APPENDIX F
ESTIMATED RADIOACTIVITY IN SUBSURFACE PIPING

PURPOSE OF THIS APPENDIX

The purpose of this appendix is to provide conservative estimates of residual radioactivity in underground piping to supplement information on the radiological status of facilties discussed in Section 4.1.

INFORMATION IN THIS APPENDIX

Information in this appendix was drawn from a radioisotope inventory report completed in July 2004. Included are a list of all buried pipelines and estimates for residual activity in pipelines in three areas: (1) beneath the Process Building, (2) west of the Process Building, and (3) east of the Process Building. An estimate is also included for residual radioactivity in the Leachate Transfer Line that runs from the NRC-Licensed Disposal Area (NDA) to Lagoon 2.

RELATIONSHIP TO OTHER PARTS OF THE PLAN

The information in this appendix supplements the information provided in Section 4 and supports the decommissioning activities described in Section 7.

1.0 Introduction

Various underground lines in WMA 1 and WMA 2 carried radioactive liquid during NFS and WVDP operations. All were evaluated and conservative estimates of residual radioactivity were made as described in the radioisotope inventory report (Luckett, et al. 2004). During this evaluation, the sources were divided into categories, including:

- Lines beneath the footprint of the Process Building,
- High-activity lines primarily west of the Process Building,
- Low-activity lines primarily east of the Process Building, and
- The leachate transfer line from the NDA to Lagoon 2.

The evaluation process included the following steps:

- Collection and review of available information and data on pipe design and location;
- Consideration of process history to determine which lines had actually carried radioactive liquid;
- Review of radiological data and inventories generated by the Facility Characterization Project;
- Preparation of activity estimates for indicator radionuclides based on (1) data on fluids carried by the pipes and an empirical relationship between the activity of the HLW fluid

and the resulting residual contamination on the pipe interior or (2) the results of surveys of rooms and systems where the pipe contents originated;

- Application of conservative radionuclide distribution scaling factors from the point of origin of the contamination to produce a conservative estimate of the activity in each line; and
- Combining individual line estimates into conservative curie estimates, that were corrected for decay and ingrowth to 2011, for groups of related lines appropriate to dose modeling.

A listing of the underground lines identified in the evaluation is provided in Table F-1. The column "Radionuclide Distribution Surrogate" refers to the distribution of radionuclide ratios assigned to each line, based on process history, the origin and terminus of the line, and the geographic location category. Note that acronyms used in the table are defined in the legend at the end of the table. Residual activity estimated to remain inside the lines is summarized below in Section 2 through 4 of this appendix. Details of the calculations, a discussion of the basis for the assignment of the surrogate radionuclide distribution, and the surface contamination ($\mu Ci/m^2$) for each radionuclide in each of the distributions are provided in Luckett, et al. 2004.

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
1P64-1	1	FRS	MSM Valve Pit	25	0	400	CD Pit
7P19-1	1	Miniature Cell	Tank 7D-14	70.6	0	0	Not Used
7P331a-3	0.25	Tank 7D-13	capped	0	30	0	Tank 7D-13
7P331b-3	0.25	Tank 7D-13	7D-13 Sample station southwest stairwell	0	30	0	Tank 7D-13
7P331c-2	0.50	Tank 7D-13	7D-13 Sample station southwest stairwell	0	30	0	Tank 7D-13
7P63-1	1	Tank 7D-8	Miniature Cell	76.6	0	0	Not Used
7P71-3	3	CPC Floor	59 ft Outside Bldg Capped	70	59	0	Not Used
7P74-3	3	CPC Floor	59 ft Outside Bldg Capped	70	59	0	Not Used
7P90-3	3	CPC Floor	59 ft Outside Bldg Capped	70	59	0	Not Used
7P112-3	3	CPC Floor	Tank 8D-1	65.8	462	0	Not Used
7P113-3	3	Tank 7D-10/ CPC Floor	Tank 8D-2	64.3	462	0	7P113
7P114-3	3	CPC Floor	59 ft Outside Bldg Capped	67.5	59	0	Not Used
7P115-3	3	CPC Floor	59 ft Outside Bldg Capped	67.6	59	0	Not Used
7P116-3	3	CPC Floor	59 ft Outside Bldg Capped	67.7	59	0	Not Used
7P120-3	3	Tank 7D-4/ CPC Floor	THOREX to 8D-4	58.7	462	0	7P120
7P151-3	3	Tank 7D-10	Future HLW Storage Capped 59 ft Outside Bldg	68.2	59	0	Not Used

