ENGINEERING CHANGE NOTICE

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14a. Justification (mark one)

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SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
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21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. T.J. Kunthara	Jim G Field for	3/12/97	PE		
Cog. Mgr. K.M. Hall	Kathleen M. Hall	3/12/97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other R.J. Cash	R.J. Cash	3-14-97	Other		
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			ADDITIONAL		

Tank Characterization Report for Single-Shell Tank 241-B-110

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U.S. Department of Energy Contract DE-AC06-96RL13200

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Abstract: This document summarizes the information on the historical uses, present status, and the sampling and anlysis results of waste stored in Tank 241-B-110. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.

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Tank Characterization Report for Single-Shell Tank 241-B-110

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LIST OF TERMS

2C1	second cycle decontamination waste from 1944 to 1949
2C2	second cycle decontamination waste from 1950 to 1956
ANOVA	analysis of variance
ASTM	American Society for Testing and Materials
B	waste from PUREX acidified waste processed for Sr extraction
BL	B Plant low-level waste
Btu/hr	British thermal units per hour
Ci	curies
Ci/L	curies per liter
cm	centimeter
CSR	waste from cesium recovery from supernates
CVAA	cold vapor atomic absorption
DQO	data quality objective
DSC	differential scanning calorimetry
DW	decontamination waste
EB	evaporator bottoms
FP	fission product waste
ft	feet
g	gram
g/L	grams per liter
g/mL	grams per milliliter
GFAA	graphite furnace atomic absorption
GEA	gamma energy analysis
HDW	Hanford defined waste
HTCE	historical tank content estimate
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inch
IX	ion exchange waste
J/g	joules per gram
kg	kilogram
g/L	kilograms per liter
kgal	kilogallon
kL	kiloliter
kW	kilowatt
L	liter
LF	laser fluorimetry
LFL	lower flammability limit
LL	lower limit
LSC	liquid scintillation counting

LIST OF TERMS (Continued)

m	meter
M	moles per liter
MTU	metric ton of uranium
mm	millimeter
n/a	not applicable
ND	not detected
P2	PUREX waste from 1964 to 1967
PF	partitioning factor
ppm	parts per million
PHMC	Project Hanford Management Contract
SORWT	sort on radioactive waste type
RSD	relative standard deviation
SVOA	semivolatile organic analysis
TCR	tank characterization report
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	tank layer model
TOC	total organic carbon
TWRS	Tank Waste Remediation System
UL	upper limit
VOA	volatile organic analysis
W	watt
WSTRS	Waste Status and Transaction Record Summary
WTR	flush water
wt%	weight percent
°C	degrees Celsius
°F	degrees Fahrenheit
μCi/g	microcuries per gram
μCi/gal	microcuries per gallon
μg C/g	micrograms of carbon per gram
μeq/g	microequivalents per gram
μg/g	micrograms per gram

1.0 INTRODUCTION

One major function of the Tank Waste Remediation System (TWRS) is to characterize wastes in support of waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis and other information about a tank are compiled and maintained in a tank characterization report (TCR). This report and its appendixes serve as the TCR for single-shell tank 241-B-110.

The objectives of this report are 1) to use characterization data in response to technical issues associated with tank 241-B-110 waste, and 2) to provide a standard characterization of this waste in terms of a best-basis inventory estimate. Section 2.0 summarizes the response to technical issues, Section 3.0 provides the best-basis inventory estimate, and Section 4.0 makes recommendations regarding safety status and additional sampling needs. The appendixes contain supporting data and information. This report also supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1996), Milestone M-44-05.

1.1 SCOPE

Characterization information in this report originated from sample analyses and historical sources. Although only the results of recent sample events will be used to fulfill the requirements of the data quality objectives (DQOs), other information can be used to support (or question) conclusions derived from these results. Appendix A provides historical information for tank 241-B-110 including surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model.

Table 1-1 lists recent sampling events that are summarized in Appendix B along with the sampling results. Characterization information for tank 241-B-110 is based on results from analyses on core composite samples. Appendix C provides information on the statistical analysis and numerical manipulation of data used in issue resolution. Appendix D contains the evaluation to establish the best basis for the inventory estimate and the statistical analysis performed for this evaluation. Appendix E is a bibliography that resulted from an in-depth literature search of all information sources applicable to tank 241-B-110 and its respective waste types. The reports listed in Appendix E can be found in the Tank Characterization Resource Center.

Table 1-1. Summary of Recent Sampling.

Sample/Data[1]	Phase	Riser No.	Segmentation	Percent Recovery of Segments
Core 1 (8/7/89-8/11/89)	Solid	7	5 segments	Incomplete for segment 1, 100 percent for the rest
Core 2 (8/14/89-8/18/89)	Solid	7	5 segments	Incomplete for segment 1, 100 percent for the rest
Core 3 (8/21/89-8/28/89)	Solid	5	5 segments	Incomplete for segment 1, 100 percent for the rest
Core 4 (9/10/89-9/11/89)	Solid	1	5 segments	Incomplete for segment 1, 100 percent for the rest
Core 9 (11/20/89)	Solid	3	5 segments	Incomplete for segment 1, 100 percent for the rest
Core 10 (11/21/89)	Solid	3	5 segments	Incomplete for segment 1, 100 percent for the rest
Core 18 (4/17/90)	Solid	6	5 segments	Incomplete for segment 1, 100 percent for the rest

Note:

[1]Dates are in the mm/dd/yy format.

1.2 TANK BACKGROUND

Tank 241-B-110 is the first tank in a cascade that includes tanks 241-B-111 and 241-B-112. Tank 241-B-110 went into service in 1945 and received second cycle decontamination waste. In 1950, some supernatant from tank 241-B-110 was cribbed. In 1954, tank 241-B-110 received decontamination waste (DW). In 1954, waste from tank 241-B-105 (which contained evaporator bottoms waste) was transferred to tank 241-B-110. From 1964 to 1967, the tank received PUREX high-level waste (P2). In 1968, the tank received B Plant fission product and waste from tank 241-BY-112. From 1964 to 1968, supernatant was transferred to various tanks. Cesium recovery waste was added in 1969. From 1969 to 1976, the tank received flush water, and supernatant was transferred to various tanks. Salt well liquid was removed from the tank in 1983 and transferred to tank 241-AN-101.

Table 1-2 summarizes a description of tank 241-B-110. Presently the tank holds an estimated 931 kL (246 kgal) of noncomplexed waste (Hanlon 1996). The tank is not on a Watch List (Public Law 101-510).

Table 1-2. Description of Tank 241-B-110.

TANK DESCRIPTION	
Type	Single-shell
Constructed	1943 to 1944
In service	1945
Diameter	22.9 m (75 ft)
Operating depth	5.2 m (17 ft)
Capacity	2,010 kL (530 kgal)
Bottom shape	Dish
Ventilation	Passive
TANK STATUS	
Waste classification	Noncomplexed
Total waste volume[1]	931 kL (246 kgal)
Supernatant volume	4 kL (1 kgal)
Saltcake volume	0 kL (0 kgal)
Sludge volume	927 kL (245 kgal)
Drainable liquid volume	87 kL (23 kgal)
Waste surface level (October 1996)	218 cm (85.5 in.)
Average temperature (May 1975 to present)	23 °C (73.5 °F)
Integrity	Assumed leaker
Watch List	None
SAMPLING DATE	
Core samples	August 1989 through April 1990
Headspace vapor readings	April 1996
SERVICE STATUS	
Declared inactive	1978
Interim stabilized	1984
Intrusion prevention	1985

Note:

[1]Hanlon (1996)

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2.0 RESPONSE TO TECHNICAL ISSUES

The following technical issues have been identified for tank 241-B-110 (Brown et al. 1996). The issues are as follows:

- **Safety Screening:** Does the waste pose or contribute to any recognized potential safety problems?

- **Vapor Screening:** 1) Are there flammable gases in the tank headspace above the 25 percent lower flammability limit (LFL)? 2) Does an organic solvent pool exist in the waste that may cause an organic solvent pool fire or ignition of organic solvents entrained in the waste solid?

In addition to the above issues, tank 241-B-110 was selected (Brown 1996) to be under the scope of Pretreatment (process testing sludge) Studies.

Data from the analysis of seven core samples retrieved in 1989, tank headspace flammability measurements taken in 1996, and historical information provide the means to respond to the safety screening issue.

Procedures used in the 1989 sampling and analyses effort are documented in the *Waste Characterization Plan for the Hanford Site Single-Shell Tanks* (Winters et al. 1990). Because the 1989 sampling of the tank 241-B-110 predated DQOs, a specific tank characterization plan or tank sampling and analysis plan was not prepared.

2.1 SAFETY SCREENING

The *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) documents the requirements for screening waste and headspace in a tank for potential safety problems. These potential safety problems are exothermic conditions in the waste, criticality conditions in the waste, and flammable gases in the tank headspace.

The following sections address these safety problems and examine results from the August 1989 sample analysis of tank 241-B-110 with the current data requirements documented in the safety screening DQO. The safety screening DQO was not in effect during the time tank 241-B-110 was sampled and analyzed (see Appendix B).

2.1.1 Exothermic Conditions (Energetics in the waste)

The first requirement of the safety screening DQO (Dukelow et al. 1995) was to ensure the concentration of exothermic constituents (organic or ferrocyanide) in tank 241-B-110 was too low to cause a safety hazard. The current safety screening DQO requires that the waste sample profile be tested for energetics every half segment (24 cm or 9.5 in.) to determine whether the energetics exceed the safety threshold limit. The threshold limit for energetics is 480 J/g of sample on a dry weight basis.

