E-02
Release Limited to Diffusion	5614	1.6E-01	5637	2.6E-02	5839	9.5E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.8E-05	5637	1.1E-05	5839	3.9E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.8E-04	4925	5.9E-05	5130	2.2E-05
Post-Retrieval						
Unlimited Advection Release	4653	1.1E-02	4676	1.7E-03	4883	6.1E-04
Release Limited to Diffusion	5614	3.4E-03	5637	5.2E-04	5839	1.9E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.8E-05	5637	1.1E-05	5839	3.9E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.8E-04	4925	5.9E-05	5130	2.2E-05

Table 6-5. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries HSRAM Recreational -- Groundwater Only.

Nitrite (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	3.2E-03	2107	5.1E-04	2324	1.7E-04
Past Tank Leaks	2092	2.6E-04	2117	4.2E-05	2333	1.4E-05
Past Ancillary Equipment Leaks	2117	1.5E-03	2141	2.4E-04	2355	8.6E-05
Unlimited Advection Release	4653	6.4E-02	4676	1.0E-02	4883	3.7E-03
Release Limited to Diffusion	5614	2.0E-02	5637	3.2E-03	5839	1.2E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	8.4E-06	5637	1.3E-06	5839	4.8E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	4.7E-05	4925	7.2E-06	5130	2.7E-06
Post-Retrieval						
Unlimited Advection Release	4653	1.3E-03	4676	2.0E-04	4883	7.5E-05
Release Limited to Diffusion	5614	4.1E-04	5637	6.5E-05	5839	2.4E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	8.4E-06	5637	1.3E-06	5839	4.8E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	4.7E-05	4925	7.2E-06	5130	2.7E-06

Table 6-6. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries HSRAM Residential -- Groundwater Only.

Nitrite (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.7E-01	2107	2.7E-02	2324	8.9E-03
Past Tank Leaks	2092	1.4E-02	2117	2.2E-03	2333	7.6E-04
Past Ancillary Equipment Leaks	2117	7.9E-02	2141	1.2E-02	2355	4.5E-03
Unlimited Advection Release	4653	3.3E+00	4676	5.2E-01	4883	1.9E-01
Release Limited to Diffusion	5614	1.1E+00	5637	1.6E-01	5839	6.1E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.4E-04	5637	6.8E-05	5839	2.5E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-03	4925	3.8E-04	5130	1.4E-04
Post-Retrieval						
Unlimited Advection Release	4653	6.8E-02	4676	1.1E-02	4883	3.9E-03
Release Limited to Diffusion	5614	2.2E-02	5637	3.4E-03	5839	1.2E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.4E-04	5637	6.8E-05	5839	2.5E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-03	4925	3.8E-04	5130	1.4E-04

Table 6-7. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries HSRAM Agricultural -- Groundwater Only.

Nitrite (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.7E-01	2107	2.7E-02	2324	8.9E-03
Past Tank Leaks	2092	1.4E-02	2117	2.2E-03	2333	7.6E-04
Past Ancillary Equipment Leaks	2117	7.9E-02	2141	1.2E-02	2355	4.5E-03
Unlimited Advection Release	4653	3.3E+00	4676	5.2E-01	4883	1.9E-01
Release Limited to Diffusion	5614	1.1E+00	5637	1.6E-01	5839	6.1E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.4E-04	5637	6.8E-05	5839	2.5E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-03	4925	3.8E-04	5130	1.4E-04
Post-Retrieval						
Unlimited Advection Release	4653	6.8E-02	4676	1.1E-02	4883	3.9E-03
Release Limited to Diffusion	5614	2.2E-02	5637	3.4E-03	5839	1.2E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.4E-04	5637	6.8E-05	5839	2.5E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-03	4925	3.8E-04	5130	1.4E-04

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ATTACHMENT C-1

SINGLE-SHELL TANK 241-C-106 COMPONENT CLOSURE ACTIVITY PLAN

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LIST OF TERMS

BBI	best basis inventory
bgs	below ground surface
C-106	single-shell tank 241-C-106
CFR	*Code of Federal Regulations*
COPC	constituents of potential concern
DQA	data quality assessment
DQO	data quality objectives
DOE	U.S. Department of Energy
DST	double-shell tank
DWTP	Dangerous Waste Training Plan
ECN	Engineering Change Notice
EIS	Environmental Impact Statement
Ecology	Washington State Department of Ecology
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate air
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
ILCR	Incremental Lifetime Cancer Risk
LDMM	Leak Detection, Monitoring, and Mitigation
LDR	land disposal restrictions
MCL	maximum contaminant level
PUREX	plutonium-uranium extraction
QA	quality assurance
QAPjP	Quality Assurance Project Plan
RCRA	*Resource Conservation and Recovery Act of 1976*
SEPA	State Environmental Policy Act
SST	single-shell tank
SVOC	semi-volatile organic compound
TSD	treatment, storage, and disposal
TVMS	tank volume measurement system
TWINS	Tank Waste Information Network System
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WMA	waste management area
WMA C	Waste Management Area C

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1.0 INTRODUCTION

This document describes component closure activities for single-shell tank (SST) 241-C-106 (hereinafter referred to as C-106). C-106 is a tank containing high-level mixed waste located in waste management area C (WMA C) of the Hanford Site. An operating history and description of C-106 is provided in Section 2.0. C-106 is the first tank to undergo component closure activities in accordance with *Hanford Federal Facility Agreement and Consent Order* (HFFACO, Ecology et al. 1989) Milestone M-45-00. This component closure activity plan (identified as the C-106 Waste Retrieval and Closure Demonstration Plan in Milestone M-45-06-A) will comply with regulatory requirements including, but not limited to, the HFFACO Milestones and *Washington Administrative Code* (WAC) 173-303. The component closure activities are in accordance with WAC 173-303-610, HFFACO, and the *Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste,* Rev. 7 (Ecology 2001, hereafter referred to as the Site-Wide Permit).

C-106 component closure action will demonstrate closure activities, regulatory processes, and provide lessons learned to accelerate future SST component and WMA closure actions. As additional components within WMA C undergo closure activities, corresponding component closure activity plans will be developed for inclusion as attachments to the WMA C Closure Action Plan, which is Appendix C to the *Framework Plan for Single-Shell Tank System Closure* (Framework Plan). Together these plans and plans for other WMAs and components form the *SST System Closure Plan*. Each component closure activity plan will constitute a modification of the *SST System Closure Plan* and require a modification to the Site-Wide Permit. Closure decisions made under corrective actions for past practices (Part IV of the Site-Wide Permit) or a *Comprehensive Environmental Response, Compensation, and Liability Act* record of decision will be approved through incorporation into the Site-Wide Permit.

1.1 PURPOSE

This plan identifies activities that will accomplish the retrieval and component closure demonstration of C-106 conforming to the applicable requirements of WAC 173-303 and the HFFACO Milestones M-45-06A, M-45-05N-T01, and M-45-05H, as well as Section 6 of the HFFACO action plan.

1.1.1 Scope of Plan Submission

The scope of this component closure activity plan is C-106, including risers. This plan does not include closure activities for any equipment or ancillary piping external to the tank, and does not include any corrective measures that may be needed for soil or groundwater contamination. A description of isolation activities for adjacent/interconnected components, including evaluations to determine impacts on future closure actions, is included in Section 5.3. Subsequent component closure activity plans and the WMA C Closure Action Plan will address the remaining components in WMA C. The C-106 component closure activities will not preclude future closure activities for other components.

Retrieval of SST waste constitutes a key SST System closure action. The C-106 retrieval actions will be approved through the HFFACO and scheduled, in advance, through HFFACO M-45 Milestones. Since retrieval actions are significant closure actions, detailed summaries of those actions are included in Section 2.5.3.

Retrieval actions will have occurred for C-106 (HFFACO Milestone M-45-05L-T01) prior to modification of the Site-Wide Permit to include this closure activity plan (HFFACO Milestone M-45-05H). Therefore, retrieval actions described in this closure activity plan are being provided to more fully address the extent of closure activities that have been and will be implemented at C-106. Pursuant to M-45-05H, the project data report will describe C-106 retrieval and characterization results.

C-106 component closure activities identified will occur in phases pursuant to approval by Ecology of the Site-Wide Permit. These phases are:

- Retrieval of remaining waste to the extent technically possible in accordance with HFFACO Milestone M-45-00
- Isolation of the tank
- Phase I fill – grout* base layer to cover remaining residuals and debris to approximately 12 to 36 inches in depth
- Phase II fill – structural layer to be placed on top of the Phase I fill to provide long-term structural stability to the tank
- Phase III fill – intruder layer consisting of a high-strength grout* fill on top of the Phase II fill that extends to the top of the tank dome. Risers will be filled to the dome elevation level.

HFFACO Milestone M-45-06A required U.S. Department of Energy (DOE) to submit to Washington State Department of Ecology (Ecology) "a certified (Framework) SST System Closure Plan and C-106 waste retrieval and closure demonstration plan" by December 19, 2002, "as a Hanford site-wide hazardous waste facility permit modification..." The milestone also required DOE to include a characterization approach for residual wastes and a risk assessment methodology in the plan. The approach for characterizing C-106 residual wastes is outlined in Section 2.5.5 with supporting details provided in Section 5.0. The results of C-106 characterization will be used to support the risk assessment methodology described in Section C5.0 of the WMA C Closure Action Plan.

HFFACO Milestone M-45-05H states criteria for interim completion of the C-106 SST waste retrieval and closure demonstration project that must be met by April 30, 2004. One criterion is "The C-106 demonstration SST closure plan has been submitted by DOE and approved by

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* See Preface in *SST System Closure Plan* (RPP-13774).

Ecology." Incorporation of this component closure activity plan into the Site-Wide Permit through the permit modification process will meet this criterion. The other criteria are "Full scale waste retrieval has been completed in accordance with applicable regulatory requirements including Washington Hazardous Waste Management Act and requirements set by this agreement [HFFACO] (DOE will document project data and results in a waste retrieval and closure demonstration report)."; "Remaining wastes have been adequately characterized, and a risk assessment, approved by Ecology, has been completed for residuals remaining in the tank; and "If appropriate, DOE has requested and Ecology has approved, an exception to waste retrieval criteria pursuant to Agreement Appendix H."

HFFACO Milestone M-45-05N-T01, *Final Completion of Tank C-106 SST Retrieval and Closure Demonstration Project*, states "Completion of the tank C-106 retrieval and closure demonstration project is defined as the completion of necessary field project actions required by the approved SST closure plan for C-106." This milestone will be fulfilled when all actions described in this component closure activity plan and required by the Site-Wide Permit are completed. The date for completion of all project activities is December 31, 2004. Table 5-4 lists the milestones for C-106 retrieval and component closure. Figure 5-4 shows the major C-106 component closure activities.

1.1.2 Component Closure Activity Process

The dangerous waste portion of the Site-Wide Permit for the treatment, storage, and disposal of dangerous waste (dangerous waste permit) issued in conjunction with the U.S. Environmental Protection Agency (EPA) hazardous and solid waste amendments permit, constitutes the Site-Wide Permit for the Hanford Site. This component closure activity plan will be incorporated into the WMA C Closure Action Plan portion of the *SST System Closure Plan*. Approval of the C-106 Component Closure Activity Plan is accomplished by incorporation into the Site-Wide Permit through the permit modification process.

In addition, a State Environmental Policy Act (SEPA) Environmental Checklist is being submitted concurrently with the application for modification of the Site-Wide Permit to support the C-106 component closure activities.

1.2 REGULATIONS AND STANDARDS APPLICABLE TO C-106 COMPONENT CLOSURE ACTIVITY

The C-106 retrieval and component closure activities are regulated by many requirements. Drivers include a state-federal agreement, federal and state statutes and regulations, and DOE directives and orders. A discussion of these requirements is contained in the Framework Plan.

Ecology regulates the SSTs as dangerous waste storage and treatment units under WAC 173-303, which implements the *Resource Conservation and Recovery Act of 1976* (RCRA). C-106 contains mixed waste and is included in the RCRA dangerous waste permit application, Part A, Form 3, submitted for the SST system.

1.2.1 SST Closure Performance Standards

The HFFACO requires that all treatment, storage and disposal (TSD) units, regardless of permit status, be closed under WAC 173-303-610. DOE will close the SST system in compliance with the performance standards set out in WAC 173-303-610 (2)(a) and -640(8). The actions described in this component closure activity plan are consistent with closure of the SST system in compliance with these performance standards. However, the C-106 component closure activities described in this plan are just the initial steps required to meet the closure performance standards for the WMA C and SST system (see Section 3.0 of the Framework Plan). Retrieval actions, isolation activities, and subsequent placement of fill layers into C-106 (described in Section 5.0 of this closure activity plan) will initiate the process of complying with the closure performance standards for the SST system.

According to HFFACO Milestone M-45-05L-T01, "Waste shall be retrieved to the DST system to the limits of the technology (or technologies) selected. Retrieval shall retrieve as much waste as technically possible, with a remaining residual of no more than 360 cubic feet (cu. ft.)." If the retrieval goal of 360 ft^3 is not met, DOE will request an exception to the criteria as specified in Appendix H of the HFFACO. This HFFACO requirement is one of the most significant tank-related performance standards. Retrieval of waste in accordance with these requirements, along with the other closure activities described in this plan, will make significant progress toward meeting closure performance standards at the WMA C and the SST system.

The three general closure performance standards defined in WAC 173-303-610(2)(a) are described in Sections 1.2.1.1 through 1.2.1.3. Removal or decontamination standards defined in WAC 173-303-610(2)(b) and WAC 173-303-640(8) are described in Section 1.2.1.4. Compliance with requirements will be documented in waste retrieval and closure demonstration project reports, and will be incorporated into the Site-Wide Permit as needed.

1.2.1.1 Minimize Need for Further Maintenance. Component closure activities planned for C-106 are designed to minimize the maintenance required after the actions are complete. Waste will be retrieved from C-106 to meet HFFACO retrieval goals and the tank will be isolated from the system. If the tank is filled as part of closure demonstration field activities, DOE will conduct annual visual inspections of the tank farm surface in the tank vicinity. If the tank is not filled as part of closure demonstration field activities, DOE will conduct annual visual inspections of the tank farm surface in the tank vicinity and will continue to operate any existing liquid detection or monitoring device, i.e., Enraf™. Other actions, such as capping lines and risers, covering the tank, and providing run-on controls also will serve to minimize the need for further maintenance.

1.2.1.2 Control the Postclosure Escape of Tank Waste to Protect Human Health and the Environment. C-106 will be retrieved to the extent technically possible in accordance with criteria set forth in Milestone M-45 and Appendix H of the HFFACO. Component closure activities, as described in Section 5.0, will include stabilizing any remaining wastes, complete filling of the tank for structural integrity and intrusion prevention, and isolating C-106 from the SST system and the environment. Tank isolation activities will include administrative actions and physical actions sealing off all pipes or other pathways between C-106 and the balance of the SST system. All of these activities will serve to control the postclosure escape of remaining

dangerous waste constituents. At a later point in the overall closure of the SST system, DOE will undertake final closure of WMA C. Individual actions will be assessed for their impact on long-term cumulative risk (i.e., WMA C together with other adjacent or nearby non-tank risk sources).

1.2.1.3 Return Land to Appearance of Surrounding Land Areas. This closure performance standard will be met as part of closure of WMA C and is not a part of this C-106 component closure activity plan.

1.2.1.4 Removal or Decontamination Standards. C-106 closure activities will comply with WAC 173-303-610 (closure and postclosure) and WAC 173-303-640(8) (tank system closure and postclosure care) requirements. WAC 173-303-640(8)(a) requires DOE to demonstrate removal or decontamination of tank waste residuals and structures to the extent practicable. Per WAC 173-303-610(2)(b)(ii), such removal or decontamination must assure on a case-by-case basis that levels of dangerous waste or dangerous waste constituents or residues do not exceed those established by Ecology and are in accordance with the closure performance standards of WAC 173-303-610(2)(a)(ii) for controlling, minimizing, or eliminating postclosure escape of dangerous waste constituents to the environment. These levels are identified as clean closure standards. Ecology clean closure guidance (Ecology F-HTWR-94-144) states that clean closure decontamination levels for metal tanks are generally considered to be met upon meeting the performance treatment standards contained in 40 *Code of Federal Regulations* (CFR) 268.45, Table 1 (debris rule treatment standards).

WAC 173-303-640(8)(b) requires that, if removal and decontamination of all contaminated soils is not practicable, postclosure care must be performed. The owner or operator must close the tank system and perform postclosure care in accordance with the closure and postclosure care requirements that apply to landfills (WAC 173-303-665(6)).

WAC 173-303-640(8)(c) requires that the closure plan for any tank system that does not have secondary containment include a contingent closure and postclosure plan. Because C-106 closure activities described in this plan do not constitute full closure of the entire tank system (WMA C), a contingent postclosure plan is not included as part of this C-106 closure activity plan. Instead, the contingent postclosure plan will be submitted as part of the WMA C closure action plan (Section C8.1) to which this plan is attached.

Retrieval and closure activities described in this plan will attempt to remove or decontaminate C-106 to the extent technically possible in accordance with HFFACO Milestone M-45-00 and to meet clean closure standards. Also, as part of this milestone, a data report will be submitted to Ecology to demonstrate completion of retrieval in accordance with M-45-00. The Tank Closure Environmental Impact Statement (EIS) under development will evaluate removal of a tank as a closure alternative.

Land use options available for tank system closure (including landfill and clean closure options) and the evaluation of environmental impacts for closure end-state alternatives will be addressed in the Tank Closure EIS during fiscal years 2003 and 2004. Ecology, as a cooperating agency, will play a key role in this process.

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2.0 C-106 UNIT DESCRIPTION

C-106 is one of twelve 100-series SSTs located in WMA C. The general WMA C site conditions are described in Section C2.0 of the WMA C Closure Action Plan (Appendix C of the *SST System Closure Plan*). Figures 2-1 and 2-2 show the location of WMA C and C-106, respectively.

2.1 C-106 COMPONENT CONSTRUCTION

Construction of C-106 was completed in 1944. The concrete foundation for the tanks was reinforced with steel reinforcing bar and formed into a dish shape. A three-ply membrane of asphalt waterproofing fabric was applied over the reinforced concrete foundation. The carbon steel tank was constructed of 0.25-inch steel using three pass welds. Waterproofing asphalt fabric was applied on the outside of the steel tank, and joined with the fabric covering the foundation. The tanks were then filled with water to test for leaks prior to pouring the concrete walls. The tank dome was poured and covered with three applications of lapidolith (zinc fluorosilicate wash), a strong concrete hardener (RPP-7155). Lead flashing was used around the top of the steel liner to protect the joint between the steel liner and the concrete wall.

2.1.1 C-106 Specifications

C-106 has a slight concave bottom and a curving intersection of the sides and bottom. This curvature decreases the buildup of stress in the bottom corners of the tank, reducing corrosive effects; thus reducing the chance of a leak developing in the tank bottom. C-106 is 23 m (75 ft) in diameter and approximately 9.75 m (32 ft) tall from the base to the dome. The dome of the tank is covered by a 1.83-m- (6 ft) thick layer of sand and gravel backfill. C-106 was constructed for a capacity of 2,000,000 L (530,000 gal) (Figure 2-3)[1].

2.1.2 Ancillary Equipment and Supporting Infrastructure

C-106 has nine associated pipelines. These include the cascade line between C-105 and C-106 and the two encased lines used for Project W-320, the waste retrieval project completed in October 1999 (RPP-6696). Four of the pipelines connect directly to the 241-CR-153 cascade diversion box. In addition, there are three at-tank pit drain lines connected to risers, three at-tank pits, an active ventilation system connected to a portable exhauster, and electrical and service connections (most of which have been disconnected, but the conduits remain in the ground) (RPP-10950).

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[1] The SST system RCRA permit application, Part A, Form 3 (see Addendum 1 to Framework Plan) states that C-106's operating capacity is 1,892,700 L (500,000 gal).

Figure 2-1. Location Map of WMA C and Surrounding Facilities in the 200 East Area.