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
7P156-2	2	Tank 7D-13 Vent	OGC	35.6	20	0	Tank 7D-13
7P159-2	2	Tank 7D-13 Jet	GP Catch Tank 7C-5	0	60	0	Tank 7D-13
7P170-2	2	7C-5 Jet	Tank 8D-1	0	482	0	Tank 8D-1
7P177-12	1.5	7 E-13 GP Evap.	7D-13	0	60	0	Tank 7D-13
7P180-12	1.5	7 E-13 via 7P177	15WW568	0	10	0	WW
7P271-2	2	7D-6 Weak Acid Catch Tank Pump 7G-1	Interceptor	0	10	0	WW
8P11-2	2	Tank 8D-1 8G-4	Lagoon	0	0	825	Vault Drip Pan
8P12-3	3	Waste Tank Off Gas Knockout Drum 8D-6	Tank 8D-1	0	41	0	Tank 8D-1
8P27-3	3	Waste Tank Off Gas Knockout Drum 8D-6	Tank 8D-2	0	52	0	Tank 8D-2
8P29-16	16	Tanks 8D-1 via 8P13; and 8D-2 via 8P28; and PVS	Waste Tank Off Gas Condensers and Relief Knock Out Drum 8D-7	0	52	0	8P29-16
8P34-2	2	Waste Tank O/H Condensate Pump 8G-1	7C-5	0	425	0	Tank 8D-2
8P35-2	2	Waste Tank Cond. Pump 8G-1 via 8P34	8D-2 via 7P170	0	5	0	Tank 8D-2
8P38-2	2	Waste Tank Blowers 8K-1/ 8K-1A VIA 8P-46	Tank 8D-2 via 8P-27	0	5	0	Tank 8D-2
8P46-6 (old)	6	Waste Tank Blowers 8K-1/8K-1A	Stack 15F-1	0	435	0	8P46-6
8P46-6 (new)	6	Waste Tank Blowers 8K-1/8K-1A	To line 6P95-8	0	415	0	8P46-6
8P68-2	2	Equipment shelter Manifold	Lagoon	0	52	0	Vault Drip Pan
8P95-3	3	Con Ed Tank 8C-1 Caustic Scrubber	Tank 8D-6 Off-Gas Knockout Drum	0	52	0	Tank 8D-4
8P120-3	3		Tank 8D-1	0	52	0	Tank 8D-1
4P92-12	1.5	Tank 4D-2 Jet 4H-60	59 ft Outside Bldg Capped	61.8	59	0	Not Used
15CH739-3	3	PMC Floor Drain	GPC Sump via 15CH760-3	13.2	0	0	PMCR
15CH750-3	3	CCR Drain	Tank 35104 via 12CH240-6	40.2	0	0	CCR
15CH752-3	3	Equipment Decon Room	Tank 35104 via 12CH240-6	65.8	0	0	EDR

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
15CH753-2	2	GPC Sump Jet and Tank 35104 Eductor	1st U Cycle Tank 4D-10	66.8	0	0	GCR
15CH754-12	1.5	From GCR Sump Jet	Tank 7D-2	77	0	0	GCR
15CH758-3	3	Mechanical Crane Room	Tank 35104 via 12CH240-6	65.5	0	0	PMCR
15CH760-3	3	PMC Floor Drain	GPC Sump	47.6	0	0	PMCR
15CH763-3	3	Scrap Removal	Tank 35104 via 12CH240-6	57.9	0	0	SRR
15CH773-3	3	Tank 35104 Eductor 15H-1	Tank 7D-2	98.2	0	0	Tank 35104
15CH774-3	3	CPC/EDR Door Slot Drain	Tank 35104 via 12CH240-6	6.6	0	0	CPC
1WW48-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	20	0	0	CD Pit
1WW49-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	20	0	0	CD Pit
1WW50-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW51-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW52-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW53-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW54-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW55-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW56-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
02WW359-3	3	Lagoon 1	Lagoon 2	0	0	540	WW
02WW360-6	6	LLWTF underslab piping drains	LLWTF Sump	0	0	80	WW
02WW362-6	6	LLWTF underslab piping drains	LLWTF Sump	0	0	40	WW
02WW363-8	8	Sump Manhole, LLWTF	Lagoon 1	0	0	167	WW
02WW364-3	3	LLWTF underslab piping drains	Lagoon 2	0	0	150	WW
15WW533-6	6	Neutralization Pit	Interceptor	0	0	10	WW
15WW534-6	6	Neutralization Pit	New Interceptor thru West Valve Pit	0	0	120	WW
15WW536-2	2	West Valve Pit	New Interceptor A	0	0	30	WW
15WW538-4	4	Interceptor B thru E Valve Pit	Lagoon 2 thru new 15WW549-4	0	0	35	WW
15WW539-4	4	New Interceptor A	E Valve Pit	0	0	10	WW
15WW549-4	4	East of Interceptor	Lagoon 1	0	0	200	WW

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
15WW567-2	2	Tank 7D-13	Interceptor thru 15WW568-2	80	0	0	WW
15WW568-2	2	Tank 7D-13	Interceptor thru 15WW569-6	50	0	0	WW
15WW569-6	6	Trunk Line S side Process Bldg	Interceptor thru 15WW533-6	100	0	110	WW
15WW570-4	4	N side Process Bldg / FRS	Interceptor thru 15WW571-6	0	0	200	WW
15WW571-6	6	FRS Cask Decon Drains	Interceptor thru 15WW843-6	60	0	13	CD Pit
15WW841-4	4	N Side of MSM Repair	Interceptor thru 15WW852-3	12	0	25	WW
15WW842-3	3	E Side of MSM Repair	Interceptor thru 15WW570-4	19	0	15	WW
15WW843-6	6	Trunk Line East of Process Bldg	Interceptor thru 15WW569-6	72	0	120	WW
15WW846-3	3	Under Lower Warm Aisle	Interceptor thru 15WW569-6	5	0	0	WW
15WW847-3	3	Under Lower Warm Aisle	Interceptor thru 15WW569-6	5	0	0	WW
15WW848-3	3	Trunk line, upper floors South side Process Bldg	Interceptor thru 15WW569-6	5	0	0	WW
15WW850-4	4	Under Floor RAM Equipment Room	Interceptor thru 15WW843-6	16	0	0	WW
15WW851-3	3	Under Floor CPC	Interceptor thru 15WW895-4	80	0	0	WW
15WW852-3	3	Equipment Decon Room	Interceptor thru 15WW570-4	13.3	0	55	WW
15WW857-3	3	Under Floor PMC	Interceptor thru 15WW851-3	45	0	0	WW
15WW858-3	3	Under Floor RAM Equipment Room	Interceptor thru 15WW895-4	6	0	0	WW
15WW859-3	3	Under Floor RAM Equipment Room	Interceptor thru 15WW895-4	20	0	0	WW
15WW860-3	3	Under Floor Cell Access Aisle	Interceptor thru 15WW851-3	16	0	0	WW
15WW861-3	3	Under Floor W Main Op Aisle	Interceptor thru 15WW895-4	25	0	0	WW
15WW863-3	3	Under Floor W Main Op Aisle	Interceptor thru 15WW895-4	6	0	0	WW
15WW885-2	2	Sink Drains	Tank 7D-13	120	0	0	WW
15WW887-2	2	Sink Drains	Tank 7D-13 via 15WW885-2	25	0	0	WW
15WW892-3	3	Scrap Removal Room	Interceptor thru 15WW852-3	10	0	10	WW