No exothermic reactions were observed in any composite samples during the differential scanning calorimetry (DSC) analyses. However, because the current safety screening DQO was not in effect when tank 241-B-110 samples were analyzed, the samples were not analyzed for energetics in half segments.

Samples from the first segment were not used in making composite samples because of incomplete recovery of the first segment. No separate DSC analyses were done in first segments.

2.1.2 Criticality

Criticality screening is performed by measuring total alpha activity and assuming that all detected alpha is from ^{239}Pu. The safety threshold limit given in the safety screening DQO is 1 gram of ^{239}Pu per liter of waste. Using the bulk density (1.35 g/ml) of waste in tank 241-B-110, 1 g of ^{239}Pu per liter is equal to a total alpha activity of 46 μCi/g. Composites and some segments were analyzed for total alpha activity. Total alpha detected in all samples was well below the threshold limit. From composite analyses, the overall tank mean for total alpha activity was 0.155 μCi/g (equal to 0.0034 g of ^{239}Pu per liter). From segment analyses, the overall tank mean for total alpha activity was 0.160 μCi/g (equal to 0.0035 g of ^{239}Pu per liter). Therefore, criticality is not an issue for this tank.

2.1.3 Flammable Gas

The third potential safety problem in the tank is the presence of flammable gas in the tank headspace. Headspace gas measurements were taken in the field in April 1996. Results indicated no flammable gas was in the headspace (0 percent of the LFL).

2.2 VAPOR SCREENING

The *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution* (Osborne et al. 1994) describes the parameters for collecting data to ensure that appropriate conclusions can be drawn, based on headspace vapor measurements.

2.2.1 Flammable Gas

Flammable gas is the same requirement as safety screening flammable gas requirement (see Section 2.1.3).

2.2.2 Organic Solvents

Other than the April 1996 headspace flammability measurements, no other vapor samples have been collected to measure the organic solvents in the vapor. Vapor samples are currently scheduled to be taken in 1998 (Stanton 1996).

2.3 PRETREATMENT

Washing and leaching studies (process testing) were performed on samples from tank 241-B-110. A summary of process testing is in Lumetta and Rapko (1994).

2.4 OTHER TECHNICAL ISSUES

A factor in assessing tank safety is the heat generation and temperature of the waste. Heat is generated in the tanks from radioactive decay. An estimate of the heat load based on the 1989 sampling event was 998 watts (3,420 Btu/hr). The heat load estimate based on tank process history was 1,170 watts (4,010 Btu/hr) (Agnew et al. 1996). Both estimates are well below the limit of 11,700 W (40,000 Btu/hr) that separate high- and low-heat load tanks (Smith 1986). An estimate of the heat resulting from major radioactive components in the tank is in Appendix B.

2.5 SUMMARY

The results from the 1989 sample analyses and the headspace gas measurements showed that no primary analyte exceeded safety decision threshold limits. Table 2-1 summarizes the analyses results.

Table 2-1. Results of the 1989 Samples Analyses.

Issue	Sub Issue	Result
Safety screening	Energetics	No exotherm was observed in any composite sample.
	Criticality	All analyses were well below 46 μCi/g total alpha.
	Flammable Gas	Reported 0 percent LFL.
Vapor Screening	Flammability	See safety screening (flammable gas).
	Organic solvents	No samples were taken.
Pretreatment	Process tests performed.	

3.0 BEST-BASIS INVENTORY ESTIMATE

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with waste management activities, as well as regulatory issues. These activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing them into a form is suitable for long-term storage.

Chemical and radiological inventory information are derived using the following approaches: 1) component inventories are estimated using the results of sample analyses, and 2) component inventories are predicted using the Hanford Defined Waste (HDW) model (Agnew et al. 1996b) based on process knowledge and historical information. Not surprisingly, the information derived from these different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for waste management activities. As part of this effort, an evaluation of chemical information for tank 241-B-110 was performed, including the following:

- Data from 1989 core samples
- An inventory estimate generated by the HDW model (Agnew et al. 1996b).

Appendix D provides the details of this evaluation. Based on this evaluation, a best-basis inventory was developed. Tables 3-1 and 3-2 summarize best-basis inventory estimate. The sample-based results were preferred when they were reasonable and consistent with other results. The HDW model was used only where no other data were available.

Table 3-1. Sample-Based Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-B-110 (September 30, 1996).

Analyte	Total Inventory (kg)[1]	Basis (S, M, or E)[2]
Al	1,420	S
Bi	23,200	S
Ca	1,010	S
Cl	1,540	S
TIC as CO_3	5,630	S
Cr	1,010	S
F	2,370	S
Fe	22,600	S
K	390	S
La	39.8	S
Mn	83.6	S
Na	122,000	S
Ni	23.3	S
NO_2	12,900	S
NO_3	234,000	S
Pb	661	S
P as PO_4	61,600	S
Si	11,700	S
S as SO_4	14,400	S
Sr	264	S
TOC	477	S
U_{TOTAL}	260	S
Zr	7.82	S

Notes:

[1]Based on concentration estimates from the 1989 core sample analyses (see Appendix B)

[2]S = Sample-based, M = HDW model-based, E = Engineering assessment-based

Table 3-2. Sample Based Best Basis Inventory Estimate for Radioactive Components in Tank 241-B-110 (September 30, 1996).

Analyte	Total Inventory[1] (Ci)	Basis (S, M, or E)[2]
^{90}Sr	136,000	S
^{99}Tc	20.7	S
^{129}I	0.045	S
^{137}Cs	18,600	S
^{237}Np	0.14	S
^{241}Am	90.7	S
$^{243/244}Cm$	1.60	S

Notes:

[1]Based on concentration estimates from the 1989 core sample analyses (see Appendix B)

[2]S = Sample-based, M = HDW, E = Engineering assessment-based

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4.0 RECOMMENDATIONS

An examination of 1989 core samples and 1996 headspace measurements revealed that all constituents associated with potential safety problems (presence of exothermic, criticality, and flammable gas conditions) in tank 214-B-110 were well within the safety notification limits.

Table 4-1 summarizes the status of the Project Hanford Management Contract (PHMC) TWRS Program office review and acceptance of the sampling and analysis results reported in the tank characterization report. Column 1 of Table 4-1 lists all DQO issues required to be addressed by sampling and analysis. Column 2 indicates whether the sampling and analysis meet the requirements of the DQO by a "yes" or a "no." Column 3 indicates concurrence and acceptance by the program in TWRS that is responsible for the DQO that the sampling and analysis activities performed adequately meet the needs of the DQO. A "yes" or "no" in column 3 indicates acceptance or disapproval of the sampling and analysis information presented in the TCR. If the results/information have not yet been reviewed, "N/R" is shown in the column. If the results/information have been reviewed, but acceptance or disapproval has not been decided, "N/D" is shown.

Table 4-1. Acceptance of Tank 214-B-110 Sampling and Analysis.

Issue/Evaluations	Sampling and Analysis Performed	TWRS[1] Program Acceptance
Safety Screening DQO	Yes	Yes
Vapor Screening (Organic Solvents)	No	No
Pretreatment	Yes	N/R

Note:
[1]PHMC Program Office.

Table 4-2 summarizes the status of TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. The evaluation specifically outlined in this report is to determine whether the tank is safe, conditionally safe, or unsafe. Column 1 lists the different evaluations directed by the applicable DQO reports. Columns 2 and 3 are in the same format as Table 4-1. The manner in which concurrence and acceptance are summarized is the same as that in Table 4-1.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-B-110.

Issue	Evaluation Performed	TWRS[1] Program Acceptance
Safety categorization (safe, unsafe or conditionally safe)	Yes	Yes
Vapor screening (organic solvents)	No	No

Note:
[1]PHMC TWRS Program Office

Auger sampling and analyses of the top layer of the waste has been recommended to characterize the visibly different top layer. Partially retrieved first segments during the 1989 sample event were dark brown in color, and second segments changed in color from a dark brown at the top to a lighter brown at the bottom. Analyses showed high beta activity in segment 1, core 2. Total beta for the segment 1, core 2 was 1,441 μCi/g and the rest of the segments were between 10 and 20 μCi/g (Heasler et al. 1993). Vapor screening of the tank headspace is required to meet the analytical needs of the vapor screening DQO and organic solvent issues.

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APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-B-110 based on historical information. For this report, historical information includes information about the fill history, waste types, surveillance, or modeling data about the tank. This information is necessary for providing a balanced assessment of the sampling and analytical results.

This appendix contains the following information:

- **Section A1:** Current status of the tank including the current waste levels and the stabilization and isolation status of the tank.
- **Section A2:** Information about the tank design.
- **Section A3:** Process knowledge about the tank, that is, the waste transfer history and the estimated contents of the tank based on modeling data.
- **Section A4:** Surveillance data including surface-level readings, temperatures, and a description of the waste surface based on photographs.
- **Section A5:** References for Appendix A.

A1.0 CURRENT TANK STATUS

As of September 30, 1996, tank 241-B-110 contained an estimated 931 kL (246 kgal) of noncomplexed waste (Hanlon 1996). The waste volumes were estimated using a manual tape surface-level gauge and photographic evaluation. Table A1-1 shows the volumes of the waste phases found in the tank.