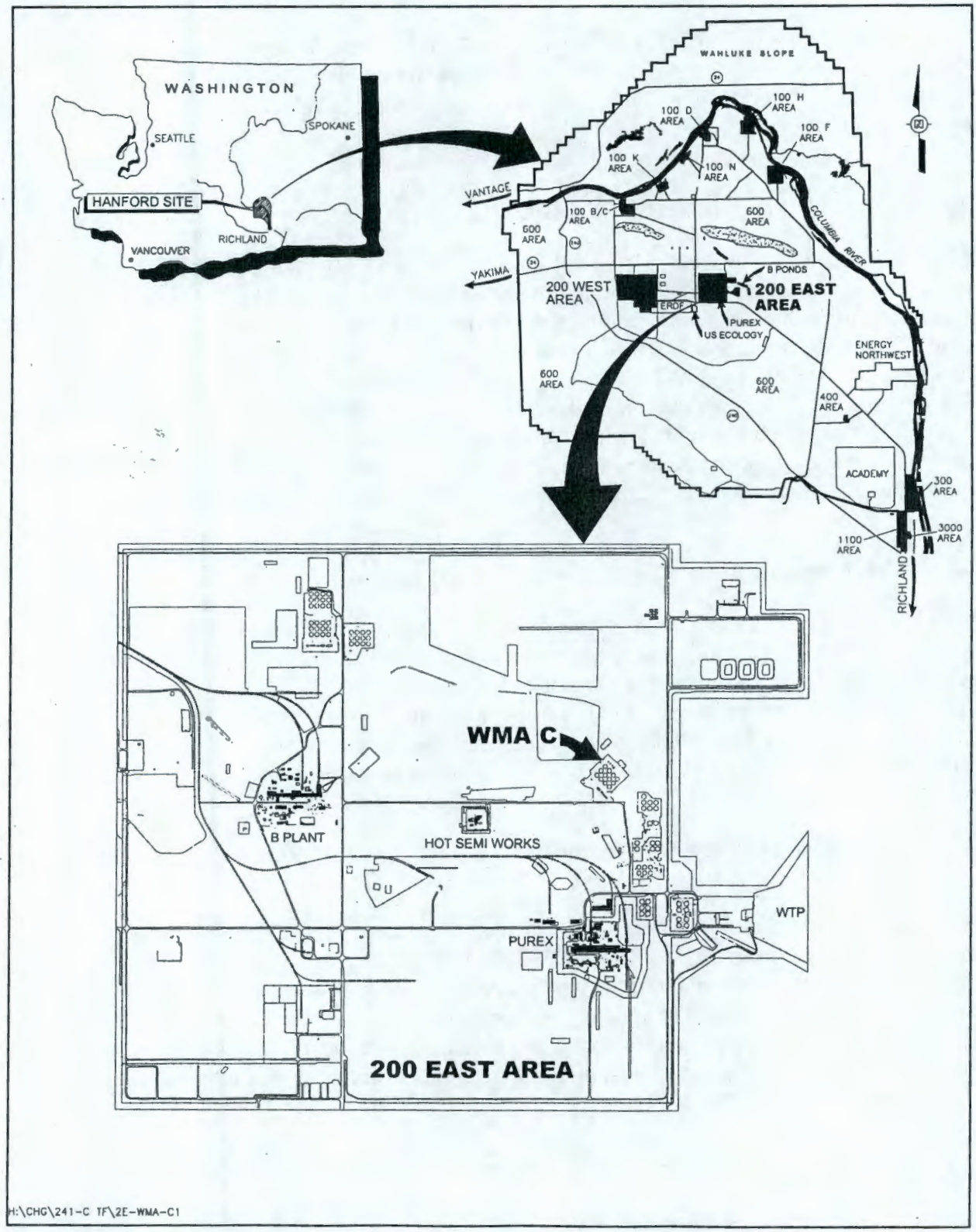


Figure 2-2. Location Map of C-106 within WMA C.

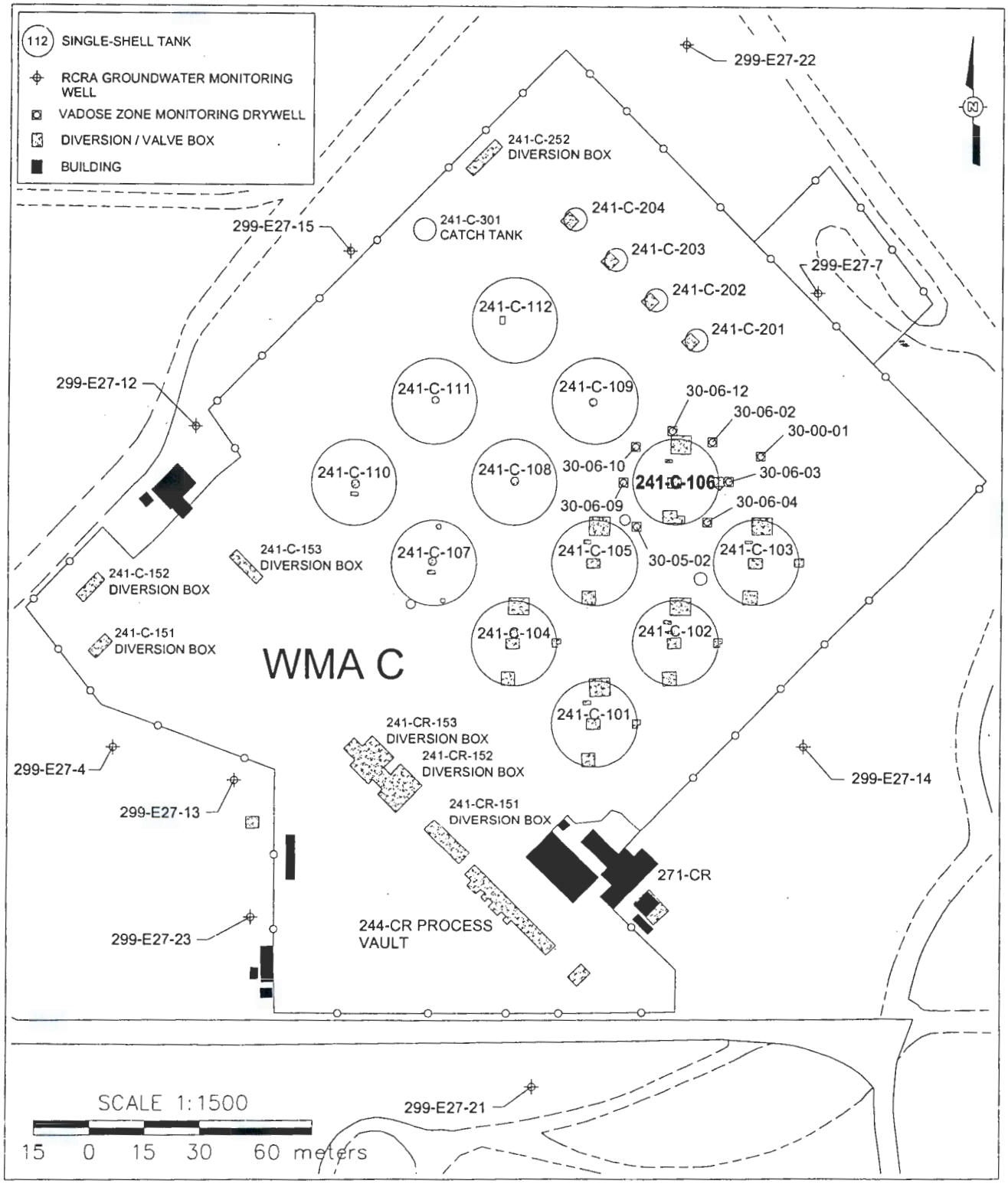
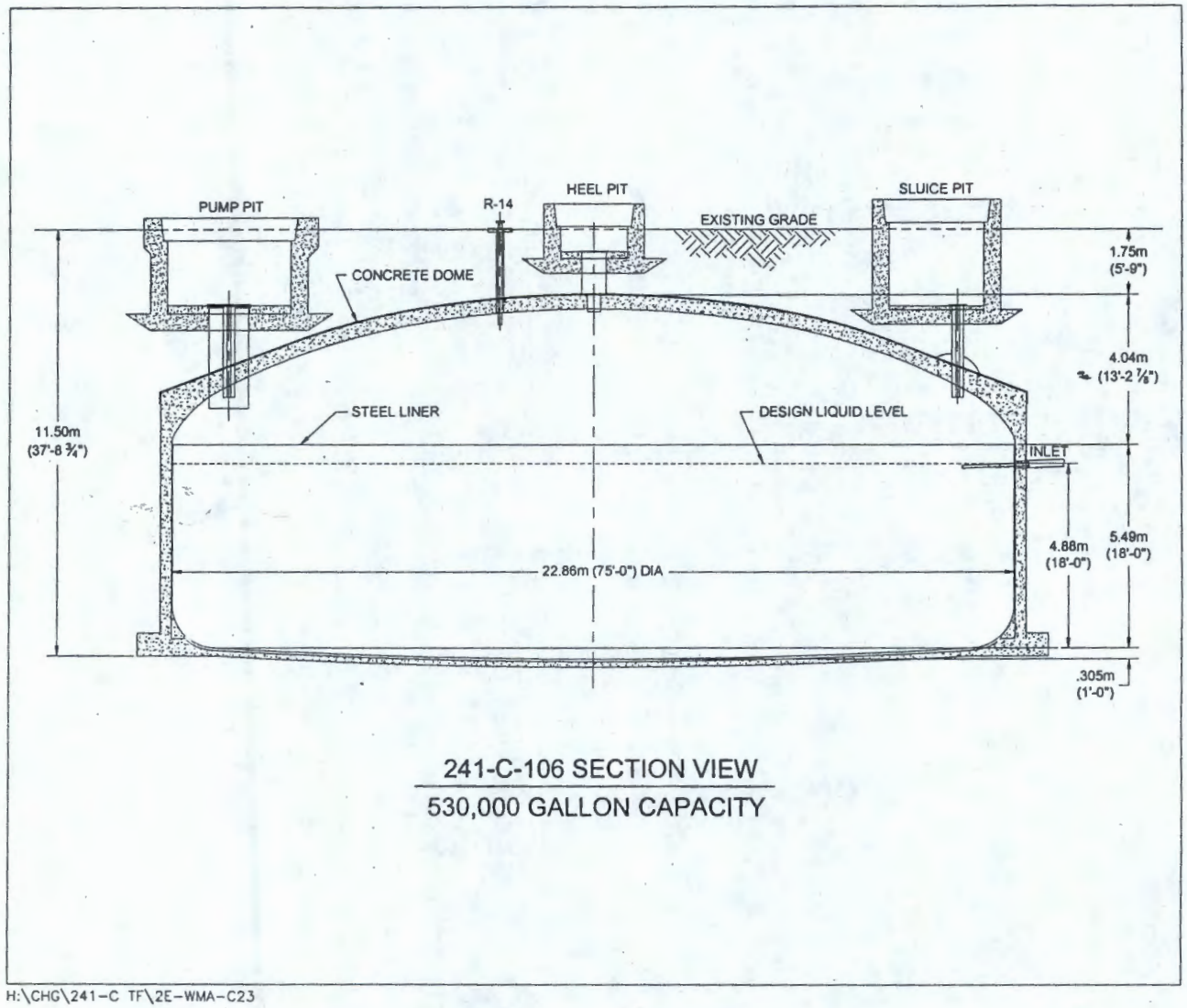


Figure 2-3. Configuration of C-106.



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C-106 also has 12 risers of varying diameters and lengths of protrusion into the tank. Each of the 12 risers is connected to various in-tank equipment, or serves a specific purpose listed as follows, as numbered on the tank:

Riser 1:	Level indicating transmitter (Enraf™)
Riser 2:	HVAC duct connected to portable exhauster
Riser 3:	Sluicer jumper assembly
Riser 4:	Recirculating dip leg (old)

Riser 5:	Shield plug
Riser 6:	Transfer pump PTX141 (failed)
Riser 7:	Mixing eductor assembly
Riser 8:	Thermocouple tree (temperature probe)
Riser 9:	Slurry pump
Riser 13:	Modified centrifugal Flygt pumps
Riser 14:	Spare
Riser 15:	High capacity breather filter

See Section 5.3 and Figure 5-2 for additional information on ancillary equipment adjacent to C-106.

2.2 C-106 OPERATIONS HISTORY

C-106 is the last tank in a three-tank cascade beginning with C-104 and C-105. C-106 was placed into service in 1947 when it received metal waste from the cascade overflow from C-105. In 1953, metal waste was sluiced for uranium recovery, then the tank became the metal waste supernatant blend tank, receiving metal waste from BY-102, C-104, C-105, C-202, C-203, and C-204 (LA-UR-96-3860). In 1953 and 1954, metal waste slurry was sent to U Plant for uranium recovery, and in 1954, uranium recovery waste was received into C-106.

In 1957, liquid waste from C-106 was sent to C-112 and C-109 for ferrocyanide scavenging and again during that same year C-106 received flush water, high-level plutonium-uranium extraction (PUREX) waste from A-101 and A-102, and organic wash water from A-102. Between 1958 and 1960, PUREX cladding waste was sent to C-106, and supernatant was sent from C-106 to BY-110. In 1963, supernatant was sent to B-101 and B-107. In 1963 and 1964, waste was received from and sent to A-102. In 1965, C-106 received decontamination waste from the CR vault.

In 1968, most of the waste in C-106 was sent to C-105. Between 1968 and 1971, C-106 received washed PUREX waste from the 244-AR vault. During this time, C-106 also received waste from A-102, A-104, A-106, and C-103, and sent waste to A-102, C-103, and C-105. In 1972, C-106 received waste from A-106.

Between 1974 and 1976, low-level waste from B Plant and flush water was sent to C-106. During this time, waste was sent from C-106 to AX-103, C-103, and C-104. Between 1976 and 1979, strontium recovery waste from B Plant and complexed and evaporator waste were sent to and received from A-102. In 1978, waste was sent from C-106 to AZ-101. In 1979, C-106 was declared inactive.

In August 1983, C-106 was partially interim isolated (WHC-SD-WM-ER-349). Partially interim isolated is an administrative designation reflecting the completion of the physical effort required to minimize the addition of liquids to an inactive storage tank, except for isolation of risers and piping that is required for jet pumping or for other methods of stabilization.

A maximum volume of approximately 2,080 kL (550 kgal) of waste in C-106 was reached twice—once in 1952 and again in 1966.

2.3 TANK INTEGRITY SUMMARY

The *Waste Tank Summary Report* (HNF-EP-0182), which documents the inventory for radioactive waste stored in the underground storage tanks, classifies C-106 as a "sound" tank. The "sound" tank classification is assigned to a tank when surveillance and historical data indicate no loss of liquid attributed to breach of integrity.

The "sound" tank classification is supported by results from vadose zone monitoring conducted in the eight vadose zone monitoring wells (drywells) associated with C-106. DOE employs various borehole geophysical logging methods in the drywells to evaluate the presence of man-made radionuclides in the vadose zone. The presence of man-made radionuclides in the vadose zone may be an indicator of contamination from the tank or ancillary equipment (e.g., pipelines) leaks, surface spills, or sources outside the WMA boundary.

Vadose zone monitoring conducted to date in drywells around C-106 have detected the presence of cesium-137, europium-154, uranium-235, and cobalt-60 at depths ranging from ground surface to below 38 m (125 ft). Analyses of the concentrations and distribution of these man-made radionuclides indicates that the presence of cesium-137, europium-154, and uranium-235 near the surface and at depths less than 15 m (50 ft) is attributed to surface spills and/or leaking pipelines. The presence of cesium-137 and cobalt-60 at depths greater than 15 m (50 ft) bgs is attributed to leaking transfer lines and/or tank leakage from sources other than C-106. Section 3.3 provides a more detailed discussion of the C-106 drywell-monitoring network and results from the borehole geophysical logging program.

Tanks listed in the Waste Tank Summary Report were categorized as leakers or assumed leakers to determine their status for continued use specifically for the receipt and storage of radioactive waste. Many of these tanks were evaluated at the initiation of the tank categorization process in 1989. With the exception of those tanks that demonstrated significant losses of tank liquids, this categorization required the interpretation and consolidation of many sources of information. Reproducibility was facilitated by procedure development. Tank status is not updated as new data and information are obtained.

Recently, in support of developing estimates of curies leaked to the vadose zone (which are not contained in the Waste Tank Summary Report), a preliminary evaluation of the available data to support these historic decisions was conducted in conjunction with the more recent geophysical data and other information. This later information was not available at the time the initial "sound tank" decisions were made. Based on that evaluation, areas of contamination were, on occasion, not found around some tanks declared leakers or assumed leakers and vice versa. Estimates of

curies leaked to the vadose zone were based on an evaluation of all the data available at the time and documented for review. The process will be updated as new information is uncovered.

For the purpose of selecting retrieval methods, no changes to the designation provided by the Waste Tank Summary Report are suggested. When other information is available that provides insight into the historical integrity of a tank, it will be evaluated and provided as part of the permitting process in light of its intended purpose in retrieval. Information provided in Section 3.3 summarizes those areas where information was noted that may warrant additional evaluation based on the proposed use of the respective tank. Current tank integrity and historical tank integrity are dissimilar concepts on occasion. Since classic field tank integrity testing is considered unwise, Leak Detection, Monitoring, and Mitigation (LDMM) will be employed as the means to confirming tank integrity and to trigger alternative courses of action, as necessary.

As mentioned above, evaluations of in-tank level records and drywell logging information provides no indication that tank C-106 has contributed contamination to the soils surrounding the tank. However, prior to and during the C-106 retrieval operations initiated in November 1998 (see Section 2.4), groundwater monitoring data indicated fluctuations in technetium-99 and nitrate concentrations in well 299-E27-14. In addition, groundwater monitoring results have shown low levels of cyanide with a maximum observation occurring in June 2000, approximately six months after the previous C-106 retrieval operations. Fluctuations of concentration/activity of nitrate and technetium-99 during the waste retrieval operation may suggest dilution by an unknown water source. To date, an exact cause for the technetium-99, nitrate, and/or cyanide occurrences in groundwater beneath WMA C has not been established. Detailed WMA C groundwater monitoring information is provided in Section C3.0 of the WMA C Closure Action Plan. External geophysical logging during the latest retrieval effort provided no confirmation to indicate that a change in the current status of C-106 was warranted. Due to the apparent relationship between the occurrence of retrieval activities and fluctuations in selected groundwater constituents, Ecology requested (letter correspondence from Washington Dept. of Ecology to Mr. K. Michael Thompson, U.S. DOE, Oct 11, 2000), that "a minimum of quarterly monitoring..." be performed. DOE agreed and instituted quarterly groundwater monitoring around WMA C.

2.4 PRIOR C-106 WASTE RETRIEVAL ACTIONS

Retrieval actions include past-practice sluicing done in the late 1990s. In November 1998, Project W-320, a waste retrieval effort, was initiated in C-106 and was completed in October 1999 (RPP-6696). The purpose of Project W-320 was to resolve the C-106 high-heat safety issue and demonstrate a sluicing retrieval technology. The retrieval effort was completed in accordance with the requirements of HFFACO Milestone M-45-03B, in effect at that time. Retrieval was performed using the Project W-320 sluicing system. Measurements at that time indicated approximately 97% of the sludge, 707 kL (187 kgal) of the estimated 727 kL (192 kgal), in C-106 was sluiced to double-shell tank (DST) AY-102. Sluicing operations were conducted using AY-102 supernatant as the sluicing medium. A description of closure related retrieval activities is in Section 2.5.3.

Approximately 75% of the sludge was removed from C-106 in the first 10 batches. In the last 10 batches, sludge recovery progressively decreased, approaching zero recovery in the final batch. This occurred for the following reasons:

- Sizes of sludge pieces (up to 8 cm [3 in.]) in sludge piles exceeded the mesh size (0.63 cm [0.25 in.]) on the submersible slurry pump screen.
- The sludge pile and debris under the submersible slurry pump prevented further lowering of the pump.
- The sludge pile and debris under the submersible slurry pump could not be moved by the sluicing jet from the opposite side of the tank.
- A severed thermocouple pipe and flexible hose/float interfered with lowering of the submersible slurry pump.

Although the Project W-320 sluicing effort successfully resolved the C-106 high-heat safety issue and met the sluicing waste retrieval requirements defined in the HFFACO at that time, this effort did not meet the waste retrieval requirements currently defined in Milestone M-45-00 for tank closure. Milestone M-45-00 states, "Closure will follow retrieval of as much waste as technically possible, with tank residues not to exceed 360 cubic feet (cu. ft.) in each of the 100 series tanks, 30 cu. ft. in each of the 200 series tanks, or the limit of waste retrieval technology capability, whichever is less."