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
15WW895-4	4	Under Floor RAM Equipment Room	Interceptor thru 15WW843-6	25	0	0	WW
15WW896-3	3	GOA Sump ejector	Interceptor thru 15WW841-4	3	0	0	WW
15WW899-3	3	Floor PPS	Interceptor thru 15WW843-6	3	0	0	WW
15WW900-3	3	Floor UPC	Interceptor thru 15WW843-6	15	0	0	WW
15WW916-6	6	FRS Resin Wash Pit	Interceptor thru 15WW843-6	5	0	20	WW
15WW917-4	4	Tank 14D-1 and Tank 14D-2	Interceptor thru 15WW920-4	0	0	15	WW
15WW918-4	4	Tank 14D-1 and Tank 14D-2	Interceptor thru 15WW920-4	0	0	15	WW
15WW919-4	4	Tank 14D-1 and Tank 14D-2	Interceptor thru 15WW920-4	0	0	15	WW
15WW920-4	4	Tank 14D-1 and Tank 14D-2	Interceptor thru 15WW569-6	0	0	125	WW
15WW923-6	6	Utility Room Floor Drain	Interceptor thru 15WW569-6	30	0	0	WW
15WW924-4	4	Utility Room Floor Drain	Interceptor thru 15WW569-6	30	0	0	WW
15WW925-6	6	Utility Room Floor Drain	Interceptor thru 15WW569-6	30	0	0	WW
15WW926-2	2	Utility Room Floor Drain	Interceptor thru 15WW569-6	30	0	0	WW
15WW927-4	4	Utility Room Floor Drain	Interceptor thru 15WW569-6	30	0	0	WW
15WW929-3	3	Tank 15D-6	New Interceptor East Valve Pit	0	0	660	WW
15WW1231-3	3	Floor Drain PPS	Interceptor via 15WW569-6	15	0	0	WW
15WW1232-3	3	Floor Drain Acid Rec Pump Room	Interceptor via 15WW569-6	15	0	0	WW
15WW1744-2	3	Laundry Sump	New Interceptor A	0	0	175	WW
6-71-6-001	6	6-50-2-015, 6-71-2-019, 6-71-2-675, 6-50-2-015	Tank 35104	0	0	15	WW
6-71-2-003	2	12CH241	Tank 35104 Pump Suction	0	0	15	WW
6-71-1-006	1	Tank 35104 Pump Discharge	LWTS Evaporator	0	0	40	WW
6-71-3-016	3	Floor Drain in 35104 pump niche	General crane Room extension	0	0	30	WW
6-71-2-019	2	Truck Fill	Tank 35104 via 6-71-6-001	0	0	4	WW
6-71-2-020	2	Tank 7D-13 Eductor 7H-19 via 7P159	PPC manifold via 01/14 & Pipe Chase	0	0	45	WW

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
6-71-2-021	2	Tank 7D-13 Eductor 7H-19 via 7P159	Interceptor via 15WW848	0	0	25	WW
6-71-4-022	4	CSS Drain Header	Tank 7D-13	0	0	70	WW
6-71-2-023	2	Tank 35104 Pump Discharge	6-50-2-153, return to STS	0	0	10	WW
6-71-2-031	2	Drain from 7D-13 valve pit	Tank 7D-13 via 6-71-4-022	0	0	15	WW
6-71-2-032	0.5	Tank 35104 Pump Discharge	35104 Sample Station GPC-CR Lower Air lock	0	0	50	WW
6-71-2-675	0.5	35104 Sample Station GPC-CR Lower Air lock	35104 Waste Catch tank via 6-71-6-001	0	0	50	WW
12CH240-6	6	Drains	Tank 35104	0	0	30	WW
12CH241-3	3	Tank 35104 Eductor	Tank 7D-2 LWC or Tank 35104 Pump Suction	0	0	20	WW
12CH365-1/8	0.125	35104 Pit	Cut and Capped 18"below grade	0	0	10	WW
12CH366-2	0.5	35104 Pit	Cut and Capped 18"below grade	0	0	10	WW
12CH367-1	1	35104 Pit	Cut and Capped 18"below grade	0	0	10	WW
undesignated	2	Tank 15D-6	MSM Valve Pit	0	0	150	Tank 5D-6
undesignated	2	MSM Shop 2 Floor Drains	Tank 15D-6	50	0	50	Tank 15D-6
Leachate Line	2	NDA Hardstand	LLWTF Lagoon 2	0	0	2,000	n/a