Tank 241-B-110 was in service from 1945 to 1975. In 1981, the tank was declared an assumed leaker. An estimated 37.9 kL (10 kgal) have leaked from the tank. Tank 241-B-110 was interim stabilized in 1984. Intrusion prevention was completed in 1985. The tank is passively ventilated and is not on a Watch List (Public Law 101-510).

Table A1-1. Tank Contents Status Summary.[1]

Waste Type	Volume	
	kL	kgal
Total waste	931	246
Supernate	4	1
Sludge	927	245
Saltcake	0	0
Drainable interstitial liquid	83	22
Drainable liquid remaining	87	23
Pumpable liquid remaining	64	17

Note:
[1]For definition and calculation methods, refer to Hanlon (1996).

A2.0 TANK DESIGN AND BACKGROUND

Tank 241-B-110 was constructed during 1943 and 1944. It is one of twelve 2,010 kL (530 kgal) tanks in B Farm. The tanks were designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F). A typical B Farm tank contains 10 to 12 risers ranging in size from 10 cm (4 in.) to 107 cm (42 in.) in diameter that provide grade-level access to the underground tank. Normally, there is one riser in the center of the tank dome and four or five each on opposite sides of the dome.

Tank 241-B-110 is the first tank in a three-tank cascade series. These tanks are connected by a 7.6 cm (3 in.) cascade line. The bottom center elevation of tank 241-B-110 is 187.4 m (615 ft) above sea level. The tank cascades to tank 241-B-111 with a bottom center elevation at 187.1 m (614 ft), which in turn cascades to tank 241-B-112 with a bottom center elevation at 186.8 m (613 ft). The cascade overflow height is approximately 4.86 m (15.9 ft) from the tank knuckle bottom and 0.62 m (2.04 ft) below the top of the steel liner.

The single-shell tanks are constructed of 30-cm (1-ft)-thick reinforced concrete with a 6.4 mm (0.25 in.) mild carbon steel liner (ASTM A283 Grade C) on the bottom and sides and a 38-cm (1.25-ft)-thick domed concrete top. The tanks have a dished bottom with a 1.2 m (4 ft) radius knuckle and a 5.18 m (17 ft) operating depth. The tanks are set on a reinforced concrete foundation.

A three-ply cotton fabric waterproofing was applied over the foundation and the steel tank. Four coats of primer paint were sprayed on all exposed interior tank surfaces. Tank ceiling domes were covered with three applications of magnesium zincfluorosilicate wash. Lead flashing was used to protect the joint where the steel liner meets the concrete dome. Asbestos gaskets were used to seal the access holes in the tank dome. The tanks were waterproofed on the sides and top with tar and a cement-like mixture. Each tank was covered with approximately 1.8 m (6 ft) of overburden.

The surface level is monitored through riser 5 with a manual tape gauge. Riser 8 contains a thermocouple tree. A salt well screen is located in riser 11. Figure A2-1 shows the riser configuration. Table A2-1 is a list of tank 241-B-110 risers showing their sizes and use.

Figure A2-2 shows a tank cross section showing the approximate waste level and a schematic of the tank equipment. Tank 241-B-110 has 12 risers. Risers 1, 3, 6, and 7 are tentatively available for sampling (Lipnicki 1996). Riser 1 is 10 cm (4 in.) in diameter. Risers 3, 6, and 7 are 30 cm (12 in.) in diameter. If used as sampling ports, these risers would access opposite sides of the tank. Risers 1 and 3 are approximately 135 degrees clockwise from the tank outlet, and risers 6 and 7 are approximately 45 degrees counterclockwise from the outlet.

Tank 241-B-110 has four process inlet nozzles located approximately 5.03 m (16.5 ft) from the tank knuckle bottom. Figure A2-1 shows the locations.

Figure A2-1. Riser Configuration for Tank 241-B-110.

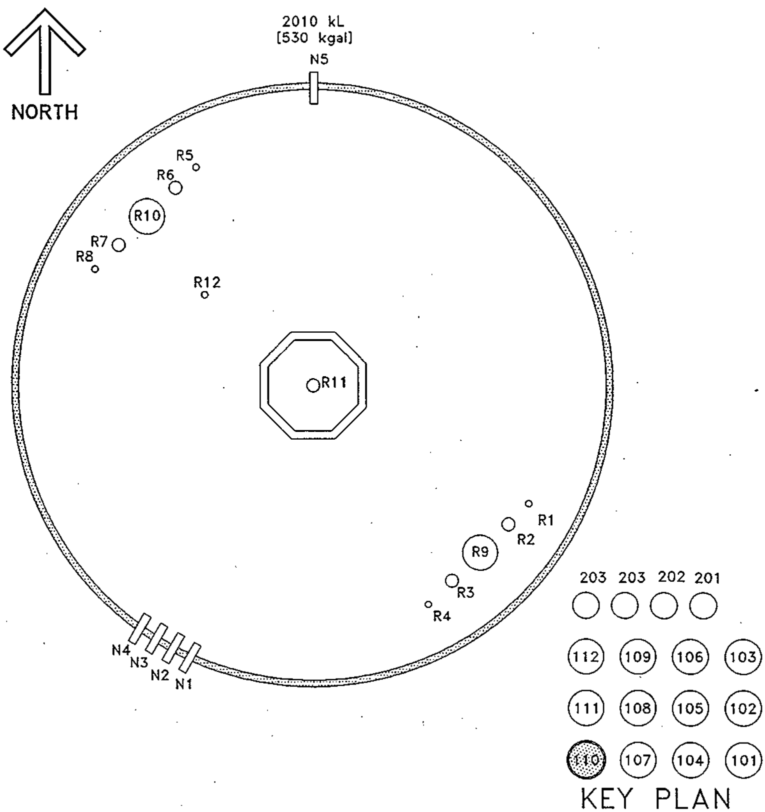


Table A2-1. Tank 241-B-110 Risers and Nozzles.

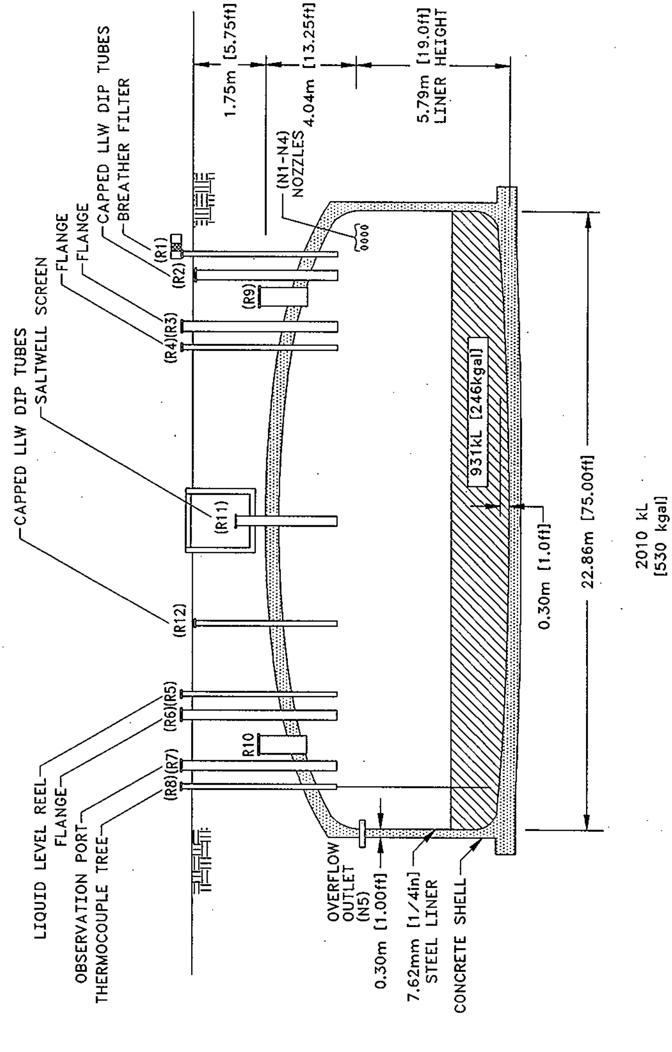
No.	Diameter		Available for Sampling[1]	Description[2,3]
	cm	in.		
R1	10	4	Yes	Breather filter (ECN-614181 September 27, 1995)
R2	30	12	No	Liquid level well dip tubes (capped below grade)
R3	30	12	Yes	Blind flange
R4	10	4	Yes	Flange (benchmark, CE0-37765 December 12, 1986)
R5	10	4	No	Liquid level reel
R6	30	12	Yes	Blind flange
R7	30	12	Yes	Observation port (observation port/air filter, ECN-614181 September 27, 1994)
R8	10	4	No	Thermocouple tree
R9	107	42	No	Manhole (below grade)
R10	107	42	No	Manhole (below grade)
R11	30	12	No	Salt well screen (weather-covered)
R12	10	4	No	Liquid level well dip tubes (capped below grade)
N1	7.6	3	n/a	Nozzle (line V-263, sealed in diversion box 241-B-153)
N2	7.6	3	n/a	Nozzle (line V-262, sealed in diversion box 241-B-153)
N3	7.6	3	n/a	Nozzle (line V-261, sealed in diversion box 241-B-153)
N4	7.6	3	n/a	Spare (capped)
N5	7.6	3	n/a	Overflow outlet nozzle

Notes:

CEO = change engineering order
ECN = engineering change notice
n/a = not applicable

[1]Lipnicki (1996)
[2]Vitro (1986), Alstad (1991) and Tran (1993)
[3]If there was a discrepancy between documents and drawings, the drawings took precedence.