2.5 C-106 WASTE CHARACTERISTICS

The estimated volume and nature of the waste remaining in C-106 are discussed in the following subsections.

2.5.1 Waste Volume

The volume of the sludge in C-106 was estimated based on videos taken on July 13, 2000 and August 1, 2002. The surface of the sludge was uneven. The sludge surface contours were mapped and sludge volume was calculated to be 34,000 L (9,000 gal). The supernatant volume on August 1, 2002 was estimated to be 70,000 L (19,000 gal). On April 1, 2003, much of the supernatant in the tank was pumped to tank AY-102. Dilution water was used to facilitate the transfer. It was estimated that approximately 19,000 L (5,000 gal) of diluted supernatant remained in the tank after pumping. The total waste volume in C-106, as of April 2, 2003, was calculated to be 53,000 L (14,000 gal) by summing the sludge and supernatant volumes.

2.5.2 Best Basis Inventory

The best basis inventory (BBI) effort involves developing and maintaining waste tank inventories comprising 24 chemical and 46 radionuclide components in the 177 Hanford Site underground storage tanks. The BBI provides waste composition data necessary as part of the

River Protection Project process flow-sheet modeling work, safety analyses, risk assessments, and system design for waste retrieval, treatment, and disposal operations.

The inventory of C-106 is estimated in the BBI, with the effective date of April 2, 2003. In fiscal year 1999, most of the sludge in C-106 was sluiced to DST AY-102. On April 1, 2003, most of the remaining supernatant in C-106 was pumped to AY-102. Current C-106 inventories are based on samples obtained from AY-102 after sluicing in 1999, and were supplemented with model-based data when sample data were not available. The volume of the residual sludge was estimated based on in-tank videos taken on July 13, 2000 and August 1, 2002. The volume of the remaining supernatant was estimated based on liquid pumping records.

Because the BBI was not developed to address tank closure activities, it does not provide all of the necessary data to satisfy closure requirements. However, it was used in preparing the initial component closure planning documentation. A data quality objectives (DQO) process was conducted that will provide the basis for sampling plan preparation. For further details on the sampling plan and the DQO process, see Section 5.1. Completion of the planned sampling and analyses will result in the data needed for this component closure activity.

2.5.3 Waste Retrieval and Compliance with HFFACO Milestone M-45-00

According to HFFACO Milestone M-45-05L-T01, "Waste shall be retrieved to the DST system to the limits of the technology (or technologies) selected. Retrieval shall retrieve as much waste as technically possible, with a remaining residual of no more than 360 cubic feet (cu. ft.)." Following retrieval activities, DOE may use in-tank survey methods to determine whether retrieval criteria are met.

If the waste residuals in C-106 meet the retrieval criteria, DOE will proceed with implementing the approved component closure activity plan. If residuals in C-106 do not meet the retrieval criteria, DOE will request an exception to the retrieval criteria. This request would be prepared pursuant to the procedure in HFFACO, Appendix H, Attachment 2: "The request shall include, at a minimum, the following information:

1. The reason DOE does not believe the retrieval criteria can be met.
2. The schedule, using existing technology, to complete retrieval to the criteria – if possible.
3. The potential for future retrieval technology developments that could achieve the criteria, including estimated schedules and costs for development and deployment.
4. The volume of waste proposed to be left in place, and it's [sic] chemical and radiological characteristics.
5. Expected impacts to human health and the environment if the residual waste is left in place.

6. Additional information as required by EPA and/or Ecology."

The request for exception to the retrieval criteria must be approved by EPA and Ecology.

Retrieval of the remaining waste in C-106 will likely have occurred prior to the effective date of modification of the Site-Wide Permit to include this C-106 closure activity plan. This timing is consistent with Milestones M-45-05L-T01 (completion of retrieval by November 2003) and M-45-05H (includes completion of approved C-106 retrieval and closure demonstration plan, i.e., this closure activity plan, by April 2004). Also, as part of this milestone, a data report will be submitted to Ecology to demonstrate completion of retrieval in accordance with M-45-00.

The majority of the waste in C-106 was removed in previous sluicing/retrieval efforts. The estimated volume of the solid waste remaining is approximately 34,000 L (approximately 9,000 gal). Because of the difficulty in removing this waste with available equipment, retrieval of the waste by dissolving it in oxalic acid will be demonstrated in C-106. The oxalic acid dissolution process has been tested on samples of C-106 residuals and more than 70% of the residual solids sample was dissolved. Laboratory testing indicates a 1-week reaction time for each of six 114,000-L (30,000-gal) batches of acid will be adequate to complete the reaction. Corrosion rates between 50 and 200 mils/yr are expected for the carbon steel walls of C-106 (RPP-16537 and RPP-16256). Because of the short duration of the oxalic acid contact with the tank and the low temperature (between 70 and 90 degrees Fahrenheit), significant corrosion is not expected. The waste retrieved from C-106 will be pumped to DST AN-106.

Oxalic acid will be added to C-106 and recirculated with a mixing eductor. The solution will be removed by a pump located in the central heel pit and transferred to AN-106 at a controlled rate using an underground, double-encased, waste-retrieval sluicing system transfer line. Enough sodium hydroxide has been added to AN-106 to neutralize the entire amount of acid to be used for C-106 acid retrieval. The pH in AN-106 will be maintained at > 8.0 at all times. After acid dissolution, the tank walls will be washed with the sluicing system and the wash water will be transferred to AN-106. A maximum of 250,000 gallons of water may be used for waste retrieval to AN-106. In the last step, liquid remaining in C-106 will be neutralized with approximately 10,000 gallons of caustic solution. This neutralized acid will also be pumped to AN-106.

The chemical wash with oxalic acid will involve the following steps:

- Adding acid to the tank to react with the residual sludge. The acid will be added into the tank in a series of batch loadings.
- Stir and allow each acid batch a 1-week reaction time or less based on pH monitoring.
- Add caustic solution to AN-106 to neutralize the oxalic acid when pumped from C-106.
- Pump each batch containing dissolved waste to AN-106.

A series arrangement of two transfer pumps exists within C-106. These pumps were installed to remove the remaining pumpable supernatant from the tank. These pumps will be used during

acid dissolution and waste transfer. A backup transfer pump arrangement has been designed and is being procured to replace the current pumps if they fail during acid dissolution operations.

An eductor was chosen as the acid mixing method because the eductor nozzle, intake, and liquid jet could be located below the surface of the acid/waste pool, resulting in little or no generation of aerosols within the tank dome space. The eductor assembly prevents the oxalic acid solution from sitting stagnant.

The sludge in C-106 contains carbonate that will neutralize the oxalic acid as it dissolves. Once the carbonate is gone, the pH will stabilize. There is still some uncertainty on how the actual waste in the tank will behave, so the rate of change in pH will be used for process control rather than the actual pH measurement.

Up to 795,000 L (210,000 gal) of acid may be used. Transfers will be through a dedicated, fully encased line, thus minimizing the possibilities of misrouting or cross-connections. The liquid waste will then be pumped to AN-106 where the acid will be neutralized by excess caustic solution.

The sluicing system in C-106 will be used after acid dissolution to rinse off the tank walls. This rinse water will be pumped to AN-106. The sluicing system includes a steerable nozzle system used to direct raw water within the interior of the tank.

2.5.4 Leak Detection, Monitoring, and Mitigation Strategy and Approach

The HFFACO identifies programmatic expectations for the advancement of retrieval and leak detection technologies. The approach is based on preventing leakage, using available data for indication of possible leakage, and minimizing leak volumes if a leak should occur. Leak Detection, Monitoring, and Mitigation methods are undergoing development and evaluation and may vary according to tank-specific conditions and waste retrieval technologies deployed. Retrieval activities are anticipated to be complete prior to the effective date of modifications of the Site-Wide Permit to include C-106 component closure activities.

The primary goal is leak mitigation. C-106 is believed to be a structurally sound tank. Oxalic acid has a very low corrosion rate for the steel used to construct the tank. The time at risk will be low as the retrieval time is projected to be less than 6 weeks. Leak mitigation strategy for C-106 heel retrieval begins by quickly removing each batch of acid/waste from the tank and keeping the liquid levels low. The operations strategy is designed to mitigate any undiscovered leaks during retrieval operations as well as to respond properly to any detected leaks. The use of common sense, operational plans, and process observations supplement the baseline leak detection methods. Transfer line leak detection will consist of transfer line and pit leak detection alarm systems.

The available leak detection methods are 1) monitoring liquid level, 2) monitoring mass balances on liquids added and removed, and 3) monitoring the eight vadose zone monitoring wells

(drywells) associated with C-106. Process control data will be used to compare liquid added to liquid removed from the tank to reveal a gross deficit resulting from possible leakage.

Leak detection in quiescent SSTs has historically been based on level monitoring. Static liquid level monitoring works well if the tank being retrieved and the receiver tank both have a free liquid surface that can be accurately measured and used to estimate waste inventory in both tanks. Static level monitoring will be used for leak detection during the acid dissolution step and to provide mass balance data.

Static liquid level measurements using a direct Enraf™ level detector will provide mass balance data to indicate leakage. This instrumentation has a high degree of resolution and repeatability and is well suited for the volumetric method in tanks with a measurable air-liquid interface.

A leak from AN-106 can also be detected by either a conductivity probe leak detection system installed in the annulus or a continuous air monitor that detects airborne radionuclides entrained in the annulus ventilation exhaust stream. Detection of a leak into the annulus of the tank by either system activates an audible alarm and an annunciator panel light.

Leakage from the primary over-ground transfer hose (inner hose) will be contained by the secondary confinement system (outer hose) and detected by one of the leak detectors. The secondary confinement system has been designed to drain any fluid released from the primary hose to a common point for collection, detection, and removal. The hydraulics of the C-106 to AN-106 transfer pipeline cause any leakage to the secondary containment to drain towards C-106.

2.5.4.1 Dry Well Monitoring. Available ex-tank leak detection methods involve indirect measurement of subsurface conditions in the drywells surrounding the tank. Drywell monitoring has been used extensively in the past for leak detection and monitoring.

The eight vadose zone monitoring wells (drywells) associated with C-106, 30-00-01, 30-06-02, 30-06-03, 30-06-04, 30-06-09, 30-06-10, 30-06-12, and 30-05-02, will be used for monitoring fluid losses that may occur during retrieval operations. These wells are open-bottom, mild steel cased, 15.2 or 20.3 cm (6 or 8 inches) in diameter, and extend to depths of 23 to 30.5 m (75 to 100 ft (7.6 to 15.2 m [25 to 50 ft] below the tank bottom). A leakage plume that migrates within the detection range of 0.3 to 0.6 m (1 to 2 ft) of the dry wells will be detected by this method. The monitoring uses gamma radiation probes and neutron moisture instruments to detect a change in the radiation and moisture profiles over the length of the dry well. A baseline profile will be taken prior to retrieval operations. Subsequent monitoring results will then be compared with that baseline profile.

Because of the low percentage of soil interrogated and the timeframe required for leaks to migrate within range of the dry wells, detection of small leakage volumes (less than 15,000 to 45,000 L [4,000 to 12,000 gal]) is beyond the capabilities of the dry well system. However, the system will provide confirming information for the occurrence of a larger leak caused by either a continuous small leak or a shorter-term leak with a fast leak rate.

Additional surveys may be done using hand-held neutron moisture monitors. These surveys would be "quick looks" taken near the elevation of the tank bottom and near the cold joint between the tank's concrete base and walls. This elevation is where a leak is most likely to occur and is also where a plume is most likely to spread out to the dry wells because of the compacted soil in the construction elevation. Hand-held monitor surveys can also be used as needed to verify conditions if other methods indicate a possible leak or if a surface event, such as a snow melt, releases moisture into the soil. These additional surveys would increase the chance that a transitory plume may be detected.

Additional drywells within the farm may be monitored to investigate whether observed changes at C-106 are localized or more widespread as would be expected from seasonal changes in precipitation.

2.5.4.2 Liquid Level Monitoring. Another leak detection method available is to monitor the liquid level using the Enraf™ level gauge or visually, if the Enraf™ is not available. At appropriate times, the Enraf™ level gauge will be lowered into C-106 and placed in the liquid level-monitoring mode. The liquid level will be monitored for a period of time ranging from overnight to several days to detect a trend in the surface level that may indicate a potential leak.

Since the mitigation strategy requires that the liquid level be minimized between or at the end of retrieval operations, it is likely that there will be no liquid level under the Enraf™ level gauge, and it will not be possible to directly measure liquid level. During the acid retrieval batches, there will be sufficient liquid in the tank to use the Enraf™. However, there will be recirculation currents. The effect of the recirculation currents on the accuracy of the Enraf™ is not known. Recirculation may have to be stopped during readings.

Solids may be present under the Enraf™ that will cause the Enraf™ to display erroneous readings. This is highly likely to occur during the acid dissolution phase as it has occurred routinely during liquid removal, sluicing, and waste redistribution operations.

In the very likely event that the Enraf™ level gage cannot access the liquid pool, visual surveys will be done based on the diameter of the pool. Video recording of the exposed area of the tank will be required at the completion of each campaign as input to the leak detection material balance.

2.5.4.3 Material Balance Monitoring. The data requirements for performing the material balance include the AN-106 tank waste level from Enraf™ measurements (or a suitable replacement method if unavailable), waste flow from C-106, and raw water flow totalizer readings or water addition log sheets as applicable. There are no transfer routes into or out of C-106 other than the waste transfer line. During retrieval of C-106, all other transfers into tank AN-106 must be curtailed. Any waste leaks inside the pit would cause the pit leak detector to alarm and lead to shutdown of the transfer pump.

The Enraf™ in C-106 is on the edge of the dished bottom. Therefore, the Enraf™ will not respond to the liquid removal during the last portions of the transfers.

The material balance will be kept to assist in understanding what is happening with the process. However, the material balance will be of limited usefulness for LDMM purposes because of the dynamics of the process, as discussed below.

When oxalic acid is added to the tank waste, approximately 25% of the waste will effervesce as gas. This amount of gas cannot be measured, which means that the material balance will be inaccurate by at least 25%. The tank waste solids will change volume as they are dissolved in the acid. The 1,000 scfm air flow through the tank will evaporate some of the rather dilute acid. Eventually, some of the oxalate has the potential of forming insoluble oxalate solids in C-106 that will have an unknown density. When the acid is neutralized in AN-106, the dissolved solids will re-precipate, but they will not necessarily be the same species as were present in C-106. The oxalic acid will neutralize into insoluble sodium oxalate, so additional solids that were not present in C-106 will be created. The solids formed in AN-106 will need time to coalesce, settle and compact. Initially these solids will form a fluffy layer that will settle into a solid bed and eventually compact to a smaller volume.

An assessment of the C-106 ventilation system for compatibility with the anticipated oxalic acid vapors concluded that there would be negligible oxalic acid vapor that will enter the ventilation system. The predicted molar concentration of oxalic acid in the vapor space is $2.1X10^{-9}$. It was also concluded that due to the design of the in-tank acid mixing system, few aerosols would be created during retrieval operations (RPP-16256). A demister upstream of the filters will remove approximately 99% of any oxalic acid aerosols. In addition, a heater upstream of the filters will raise the temperature of the gas by 10 degrees Fahrenheit to minimize any condensation on the filter media.

The majority of the components of the ventilation system are stainless steel with a few items being carbon steel. Stainless steels and carbon steels are generally rated unsatisfactory for oxalic acid for long-term use. However, due to the short life of the project and low temperatures, the stainless steel and carbon steel components of the ventilation system are not expected to suffer significant corrosion.

Calculations of the heat of reaction caused by neutralizing the acid in AN-106 predict a maximum increase in temperature of 13 degrees Fahrenheit, assuming a worst-case scenario where all the acid was neutralized at once. The actual temperature rise will be less than this and well within the operating temperature for the tank (RPP-16462). The neutralization reaction will not produce gases.

The measured flow out of C-106 will be compared with the measured volume in AN-106. This will provide an understanding of the change in volume resulting from solids. However, this volume may be too small on any given batch to make a clear determination.

2.5.5 Characterization of Residual Wastes

Residual waste is any waste left in the tank at the end of the waste retrieval process. A DQO has been completed to develop a sampling plan for the C-106 residual waste (RPP-13889). Residual

waste in the tank will be sampled and analyzed after completion of the waste retrieval activities (see Section 5.1 for details).

The current method available for determining the residual waste volume remaining in C-106 is a video camera and modeling system. This system, used for the initial baseline measurements of C-106 (RPP-12547), can be deployed without additional development. A second method, the tank volume measurement system (TVMS), consists of a television camera and a laser range finder. The TVMS is inserted into a tank riser and the camera and laser range finder are used to map the surface of the residual waste in the tank. The TVMS will be used in C-106 if it is developed in time and determined to be a more effective and accurate method for waste volume measurements.

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3.0 HYDROGEOLOGY AND EXTENT OF VADOSE ZONE CONTAMINATION AT C-106

This section describes the hydrogeology, depth to the unconfined aquifer, and known extent of vadose zone contamination in the vicinity of C-106. Vadose zone monitoring activities are summarized and plans for future vadose zone characterization are identified. No tank-specific groundwater quality data exist, because groundwater monitoring is conducted for the entire WMA C. Further discussion of groundwater quality is provided in the annual RCRA groundwater monitoring reports (PNNL-13788). A description of groundwater monitoring activities is available in the WMA C groundwater monitoring plan (PNNL-13024 -ICN-1) and summarized in the WMA C Closure Action Plan (Appendix C of the *SST System Closure Plan*).

3.1 HYDROGEOLOGIC DESCRIPTION

The uppermost aquifer beneath C-106 occurs at approximately 75.9 m (249 ft) below ground surface (bgs) or 64.6 m (212 ft) below the bottom of the tank (PNNL HydroDat Database 2002). Details on the nature of the unconfined, uppermost aquifer are provided in PNNL-13024 and PNNL-13024-ICN-1.

In general, aquifer materials beneath C-106 are composed of sandy gravel or silty sandy gravel. Although there is some consolidation of sediments within the unconfined aquifer, there is little evidence of compaction or cementing. Consequently, permeability is high and relatively homogeneous within the aquifer. The hydraulic gradient beneath C-106 is relatively flat and groundwater currently flows toward the southwest (PNNL-13024, PNNL-13024-ICN-1). Historically, groundwater flow direction and gradient in the vicinity of WMA C has been influenced by the substantial groundwater mound beneath 216-B-3 ponds (B pond), located east of WMA C. The B pond mound, when at its peak, caused groundwater to assume a west to northwest flow direction. Following discontinuation of discharges to B pond, the mound has dissipated. As a result, the groundwater flow direction beneath WMA C has begun to return to what is expected to be its natural flow direction (generally southeast toward the Columbia River). The gradient beneath WMA C is currently very small and the flow direction (where it can be reliably measured) is variable, but is generally toward the southwest. The flow direction is expected to continue to change until it ultimately assumes a southeast direction. The actual time required for return to a normal flow pattern beneath WMA C will be driven by the decay of the B pond mound and potentially by continuing discharges to the Treated Effluent Discharge Facility located to the east of the 200 East Area.

The base of the uppermost unconfined aquifer is defined by the top of the basalt, which is estimated at 92 m (303 ft) bgs or 81 m (266 ft) below the bottom of C-106. Based on this estimate, the unconfined aquifer below C-106 is approximately 17 m (54 ft) thick.

3.2 VADOSE ZONE DESCRIPTION

The vadose zone is contained within the following strata (listed oldest to youngest). A brief description of each of these strata is found in Section C3.2.1 of the WMA C Closure Action Plan.

- Hanford formation lower-gravel sequence
- Hanford formation sand sequence
- Hanford formation upper-gravel sequence
- Backfill material.

Texturally, the vadose zone is largely comprised of coarse sands with some gravels and silts. Clastic dikes were observed during construction of WMA C but were not mapped (ARH-LD-132).