LEGEND: Tanks referred to are located within the Process Building, except 15D-6 that is an underground tank located northeast of the Process Building. CCR is the Chemical Process Cell Crane Room. CD Pit is the Cask Decon Pit. CPC is the Chemical Process Cell. CSS is the Cement Solidification System. EDR is the Equipment Decontamination Room. FRS is Fuel Receiving and Storage. GOA is General Purpose Cell Operating Aisle. GP is General Purpose. GPC is General Purpose Cell. GPC-CR is the General Purpose Cell Crane Room. LWC is the Liquid Waste Cell. LWTS is the Liquid Waste Treatment System. MSM is Master-Slave Manipulator. OGC is the Off-Gas Cell. PMCR is the Process Mechanical Cell Crane Room. PPC is the Product Purification Cell. SRR is the Scrap Removal Room. STS is the Supernatant Treatment System. WW is wastewater.

2.0 Lines Beneath the Process Building

Review of drawings and process history established that 57 pipelines or portions of pipelines located beneath the Process Building, Utility Room, or Utility Room Expansion carried radioactive liquid. These include:

- Eleven process drains,
- Two waste transfer lines,

- Eleven Fuel Receiving and Storage Area cask decon lines,
- Thirty-three wastewater drains.

There were 11 lines under the Process Building that were designed to carry radioactive fluids, but were spares that were never used as designed. Their inventory is considered negligible (zero).

Figure F-1 shows the lines that were estimated to contribute more than 98 percent of the total activity in the lines beneath the Process Building. The lines in each category and the estimated source terms are described below.

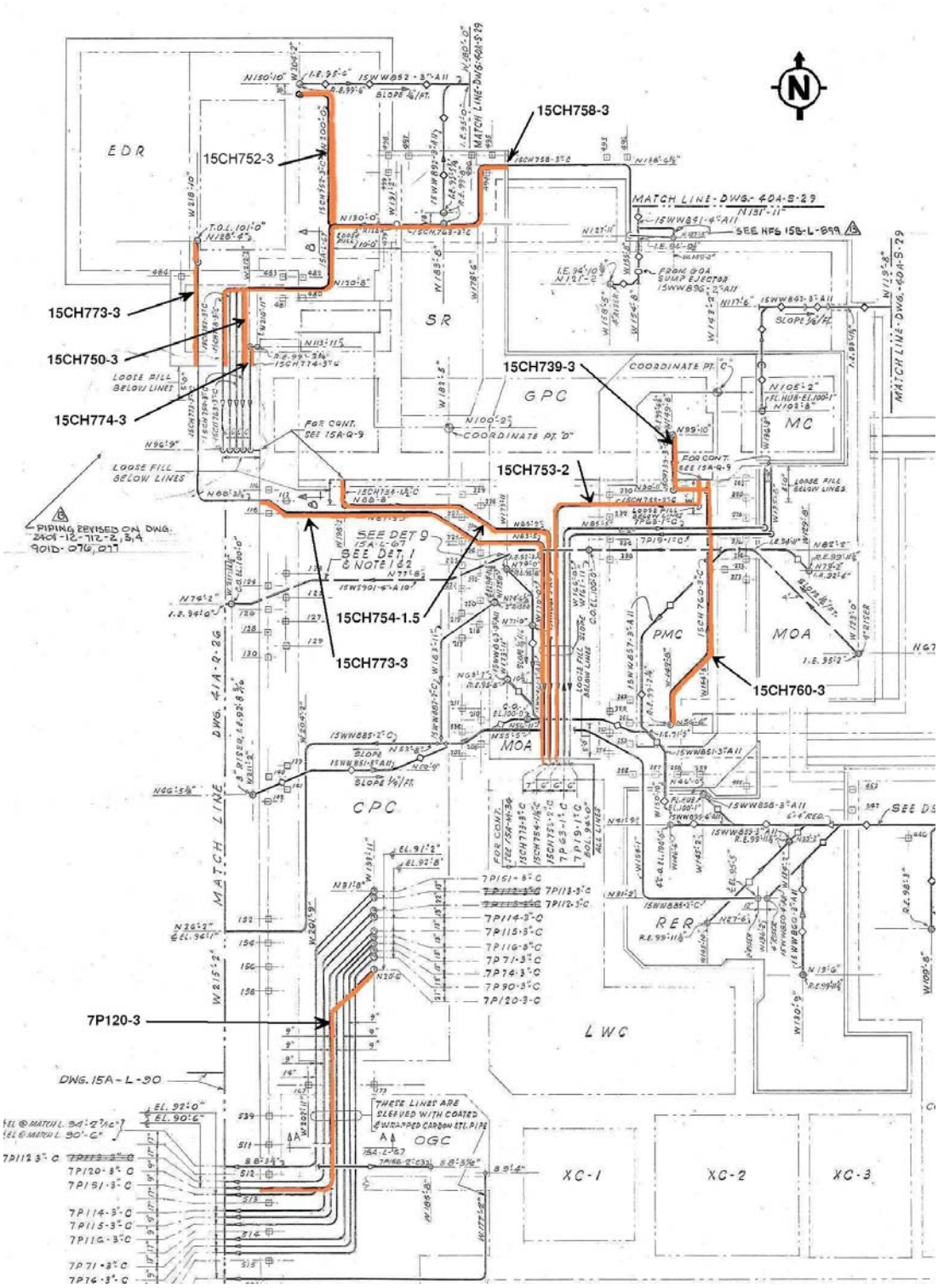

Figure F-1. Location of Pipelines Beneath the Process Building. (Marked lines are estimated to contain more than 98 percent of the activity in piping under the building.)