Figure A2-2. Tank 241-B-110 Cross Section and Schematic.



A3.0 PROCESS KNOWLEDGE

The sections below provide information about the transfer history of tank 241-B-110, describe the process wastes that made up the transfers, and give an estimate of the current tank contents based on transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-B-110 (Agnew et al. 1996b). Tank 241-B-110 began receiving waste in the second quarter of 1945 (second cycle waste from the bismuth phosphate process [2C1]). By the end of 1945, tank 241-B-110 was filled and cascaded to tank 241-B-111. Tank 241-B-110 continued to receive 2C1 waste and cascade to tank 241-B-111 until 1950.

In 1950, 1,960 kL (517 kgal) was transferred from tank 241-B-110 to a crib. From 1950 to 1953, tank 241-B-110 received second cycle waste from the bismuth phosphate processes (2C1 from 1945 to 1949 and 2C2 from 1952 to 1956), some of which cascaded to tank 241-B-111. After 1953, the tank 241-B-110 cascade was no longer used.

In 1954, evaporator bottoms waste from tank 241-B-105 was transferred to tank 241-B-110, and supernatant was transferred to a crib. Evaporator bottoms is a slurry product from the evaporators that precipitated as a solid saltcake which was stored in the tanks.

In early 1955, supernatant was pumped from tank 241-B-110 to tank 241-B-108. In late 1955 to 1963, tank 241-B-110 received decontamination waste. In 1963, supernatant from tank 241-B-110 was transferred to tank 241-B-112.

Between 1963 and 1967, tank 241-B-110 received 2,550 kL (674 kgal) of PUREX high-level waste. This waste consisted of fission products with most strontium and cesium removed. During this period, supernatant from tank 241-B-110 was sent to tanks 241-B-112, 241-A-102, or 241-BY-102.

In the first quarter of 1968, waste from B Plant and tank 241-BY-112 was added to tank 241-B-110 and supernatant waste was transferred to tank 241-B-112. In the third quarter of 1969, cesium recovery waste from B-Plant was added to the tank and supernatant waste was transferred to tank 241-B-112. From 1972 to 1975, the tank received flush water waste and supernatant waste was transferred to tank 241-B-102. In 1983, salt well liquid was transferred to tank 241-AN-101.

Table A3-1. Tank 241-B-110 Transfer History.[1,2] (2 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume	
				kL	kgal
B-Plant		Second cycle waste	1945 - 1950	8,656	2,287
	241-B-111	Second cycle waste	1945 - 1950	-5,954	-1,573
	Crib	Supernatant	1950	-1,960	-517
B-Plant		Second cycle waste	1950 - 1953	15,750	4,162
	241-B-111	Second cycle waste	1950 - 1953	-14,490	-3,829
B-Plant		Decontamination waste	1954	273	72
	241-B-112	Supernatant	1954	-273	-72
241-B-105		Supernatant	1954	587	155
	Crib	Supernatant	1954	-587	-155
	241-B-108	Supernatant	1955	-689	-182
B-Plant		Decontamination waste	1955 - 1956	689	182
B-Plant		B-Plant Section 5 waste	1961 - 1963	556	147
	241-B-112	Supernatant	1963	-1,160	-307
PUREX		PUREX high-level waste	1964 - 1967	2,550	674
	241-B-112	Supernatant	1964	-23	-6
	241-A-102	Supernatant	1965 - 1966	-1,310	-346
	241-BY-102	Supernatant	1967	-257	-68
	241-B-112	Supernatant	1967	-579	-153
B-Plant		B-Plant acid waste	1968	511	135
241-BY-112		Concentrated ITS waste	1968	1,180	311
	241-B-112	Supernatant	1968 - 1969	-2,170	-572

Table A3-1. Tank 241-B-110 Transfer History.[1,2] (2 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume	
				kL	kgal
B-Plant		Cesium recovery waste	1969	753	199
		Flush water	1970 - 1974	95	25
	241-B-102	Supernatant	1971 - 1976	-1,190	-315
	241-AN-101	Salt well liquid	1983	-136	-36

Notes:

[1]Agnew et al. (1996b)

[2]The sum of the transfers do not equal the current tank waste volume because several unknown transfers with a net volume addition of 106 kL (28 kgal) are not listed.

A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS

The historical transfer data used for the estimate are from the following sources:

- *Waste Status and Transaction Record Summary for the Southwest Quadrant of the Hanford 200 East Area* (WSTRS) (Agnew et al. 1996b). The WSTRS is a tank-by-tank quarterly summary spreadsheet of waste transactions.

- *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3* (Agnew et al. 1996a). This document contains the Hanford Defined Waste (HDW) list, the Supernatant Mixing Model (SMM), and the Tank Layer Model (TLM).

- Historical Tank Content Estimate (HTCE) for the (Northeast, Northwest, Southeast, Southwest) Quadrant of the Hanford 200 (East or West) Area. This set of four documents compiles and summarizes much of the process history, design, and technical information about the underground waste storage tanks in the 200 Areas.

- Tank Layer Model (TLM). The TLM defines the sludge and saltcake layers in each tank using waste composition and waste transfer information.

- Supernatant Mixing Model (SMM). This is a subroutine within the HDW model that calculates the volume and composition of certain supernatant blends and concentrates.

Using these records, the TLM defines the sludge and saltcake layers in each tank. The SMM uses information from both the WSTRS and the TLM to describe the supernatants and concentrates in each tank. Together the WSTRS, TLM, and SMM determine each tank's inventory estimate. These model predictions are considered estimates that require further evaluation using analytical data.

Based on Agnew et al. (1996a), tank 241-B-110 contains a 541 kL (143 kgal) layer of second cycle (2C1) waste, a 378 kL (100 kgal) layer of second cycle (2C2) waste, a 11 kL (3 kgal) layer of PUREX high-level (P2) waste, and 4 kL (1 kgal) of supernatant. Figure A3-1 is a graph of the waste types and estimated volumes for each tank layer. Table A3-2 shows the historical inventory estimate, including expected waste constituents and their concentrations and quantities.

Figure A3-1. Tank Layer Model.

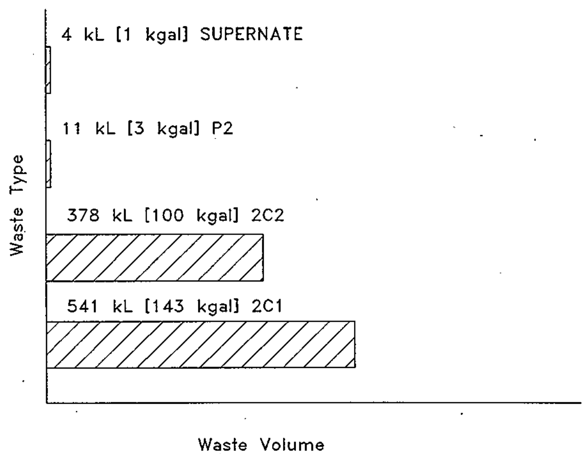


Table A3-2. Tank 241-B-110 Historical Tank Inventory Estimate.[1,2,3] (2 sheets)

Physical Properties			
Total waste	1.12E+06 kg (246 kgal)		
Heat load	1,080 W (3,670 Btu/hr)		
Bulk density[4]	1.20 g/mL		
Water[4]	75.1 wt %		
TOC[4]	0 wt % C (wet)		
Chemical Constituents	*M*	μg/g	kg
Na^+	2.96	56,600	63,400
Al^{3+}	0	0	0
Fe^{3+} (total Fe)	0.681	31,600	35,400
Cr^{3+}	0.00407	176	197
Bi^{3+}	0.0703	12,200	13,700
La^{3+}	0	0	0
Hg^{2+}	0	0	0
Zr (as $ZrO(OH)_2$)	0	0	0
Pb^{2+}	0	0	0
Ni^{2+}	0.00205	100	112
Sr^{2+}	0	0	0
Mn^{4+}	0	0	0
Ca^{2+}	0.199	6,630	7,420
K^+	0.00445	145	162
OH^-	2.09	29,600	33,200
NO_3^-	0.829	42,800	47,900
NO_2^-	0.00891	341	382
CO_3^{2-}	0.199	9,920	11,100
PO_4^{3-}	0.647	51,100	57,200
SO_4^{2-}	0.0345	2,750	3,080
Si (as SiO_3^{2-})	0.0714	1,670	1,870
F^-	0.145	2,280	2,560
Cl^-	0.0205	603	675
$C_6H_5O_7^{3-}$	0	0	0
$EDTA^{3-}$	0	0	0

Table A3-2. Tank 241-B-110 Historical Tank Inventory Estimate.[1, 2, 3] (2 sheets)

Chemical Constituents	*M*	μg/g	kg
$HEDTA^{3-}$	0	0	0
glycolate	0	0	0
acetate	0	0	0
oxalate	0	0	0
DBP	0	0	0
butanol	0	0	0
NH3	0.00295	41.7	46.7
$Fe(CN)_6^{4-}$	0	0	0
Radiological Constituents	**Ci/L**	**μCi/g**	**Ci**
Pu		0.0260	0.485 (kg)
U	0.00220 (*M*)	436 (μg/g)	488 (kg)
Cs	0.00705	5.87	6,560
Sr	0.167	139	1.55E+05

Notes:

[1]Agnew et al. (1996a)

[2]The HTCE prediction has not been validated and should be used with caution.