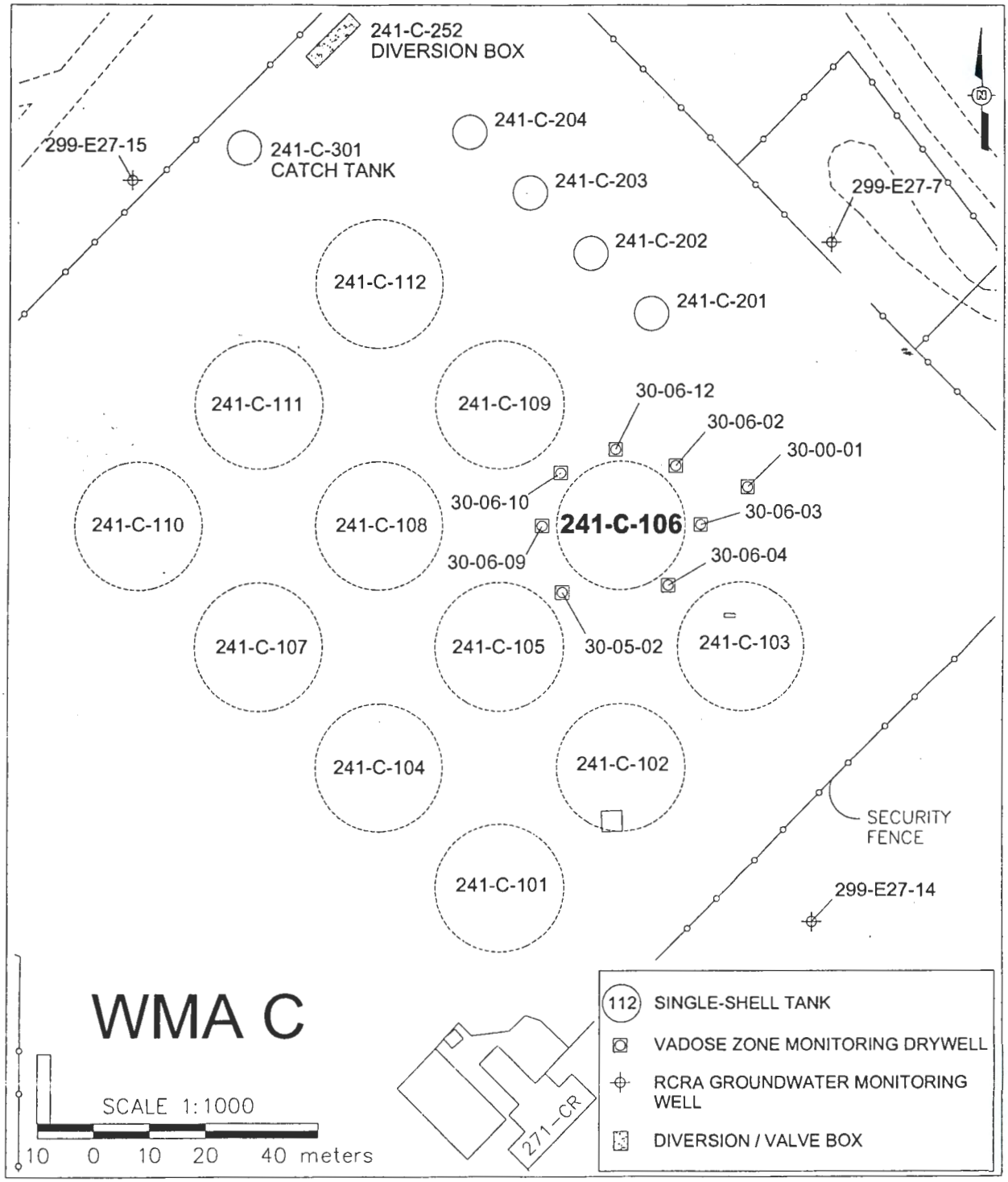
3.3 EXTENT OF VADOSE ZONE CONTAMINATION

This section describes the known extent of vadose zone contamination in the vicinity of C-106 to supplement groundwater data. As noted in Section 2.3, C-106 is believed to be a sound tank. There is no evidence of any waste leakage from C-106. There have been releases that have contaminated the environment from other tanks and ancillary equipment within the WMA C. Vadose monitoring efforts described in the following section provide data from drywells located around C-106.

3.3.1 Vadose Zone Monitoring – C-106 Drywells

Figure 3-1 shows the eight vadose zone monitoring wells (drywells) associated with C-106. These wells are identified as 30-00-01, 30-06-02, 30-06-03, 30-06-04, 30-06-09, 30-06-10, 30-06-12, and 30-05-02. In 1997, under DOE *Atomic Energy Act of 1954* authority, these eight wells were logged using a high-resolution spectral-gamma logging system. This effort was part of the baseline characterization for WMA C (GJO-HAN-18). Follow-up logging was conducted on selected drywells based on findings from the baseline characterization. Results from the follow-up logging have been documented (GJO-HAN-18). The purpose of the baseline characterization was to acquire a technically defensible baseline of the distribution and concentrations of individual gamma-emitting radioisotopes within the vadose zone. Results of the baseline characterization for C-106 are documented in GJ-HAN-84.

Figure 3-1. C-106 Vadose Zone Monitoring Network.



The current vadose zone monitoring program implemented at WMA C as well as other tank farms on the Hanford Site is described in GJO-HGLP-1.7.1. Under this plan, drywells are monitored (logged) on a quarterly, annual, or a 5-year frequency. The order and frequency of monitoring is based on a priority score that is calculated using tank and plume-related factors developed from the baseline characterization. Table 3-1 lists the frequency of routine monitoring currently established for the eight wells associated with C-106 (MAC-HGLP 1.8.1, Appendix A).

GJO-HGLP-1.7.1 describes the tasks and organizational requirements associated with routine vadose zone monitoring operations in the SST system farms. Included are the methods and procedures associated with data evaluation, selection, and prioritization of individual borehole intervals to be logged, scheduling, data acquisition procedures, and reporting.

Table 3-1. Frequency of Monitoring for C-106 Drywells.

Well Identification	Monitoring Frequency (yrs)
30-06-02	5.0
30-06-03	5.0
30-06-04	1.0
30-06-09	1.0
30-06-10	0.5
30-06-12	1.0
30-00-01	1.0
30-05-02	1.0

3.3.2 Vadose Zone Monitoring Results

The tank summary data report for C-106 documents the results of the 1997 spectral-gamma logging performed in the eight drywells around the tank (GJ-HAN-84). In general, manmade radionuclides detected in the subsurface around C-106 were cesium-137, cobalt-60, europium-154, and uranium-235.

Table 3-2 provides a summary of the detected gamma-emitting radionuclides from the 1997 spectral-gamma logging and previous radionuclide logging activities. A detailed analysis of these data and explanation of possible sources is provided in GJ-HAN-84.

The major conclusions from the 1997 logging effort at C-106 are as follows (GJ-HAN-84):

- Surface spills and subsurface leaks may have previously occurred in the vicinity of the tank and may be related to activities associated with C-106 or other nearby tanks.

- Cesium-137 is stable (not moving), based on a comparison of the 1997 spectral-gamma logging system data with the 1993 radionuclide logging system radionuclide logging system data.

Table 3-2. Summary of 1997 Baseline Spectral-Gamma Logging Around Tank C-106.

Radionuclide	Detected Location		Suspected Source	Suspected Migration Route
	Boreholes	Depth (datum-ground surface)		
Cesium-137	All	Near surface and shallow subsurface	Surface spills, airborne, or both (WHC-SD-EN-TI-185)	Soils, pipelines
Cesium-137, Europium-154, Uranium-235	All	Ground surface	Direct gamma radiation from contaminated equipment or localized surface spill	Soils
Cesium-137	30-06-02 30-06-03 30-06-04 30-05-02	2-3 m (5-10 ft)	Surface spills	Soil and/or tank dome
Cesium-137	All	10-20 m (40-50 ft)	Near surface spills	Tank dome runoff
Cesium-137	30-06-03 30-06-04 30-05-02 30-06-09	8.2 m (27 ft)	Separate source, surface spill or transfer line leak (WHC-SD-EN-TI-185)	Soil
Cesium-137, Cobalt-60 (intermittent)	30-00-01	15.4-20.6 m (50.5-67.5 ft)	Nearby tank or ancillary equipment	Soil
Cesium-137	30-06-04	16 m (52 ft)	Tank C-103 leak or ancillary equipment	Soil
Cobalt-60	30-05-02	23-24.5 m (75-80.5 ft)	Tank C-103 leak or ancillary equipment (WHC-SD-EN-TI-185)	Soil
Cobalt-60	30-06-04	26-27.6 m (85-90.5 ft)	Tank C-103 leak or ancillary equipment (WHC-SD-EN-TI-185)	Soil
Cobalt-60	30-06-10	26-35.51 m (86-116.5 ft)	Tank C-109 leak or ancillary equipment (WHC-SD-EN-TI-185)	Soil
Cobalt-60	30-06-12	5.94-6.86 (19.5-22.5 ft)	Transfer line or pipeline	Soil
Cobalt-60	30-06-12	30-40 m (90-130 ft)	Tank C-109 leak or ancillary equipment (WHC-SD-EN-TI-185)	Soil

Source: GJ-HAN-84

- Cobalt-60 has migrated, based on a comparison of the 1997 spectral-gamma logging system data with the 1993 radionuclide logging system data from borehole 30-06-10.

In 1999, geophysical logging using the spectral-gamma logging system was repeated in well 30-06-10. The primary purpose for this logging effort was to further evaluate the cobalt-60 plume below 26 m (86 ft). Data from the 1999 logging were compared to the baseline

characterization data from 1997 as well as previous spectral logging and gross-gamma logging dating back to 1985.

The primary observations from this study were that cobalt-60 appears to be relatively stable over time from 26 m (86 ft) to about 33 m (108 ft) and cobalt-60 below 33 m (108 ft) is increasing over time.

A detailed discussion of the 1999 spectral-gamma logging results for well 30-06-10 as well as the analysis of the cobalt-60 plume are documented in GJO-HAN-18. Movement of cobalt-60 also was noted in a letter to DOE dated March 10, 1999 (Bertsch 1999).

During the third quarter of fiscal year 2002, well 30-06-10 was logged as part of the routine vadose-zone monitoring program discussed in Section 4.3.1. Spectral-gamma logging system data collected from this event continued to exhibit evidence of downward migration of cobalt-60 below approximately 38 m (125 ft) (DOE-GJO 2002).

The cobalt-60 plume identified in well 30-06-10 appears to correlate with cobalt-60 detected between tanks C-108 and C-109, and at a similar depth in well 30-06-12 (GJO-HAN-18) and was previously attributed to source(s) associated with C-109 (WHC-SD-EN-TI-185).

After the 1997 spectral-gamma logging was performed around C-106, additional data were obtained from spectral-gamma logging around C-103 (GJ-HAN-82) and C-109 (GJ-HAN-91). These data, and additional vadose characterization data have been analyzed and reported in "Subsurface Conditions Description of the C and A-AX Waste Management Area" (RPP-14430). The primary conclusions presented in this report are (1) most of the vadose zone contamination in C Farm originated from surface or near surface sources, (2) tanks listed as known or suspected leakers did not exhibit an expected soil leak signature, and 3) contamination around C-106 may indicate the need for additional investigation prior to the implementation of a modified sluicing or similar retrieval technology.

3.3.3 Planned Vadose Zone Characterization

There are no contaminant characterization data for the vadose zone from the bottom of the drywell monitoring network to the groundwater in the vicinity of C-106. The deepest drywell around C-106 is 46 m (150 ft) bgs (well 30-00-01), and the maximum logged depth is 39.47 m (129.5 ft) bgs (well 30-06-04). A vadose zone investigation is planned for WMA C in fiscal year 2004 or 2005 (RPP-16608).

Additional vadose zone characterization outside the WMA C fenceline also will be conducted during the drilling and installation of the new groundwater monitoring wells discussed in Section C3.5.5 of the WMA C Closure Action Plan.

4.0 CLOSURE RISK ASSESSMENT RESULTS

The first approximation of the comprehensive closure risk assessment for WMA C has been prepared. The comprehensive risk assessment is presented and described in detail in the WMA C Closure Action Plan, Section 5.0 and Addendum C1. The purpose of this section is to describe the estimated risk impacts related to tank waste retrieval efficacy and proposed closure conditions for C-106. The analysis presented in this section is intended to focus the results of the WMA-level risk assessment to the single component (i.e., C-106). Using this approach, the component risk assessment can be appropriately placed in the perspective of the WMA as a whole. This approach also provides a basis for evaluation of potential waste retrieval effects on long-term risk metrics.

Included in this section are the long-term impacts to groundwater and the future use of this groundwater. Multiple exposure pathways (ingestion, inhalation, food chain, etc.) were considered for groundwater use. These exposure pathways are given in Table 26 of Addendum C1. Intruder scenarios were not considered in this document. However, in the future, DOE O 435.1 based intruder calculations will be provided to Ecology as part of a performance assessment. Based on preliminary discussions on implementing the recently proposed TPA Closure Process, performance assessments will replace risk assessments. The performance assessments will be designed to meet DOE, Ecology, and EPA's needs in this area. The performance assessment will become a central document in the effective integration of each agencies regulations and guidelines. The performance assessment document's contents will generally follow the DOE O 435.1 with modifications based on discussions among Ecology and EPA, and DOE. Short-term risk for C-106 is given in Section 9.0 of Addendum C1.

The WMA C risk assessment provides the mechanism for cumulative evaluation of risk contributions from multiple source terms as well as multiple constituents within individual source terms. At the individual WMA component level for C-106, the following source terms have been identified as applicable:

- Residual post-retrieval tank waste
- Residual waste in ancillary equipment adjacent to the tank (no inventory has been specified for ancillary equipment specifically associated with C-106 at this time, although ancillary equipment is addressed at the WMA C level)
- Hypothetical leaks from the tank occurring during waste retrieval
- Past leaks from the tank and/or adjacent ancillary equipment (no inventory is applicable to C-106 at this time).

The base case closure condition identified for C-106 risk assessment is described as follows:

- Residual waste will be retrieved to a maximum of 360 ft^3 residual waste using oxalic acid dissolution.

- Grout* fill will be placed in the tank.
- The tank will be isolated to prevent inadvertent entry of waste or other materials (e.g., rainwater) into the tank.
- An 8,000-gal leak of solution during retrieval is assumed to occur.
- Ancillary equipment adjacent to the tank (e.g., pipes, valves, valve pits, etc.) will remain in place and may contain currently-unquantified amounts of residual waste.
- The existing vadose zone contamination adjacent to the tank will remain in place after component closure activities.

A hypothetical retrieval leak is applied to the waste retrieval action at C-106 based on the current plan to use a high-volume liquid retrieval method. The hypothetical retrieval leak contributes most of the estimated long-term impacts to groundwater related to this tank. For the purposes of this component closure activity plan, the selected risk metrics examined are incremental lifetime cancer risk (ILCR) (target is less than 1.0×10^{-5}), the non-carcinogenic hazard index (target is less than 1.0), the DOE drinking water beta/photon dose limit (target is less than 4.0 mrem/yr effective dose equivalent [EDE]), and the individual-constituent maximum contaminant levels (MCLs) defined by the federal primary drinking water standards (target is no exceedence). The results of the long-term impact estimate for the closure conditions described above are summarized in Table 4-1 for the selected closure metric exposure scenario (i.e., the industrial worker scenario). The individual contributions of source terms and other variables are described in the following subsections. The values presented in Table 4-1 are peak values identified over the 10,000-year simulation period. For the base case retrieval of C-106, there is approximately a four-fold reduction in ILCR if the tank is retrieved to TPA goals. However, the major contributing source term is the retrieval leaks. If retrieval leaks are mitigated (i.e., they do not occur), then there is a six-fold reduction in ILCR.

Table 4-1. Summary of Long-Term Groundwater Impacts Based on Selected Closure Conditions for C-106. (2 Pages)

Groundwater Risk Metric	Pre-Retrieval Value (Peak)	C-106 Closure Value (Peak)	Closure Target Value	Major Contributing Source Term
ILCR (unitless) (Industrial Worker Scenario)	4.9 E-07	1.3 E-07	<1.00 E-05	Hypothetical 8,000-gal retrieval leak
Non-Carcinogenic Hazard Index (unitless) (Industrial Worker Scenario)	3.7 E-03	9.8 E-04	<1.00 E+00	Residual Tank Waste

* See Preface in *SST System Closure Plan* (RPP-13774).

Table 4-1. Summary of Long-Term Groundwater Impacts Based on Selected Closure Conditions for C-106. (2 Pages)

Groundwater Risk Metric	Pre-Retrieval Value (Peak)	C-106 Closure Value (Peak)	Closure Target Value	Major Contributing Source Term
Ionizing Radiation Dose via Drinking Water Exposure (mrem/yr EDE) (2 L/day consumption))	5.7 E-02	1.5 E-03	<4.00 E+00	Hypothetical 8,000-gal retrieval leak
MCLs (Primary Drinking Water Standards)	Not Evaluated	No Exceedences	No Exceedences	Hypothetical 8,000-gal retrieval leak

EDE = effective dose equivalent
ILCR = incremental lifetime cancer risk
MCL = maximum contaminant level

4.1 INTRODUCTION AND RELATIONSHIP TO WMA C CUMULATIVE RISK ASSESSMENT

The risk assessment metric values and data presented in this section are derived from the WMA C cumulative risk assessment data and are intended to describe closure conditions for C-106. The WMA C cumulative risk assessment includes quantitative estimates of long-term risk impacts to a wide variety of hypothetical receptors and exposure scenarios. The WMA C cumulative risk assessment was prepared in a manner consistent with the approach to closure risk assessment for SSTs described in the Framework Plan.

Only a summary of the results for WMA C are provided in this attachment (Single-Shell Tank 241-C-106 Component Closure Activity Plan). The Addendum C1 provides for the complete WMA C risk assessment. Section 3.0 of the addendum provides the methodology, assumptions, and conceptual model; Section 4.0 provides the numerical results and sensitivity analysis; Section 5.0 lists exposure scenarios; Section 6.0 gives the limitations and uncertainties; Section 7.0 provides the long-term risks related to groundwater; while Sections 8 and 9 provides short-term risk assessment related to closure activities.

4.2 C-106 RETRIEVAL AND CLOSURE EFFECTS ON SELECTED LONG-TERM RISK METRICS

The projected effects of residual waste retrieval and other component closure activities on selected long-term risk metrics are described in this subsection. The long-term effects are organized as follows:

- By contaminant source (i.e., residual tank waste, past leaks, ancillary equipment inventory, and hypothetical retrieval leaks)
- By risk metric within each source term (i.e., ILCR, hazard index, groundwater dose, and drinking water standards)

- By exposure scenario/receptor within each metric (i.e., industrial worker, residential)
- Cumulative effects of applicable source terms at selected "representative" conditions and receptors.

4.2.1 Residual Tank Waste Inventory

The baseline assumption for residual waste inventory remaining in the tank after retrieval is based on the following conditions:

- All liquid-phase waste identified in the pre-retrieval BBI is removed from the tank.
- Waste retrieval for C-106 consisted of an oxalic acid wash (see Section 4.3.1 in Addendum C1). However, no inventory post-retrieval inventory has been calculated using this retrieval method. Therefore, the most conservative method, selected phase removal (Addendum C1, Section 3.6.1), for calculating post-retrieval inventory was used to apply an inventory to this tank. This inventory will be compared to the inventory calculated after a post-retrieval sample has been taken. .
- The waste is retrieved to a maximum remaining volume of 360 ft^3 residual waste.
- The remaining solids are uniformly distributed over the area of the tank bottom.
- The remaining residual waste inventory is encapsulated between a cementitious tank fill and the reinforced concrete tank structure and/or partially incorporated into the tank fill material itself. A diffusion-limited waste constituent release mode was selected to simulate contaminant release from the final encapsulated waste form.

The effects of tank residual waste inventory on selected risk metrics presented below are derived from these assumptions.

The estimated peak values for ILCR, hazard index, and dose for receptors via long-term exposure to contaminated groundwater resulting from residual tank waste are shown in Table 4-2.

Table 4-2. Estimated Peak Values for Groundwater Risk Assessment Cumulative Metrics related to Residual Waste Volume in C-106.