2.1 Process Drain Lines

All 11 lines are stainless steel pipe designated for chemical service. Eight are three-inch, two are two-inch, and the other is 1.5-inch in diameter. Each line is encased in an outer carbon steel pipe providing double containment. They are located in side-by-side runs within earth fill beneath the Process Building's reinforced concrete floor slabs.

The lines run typically about 10 feet below grade (reference elevation approximately 90 feet) and are sloped downward in the direction of flow, typically about 0.25 inch per foot. Table F-2 shows conservative estimates of the total activity within all 11 lines.

Table F-2. Estimated Process Drain Line Activity in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Am-241	7.5E-02	Np-237	3.7E-05	Tc-99	3.9E-04
C-14	1.3E-04	Pu-238	1.8E-02	U-232	4.4E-05
Cm-243	7.8E-05	Pu-239	1.7E-02	U-233	4.2E-05
Cm-244	1.8E-03	Pu-240	1.1E-02	U-234	1.6E-05
Cs-137	8.0E-01	Pu-241	2.6E-01	U-235	6.8E-05
I-129	2.0E-06	Sr-90	4.6E-01	U-238	2.0E-05

2.2 Waste Transfer Lines

Both lines are three-inch stainless steel pipe; each is encased within an outer six-inch carbon steel pipe. These lines run approximately 10 feet below grade within a concrete pipe trench. The lines are sloped downward in the direction of flow, about 0.25 inch per foot. Estimated activity in the lines is shown in Table D-3 below.

Line 7P120-3 contains much more radioactivity than the other line, 7P113-3. Line 7P120-3, which runs from the Chemical Process Cell to HLW Tank 8D-4, was used by NFS to transfer THOREX process waste during one fuel reprocessing campaign. Line 7P113-3 was used by NFS to transfer PUREX process wastes to Tank 8D-2; this line was flushed with decontamination solutions and with lower level waste solutions after reprocessing operations ended. Table F-3 shows conservative estimates of the total activity within both lines.

Table F-3. Estimated Waste Transfer Line Activity in Curies (as of 2011)

Nuclide/Line	7P113-3	7P120-3	Nuclide/Line	7P113-3	7P120-3
Am-241	1.1E-05	1.0E-02	Pu-240	1.3E-06	3.3E-04
C-14	1.9E-07	5.4E-06	Pu-241	1.7E-05	1.1E-02
Cm-243	3.8E-08	5.3E-06	Sr-90	2.9E-04	1.0E+01
Cm-244	8.9E-07	2.2E-04	Tc-99	2.2E-07	4.3E-03
Cs-137	3.6E-03	1.1E+01	U-232	3.6E-08	8.9E-05

Table F-3. Estimated Waste Transfer Line Activity in Curies (as of 2011)

Nuclide/Line	7P113-3	7P120-3	Nuclide/Line	7P113-3	7P120-3
I-129	1.6E-07	7.4E-06	U-233	1.6E-08	8.7E-05
Np-237	9.9E-09	1.3E-05	U-234	7.9E-09	9.1E-05
Pu-238	2.4E-06	1.6E-02	U-235	6.3E-11	2.1E-07
Pu-239	1.7E-06	6.4E-04	U-238	8.0E-10	2.9E-09

2.3 Cask Decon Lines

Nine lines are four inches in diameter and are associated with floor drains for the Fuel Receiving and Storage Building; these lines connect to the six-inch trunk line (15WW571-6). Line 1P64-1, a one-inch discharge line running toward the Low-Level Waste Treatment Facility (LLWTF) Interceptor, is also grouped with the cask decon lines.

The estimated activity in these lines, based on the assumption that their average interior surface contamination is similar to that remaining on the floor of the Cask Decon Pit, is shown in Table F-4.

Table F-4. Estimated Cask Decon Line Activity in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Am-241	1.9E-02	Np-237	2.3E-06	Tc-99	5.2E-05
C-14	2.5E-05	Pu-238	2.8E-03	U-232	2.9E-06
Cm-243	7.4E-06	Pu-239	5.4E-03	U-233	6.9E-06
Cm-244	1.5E-04	Pu-240	2.8E-03	U-234	5.9E-07
Cs-137	1.3E-01	Pu-241	7.6E-02	U-235	8.4E-07
I-129	1.2E-07	Sr-90	1.2E-01	U-238	7.1E-06

2.4 Wastewater Drain Lines

These lines deliver low-level or uncontaminated wash water and spills from various drains in the Process Building to the LLWTF Interceptor. This piping is made of Duriron, a high silicone cast iron, in diameters ranging from two-inch to six-inch. Beneath the Process Building, the runs are encased within concrete of 12-inch-square cross section. They are located eight to 12 feet below grade, sloping about 0.25 inch per foot.

The estimated activity in these lines was based on an empirical relationship between the residual contamination and the radioactivity in the fluid carried by the lines observed in HLW lines. (This relationship is based on WVDP experience with residual contamination measured in other piping where the activity of the liquid that passed through the piping was known.) The LLWTF Interceptor operating limit (0.005 µCi/mL) was used in the calculations for conservatism; many discharges though the lines likely had radioactivity concentrations well below this value. The use of the bounding spent nuclear fuel distribution as the surrogate for the waste water also

provides a level of conservatism by assigning the maximum radionuclide ratio observed in any spent fuel batch to the residual in the waste water pipes. The total estimated activity in all the lines is shown in Table F-5.