[3]Unknowns in tank solids inventory are assigned by the Tank Layer Model.

[4]This is the volume average for density, mass average weight percent water, and weight percent TOC.

A4.0 SURVEILLANCE DATA

Tank 241-B-110 surveillance consists of surface-level measurements, temperature monitoring inside the tank (waste and headspace), and leak detection well (dry well) monitoring for radioactivity outside the tank. Surveillance data provide the basis for determining tank integrity.

Liquid-level measurements can indicate whether the tank has a major leak. Solid surface-level measurements indicate physical changes in and consistencies of the solid layers of a tank. Four dry wells, located around the tank perimeter, may be used to monitor radioactivity caused by leaks.

A4.1 SURFACE-LEVEL READINGS

Tank 241-B-110 is categorized as an assumed leaker. A manual tape in riser 5 is used to measure the surface level in the tank. Figure 4-1 is a surface-level history graph. The surface-level plot indicates a steady waste level since 1973, except for a level adjustment in 1982. The most recent surface level was 2.18 m (7.13 ft) in October 1996. Tank 241-B-110 has one liquid observation well and four identified dry wells.

A4.2 INTERNAL TANK TEMPERATURES

Tank 241-B-110 has a single thermocouple tree with 11 thermocouples to monitor the waste temperature through riser 8. Thermocouple elevations are unavailable. Thermocouples 1, 2, 3, and 4 do not operate (Tran 1993).

From May 1975 to the present, the average tank temperature was 23 °C (73.5 °F), the minimum was 13 °C (55 °F), and the maximum was 33 °C (91 °F). Plots of the thermocouple readings can be found in the supporting document for the HTCE (Brevick et al. 1996). Figure A4-2 is a graph of the high temperature in the tank. During 1996, the average tank temperature was 19 °C (66 °F), the maximum was 20 °C (67 °F), and minimum was 17 °C (62 °F).

A4.3 TANK 241-B-110 PHOTOGRAPHS

Photographs inside tank 241-B-110 were taken in March 1988. A photographic montage may be found in Brevick et al. (1996). Because the tank has been inactive since 1975, the photographs should accurately represent the tank interior.

The waste appears to have a crusted surface with colors ranging from brown to red and yellow. Portions of the waste surface are cracked. Miscellaneous equipment is visible in the montage including a temperature probe, salt well screen, and liquid level well.

Figure A4-1. Tank 241-B-110 Level History.

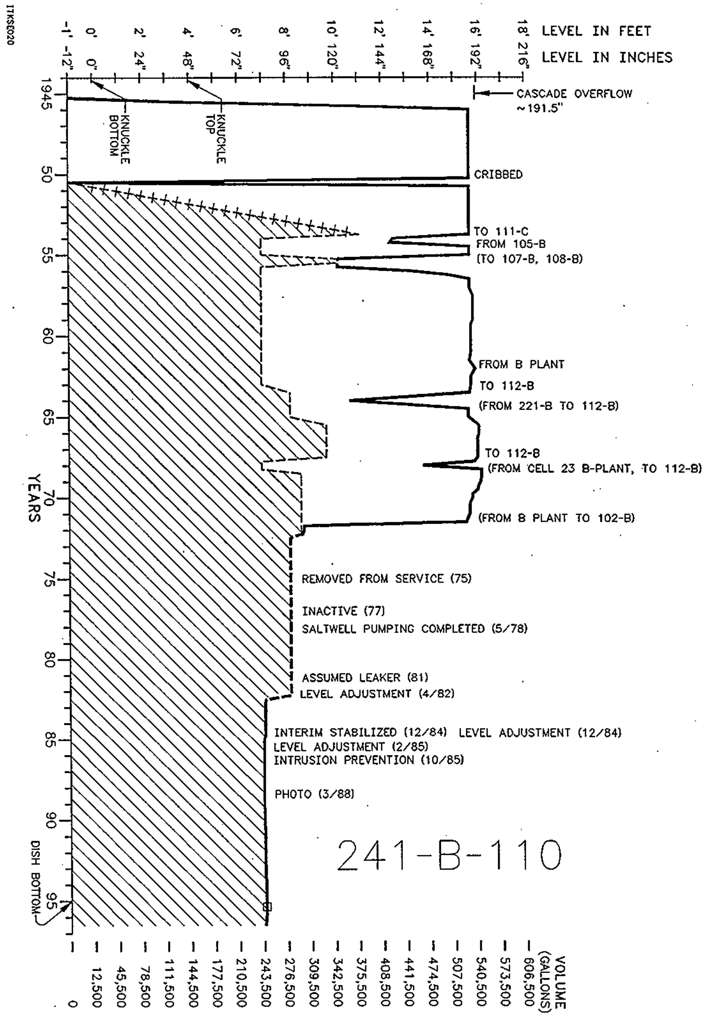
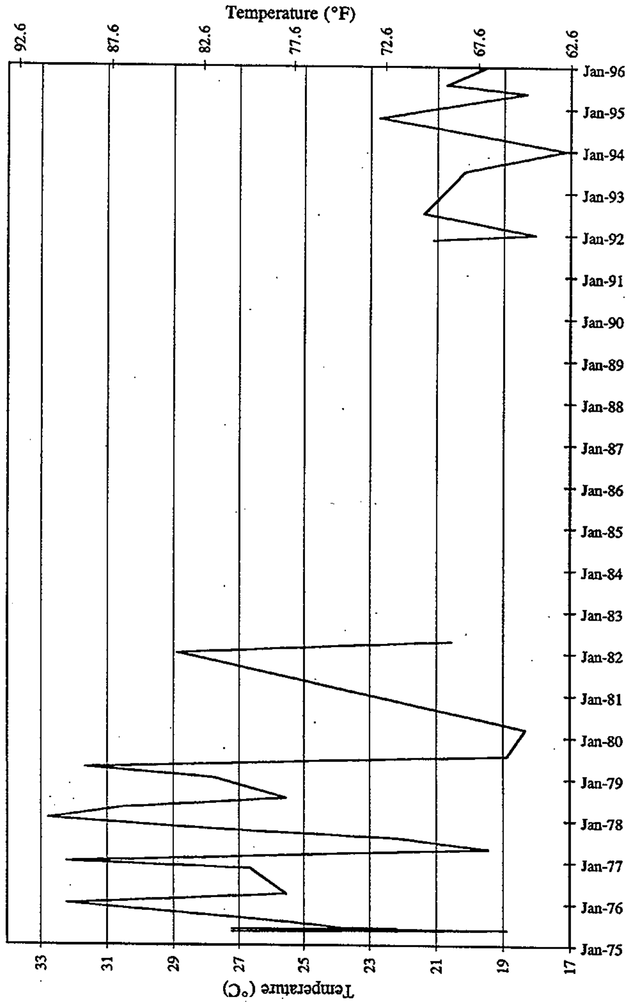


Figure A4-2. Tank 241-B-110 High Temperature Plot.



A5.0 APPENDIX A REFERENCES

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APPENDIX B

SAMPLING OF TANK 241-B-110

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APPENDIX B

SAMPLING OF TANK 241-B-110

Appendix B provides sampling and analysis information for each known sampling event for tank 241-B-110 and provides an assessment of the core sample results.

- **Section B1:** Tank Sampling Overview
- **Section B2:** Analytical Results
- **Section B3:** Assessment of Characterization Results
- **Section B4:** References for Appendix B.

B1.0 TANK SAMPLING OVERVIEW

This section describes the August 1989 through April 1990 sampling and analysis events for tank 241-B-110. The sampling of tank 241-B-110 was part of an in-depth pilot study to determine the adequacy of current chemical analysis and sampling procedures and contains more data than most other tanks being sampled. The major objectives of the analyses included estimating the average concentration of the measured analytes in the tank; estimating the laboratory, sampling, and spatial variability within the tank; evaluating the sampling methodology; and providing a basis for making a leave/retrieve decision about tank 241-B-110 waste. For further discussions about sampling and analysis procedures, refer to the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

B1.1 DESCRIPTION OF SAMPLING EVENT

A total of eight core samples were collected from tank 241-B-110 between August 1989 through April 1990. Seven of eight cores were analyzed; core 11 from riser 3 was collected but not analyzed.

Table B1-1 summarizes sampling and analytical requirements from the safety screening DQO for information only. The safety screening DQO did not exist at the time of the sampling of tank 241-B-110.

Table B1-1. Integrated Data Quality Requirements for Tank 241-B-110.

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
Core sampling	Safety screening	Sample from a minimum of two risers separated radially to the maximum extent possible.	Energetics Moisture content Total alpha
Combustible gas meter reading	Safety screening	Measurement in a minimum of one location within tank headpsace.	Flammable gas concentration

B1.2 SAMPLE HANDLING

The core samples were shipped to the Pacific Northwest National Laboratory 325 Laboratory for analysis. Segment 1 from cores 3 and 9 contained no sample. Segment 1 from cores 1, 4, and 10 had lower than expected sample recovery, insufficient for the full suite of analyses. Although several segments had small amounts of drainable liquid, the amount was insufficient for separate analysis. Table B1-2 summarizes the mass and visual description for each segment. The segments were homogenized and subsampled for analysis, including preparation of core composites.