Metric	Industrial Receptor		Residential Receptor		Year of Peak
	Pre-Retrieval	Retrieved to 360 ft^3	Pre-Retrieval	Retrieved to 360 ft^3	
Radoactive Chemicals ILCR[a] (unitless)	4.9 E-07	7.8 E-08	9.7 E-06	1.5 E-07	5610
Hazard Index[b] (unitless)	3.7 E-03	9.9 E-04	2.2 E-02	5.5 E-03	5614

Table 4-2. Estimated Peak Values for Groundwater Risk Assessment Cumulative Metrics related to Residual Waste Volume in C-106.

Metric	Industrial Receptor		Residential Receptor		Year of Peak
	Pre-Retrieval	Retrieved to 360 ft^3	Pre-Retrieval	Retrieved to 360 ft^3	
Radiological Dose via Drinking Water[c] (mrem/yr EDE)	2.04 E-02	3.4 E-03	5.7 E-02	1.0 E-03	5612

[a] ILCR target value is < 1.00 E-05

[b] Non-carcinogenic Hazard Index is < 1.00

[c] Groundwater dose target values is < 4 mrem/yr (1 L/day ingestion for 250 days for industrial, and 2 L/day for 365 days for residential)

EDE = effective dose equivalent

ILCR = incremental lifetime cancer risk

4.2.2 Past Leaks

No past leaks have been attributed to either C-106 or its associated adjacent ancillary equipment. Vadose zone monitoring performed in the vicinity of C-106, however, indicates vadose zone contamination in the immediate vicinity of the tank. A summary of vadose zone monitoring results is presented in Section 4.3 of this component closure activity plan. Because no documented past leaks or releases have been recorded for this tank and/or its adjacent ancillary equipment, no past leak inventory was created for C-106. Development of the past leak source term inventory, if appropriate, will be performed as either sampling and analysis results or additional historical information become available to support the inventory development.

4.2.3 Residual Ancillary Equipment Waste Inventory

Ancillary equipment immediately adjacent to C-106 is shown schematically in Figure 5-2 and includes the pump pit, heel pit, sluice pit, ventilation equipment, and aboveground and underground piping connecting the tank to other components. Existing information does not support development of a detailed inventory for waste remaining in ancillary equipment associated with this tank. An estimate of possible impacts from ancillary equipment residuals was prepared and included in the source uncertainty discussion presented in Section 5.0 of the WMA C Closure Action Plan. The potential residual waste inventory contained in ancillary equipment immediately adjacent to C-106 is not included in this risk analysis. Development of the ancillary equipment source-term inventory for this component will be delayed until such time as either sampling and analysis results or adequate historical information become available to support the inventory development.

4.2.4 Hypothetical Retrieval Leaks

Application of the hypothetical retrieval leak source term to specific components is determined by the waste retrieval method selected for the individual component. Acid dissolution, using

approximately 1 molar oxalic acid solution in water, is the selected approach for retrieval of waste from C-106 (see Addendum C1 Section 4.3.1 for more information on the oxalic acid wash). Current waste retrieval plans exclude the application of high-volume liquid retrieval methods in tanks with known or suspected integrity problems. Although C-106 is currently believed to be a sound tank, application of relatively high-volume liquid retrieval systems in the tank presents the opportunity for a retrieval leak in the event of a tank integrity failure. An 8,000-gal leak of retrieval fluid was selected to characterize this hypothetical event. The inventory associated with this leak is given in Addendum C1 Section 3.6.1. The retrieval leak source term consists of 8,000 gal of that solution released at the bottom of the tank. The potential effects of the hypothetical retrieval leak on the selected risk metrics are presented in Table 4-3.

Table 4-3. Estimated Peak Values for Groundwater Risk Assessment Cumulative Metrics related to Hypothetical Retrieval Leak from C-106.

Metric	Industrial Receptor	Residential Receptor	Year of Peak
	8,000-gal Retrieval Leak	8,000-gal Retrieval Leak	
Radioactive Chemical ILCR[a] (unitless)	1.3 E-07	2.5 E-06	2082
Hazard Index[b] (unitless)	9.4 E-04	5.6 E-03	2082
Radiological Dose via Drinking Water[c] (mrem/yr EDE)	5.0 E-03	1.5 E-02	2082

[a] Incremental Lifetime Cancer Risk target value is < 1.00E-05

[b] Non-carcinogenic Hazard Index is < 1.00

[c] Groundwater dose target values is < 4 mrem/yr (1 L/day ingestion for 250 days for industrial, and 2 L/day for 365 days for residential)

EDE = effective dose equivalent

ILCR = Incremental Lifetime Cancer Risk

4.2.5 C-106 Effects on Drinking Water Standards

Estimated long-term groundwater quality effects are compared to the primary drinking water standards (MCLs) in Table 4-4.

Table 4-4. Summary of Groundwater Impacts from C-106 Closure Conditions Compared to Concentration-Based Primary Drinking Water Standards (MCLs). (2 Pages)

Constituent	Post-Retrieval Tank Residual Contribution	Hypothetical Retrieval Leaks Contribution	Drinking Water Standard (MCL)
Technetium-99	3.9 pCi/L	7.0 pCi/L	900 pCi/L[a]
Iodine-129	0.032 pCi/L	0.038 pCi/L	1 pCi/L[a]
Carbon-14	0.021 pCi/L	0.127 pCi/L	2,000 pCi/L[a]
Nitrate	4.6 E-05 mg/L	1.7 E-04 mg/L	44 mg/L[b]
Nitrite	3.1 E-04 mg/L	3.4 E-03 mg/L	3.3 mg/L[b]

Table 4-4. Summary of Groundwater Impacts from C-106 Closure Conditions Compared to Concentration-Based Primary Drinking Water Standards (MCLs). (2 Pages)

Constituent	Post-Retrieval Tank Residual Contribution	Hypothetical Retrieval Leaks Contribution	Drinking Water Standard (MCL)
Chromium	2.2 E-04 mg/L	1.4 E-04 mg/L	0.10 mg/L
Fluoride	9.2 E-06 mg/L	3.7 E-05 mg/L	4 mg/L

[a] The radionuclide concentrations shown are the "C4" concentration, which is the concentration of the individual nuclide in drinking water that would result in an annual dose of 4 mrem/yr using the target organ dose methodology specified by the Washington State Environmental Policy Act.

[b] The MCLs for nitrate and nitrite are defined in terms of nitrogen in the form of nitrate or nitrite. The values presented in this table have been converted to the corresponding concentration values for the respective ions to match the reported concentration values.

- MCL = maximum contaminant level

4.3 CUMULATIVE EFFECTS OF REPRESENTATIVE COMPONENT SOURCE TERMS

The base case evaluated for C-106 includes contribution to risk metrics from residual tank waste after retrieval to 360 ft^3 and the hypothetical 8,000-gal retrieval leak. Past leak and adjacent ancillary equipment source terms are identified as applicable; however, these source terms are addressed cumulatively at the WMA C level risk assessment. The cumulative pre- and post-retrieval effects of contributions to ILCR, hazardous index for the industrial receptor, and drinking water dose from C-106 compared to the cumulative WMA C effects are shown graphically in Figures 4-1 through 4-6. Figures 4-7 and 4-8 provide these comparisons for the HSRAM Residential Scenario which shows C-106 below the target value of 1.0 E-05, but that the WMA C above the target value of 1.0 E-05 for approximately 6,500 years. Note that log scale is used for the metric value axes of these graphs to facilitate presentation of the relatively small contributions from C-106. These results are based on comparison of fenceline average concentrations for the sources.

Figure 4-1. Comparison of Incremental Lifetime Cancer Risk Contribution from C-106 to Cumulative WMA C for Tank Contents Incremental Lifetime Cancer Risk – Pre-Retrieval.

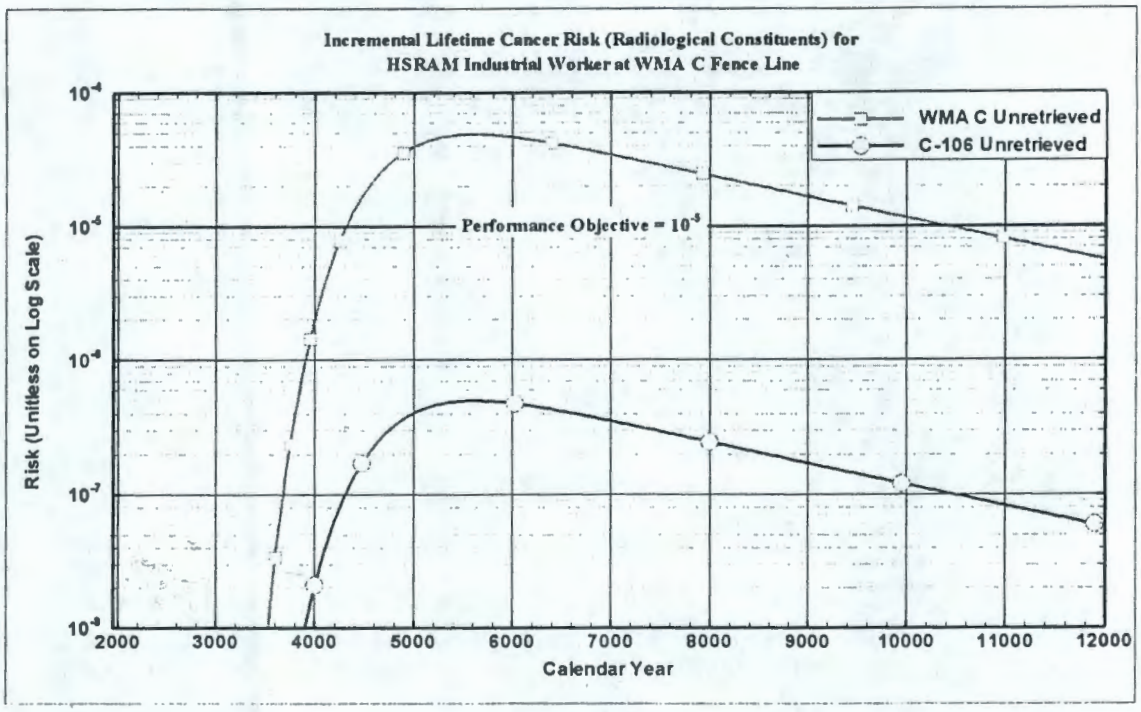


Figure 4-2. Comparison of Incremental Lifetime Cancer Risk Contribution from C-106 to Cumulative WMA C Incremental Lifetime Cancer Risk – Post-Retrieval.

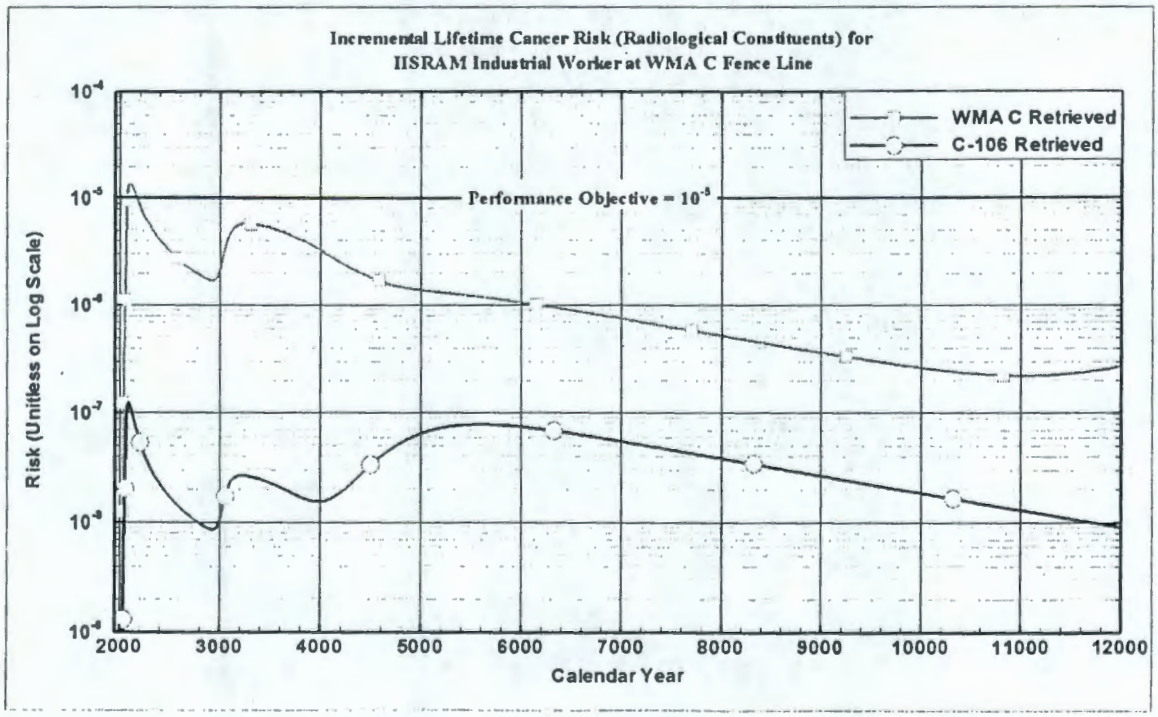


Figure 4-3. Comparison of Hazardous Index Contribution from C-106 to Cumulative WMA C for Tank Contents Hazardous Index – Pre-Retrieval.

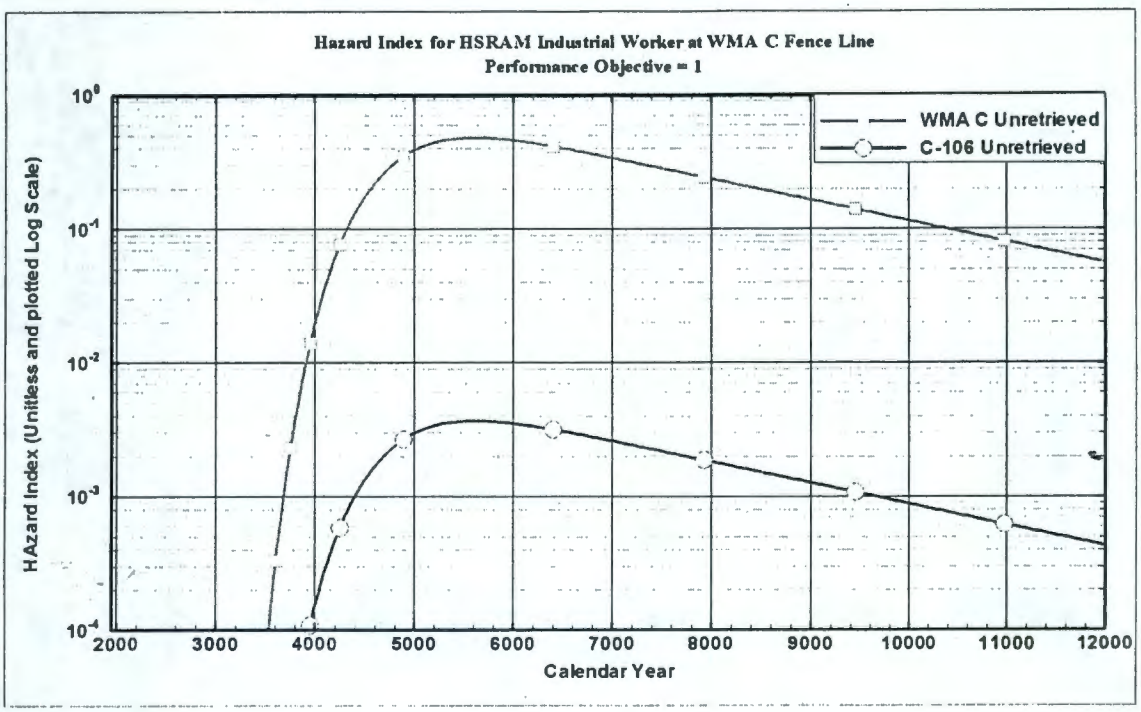


Figure 4-4. Comparison of Hazardous Index Contribution from C-106 to Cumulative WMA C Hazardous Index – Post-Retrieval.

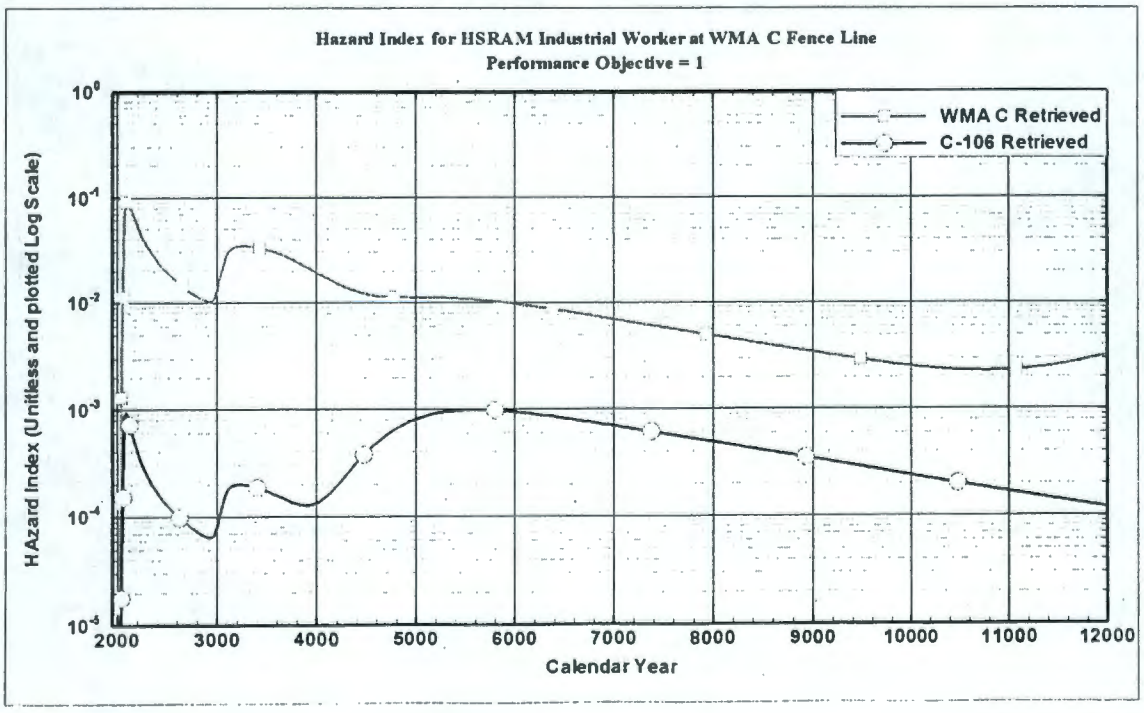


Figure 4-5. Comparison of Dose Contribution from C-106 to Cumulative WMA C Drinking for Tank Contents Industrial Water Dose – Pre-Retrieval.

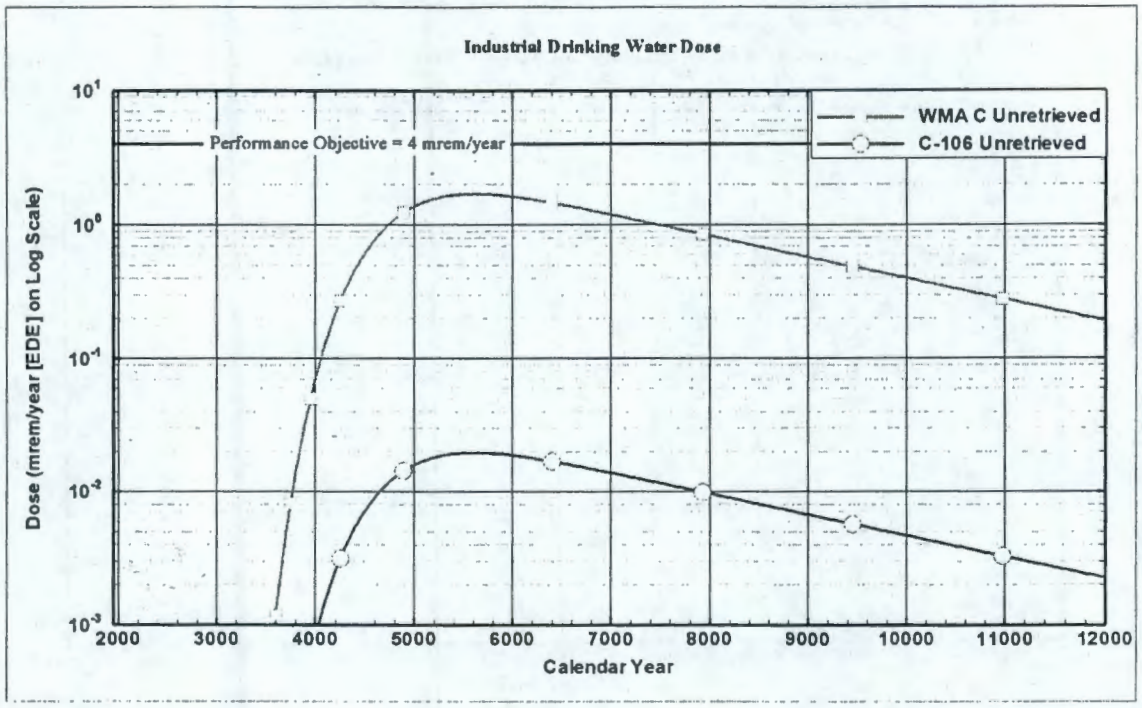


Figure 4-6. Comparison of Dose Contribution from C-106 to Cumulative WMA C Drinking Water Dose – Post-Retrieval.