Table F-5. Estimated Wastewater Drain Line Activity in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Am-241	2.1E-06	Np-237	1.3E-09	Tc-99	5.6E-09
C-14	3.2E-11	Pu-238	2.3E-07	U-232	5.8E-10
Cm-243	1.2E-08	Pu-239	7.2E-08	U-233	2.4E-10
Cm-244	2.6E-07	Pu-240	5.2E-08	U-234	9.7E-11
Cs-137	1.4E-04	Pu-241	1.1E-06	U-235	2.5E-12
I-129	2.6E-14	Sr-90	1.3E-04	U-238	2.3E-11

2.5 Total Estimated Inventory in Lines Beneath the Process Building Footprint

As shown in Table F-6 the total estimated residual inventory for all the combined lines beneath the Process Building footprint is approximately 23 Ci, predominantly Sr-90 and Cs-137 activity. The table indicates that Line 7P120-3 and the process drain lines have over 95 percent of the Cs-137 and Sr-90 activity under the Process Building, as well as 71-98 percent of the Pu and U isotopes.

Table F-6. Estimated Total Residual Inventory in Lines Under the Process Building (as of 2011)

Nuclide	Residual Inventory (Ci)			Contribution to Total	
	Total All Lines	Process Drains	Line 7P120-3	Line 7P120-3	Line 7P120-3 and Process Drains
Am-241	1.0E-01	7.5E-02	1.0E-02	10.0%	85.0%
C-14	1.6E-04	1.3E-04	5.4E-06	3.4%	84.6%
Cm-243	9.1E-05	7.8E-05	5.3E-06	5.8%	91.5%
Cm-244	2.2E-03	1.8E-03	2.2E-04	10.0%	91.8%
Cs-137	1.2E+01	8.0E-01	1.1E+01	91.7%	98.3%
I-129	9.7E-06	2.0E-06	7.4E-06	76.3%	96.9%
Np-237	5.2E-05	3.7E-05	1.3E-05	25.0%	96.2%
Pu-238	3.7E-02	1.8E-02	1.6E-02	43.2%	91.9%
Pu-239	2.3E-02	1.7E-02	6.4E-04	2.8%	76.7%
Pu-240	1.4E-02	1.1E-02	3.3E-04	2.4%	80.9%

Table F-6. Estimated Total Residual Inventory in Lines Under the Process Building (as of 2011)

Nuclide	Residual Inventory (Ci)			Contribution to Total	
	Total All Lines	Process Drains	Line 7P120-3	Line 7P120-3	Line 7P120-3 and Process Drains
Pu-241	3.5E-01	2.6E-01	1.1E-02	3.1%	77.4%
Sr-90	1.1E+01	4.6E-01	1.0E+01	90.9%	95.1%
Tc-99	4.7E-03	3.9E-04	4.3E-03	91.5%	99.8%
U-232	1.4E-04	4.4E-05	8.9E-05	63.6%	95.0%
U-233	1.4E-04	4.2E-05	8.7E-05	62.1%	92.1%
U-234	1.1E-04	1.6E-05	9.1E-05	82.7%	97.3%
U-235	6.9E-05	6.8E-05	2.1E-07	0.3%	98.9%
U-238	2.8E-05	2.0E-05	2.9E-09	0.0%	71.4%

3.0 Lines West of the Process Building

The lines west of the Process Building identified in Table F-1 include:

- Four ventilation lines;
- Three waste transfer lines, two of which were used; and
- Twenty-four other lines that carried wastewater or ventilation condensate.

3.1 Lines of Interest

Ventilation Lines

The ventilation lines are:

- 8P29-16, a 16-inch header line that runs from the Permanent Ventilation System to the Equipment Shelter
- 8P34-2, an abandoned and capped two-inch ventilation condensate line from Tank 8D-2,
- 7P170-2, an abandoned and capped two-inch ventilation condensate line from Tank 8D-1, and
- 8P46-6 (old and new), two six-inch lines that connect the Equipment Shelter to the Main Plant Stack.

Waste Transfer Lines

The two waste transfer lines of interest are the downstream ends of those discussed in Section 2.2, 7P120-3 and 7P113-3.

Other Lines West of the Process Building

The other 24 lines of interest shown in Table F-1 carried process drain fluids, wastewater, and ventilation condensate.

3.2 Estimated Inventory in Lines West of the Process Building

The estimated total inventory of the 31 underground lines west of the Process Building is shown in Table F-7. The total length of all of these lines together is approximately 4,176 feet. The total interior surface area is approximately 3.47E+06 cm^2.

Table F-7. Estimated Total Residual Inventory of Lines West of the Process Building in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Am-241	8.3E-02	Np-237	1.0E-04	Tc-99	3.4E-02
C-14	4.6E-05	Pu-238	1.3E-01	U-232	7.1E-04
Cm-243	4.4E-05	Pu-239	5.2E-03	U-233	6.9E-04
Cm-244	1.8E-03	Pu-240	2.7E-03	U-234	7.2E-04
Cs-137	8.5E+01	Pu-241	8.6E-02	U-235	1.8E-06
I-129	6.0E-05	Sr-90	8.1E+01	U-238	1.0E-06

4.0 Lines East of the Process Building

4.1 Lines of Interest

Table F-1 identifies 47 lines east of the Process Building. Most deliver low-level radioactive or uncontaminated wastewater, wash water, or liquid from spills from various drains throughout the Process Building to the Interceptor in WMA 2. From the Interceptor, the water can be sampled, diverted to storage tanks, sent to the LLWTF for treatment, or released to the lagoon system through other lines identified in the table. Other lines in WMA 2 connect various tanks with the LLWTF and the LLWTF to the lagoons. From the lagoons, waters can be discharged to surface streams on the Center.