Table B1-2. Tank 241-B-110 Sample Description.[1] (2 sheets)

Core	Segment	Segment Mass (g)	Percent Recovery	Description
1	1	33	18	Brown sludge that held its shape
	2	315	100	Brown and tan sludge that held its shape
	3	310.87	100	Brown and light tan sludge that held its shape
	4	327.70	100	Light tan sludge that held its shape
	5	326.95	100	Tan and brown sludge that held its shape
2	1	149.10	85	9 to 10 in. of dark-to-light brown sludge that held its shape; less than 5 mL of liquid
2	2	300.30	100	Tan sludge that held its shape; top portion (less than 1 in.) rust colored
	3	314.55	100	Light tan sludge that held its shape
	4	312.80	100	Lan sludge; less than 1 mL free liquid
	5	312.70	100	Lan sludge that held its shape; top portion lighter and creamier, bottom 6 in. granular and broken into chunks
3	1	0.00	0	No sample recovered
	2	318.59	100	Dark chocolate brown and light tan sludge that held its shape
	3	320.12	100	Dark chocolate brown, light gray, and brownish tan sludge
	4	319.72	100	Grayish tan to dark tan sludge that held its shape except for the top three in.
	5	306.73	100	Grayish tan to tan sludge that held its shape except for the bottom 7 in.
4	1	91.78	0	Approximately 20 mL of drainable liquid; half in. piece of brown sludge that held its shape at bottom of segment
	2	307.44	100	Dark chocolate brown to light tan sludge that did not flow; small amount of free liquid
	3	297.77	94	Light tan to grayish sludge that held its shape
	4	319.57	100	Light grayish tan slurry that contained no drainable liquid and was pourable
	5	327.31	100	Light grayish tan sludge; top portion did not hold its shape

Table B1-2. Tank 241-B-110 Sample Description.[1] (2 sheets)

Core	Segment	Segment Mass (g)	Percent Recovery	Description
9	1	0.00	0	No sample recovered
	2	294.13	98	Dark brown to light tan sludge that held its shape; creamy texture
	3	318.79	100	Light tan to light brown sludge that held its shape
9	4	324.88	100	Light tan sludge that held its shape; creamy texture except for bottom 2 in. which was granular
	5	303.96	100	Light tan and light brown sludge that held its shape except for the top in.
10	1	76	35	3 in. (in 2 pieces) of dark brown sludge; 10 to 15 mL of drainable liquid
	2	304.57	100	Dark brown to light brown to tan sludge with dark brown streaks; did not hold its shape; creamy texture
	3	285.81	100	Light grayish tan sludge that held its shape; creamy texture
	4	335.07	100	Light tan sludge that held its shape except for top 2 in.; creamy texture
	5	332.28	100	Light grayish tan sludge that held its shape except for the top inch
18	1	149.84	81	9 in. of light brown and dark brown sludge; less than 10 mL of drainable liquid
	2	314.18	100	Dark brown to light tan sludge that held its shape; light and dark streaks throughout the top 6 in.; creamy texture
	3	319.34	100	Light tan sludge that held its shape; granular texture
	4	317.63	100	Light tan sludge that held its shape; creamy texture
	5	295.48	100	Light tan to brown sludge that held its shape except for the top inch; creamy texture

Note:

[1]Jones (1990), Jones et al. (1990a, 1990b, 1990c, 1990d, 1991a, 1991b).

B1.3 SAMPLE ANALYSIS

The following extensive analyses were performed on the core samples from tank 241-B-110: bulk density; weight percent solids; thermogravimetric analysis (TGA); DSC; metals by inductively coupled plasma spectroscopy (ICP); arsenic, selenium and other metals by graphite furnace atomic absorption (GFAA); mercury by cold vapor atomic absorption (CVAA); anions by ion chromatography (IC); total inorganic carbon (TIC); total organic carbon (TOC); ammonia; cyanide; volatile and semivolatile organics; total alpha; total beta; and various radionuclides.

Prehomogenized segment subsamples were analyzed for particle size and volatile organics. For cores 3, 9, 10, and 18, these were the only analyses performed on segments 1, 2 and 4; more extensive analyses were performed on segments 3 and 5. For cores 1, 2 and 4, similar analyses were performed on all segments.

The analysis of segments from core 4 included a holding time study to assess the effects of sample holding times on analytical data quality. Data were obtained by performing time-phased analyses for analytes that were expected to exhibit sensitivity to holding times including semi-volatile organics, pH, anions by IC, total inorganic and organic carbon, chromium(VI), ammonia, and cyanide. Samples were prepared and analyzed at 14, 30, and 60 day intervals, respectively. The laboratory data package referred to these intervals as phases I, II, and III (Jones et al. 1990c).

Table B1-3 summarizes sample numbers, digestion methods, and analyses. All reported analyses were performed according to approved laboratory procedures (see Section B2.0).

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 1			
1	n/a	n/a	n/a
2	89-0648	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
		Acid	ICP
		Water	pH, IC, TIC, TOC
	89-0322	Direct	VOA
	89-0325	Direct	Particle size
	89-0331	Fusion	ICP, GEA, total alpha, total beta, uranium
	89-0332	Fusion	ICP, GEA, total alpha, total beta, uranium
3	89-0649	Direct	Wt% solids
	89-0649	Acid	ICP
		Water	pH, IC, TIC, TOC
	89-0323	Direct	VOA
	89-0326	Direct	Particle size
	89-0333	Fusion	ICP, GEA, total alpha, total beta, uranium
	89-0334	Fusion	ICP, GEA, total alpha, total beta, uranium
4	89-0650	Direct	Wt% solids
		Acid	ICP
		Water	pH, IC, TIC, TOC
	89-0324	Direct	VOA
	89-0327	Direct	Particle size
	89-0335	Fusion	ICP, GEA, total alpha, total beta, uranium
	89-0336	Fusion	ICP, GEA, total alpha, total beta, uranium

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 1 (Continued)			
5	89-0651	Direct	Wt% solids
		Acid	ICP
		Water	pH, IC, TIC, TOC
	89-0329	Direct	VOA
	89-0330	Direct	Particle size
	89-0337	Fusion	ICP, GEA, total alpha, total beta, uranium
	89-0338	Fusion	ICP, GEA, total alpha, total beta, uranium
Comp.	None	Direct	Bulk density, centrifuged solids density, centrifuged supernate density, wt% centrifuged solids, volume percent centrifuged solids, wt% dissolved solids, wt% solids, rheology, TGA, DSC
Comp.	89-0621	Direct	SVOA
		Acid	ICP, GFAA, mercury
		Water	pH, ICP, IC, TIC, TOC, chromium(VI), ammonia, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{241}Am, $^{243/244}$Cm, tritium, C-14
	89-0980	Fusion	GEA
	89-0981	Fusion	GEA
	89-0622	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm, U isotopic, Pu isotopic
	89-0623	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm, U isotopic, Pu isotopic
	90-1125	Fusion	ICP
	90-1126	Fusion	ICP

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 2			
1	89-0412	Direct	VOA
	89-0410	Direct	Particle size
	89-0465	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	89-0466	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
2	89-0413	Direct	VOA
	89-0411	Direct	Particle size
	90-0636	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
		Acid	ICP
		Water	pH, IC, TIC, TOC
3	89-0419	Direct	VOA
	89-0727	Fusion	ICP, GEA, total alpha, total beta, uranium
	89-0728	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	90-0637	Direct	Wt% solids
		Acid	ICP
		Water	pH, IC, TIC, TOC
4	89-0420	Direct	VOA
	89-0423	Direct	Particle size
	90-0638	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
		Acid	ICP
		Water	pH, IC, TIC, TOC
5	89-0421	Direct	VOA
	89-0424	Direct	Particle size
	89-0729	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 2 (Continued)			
5	89-0730	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	90-0639	Direct	Wt% solids
		Acid	ICP
		Water	pH, IC, TIC, TOC
Comp.	None	Direct	Bulk density, centrifuged solids density, centrifuged supernate density, wt % centrifuged solids, vol % centrifuged solids, wt % dissolved solids, wt % solids, rheology, TGA, DSC
	89-1251	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	89-1252	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	90-0640	Direct	Wt% solids
		Acid	ICP, GFAA, mercury
		Water	pH, ICP, IC, TIC, TOC, chromium(VI), ammonia, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, tritium, ^{238}Pu, $^{239/240}Pu$, ^{237}Np, ^{241}Am, $^{243/244}Cm$
Core 3			
1	n/a	n/a	n/a
2	89-0449	Direct	Particle size
	89-0453	Direct	VOA
3	89-0450	Direct	Particle size
	89-0454	Direct	VOA
	89-0668	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	89-0669	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	89-1107	Direct	Wt% solids
		Acid	ICP