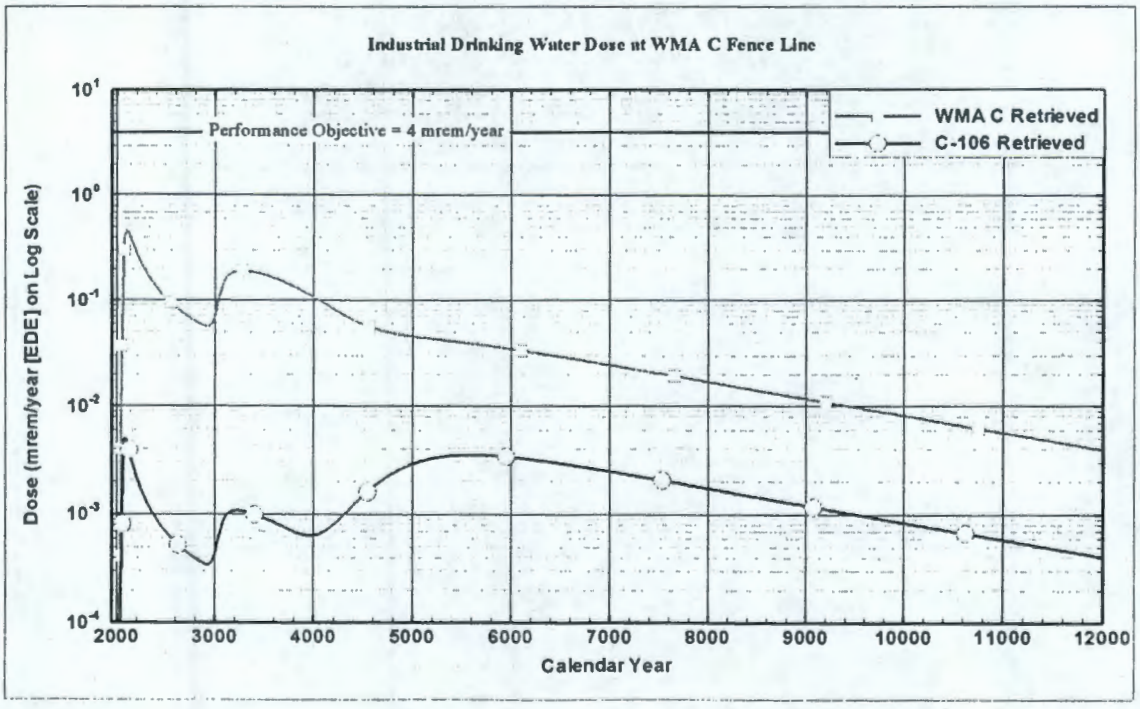


Figure 4-7. Comparison of Residential ILCR Contribution from C-106 to Cumulative WMA C for Tank Contents Incremental Lifetime Cancer Risk – Pre-Retrieval.

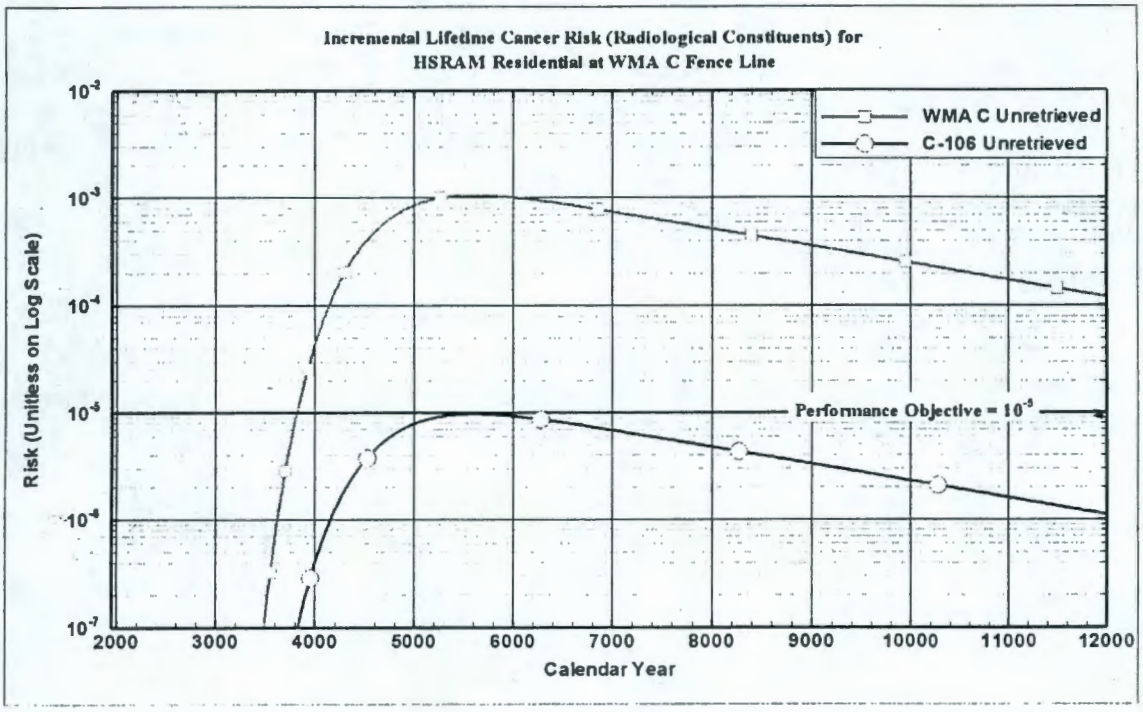
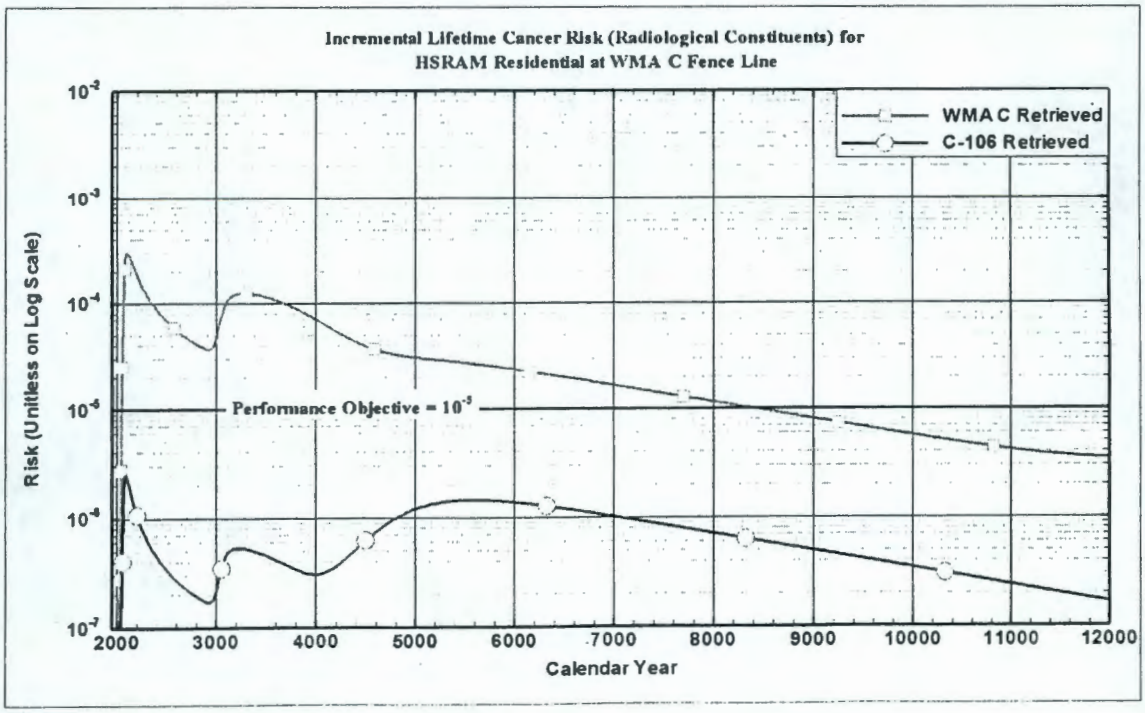


Figure 4-8. Comparison of Incremental Lifetime Cancer Risk Contribution from C-106 to Cumulative WMA C Incremental Lifetime Cancer Risk – Post-Retrieval.



4.4 CONCLUSIONS

The contribution to risk metrics from closure conditions of C-106 is small compared to the cumulative effects of all source terms in WMA C. Comparison of the metrics considered in this analysis with those of WMA C post-retrieval generally indicate the C-106 contribution to be approximately two orders of magnitude lower than the cumulative WMA C for hypothetical retrieval leaks and approximately one order of magnitude lower for tank residuals. Pre-retrieval results indicate that C-106 contribution would be approximately two orders of magnitude lower than those of the total WMA C.

Hypothetical retrieval leak losses and tank residuals are approximately equal in value for the risk analysis for the C-106 base case.

Large uncertainties remain at this time, primarily related to waste inventory (both volume and content) and source release mechanisms. Post-retrieval sampling and analysis are planned to address inventory and waste release behavior uncertainty.

There is ongoing work to further refine this preliminary risk assessment. In particular, aquifer testing in the vicinity of WMA C, sampling and analysis of tank residual waste contents to further refine the inventory, drilling of the vadose zone in the vicinity of the unplanned releases, and three-dimensional modeling.

5.0 COMPONENT CLOSURE ACTIVITIES

Actions to be performed as part of the C-106 component closure activity are described in the following subsections.

5.1 C-106 MEASUREMENTS, SAMPLING, AND ANALYSIS

This section addresses the in-tank measurements (volume), sampling, and analysis needed to address closure criteria and applicable regulatory requirements (WAC-173-303, Site-Wide Permit, and HFFACO) for C-106 component closure activities.

5.1.1 C-106 Data Quality Objectives Process

The overall tank closure characterization effort is discussed in the Framework Plan. A DQO process will be conducted for the component closure activities within the WMA. The DQO process is undertaken to ensure appropriate data are collected to support the component closure activities. The DQO document generated from the DQO process will include all sampling and analytical activities required for the respective component closure activity (e.g., sampling residual waste to support the tank component closure activity). DOE will request approval of the DQO by Ecology. Pertinent sampling and analysis information will be summarized in sampling and analysis plans, the component closure plans, and if appropriate, the associated WMA closure action plan.

The DQO process was used to identify the specific data needs for the C-106 component closure activities. These data needs include the composition of the residual waste and the volume of the residual waste. The DQO process also identifies the specific requirements for quality control, quantitation limits, and error tolerance for the data generated by the sampling and analysis process. As of November 2003, the draft C-106 DQO (*Tank 241-C-106 Component Closure Action Data Quality Objectives* [RPP-13889]) had been prepared, reviewed by Ecology, and was in the comment resolution process. Upon completion of comment resolution, the C-106 DQO will be attached to the C-106 component closure activity plan as Supplement C2.

5.1.2 C-106 Sampling and Analysis Plan

The sampling design is presented in the C-106 DQO (Supplement C2). Table 5-1 provides a cross walk between the C-106 DQO and the sampling and analysis plan requirements. As a condition of the permit, a sampling and analysis plan for C-106 will be submitted within 45 days of the effective date of the permit for Ecology's approval.

5.1.2.1 Objectives. The objectives of the sampling and analysis for C-106 are as follows:

- Determine the volume of waste remaining in the tank at the completion of the retrieval actions.
- Collect and analyze liquid waste samples at the end of the retrieval activities to support determination of the concentrations of chemical and radiological constituents of the tank constituents.
- Collect and analyze solid waste samples to determine the concentrations of chemical and radiological constituents remaining in the tank at the completion of the retrieval actions.
- Collect and analyze solids to obtain additional data (such as leach rates) to support the risk assessment methodology.

5.1.2.2 Liquid Sampling Activities. The liquids in the tank will be sampled at the completion of waste retrieval activities. Sampling will occur prior to pumping the last batch of liquid used for waste retrieval out of the tank.

A sampling strategy was developed during the DQO process to obtain the most representative samples of the residual liquid waste. The current plan is to obtain the liquid samples after completion of the final washing activity and prior to pumping the remaining liquid out of the tank. These samples should be representative of any liquid remaining in the tank (after final pumping) because no additional liquid will be added and the retrieval process will leave the liquid well mixed. In addition the timing of the sampling activity (before rather than after final pumping) will increase the likelihood of obtaining sufficient liquid samples with current grab sampling techniques.

A minimum of two liquid samples (a sample and a duplicate sample) are required by the DQO. The quantity of liquid in one of the samples must be sufficient to obtain a duplicate analysis. In addition, two bottles are required to conduct the volatile organic compound (VOC) analyses (sample and duplicate sample) and another two are required to conduct the semi-volatile organic compound (SVOC) analyses (sample and duplicate sample). The contents from each pair of bottles can be combined (if insufficient sample material is available) for the rest of the required analyses.

5.1.2.3 Solids Sampling Activities. Samples of any residual solids will be obtained after retrieval is completed. Residual solids on the bottom of C-106 will be sampled using clamshell samplers. This sampler will be able to sample a small waste depth, but does not have off-riser sampling capability at this time. Sampling devices capable of off-riser sampling are being developed, but may not be available before C-106 waste sampling is required.

After retrieval activities are completed, a possibility exists that insufficient residual solids or the location of the residual solids may prevent the collection of a sample. For this reason, pre-retrieval samples of the solids in C-106 were obtained. These samples were collected using the existing finger trap sampler and archived.

At the end of the final waste washing activity, an attempt will be made to move any solid waste, which cannot be retrieved, under a tank riser available for sampling. This will be attempted to facilitate sampling and increase the probability of collecting sufficient waste for the planned analyses. In the current retrieval plans, only one riser (riser 14) will be available for waste sampling because the other risers will contain equipment. Sampling from one riser (i.e., one location) may be adequate because the retrieval activities will mobilize and mix the solid waste within the tank.

A minimum of two solid samples (a sample and a duplicate sample) will be collected for the analyses specified in the DQO. A sample will be composed of multiple clamshells to obtain the amount of sample material needed for testing and analysis. It is desirable that the two samples contain as much as 300 grams and 150 grams of solids, respectively.

5.1.2.4 Volume Measurements. Volume measurements will be made of the waste remaining in the tank after completion of waste retrieval.

The current method for determining the residual waste volume in a tank is the video camera and modeling system. This system, used for the initial baseline measurements of C-106 (RPP-12547), can be deployed without additional development. Residual waste volume measurements are obtained by inserting a video camera into a tank riser and obtaining a videotape of the tank interior. The videotape is used to identify the physical shapes of the waste and to develop a three-dimensional model of the waste surface. The model is developed using a configuration of the tank. The modeling methodology is being refined to include information on accuracy of the volume estimate.

5.1.2.5 Quality Assurance Requirements. The Quality Assurance Project Plan (QAPjP) requires that laboratories performing analyses specified in the C-106 DQO shall maintain a quality assurance (QA) plan. The plan shall meet the *Hanford Analytical Services Quality Assurance Requirements Documents* (DOE-RL-98-28 1998) baseline requirements for laboratory quality systems.

All sampling events will be conducted using controlled procedures. Recommendations for ensuring sample integrity prior to analysis are provided in SW-846 (EPA 1996). The recommendations include type of sample container, holding time, preservation, and zero headspace in samples (for volatile components). Details for sampling requirements are presented in the C-106 DQO.

The analytical data from the laboratory are entered into Labcore, the Laboratory Information Management System at 222-S Laboratory. Then it is transferred to the Tank Waste Information Network System (TWINS) per the TWINS/Labcore Configuration Control Desk Manual upon release of the concurrent data report. The data report from the 222-S Laboratory will be a Format IV data package which includes data for all samples and associated blanks taken and analyzed during a single sampling activity. A Format IV data package, as defined in HNF-SD-CP-QAPP-016 (2003), is necessary because the data are expected to receive extensive review from outside individuals and organizations. The Format IV data package is subject to internal laboratory QA verification and review including peer review prior to release. The Format IV data package will be evaluated against the applicable Level C data validation requirements of

WHC-SD-EN-SPP-001, Rev 1, *Data Validation Procedure for Radiochemistry Analyses,* or WHC-SD-EN-SPP-002, Rev 2, *Data Validation Procedures for Chemical Analyses*, as appropriate. Other qualified and approved validation requirements may be used. The data package shall be issued as a document approved for public release via an Engineering Data Transmittal form.

5.1.3 Data Quality Assessment.

A data quality assessment (DQA) process is used to determine the adequacy of the data to support the decisions established in the DQO. The DQA process includes a review of the data to determine if it meets data quality requirements and to compare the data to the decision rules defined in the DQO. The DQA process will be accomplished using the subjective and quantitative DQA methods described below:

- Examine the data. This includes reviewing the data to determine if it meets the data quality requirements defined in the DQO. If the data do not meet DQO requirements for sampling and analysis, either additional samples must be obtained or the DQO requirements will need to be reevaluated.

- Review the project DQO. This includes comparing the data to the decision rules defined in the DQO. Decision rules define the actions to be taken as a result of exceeding an action level. Decision rules require action levels and alternative actions that will be taken if the action levels are exceeded. Decision rules are expressed as "if then" statements that incorporate the parameter of interest, the scale of decision making, the action level, and the actions that would result from resolution of the decision rule.

The DQO process and the DQA process described above will be applied to C-106 residual waste characterization described in Section 2.5.5.

Table 5-1. Sampling and Analysis Crosswalk

Sampling and Analysis Plan Requirement	C-106 DQO Location (Section) [a]
Analytical Parameters (General)	4.1
Organics analytical parameters, methods, and methodology	4.1.1
Inorganics analytical parameters, methods, and methodology	4.1.2
Radiological analytical parameters, methods, and methodology	4.1.3
Quality Control (General)	4.2
Type of sample containers	4.2
Holding Times	4.2
Sample Preservation	4.2
Data Package	4.2
Quantitation Limits	4.3
Action Levels	4.3
QAPjP Requirements	4.2
Sampling Constraints	5.2
Error Tolerance	7.0
Sampling Design (General)	8.0
Volume Measurement	8.1
Liquid Sampling	8.2
Solids Sampling	8.2
Number of Samples	8.2
Sample Locations (Riser availability)	8.2

[a] Supplement C1 of the C-106 component closure activity plan

5.2 TANK STABILIZATION

Tank stabilization activities are initiated subsequent to satisfying HFFACO Milestone M-45-05H. Tank stabilization activities will provide information as a demonstration for subsequent tank closures. Various testing activities will occur in the laboratory, in the field, and during C-106 filling to obtain data regarding the performance and logistics of placing fill in an SST.