Various underground lines were realigned from Lagoon 1 to Lagoon 2 and from Lagoon 2 to Lagoon 3 in 1984 when Lagoon 1 was removed from service. At that time, Lagoon 2 became the initial receiving lagoon for the LLWTF. Originally, water treatment was performed in the O2 Building, but it was replaced by the LLWTF. The New Interceptors (A and B) were installed in 1967 to replace the single Old Interceptor.

4.2 Estimated Inventory in Lines East of the Process Building

The estimated total inventory of the 47 underground lines east of the Process Building is shown in Table F-8. The total length of all of these lines together is approximately 4,559 feet. The total interior surface area is approximately 3.40 E+06 cm^2.

Table F-8. Estimated Total Residual Inventory of Lines East of the Process Building in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Am-241	1.3E-02	Np-237	1.5E-06	Tc-99	3.4E-05
C-14	1.6E-05	Pu-238	1.9E-03	U-232	1.9E-06
Cm-243	4.9E-06	Pu-239	3.6E-03	U-233	4.6E-06
Cm-244	9.9E-05	Pu-240	1.9E-03	U-234	3.9E-07
Cs-137	8.5E-02	Pu-241	5.0E-02	U-235	5.6E-07
I-129	7.9E-08	Sr-90	7.9E-02	U-238	4.7E-06

5.0 Leachate Transfer Line

5.1 Description

The Leachate Transfer Line is a buried two-inch polyvinylchloride pipe that originates on the south plateau at the NDA and continues northward across WMA 6 to Lagoon 2 in WMA 2. The line was laid within a five-inch sand layer at the base of a 36-inch wide trench located five feet below the surface.

The line was originally used to transfer fluids originating from the SDA Lagoons to Lagoon 1 in the LLWTF via a pumphouse adjacent to the NDA hardstand. More recently, it has been used to transfer groundwater from the NDA interceptor trench to Lagoon 2. The total length of the line is approximately 2,000 feet. The location of the Leachate Transfer Line is shown on Drawing 40C-S-1057, on which Figure F-2 is based.