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 3 (Continued)			
3		Water	pH, IC, TIC, TOC
4	89-0451	Direct	Particle size
	89-0455	Direct	VOA
5	89-0452	Direct	Particle size
	89-0456	Direct	VOA
	89-1109	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
		Acid	ICP
		Water	pH, IC, TIC, TOC
Comp.	None	Direct	Bulk density, centrifuged solids density, centrifuged supernate density, wt % centrifuged solids, vol % centrifuged solids, wt % dissolved solids, wt % solids, rheology, TGA, DSC
	89-0971	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	89-0972	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	89-0973	Direct	Wt% solids
		Fusion	ICP, GEA
	89-0974	Direct	Wt% solids
		Fusion	ICP, GEA
	89-0975	Direct	Wt% solids
		Fusion	ICP, GEA
	89-0976	Direct	Wt% solids
		Fusion	ICP, GEA
	89-0977	Direct	Wt% solids
		Acid	ICP, GFAA, mercury

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 3 (Continued)			
Comp.		Water	pH, ICP, IC, TIC, TOC, chromium(VI), ammonia, GEA, total alpha, total beta, uranium, ^{90}Sr, tritium, ^{14}C, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
Core 4			
1	n/a	n/a	n/a
2	89-0468	Direct	VOA
	89-0473	Direct	Particle size
	89-0478	Direct	SVOA, wt% solids
		Fusion	ICP, GEA
		Acid	ICP, mercury
		Water	pH, IC, TIC, TOC, chromium(VI), ammonia, cyanide
	89-0835	Direct	SVOA
		Water	pH, IC, TIC, TOC, chromium(VI)
	89-1449	Acid	Mercury
		Water	IC, TIC, TOC, chromium(VI), ammonia
3	89-0469	Direct	VOA
	89-0479	Direct	SVOA, wt% solids
		Fusion	ICP, GEA
		Acid	ICP, mercury
		Water	pH, IC, TIC, TOC, chromium(VI), ammonia, cyanide
	89-0836	Direct	SVOA
		Water	pH, IC, TIC, TOC, chromium(VI)
	89-1450	Acid	Mercury
		Water	IC, TIC, TOC, chromium(VI), ammonia
4	None	Direct	Bulk density, centrifuged solids density, centrifuged supernate density, wt % centrifuged solids, vol % centrifuged solids
	89-0470	Direct	VOA
	89-0475	Direct	Particle size
	89-0480	Direct	Wt% solids, SVOA
		Fusion	ICP, GEA

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 4 (Continued)			
4		Acid	ICP, mercury
		Water	pH, IC, TIC, TOC, chromium(VI), ammonia, cyanide
	89-0837	Direct	SVOA
		Water	pH, IC, TIC, TOC, chromium(VI)
	89-1451	Acid	Mercury
		Water	IC, TIC, TOC, chromium(VI), ammonia
5	89-0471	Direct	VOA
	89-0476	Direct	Particle size
	89-0481	Direct	SVOA
		Acid	ICP, mercury
		Water	pH, IC, TIC, TOC, chromium(VI), ammonia, cyanide
	89-0482	Direct	Wt% solids
		Fusion	ICP, GEA
	89-0483	Direct	Wt% solids
		Fusion	ICP
	89-0838	Direct	SVOA
		Water	pH, IC, TIC, TOC, chromium(VI)
	89-1452	Acid	Mercury
		Water	IC, TIC, TOC, chromium(VI), ammonia
Comp.	None	Direct	Bulk density, TGA, DSC
	90-0714	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}Pu$, ^{237}Np, ^{241}Am, $^{243/244}Cm$
	90-0715	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}Pu$, ^{237}Np, ^{241}Am, $^{243/244}Cm$, U isotopic, Pu isotopic

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 4 (Continued)			
Comp.	90-0716	Direct	SVOA
		Acid	ICP, GFAA
		Water	ICP, IC, TIC, TOC, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, tritium, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
Core 9			
1	n/a		n/a
2	89-1560	Direct	Particle size
	89-1561	Direct	VOA
3	89-1562	Direct	Particle size
	89-1563	Direct	VOA
	90-0300	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	90-0301	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	90-1275	Direct	Wt% solids
		Acid	ICP
		Water	pH, IC, TIC, TOC
4	89-1564	Direct	Particle size
	89-1565	Direct	VOA
5	89-1566	Direct	Particle size
	89-1567	Direct	VOA
	90-0304	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	90-0305	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium
	90-1276	Direct	Wt% solids
		Acid	ICP
		Water	pH, IC, TIC, TOC

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 9 (Continued)			
Comp.	None	Direct	Bulk density, centrifuged solids density, centrifuged supernate density, wt % centrifuged solids, vol % centrifuged solids, wt % dissolved solids, wt % solids, rheology, TGA, DSC
	90-1255	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am
	90-1256	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	90-1257	Direct	SVOA, wt% solids
		Acid	ICP, GFAA, mercury
		Water	pH, ICP, IC, TIC, TOC, chromium(VI), ammonia, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, tritium, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am
Core 10			
1	n/a	n/a	n/a
2	89-1568	Direct	Particle size
	89-1569	Direct	VOA
3	89-1968	Direct	Particle size
	89-1969	Direct	VOA
	90-0708	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	90-0709	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	90-1280	Direct	Wt% solids
		Acid	ICP
		Water	pH, IC, TIC, TOC

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 10 (Continued)			
4	89-1570	Direct	Particle size
	89-1571	Direct	VOA
5	89-1970	Direct	Particle size
	89-1971	Direct	VOA
	90-0712	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	90-0713	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	90-1281	Direct	Wt% solids
		Acid	ICP
		Water	pH, IC, TIC, TOC
Comp.	None	Direct	Bulk density, centrifuged solids density, centrifuged supernate density, wt % centrifuged solids, vol % centrifuged solids, wt % dissolved solids, wt % solids, rheology, TGA, DSC
	90-1277	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	90-1278	Direct	Wt% solids
		Fusion	ICP, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	90-1279	Direct	SVOA, wt% solids
		Acid	ICP, GFAA, mercury
	90-1279	Water	pH, ICP, IC, TIC, TOC, chromium(VI), ammonia, GEA, total alpha, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, tritium, ^{14}C, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 18			
1	90-3514	Direct	VOA
	90-3515	Direct	Particle size
2	90-3516	Direct	VOA
	90-3517	Direct	Particle size
3	90-3518	Direct	VOA
	90-3519	Direct	Particle size
	90-3617	Direct	Wt% solids
		Fusion	ICP, GEA, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	90-3618	Direct	Wt% solids
		Fusion	ICP, GEA
4	90-3520	Direct	VOA
	90-3521	Direct	Particle size
5	90-3522	Direct	VOA
	90-3523	Direct	Particle size
	90-3619	Fusion	ICP, GEA, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	90-3620	Direct	Wt% solids
		Fusion	ICP, GEA
Comp.	None	Direct	Bulk density, centrifuged solids density, centrifuged supernate density, wt % centrifuged solids, vol % centrifuged solids, wt % dissolved solids, wt % solids, rheology, TGA, DSC
	90-4178	Direct	Wt% solids
		Fusion	ICP, GEA, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, ^{241}Am, $^{243/244}$Cm
	90-4179	Fusion	ICP, GEA

Table B1-3. Tank 241-B-110 Sample Analysis Summary.[1] (12 sheets)

Segment	Sample Number	Digestion Method	Analyses
Core 18 (Continued)			
Comp.	90-4180	Direct	SVOA, wt % solids
		Acid	ICP, GFAA, mercury
	90-4180	Water	pH, ICP, IC, TIC, TOC, chromium(VI), ammonia, GEA, total beta, uranium, ^{90}Sr, ^{99}Tc, ^{129}I, tritium, ^{14}C, ^{238}Pu, $^{239/240}Pu$, ^{237}Np, ^{241}Am

Notes:

Comp. = Composite
gea = gamma energy analysis
SVOA = semivolatile organic analysis
VOA = volatile organic analysis

[1]Jones (1990), Jones et al. (1990a, 1990b, 1990c, 1990d, 1991a, 1991b).

B1.4 DESCRIPTION OF HISTORICAL SAMPLING EVENT

There are no historical sampling events for tank 241-B-110.

B2.0 ANALYTICAL RESULTS

B2.1 OVERVIEW

This section summarizes the analytical results associated with the August 1989 through April 1990 core sampling of tank 241-B-110. Table B2-1 shows the mean analytical results for the core composites associated with this tank. Although segment analyses are discussed, no segment-level analytical results are shown except for a few physical properties. These results are documented in Jones (1990) and Jones et al. (1990a, 1990b, 1990c, 1990d, 1991a, and 1991b).

Table B2-1. Analytical Data Presentation Tables. (2 sheets)

Analysis	Table Number(s)
Metals by ICP	B2-2 through B2-35
Anions by IC	B2-36 through B2-41
Uranium by laser fluorimetry	B2-31
Mercury by CVAA	B2-42
Ammonia	B2-43
Chromium(VI) by colorimetry	B2-44
VOA	B2-45
SVOA	B2-46
TIC	B2-47
TOC	B2-48
GEA	B2-49 through B2-59
Americium-241 and Curium-243/244	B2-59 and B2-60
Carbon-14	B2-61
Iodine-129	B2-62
Neptunium-237	B2-63
Plutonium-238 and plutonium-239/240	B2-64 and B2-65
Pu isotopics	B2-66
U isotopics	B2-67
Strontium-90	B2-68
Technetium-99	B2-69
Tritium	B2-70
Total alpha activity	B2-71
Total beta activity	B2-72
Bulk density	B2-73
Centrifuged solids density	B2-74
Centrifuged supernate density	B2-75
Wt% centrifuged solids	B2-76
Volume percent centrifuged solids	B2-77

Table B2-1. Analytical Data Presentation Tables. (2 sheets)

Analysis	Table Number(s)
Wt% dissolved solids	B2-78
Wt% solids	B2-79
pH	B2-80
Rheology	B2-81 and B2-82
TGA	B2-83
DSC	B2-84
Vapor phase measurements	B2-85
Total heat load	B2-86

In each data table, "Mean" is the average of result and duplicate values. All values, including those below the detection level (denoted by the less-than symbol, <), were averaged. If both result and duplicate values were nondetected, the mean is expressed as a nondetected value. If one value was detected and the other nondetected, the mean is expressed as nondetected.