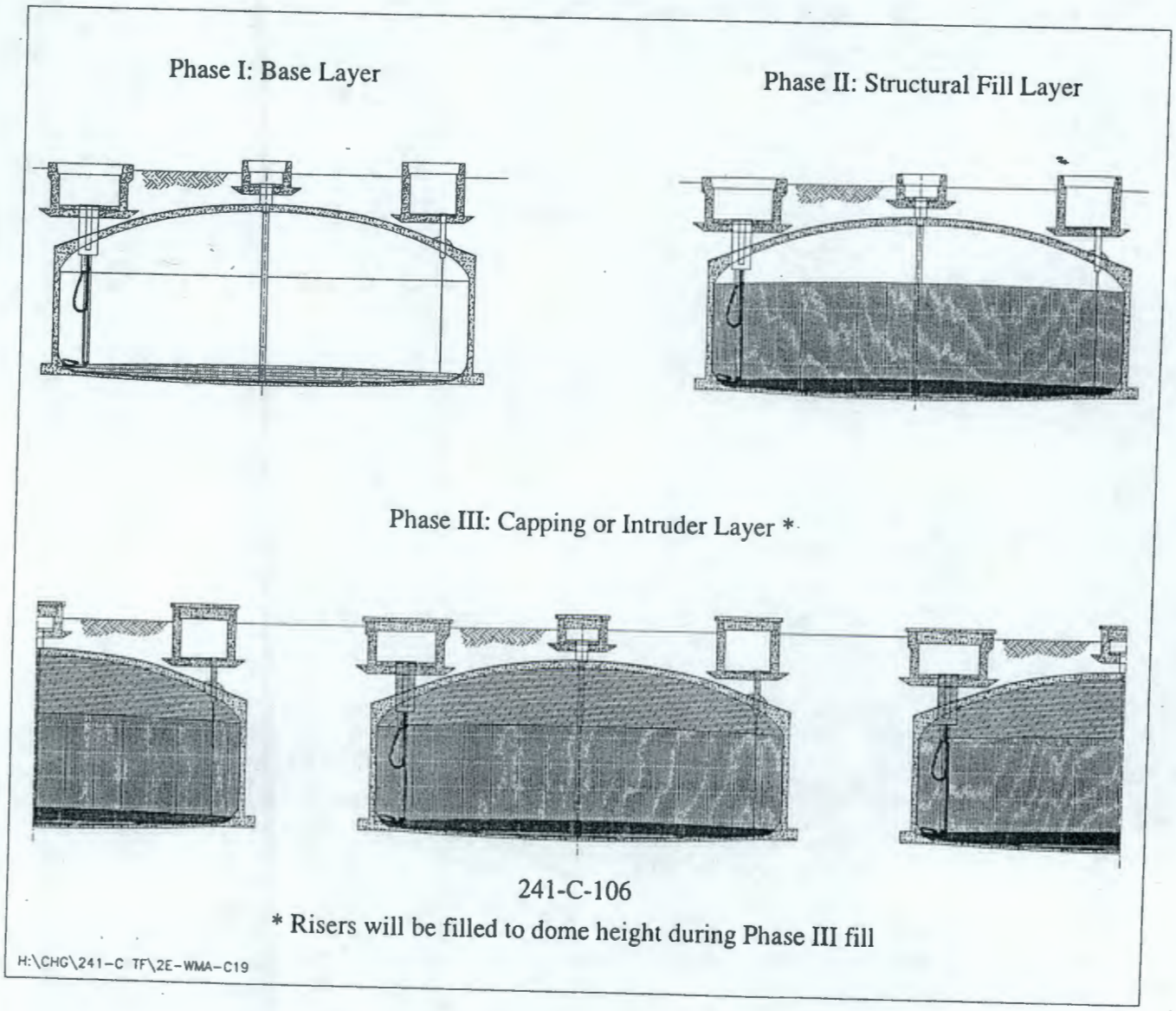
Tank stabilization will be accomplished by adding grout* or other structural material in layers into C-106. Phase I fill will be composed of a free-flowing grout* and will cover the waste residuals and debris on the tank bottom and provide structural support for subsequent fills. The Phase II fill will provide structural stability and fill the majority of the tank volume. The Phase

* See Preface in *SST System Closure Plan* (RPP-13774).

III fill will be a high-compressive-strength grout* placed in the remaining void space between the Phase II grout* and the tank dome and fill tank risers to the maximum dome height. The function of the Phase III grout* is to discourage intruder access. The entire fill system, consisting of Phases I, II, and III, provides structural support to the tank dome to prevent subsidence and degradation of the surface barrier placed at the time of WMA C closure.

Figure 5-1 displays the planned multi-phased approach to tank stabilization for final closure.

Figure 5-1. Conceptual Tank Stabilization and Closure.



* See Preface in *SST System Closure Plan* (RPP-13774).

5.2.1 Phase I Fill: Base Layer*

The Phase I grout addition to C-106 will involve adding a 30- to 90-cm (12- to 36-in.) base layer of grout to the tank.

Cementitious grout will be produced offsite and transported by truck to the C Tank Farm, or a mix plant located on the Hanford Site may be used. As defined in the *Accelerated Tank Closure Demonstration Basis of Design* (RPP-12331), the grout will be formulated to be free-flowing and of sufficient volume so as to cover the residual waste at the bottom of the tank and form a base grout layer. The grout may be placed in approximately 30-cm (12-in.) lifts through an existing riser (RPP-12331). Up to three lifts may be placed in the tank. Although an uneven residual waste surface is expected, sufficient grout will be placed in the tank to cover the residual waste volume at the bottom of the tank, hence substantially reducing in-tank dose rates. An in-tank video system will be used to document and provide information to confirm the placement and lift thickness.

Some debris will not be covered by Phase I grouting (discarded equipment may protrude above the initial grout layer and residual waste may be on the walls above the grout level). The bottom portion of pumps or other equipment may also extend into this Phase I base layer.

Active ventilation with a high-efficiency particulate air (HEPA) filtration system will be used during grouting activities to control potential release of contaminants to the environment. Appropriate air permits will be obtained. Information will be obtained during the placement of the Phase I layer of grout on how operations are affected, such as impact on HEPA filter change-out.

The performance objectives of the Phase I grout are as follows:

- Provide sufficient compressive strength to support the Phase II and Phase III fill layers.
- Completely cover the residual waste.
- Exhibit a relatively low heat of hydration.
- Be free-flowing, self-compacting, self-leveling, and low-shrink.

The following information is expected to be obtained during the demonstration of Phase I grout addition to C-106 during this component closure activity.

- **Field deployment of grout production and placement equipment.** There are numerous logistical and risk considerations for working in and around the tank farms, especially for initial implementation of a new activity. Gaining essential experience and identifying potential problems during the mobilization and deployment phase can only be accomplished in the field. The information gained during the demonstration will help to better anticipate and avoid future problems and worker and environmental risks.

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* See Preface in *SST System Closure Plan* (RPP-13774).

- **Placement and distribution of grout in tank.** In this demonstration, flowable grout will be placed in C-106. This part of the demonstration will help to determine flowability characteristics of the grout as it is distributed in the tank and grout behavior within the in-tank environment.

- **Physical response of tank residual to grout during placement.** Residual waste behavior when grout is dispersed throughout the tank in the actual tank environment will be better understood from this demonstration. This demonstration will provide insight into whether any remaining residuals stay in place or are relocated during grout placement. Further information will be obtained on how any remaining liquid will interact with the grout, potentially affecting distribution and placement.

- **Worker exposure measurements/mitigation.** In addition to addressing the logistical issues of deployment of grout production and the placement of equipment, the demonstration will help determine how to improve worker safety in the actual working environment.

- **Project costs and efficiencies.** One of the key elements of the demonstration is to gain information on how placement of grout in a tank can be more efficient and cost-effective in the future, based on lessons learned.

Test plans for tank fill formulation and placement will be developed. The development program will recommend a grout formula based on variables such as compressive strength, flow, gel time, set time, bleed water, air content, hydraulic conductivity, and porosity.

Grout placement performance information will be gathered through use of video cameras. Distribution of grout and displacement of residuals will be understood through visual observation. Radiological measurements during and after fill placement can be obtained through existing or planned monitoring activities.

During placement of the Phase I base layer, it will be determined whether adjustments need to be made to grout material specifications, methods of placement, or introduction of other measures. During previous tank fill demonstrations at DOE's Savannah River Site in South Carolina, a dry material "top dressing" was used to incorporate the residual liquid into grout. Savannah River Technology Center is formulating a top dressing material for Hanford based on their tank filling experience. If a portion of the waste is displaced by the grout, the specially formulated granular grout material (top dressing) may be used to adsorb the excess liquid prior to placement of additional grout. Failure to evaluate the potential for liquid waste heel displacement and incorporation of the liquid into the initial grout layer via the Phase I base layer addition demonstration for C-106 increases the difficulties during future tank closure activities. Savannah River Technology Center will conduct laboratory, bench, and large-scale (up to a 6-m- [20-ft]-diameter swimming pool) cold tests at their facility during Hanford SST grout formulation and specification development efforts.

5.2.2 Phases II and III: Structural and Intruder Layers*

The initial conditions of the tank prior to the addition of the Phase II and III tank layer assumes that 30- to 90 cm (12- to 36 in) of waste stabilizing grout will exist in the tank. The Phase II layer is intended to provide structural integrity to the tank. Phase III is an intruder (capping) grout, which is composed of a high-compressive-strength grout. The Phase III grout is intended to inhibit postclosure intruder access into the tank (for example, as a result of drilling activities).

Phases II and III will install multiple layers of cementitious grout on top of the Phase I base layer. The specific grout mix design specifications have not yet been determined, but are intended to meet the following performance objectives:

- Provide sufficient compressive strength to maintain the structure of the tank wall (Phase II).
- Provide sufficient strength to maintain the integrity of the tank dome (Phase III).
- Create a cover of grout to mitigate liquid infiltration that could mobilize remaining residuals (Phases II and III).
- Create a high-strength grout to discourage or prevent intruder access by excavation or drilling (Phase III).
- Exhibit a relatively low heat of hydration.
- Be free-flowing, self-leveling, self-compacting, and low-shrinking.

The grout may be placed in approximately 90-cm (36-in.) lifts through existing risers (RPP-12331). Final design of the grout will be documented prior to emplacement. An in-tank video camera will be used to document and provide information to confirm the proper emplacement and lift thickness. During placement of the Phase III grout to the tank dome, the grout may partially fill risers penetrating the tank dome. Completion of grout placement in the tank risers to the top of the riser will be performed as part of the component closure activities, or at the time of WMA C closure.

During grouting operations, active ventilation will be maintained to control potential release of contaminants to the environment. Appropriate air permitting will be obtained.

In addition, grouting operations in C-106 will be conducted in such a manner that grout does not flow through the cascade line connecting C-105 to C-106. This will be accomplished, with the aid of in-tank video camera surveillance, by stopping the grout fill operation at the point grout has just reached the top of the 7.6-cm (3-in.) diameter cascade line. The grout will then be allowed to cure before proceeding with additional lifts. The cured grout will form a plug at the

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* See Preface in *SST System Closure Plan* (RPP-13774).

lower end of the cascade line, thus preventing flow of grout uphill through the cascade line into C-105.

5.3 ISOLATION OF TANK INFRASTRUCTURE FROM ANCILLARY/SUPPORT EQUIPMENT

During the period between this component closure activity and final WMA C closure, which could span several years, the possibility exists, without the implementation of appropriate controls, for the inadvertent re-introduction of waste into C-106 through various pathways. Without controls, it also is possible while grouting* C-106 to prematurely introduce grout* into C-105 through the cascade line connecting the two tanks. This will be controlled as described in Section 5.2.2.

With the exception of the cascade line to C-105, C-106 has been isolated from all of the original waste transfer pipeline network installed when the tank was constructed. C-106 also has been isolated from piping installed for the saltwell pumping campaigns conducted in the 1970s. Isolation has been documented on the drawings and verified to the extent possible by in-pit video inspections. Figure 5-2 illustrates the line and riser locations into and around C-106, along with their current status.

The pipelines that have the potential to re-introduce waste into C-106 are the supernate and slurry lines installed between C-106 and AY-102 in the late 1990s to resolve the C-106 high-heat issue, and the original cascade line from C-105. The supernate and slurry lines currently rely on administrative controls, but will be capped or rerouted to another tank. The cascade line from C-105 will be isolated with administrative controls and left open until tank fill blocks the line. An over-ground transfer line connected to the heel pit for the waste retrieval efforts will be removed after retrieval is completed.

Since the bottom of the above-tank pits are higher than the inside apex of the tank dome, premature grouting* of adjacent tanks or facilities is considered implausible. The inlet sides of the supernate and slurry lines (at the pit nozzles) are approximately 10 m (33 ft) above the bottom of the tank, and the cascade line is approximately 4.9 m (16 ft) above the tank bottom.

This project will maintain or implement administrative isolation actions for these components (such as through procedural changes) pending final regulatory reviews and approvals. The administrative actions will include actions to prevent water infiltration and inadvertent transfers into the closed tank. Final closure of the ancillary equipment will be addressed in future documents.

Thirty-six pathways enter tank C-106 or its associated pits. The pathways include lines, risers, pit drains, weep holes and ventilation ducts. Eighteen pathways into C-106 have already been isolated, as shown on Table 5-3. DOE will take isolation actions on all remaining pathways, as

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* See Preface in *SST System Closure Plan* (RPP-13774).

shown on Table 5-4 to prevent introduction of new wastes or the intrusion of other liquids into the tank. DOE will use isolation methods based on engineering analysis that do not preclude future remediation. Actions will be implemented via established Engineering Change Notice (ECN) and work control processes.

Figure 5-3 shows major potential pathways into C-106, and also identifies lines previously used to carry tank waste.

Table 5-2. Tank 241-C-106 Previously Isolated Lines. (2 Pages)

Line Number	Description	Tank Waste Transfer Line	Isolation Technique & Status	Verification
8202	Waste Line from Diversion Box to Pump Pit	Yes	Physically Isolated: U-1 Nozzle Capped in Pump Pit	Video, 10/24/02
8232	Waste Line from Diversion Box to Pump Pit	Yes	Physically Isolated: U-2 Nozzle Capped in Pump Pit	Video, 10/24/02
8310	Spare Waste Line	Never Used	Physically Isolated: Capped Outside Pump Pit and U-4 Nozzle Capped	Video, 10/24/02
8232	Conduit	No	Physically Isolated: U-5 Nozzle Capped	Video, 10/24/02
8301	Conduit	No	Physically Isolated: U-6 Nozzle Capped	Video, 10/24/02
8336	Conduit	No	Physically Isolated: U-7 Nozzle Capped	Video, 10/24/02
8260	Steam Line from Heel Pit to Old Gang Valve	No	Physically Isolated: U-1 Nozzle Capped	Video, 09/20/02
8256	Waste Line (Line T's Into 8202 Above)	Yes	U-2 Nozzle Has Jumper Grapple in Place. 8202 is Capped at Both Ends.	Video, 09/20/02
8316	Spare Waste Line	Never Used	Physically Isolated: Capped Outside Heel Pit and U-3 Nozzle Capped	Video, 09/20/02
8235	Waste Line from Diversion Box to Sluice Pit	Yes	Physically Isolated: U-1 Nozzle Capped in Sluice Pit	Video, 10/24/02
8214	Waste line from Diversion Box to Sluice Pit	Yes	Physically Isolated: U-2 Nozzle Capped in Sluice Pit	Video, 10/24/02
8322	Spare Waste Line	Never Used	Physically Isolated: Capped outside Sluice Pit and U-3 Nozzle Capped	Video, 10/24/02

Table 5-2. Tank 241-C-106 Previously Isolated Lines. (2 Pages)

Line Number	Description	Tank Waste Transfer Line	Isolation Technique & Status	Verification
8279	Spare Waste Line	Never Used	Physically Isolated: Capped Outside Sluice Pit and U-4 Nozzle Capped. Line is also Designated as 8379 on Some Drawings	Video, 10/24/02
8328	Spare Waste Line	Never Used	Physically Isolated: Capped Outside Sluice Pit and U-5 Nozzle Capped	Video, 10/24/02
CI	Spare Nozzle through Tank Wall Near Cascade Line	Never Used	Spare Inlet, Capped Outside Tank, Never Used. (Partially filled with waste or grout)	Video, 07/14/00
C2	Spare Nozzle Through Tank Wall Near Cascade Line. Never Used.	Never Used	Spare Inlet, Capped Outside Tank, Never Used. (Partially filled With Waste or Grout)	Video, 07/14/00
C3	Spare Nozzle Through Tank Wall Near Cascade Line	Never Used	Spare Inlet, Capped Outside Tank, Never Used. (Partially filled With Waste or Grout)	Video, 07/14/00
C4	Spare Nozzle Through Tank Wall Near Cascade Line	Never Used	Spare Inlet, Capped Outside Tank, Never Used. (Partially Filled With Waste or Grout)	Video, 07/14/00

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Table 5-3. Tank 241-C-106 Currently Open Lines. (2 Pages)

Line	Description	Tank Waste Transfer Line	Planned Isolation Technique
SL-100	Encased Slurry Line (RCRA-compliant) from AY-102 installed by Project W-320	Yes	Cap Line in AY Farm. Potential Use in Other C Farm Retrievals
ENC-100	Encasement for SL-100	No	Cap in C Farm
CWR-850	Chill Water Line in the Vicinity of the Tank	No	Cut and Cap Outside Process Building
CWS-803	Chill Water Line in the Vicinity of the Tank	No	Cut and Cap Outside Process Building
SN-200	Encased Supernate Line (RCRA-compliant) from AY-102 Installed by Project W-320	Yes	Cap in AY Farm. Potential Use in Other C Farm Retrievals
ENC-200	Encasement for SN-200	No	Cap in C Farm
DR-302	Encased Process Building Drain Line	No	Insert Blank Between Flanges in the Process Building (ECN 720997)

Table 5-3. Tank 241-C-106 Currently Open Lines. (2 Pages)

Line	Description	Tank Waste Transfer Line	Planned Isolation Technique
DR-301	Encased Process Building Drain Line	No	Grout/Foam Inlet Side in Process Building (ECN 721029). Also, Remove Jumpers and Cap (in Sluice Pit)
ENC-M26a	Drain Line Encasement from Process Building Drain Line	No	Same as DR-301 Above
ENC-302	Drain Line Encasement from Process Building Drain Line	No	Same as DR-302 Above
RAW-601	Raw Water Supply Line	No	Cut and Cap at the Supply End
Nozzle B	Cascade Line from C-105	Yes	Administrative Controls on C-105. Leave Line Open Until Tank Fill Blocks Line
Pump Pit Floor Drain to R-5	Pit Floor Drain Routed to Riser 5	No	Leave Open and Weather Proof Pit Covers
R-15 (in Condenser Pit)	Pit Floor Drain Routed to Riser 15	No	Leave Open and Weather Proof Pit Covers
Heel Pit Floor Drain to R-13	Pit Floor Drain Routed to Riser 13	No	Leave Open and Weather Poof Pit Covers
Sluice Pit Floor Drain to R-4	Pit Floor Drain Routed to Riser 4	No	Leave Open and Weather Proof Pit Covers
HVAC to Riser 2	Part of Ventilation System Used During Retrieval	No	Cut and Cap Lines (ECN 720975 in Preparation)
HVAC to Riser 15	Part of Ventilation System Used During Retrieval	No	Remove Valve and Install Blank (ECN 720974 in Preparation)

Notes:

All over ground transfer lines (hose-in-hose) will be removed from Pit-06A, Pit-06B and Pit-06C upon completion of retrieval.

Risers 16 through 19 penetrate the Exhaust Hatchway (sometimes called the Condenser Pit) cover, but not the tank dome. The dome penetration is designated R15. Blank flanges have been installed on R17 and R19, and on a flange in the Process Building to block the duct to R16. The inlet filter bank previously installed on R15 has been replaced with a breather filter assembly. R18, a ½" pressure tap, has an instrument package installed, effectively blocking this penetration.

A flush water line is attached to the ductwork on R16, but terminates at a quick disconnect hose fitting. The raw water line used for high heat control water additions has been removed.

Weep holes will be plugged with foam, and pit covers will be weather proofed at completion of isolation.

1

Figure 5-2. Current Configuration of C-106.