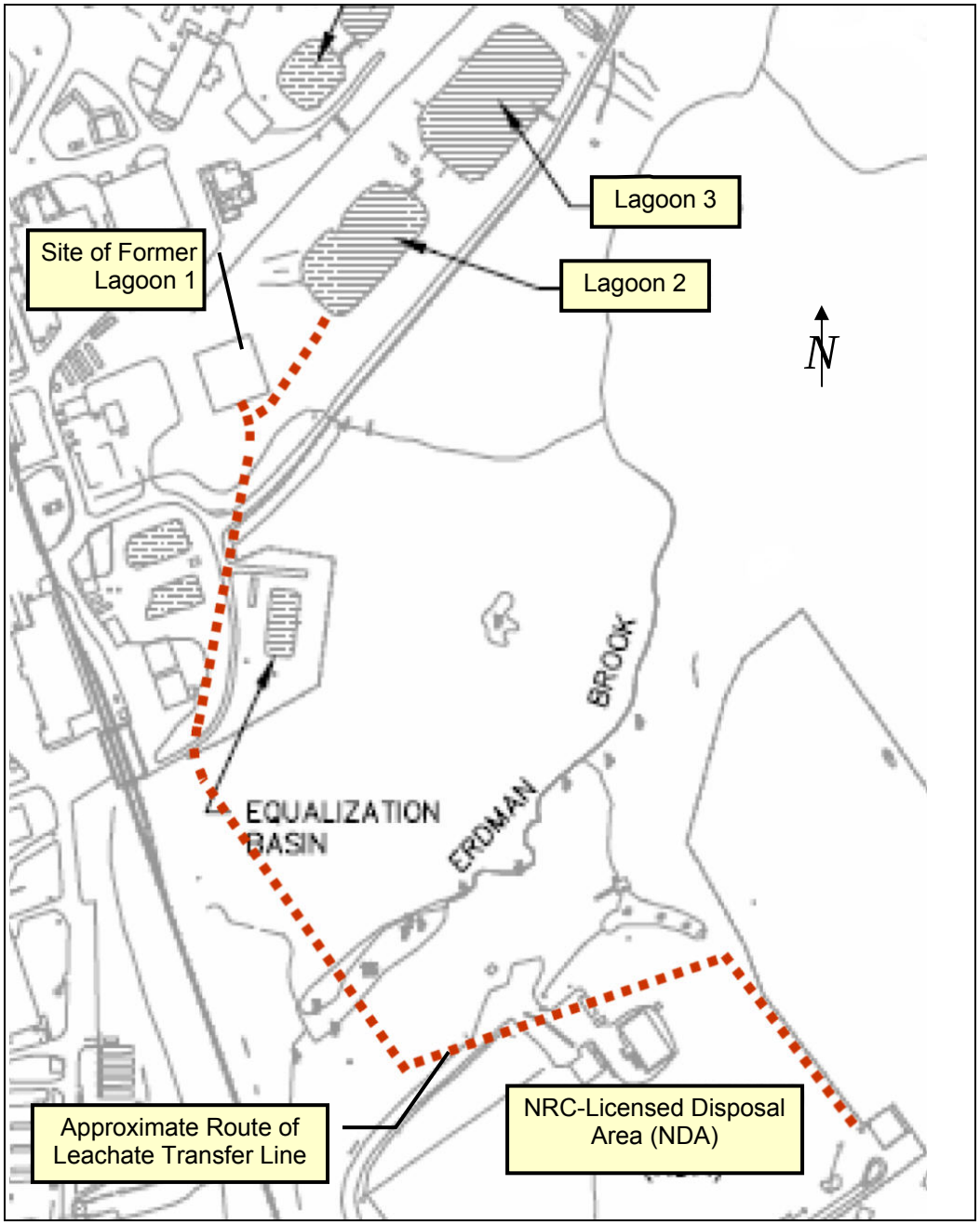

Figure F-2. Leachate Transfer Line Routing From NDA to Lagoon 1 (based on drawing 40C-S-1057)

5.2 Fluids Conveyed by the Line

The use of the Leachate Transfer Line to convey burial trench leachate is described in the RCRA Facility Investigation Report for the NYSERDA-maintained portions of the Center (NYSERDA 1994).

In March 1975 leachate levels in Trenches 4 and 5 of the SDA[1] reached the ground surface and seeped through the earthen covers. NFS began a permitted operation to pump, treat and dispose of leachate[2] from the burial trenches. From 1975 through 1981 NFS pumped over 2,850,000 gals of fluid through the Leachate Transfer Line to Lagoon 1 in WMA 2 for treatment in the LLWTF and eventual discharge to Erdman Brook. Typically, concentrations of radionuclides were in the range of 1 E-03 to 1 E-06 µCi/mL, although in the case of tritium (H-3), concentrations up to ~4 µCi/mL were observed. Before transfer to Lagoon 1 the leachate was chlorinated to destroy biological matter and then treated to reduce water hardness and to precipitate some of the radionuclides. A list of SDA trench-pumping events and volumes is provided in Luckett, et al. 2004. Activity concentrations of radionuclides detected in the leachate are also provided in Luckett, et al. 2004.

The NDA interceptor trench was installed in 1991 on the northeast and northwest boundaries of the NDA to intercept and collect potentially contaminated groundwater migrating from the NDA. The base of the trench extends to a minimum of one foot below the interface of the weathered till with the unweathered till. The trench is drained by a drainpipe that directs accumulated water to a collection sump.

Liquid that collects in the sump is routinely sampled, analyzed, and transferred through the Leachate Transfer Line to Lagoon 2 in WMA 2 for treatment and release. Since its installation, over 3,000,000 gallons of intercepted groundwater have been pumped through the Leachate Transfer Line. Details of fluid volumes pumped through the Leachate Transfer Line from the interceptor trench during the period 1991-2003 are provided in Luckett, et al. 2004.

The NDA interceptor trench is sampled as part of the WVDP environmental monitoring program. Radionuclides detected in samples of the fluid are typically in the range of 1 E-07 to 1 E-10 µCi/mL with two exceptions: Tritium (H-3) is observed in the range of 1 E-05 µCi/mL and uranium, attributed to naturally occurring materials, is observed in the range of 3E-03 µg/mL. A summary of radionuclides detected and their concentrations in the samples of the fluid during the period 1993-2003 are provided in Luckett, et al. 2004

5.3 Estimate of Activity Inventory in Leachate Transfer Line

Based on the design, operating history, and radioactivity analyses of fluids conveyed by the line, residual activity remaining in the line is insignificant to the performance assessment. Among the factors which led to this conclusion:

- The line is made of plastic designed to be non-reactive with water-based fluids.
- The leachates were dilute fluids, which had been treated with a precipitant; there would have been little material in solution to plate out or deposit in the pipe.

[1] The term “leachate” is used here as a general term for water that has accumulated in a disposal trench and leached constituents from the materials disposed of in the trench. The use of the term does not imply that the water and the associated leached constituents constitute a regulated “leachate” as defined under RCRA or other regulatory regimes.

- The leachate had been chlorinated; there would have been little opportunity for flora or scum to grow in the pipe and filter or trap radioactive materials conveyed in the fluids.
- The major activity in the leachate was tritium which passed through the pipe with the fluid.
- Since the leachate was conveyed in the pipe, the pipe has been flushed with over 2,600,000 gallons of groundwater that is essentially free of radionuclides.
- Measured radionuclide concentrations are detectable only with the most sensitive analysis and are well below the regulatory limits for the LLWTF inflow waters of 5.0E-03 µCi/ml.
- The total uranium observed is typical of uranium occurring naturally in groundwater, and is well below the EPA drinking water standard of 30 µg/L (or 3.0 E-02 µg/mL) for uranium, as specified in Title 10 CFR 40, Part 141.55.

6.0 References

Luckett, et al. 2004, *Radioisotope Inventory Report for Underground Lines and Low Level Waste Tanks at the West Valley Demonstration Project*, WSMS-WVNS-04-0001, Revision 0. Luckett, L., J. Fazio, and S. Marschke, Washington Safety Management Solutions, Aiken, South Carolina, July 6, 2004.

NYSERDA 1994, *RCRA Facility Investigation for NYSERDA-Maintained Portions of the Western New York Nuclear Services Center*, NYSERDA, West Valley, New York, December 1994.