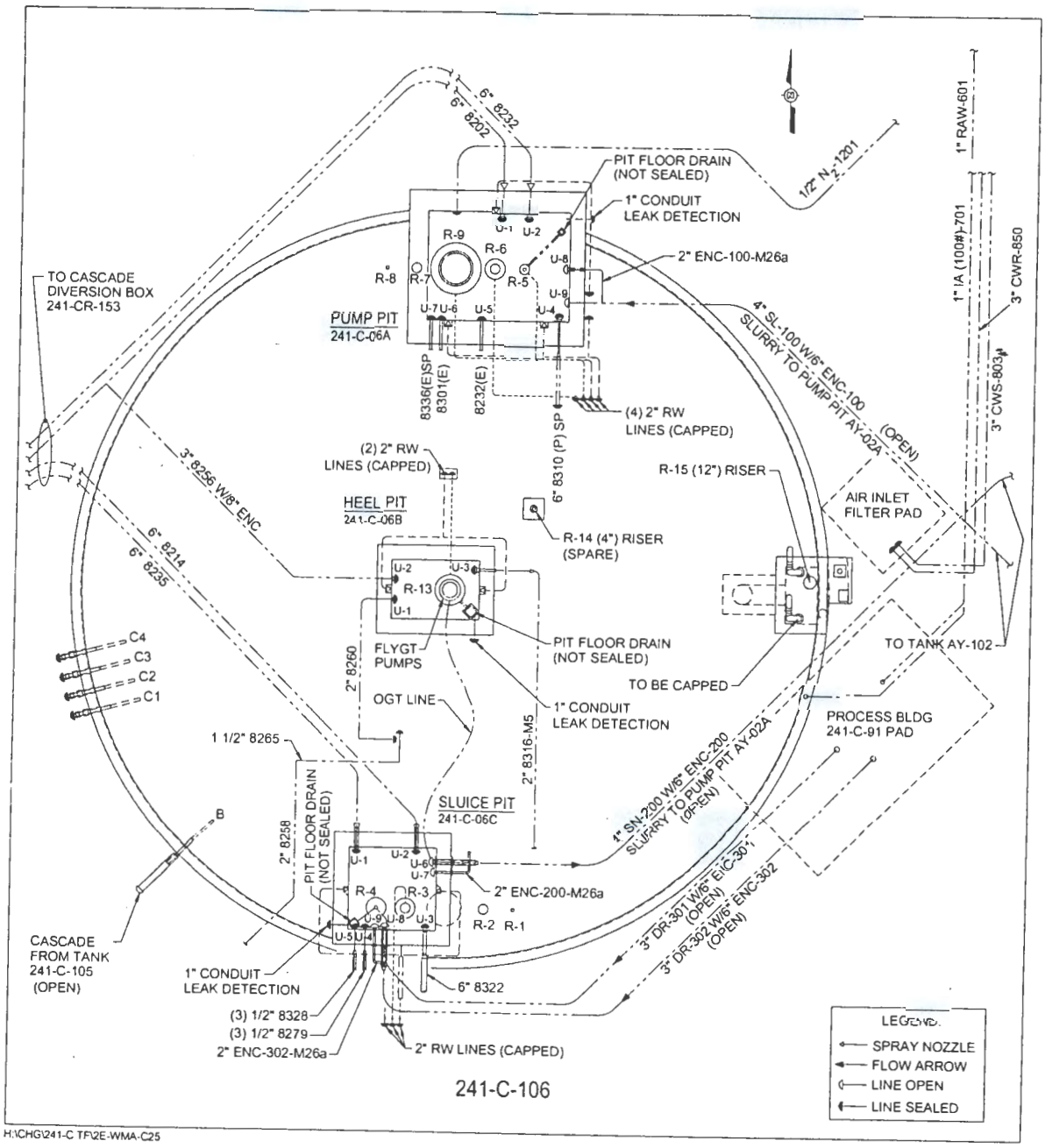
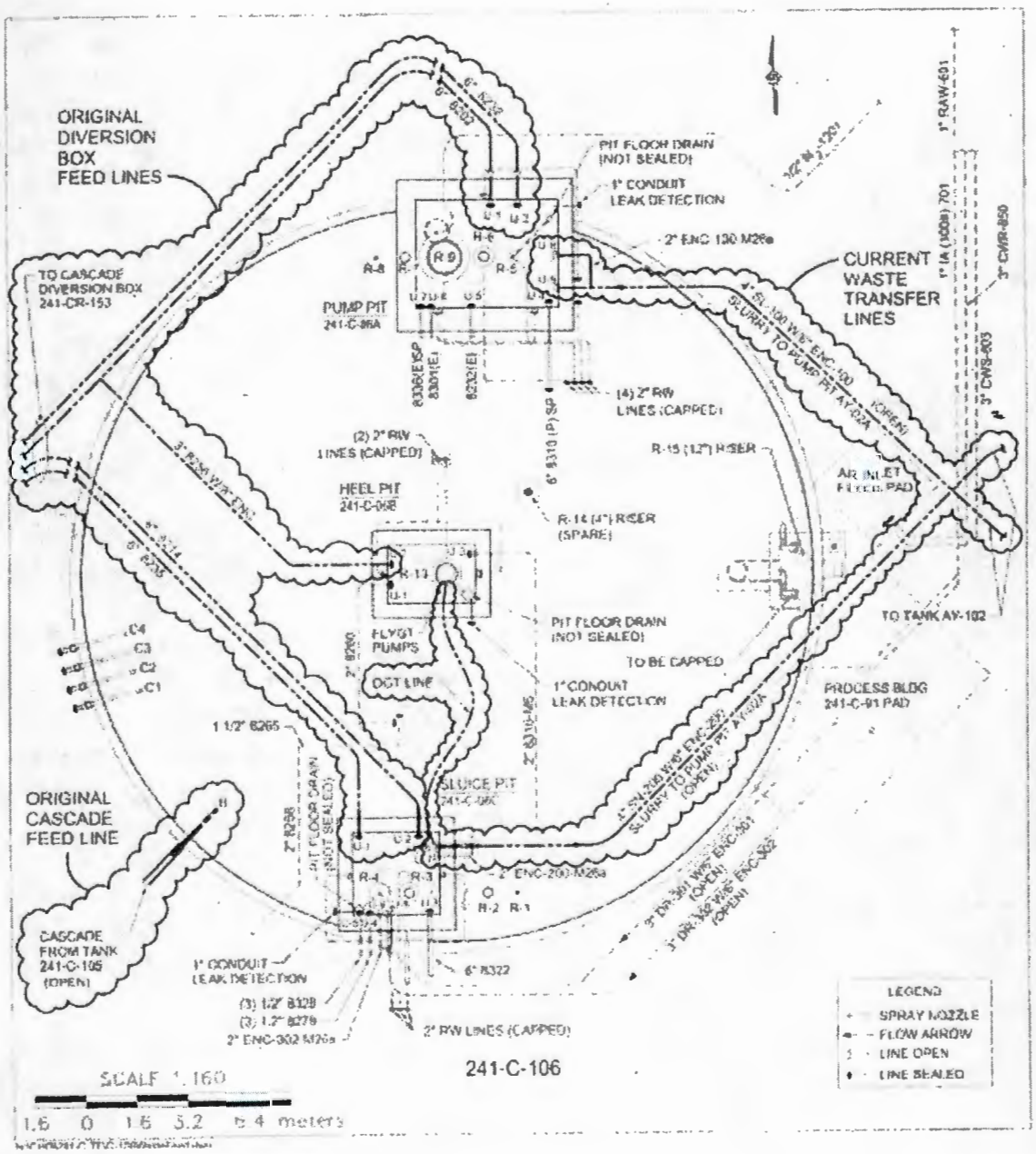


Figure 5-3. Tank 241-C-106 Plan View with Tank Waste Transfer Lines Clouded.



5.4 LAND DISPOSAL RESTRICTIONS COMPLIANCE

Retrieval of as much waste as technically possible will be pursued according to HFFACO requirements; however, DOE must consider the possibility of leaving some waste residuals in place at closure. In the event that waste is not satisfactorily removed from C-106, the RCRA land disposal restrictions (LDR) treatment standards (WAC 173-303-140 and 40 CFR 268) will apply. A site-specific treatability variance is needed to allow an alternative approach to protecting human health and the environment from the land disposal of dangerous waste (to be approved by Ecology separately from this closure plan) for the following reasons:

- The residual waste cannot be treated by the technology specified by regulations for some of the applicable waste codes (vitrification for high-level radioactive wastes exhibiting the characteristics of corrosivity and toxicity for metals).
- Treatment to performance-based treatment levels for other applicable waste codes is likely unachievable.
- 40 CFR 268.48 Table 1 treatment standards are expected to be unachievable in the short-term for the tank and abandoned equipment.

Enhanced containment is the proposed treatment action for C-106. Enhanced containment is achieved through placement of a Phase I cemetitious grout* fill and the Phase II structural fill followed by the Phase III intruder fill as described in Section 5.2. The Phase I fill will stabilize residuals and provide an infiltration barrier within the tank, providing some protection from water intrusion. The combined protectiveness of the fill material and the existing concrete tank shell and dome reduces the potential for migration of hazardous constituents. Enhanced containment complies with the requirements for an LDR treatment standard (42 USC 6924(m)) because it substantially reduces the mobility of the waste by reducing infiltration, and minimizes the threat to human health and the environment as part of an integrated approach to meeting closure performance standards of WAC 173-303-610(2) during the C-106 component closure activities. The addition of the Phase II and Phase III fills will further enhance the reduction of infiltration for the tank walls and abandoned equipment.

5.5 WASTE MANAGEMENT

Retrieved waste will be pumped to the DSTs for storage pending treatment in the waste treatment plant and disposal at an offsite geologic repository. Fill and isolation activities are not expected to generate significant wastes. Wastes generated include personal protection equipment, failed equipment, and tools used during the execution of component closure activities. Materials will be decontaminated and reused, or packaged and disposed of appropriately. Decontamination will be conducted in accordance with standard tank farm

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* See Preface in *SST System Closure Plan* (RPP-13774).

procedures. Disposal will follow approved waste acceptance criteria for the appropriate storage and/or disposal facility.

5.6 PERSONNEL TRAINING

In accordance with WAC 173-303-806(4)(a)(xii), the *Hanford Facility Dangerous Waste Permit Application, General Information Portion* (DOE/RL-91-28) 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)." The Site-Wide Permit, Condition II.C (Personnel Training) contains requirements applicable to Hanford facility personnel and non-facility personnel.

Compliance with these requirements is discussed in Chapter 8.0 of DOE/RL-91-28 (Attachment 33 of Site-Wide Permit) and the following subsections.

5.6.1 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.

Introductory training includes general Hanford training and TSD unit-specific training. General Hanford Facility training is described in Section 8.1 of DOE/RL-91-28, and is provided in accordance with the Site-Wide Permit, Condition II.C.2. TSD unit-specific training is provided to Hanford personnel allowing personnel to work unescorted. Hanford 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 co-worker who is properly trained. Hanford personnel assigned the job title of Emergency Coordinator and alternates to this position performing tasks described in WAC 173-303-360 (such as Building Emergency Directors) are 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.

Continuing training meets the requirements for WAC 173-303-330(1)(b) and includes general Hanford training and TSD unit-specific training. General Hanford training is the same as described for introductory training. TSD unit-specific training provides an annual review of emergency response training and an annual review of training necessary to ensure TSD unit operations are in compliance with WAC 173-303.

5.6.2 Description of Training Design

Proper design of a training program ensures personnel who perform duties on the Hanford Site 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 and responsibilities, are used to determine training requirements.

Elements of WAC 173-303-330(1)(d) applicable to C-106 component closure activities include the following:

- Procedures for using, inspecting, repairing, and replacing emergency and monitoring equipment
- Communications or alarm systems
- Response to fires or explosions
- Shutdown of operations.

Hanford personnel who perform these duties and have these responsibilities receive training pertaining to their duties and responsibilities. The written training plan documentation as required by WAC 173-303-330(2) contains specific information regarding the types of training that Hanford personnel receive.

5.6.3 Description of Training Plan

Unit-specific training plan documentation is maintained outside of the *Hanford Facility Dangerous Waste Permit Application* (DOE/RL-91-28) and the Site-Wide Permit. Therefore, changes made to the written training plan documentation are not subject to the Site-Wide Permit modification process.

Training plan documentation is prepared to comply with WAC 173-303-330(2). Documentation prepared to meet the training plan requirement could consist of hard copy or electronic media as provided by Site-Wide Permit, Condition II.I.1. The training plan documentation could consist of more than one document or a training database as long as the components are identified in a core document.

The following describes how Dangerous Waste Training Plan (DWTP) documentation meets the three items in WAC 173-303-330(2):

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 personnel job titles and duties for each position are maintained in the core DWTP document. Duties (responsibilities) for positions

relating to WAC 173-303 are described in the DWTP core document and are listed under the specific job title to ensure training for personnel are determined properly.

Names of Hanford Facility personnel who carry out activities are maintained. Names could be maintained within the DWTP core document or by other means referenced in the DWTP core document.

Prerequisite skills, education, and other qualification requirements are addressed by making general statements in the DWTP and referencing where this information is maintained (such as the human resources department). Specific information concerning job title, requisite skills, education, and other qualifications for personnel might not be included in the DWTP core document if this information 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 discussion provided in Section 8.1 of DOE/RL-91-28, courses developed to comply with the introductory and continuing training programs are identified and discussed in the DWTP documentation. The frequency for retraining is specified in the DWTP documentation.

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 DOE/RL-91-28, Section 8.3.

5.7 C-106 COMPONENT CLOSURE ACTIVITY CONTACT POINT

DOE will be the official contact for C-106 during and after the component closure activity at the following address:

Tank Closure Program Manager
Office of River Protection
U.S. Department of Energy
PO Box 450 (H6-60)
Richland, Washington 99352

5.8 C-106 COMPONENT CLOSURE ACTIVITY SCHEDULE

The current schedule for C-106 component closure activities are contained in the HFFACO Milestone M-45 series and will be modified, if needed, according to the HFFACO change process. Table 5-4 lists the HFFACO Milestones associated with the C-106 retrieval and component closure activities.

Table 5-4. HFFACO Milestones for C-106 Retrieval and Component Closure.

Milestone	Activity	Date
M-45-06A	Submit a certified (framework) SST system closure plan modification and C-106 retrieval and closure demonstration plan to Ecology.*	12/19/2002
M-45-05I-T01	Conduct C-106 waste retrieval and closure demonstration project 30% design consultation.	1/31/2003
M-45-05J-T01	Complete C-106 waste retrieval and closure demonstration project design.	4/30/2003
M-45-05K-T01	Complete C-106 waste retrieval and closure demonstration project construction.	9/30/2003
M-45-05L-T01	Complete full-scale C-106 waste retrieval.	11/01/2003
M-45-05M-T01	Submit C-106 waste retrieval results, analysis of residual waste(s), and (if appropriate) request for exception to the criteria pursuant to Agreement Appendix H.	2/27/2004
M-45-05H	Interim completion of C-106 SST waste retrieval and closure demonstration project.	4/30/2004
M-45-05N-T01	Final completion of C-106 SST waste retrieval and closure demonstration project.	12/31/2004

* Certification obtained for RPP-13774, Rev. 0

Figure 5-4 is a summary schedule of the major C-106 component closure activities.

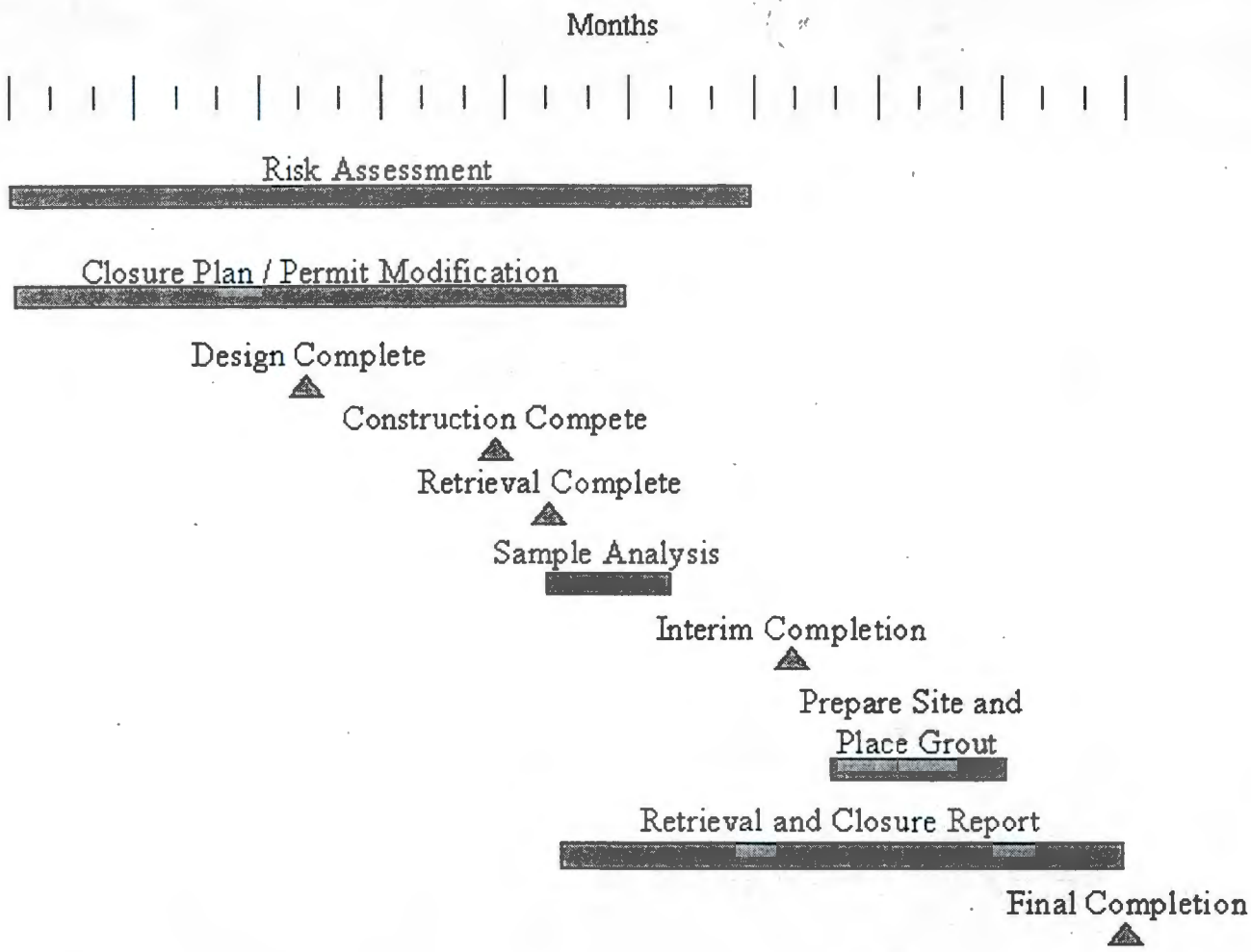

Figure 5-4. Major C-106 Component Closure Activities.

5.9 FUTURE AMENDMENT OF C-106 COMPONENT CLOSURE ACTIVITY PLAN

This component closure activity plan will be amended whenever changes in component closure activities occur that would constitute a Class 1, 2, or 3 modification to the permit (WAC 173-303-830).

5.10 REPORT OF C-106 COMPONENT CLOSURE ACTIVITY

Within 60 days of the completion of each phase of activities at C-106, DOE will submit to Ecology a letter report documenting activities that have been conducted in accordance with the specifications contained within the approved plan, as amended, and as contained in the permit.

6.0 CARE OF C-106 AFTER COMPONENT CLOSURE ACTIVITIES

This section describes activities DOE will undertake to provide care for C-106 between the time DOE completes component closure activities and the time DOE closes WMA C. While conducting closure actions under HFFACO schedules of compliance and permit requirements, the tank system must continue to comply with interim-status standards.

DOE will maintain control over WMA C for the foreseeable future. Roadways to the unit and site access will remain administratively restricted to use by authorized personnel only. Posted warning signs restrict access from the Columbia River. A chain-link fence surrounds WMA C. The 200 Areas are under 24-hour security surveillance. DOE will inspect security systems and controls on a routine basis.

The current vadose zone and groundwater monitoring programs will continue after component closure activities are completed. Current restrictions ensuring that groundwater is not used as a drinking water source in the 200 Areas will continue after component closure activities.

Isolation techniques were discussed in Section 5.3. Administrative isolation of C-106 will be continued pending WMA C closure.

6.1 FUTURE POSTCLOSURE ACTIONS

Final closure of C-106 through closure of WMA C will require compliance with the postclosure provisions contained in WAC 173-303-610(7) and -665(6). Closure activities contained in this component closure activity plan, however, will not constitute final closure for C-106. Final postclosure actions for C-106 will occur as part of the postclosure plan for WMA C. At that time, WMA C will enter a control period during which monitoring and maintenance will take place. Administrative controls such as deed restrictions also may be defined.

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