B2.2 INORGANIC ANALYSES

B2.2.1 Inductively Coupled Plasma

Homogenized segments and core composites were prepared by fusion digestion according to procedure PNL-ALO-102 and analyzed for metals by ICP according to procedure PNL-SP-7. Homogenization test analyses were performed on all samples. Homogenized segments and core composites were prepared by acid digestion according to procedure PNL-ALO-101. Core composites were prepared by water digestion according to procedure PNL-ALO-103. The digested subsamples were analyzed according to procedure PNL-SP-7.

B2.2.2 Ion Chromatography

Homogenized segment and core composites were prepared by water digestion according to procedure PNL-ALO-103 and analyzed for anions by IC according to procedure 7-40.8 or PNL-ALO-212. Time-phased analyses for the holding time study (phases I, II, and III) were performed on core 4 segments.

B2.2.3 Laser Fluorimetry

Homogenized segments were prepared by fusion digestion according to procedure PNL-ALO-102. Core composites were prepared by fusion digestion accoring to procedure PNL-ALO-102 and prepared by water digestion according to procedure PNL-ALO-103. The digested samples were analyzed for uranium by laser fluorimetry according to procedure HTA-4-16. The range of values in composites for uranium by laser fluorimetry were 0.52 to 2.5 μg/g (water digestion) and 142 to 283 μg/g (fusion digestion).

B2.2.4 Graphite Furnace Atomic Absorption

Core composites were prepared by acid digestion according to procedure PNL-ALO-101 and analyzed by GFAA according to procedures PNL-ALO-214 (arsenic), PNL-ALO-215 (selenium), PNL-ALO-216 (lead), PNL-ALO-219 (antimony), and PNL-ALO-220 (thallium). Only arsenic results were reported for all composites. Antimony, lead, selenium, and thallium results were reported for some composites.

B2.2.5 Mercury by Cold Vapor Atomic Absorption

Core composites were prepared and analyzed for mercury by CVAA according to procedure PNL-ALO-213. In addition, time-phased analyses for the holding time study (phases I and III) were performed on core 4 segments. Results for mercury in composites ranged from 0.6 to 1.86 μg/g.

B2.2.6 Ammonia

Core composites were prepared by water digestion according to procedure PNL-ALO-103 and analyzed for ammonia according to procedure PNL-ALO-226. In addition, time-phased analyses for the holding time study (phases I, II, and III) were performed on core 4 segments. Values for ammonia in composites ranged from 148 to 319 μg/g.

B2.2.7 Chromium(VI) by Colorimetry

Core composites were prepared by water digestion according to procedure PNL-ALO-103 and analyzed for chromium by colorimetry according to procedure PNL-ALO-227. In addition, time-phased analyses for the holding time study (phases I, II, and III) were performed on the core 4 segments. Results for chromium (VI) in composites ranged from 28.6 to 67 μg/g.

B2.3 ORGANIC ANALYSES

B2.3.1 Volatile Organic Analysis

Volatile organic analysis was performed on prehomogenized segments according to procedure PNL-ALO-335. No target VOA analyte was detected above its detection limits.

B2.3.2 Semivolatile Organic Analysis

Semivolatile organic analysis was performed on core composites according to procedure PNL-ALO-345. In addition, time-phased analyses for the holding time study (phases I and II) were performed on core 4 segments. No target SVOA analyte was detected above its detection limits.

B2.4 TOTAL INORGANIC AND ORGANIC CARBON ANALYSES

Homogenized segments and core composites were prepared by water digestion according to procedure PNL-ALO-103 and analyzed for TIC and TOC according to procedure 7-40.7. Time-phased analyses for the holding time study (phases I, II, and III) were performed on core 4 segments.

B2.5 RADIONUCLIDE ANALYSES

B2.5.1 Gamma Energy Analysis

Homogenized subsegments and core composites were fusion digested according to procedure PNL-ALO-102 and analyzed by gamma energy analysis (GEA) according to procedure HTA-4-5. Homogenization test analyses were performed on most fusion-digested samples. In addition to fusion digestion, the core composites were water digested according to procedure PNL-ALO-103 and analyzed by GEA.

Cerium-144, cesium-134, cesium-137, cobalt-60, europium-152, euporium-154, europium-155, gadolinium-153, ruthenium-106, selenium-75, and americium-241 were detected in core composites.

B2.5.2 Americium-241 and Curium 243/244

Core composites were fusion digested according to procedure PNL-ALO-102, water digested according to procedure PNL-ALO-103, and analyzed for americium-241 and curium-243/244 according to procedure HTA-4-5. Homogenized subsamples from segments 3 and 5 of cores 10 and 18 were also fusion digested and analyzed for americium-241 and curium-243/244. Homogenization test analyses were performed on most fusion-digested samples.

B2.5.3 Carbon-14

Core composites were water digested according to procedure PNL-ALO-103 and analyzed for carbon-14 according to procedure HTA-4-17. The highest value found for carbon-14 in composites was 0.0036 μCi/g.

B2.5.4 Iodine-129

Core composites were fusion digested according to procedure PNL-ALO-102, water digested according to procedure PNL-ALO-103, and analyzed for iodine-129 according to procedure 7-40.17 or 7-40.26. Homogenized subsamples from segments 3 and 5 of cores 10 and 18 were also fusion digested and analyzed for iodine-129. Homogenization test analyses were performed on most fusion-digested samples.

B2.5.5 Neptunium-237

Core composites were fusion digested according to procedure PNL-ALO-102, water digested according to procedure PNL-ALO-103, and analyzed for neptunium-237 according to procedure HTA-4-6. Homogenized subsamples from segments 3 and 5 of cores 10 and 18 were also fusion digested and analyzed for neptunium-237. Homogenization test analyses were performed on most of the fusion-digested samples.

B2.5.6 Plutonium-238 and Plutonium 239/240

Core composites were fusion digested according to procedure PNL-ALO-102, water digested according to procedure PNL-ALO-103, and analyzed for plutonium-238 and plutonium-239/240 according to procedure HTA-4-15. Homogenized subsamples from segments 3 and 5 of cores 10 and 18 were also fusion digested and analyzed for plutonium-238 and plutonium-239/240. Homogenization test analyses were performed on most fusion-digested samples.

B2.5.7 Plutonium and Uranium Isotopics

Core composites from cores 1 and 4 were fusion digested according to procedure PNL-ALO-102 and analyzed for plutonium and uranium isotopes according to procedure HTA-4-40. A homogenization test analysis was performed on the core 1 composite.

B2.5.8 Strontium-90

Core composites were fusion digested according to procedure PNL-ALO-102, water digested according to procedure PNL-ALO-103, and analyzed for strontium-90 according to procedure HTA-4-8. Homogenized subsamples from segments 3 and 5 of cores 10 and 18 were also fusion digested and analyzed for strontium-90. Homogenization test analyses were performed on most fusion-digested samples. Values for strontium-90 in composites ranged from 6.78 to 224 μCi/g.

B2.5.9 Technetium-99

Core composites were fusion digested according to procedure PNL-ALO-102, water digested according to procedure PNL-ALO-103, and analyzed for technetium-99 according to procedure HTA-4-12. Homogenized subsamples from segments 3 and 5 of cores 10 and 18 were also fusion digested and analyzed for technetium-99. Homogenization test analyses were performed on most fusion-digested samples. Values for technetium-99 in composites ranged from 0.00609 to 0.0208 μCi/g (fusion digest) and from 0.0156 to 0.0225 μCi/g (water digest).

B2.5.10 Tritium

Core composites were water digested according to procedure PNL-ALO-103 and analyzed for tritium according to procedure PNL-SP-30 or PNL-SP-33.

B2.5.11 Total Alpha Activity

Homogenized segments and core composites were prepared by fusion digestion and analyzed for total alpha activity according to procedure HTA-4-22 or HTA-4-6. Homogenization test analyses were performed on all samples. Total alpha activity analysis was not performed on samples from core 18. In addition to fusion digestion, the core composites were water digested according to procedure PNL-ALO-103 and analyzed for total alpha activity. Appendix C contains the total alpha activity results for segments.

B2.5.12 Total Beta Activity

Homogenized segments and core composites were prepared by fusion digestion and analyzed for total beta activity according to procedure HTA-4-23 or HTA-4-8. Homogenization test analyses were performed on most samples. In addition to fusion digestion, the core composites were water digested according to procedure PNL-ALO-103 and analyzed for total beta activity.

B2.6 PHYSICAL ANALYSES

B2.6.1 Density and Percent Solids

Core composites were analyzed for bulk density, centrifuged solids density, centrifuged supernate density, weight percent centrifuged solids, volume percent centrifuged solids, weight percent dissolved solids, and weight percent total solids according to procedure WHC-053-1. The core 4 composite was analyzed only for bulk density. A prehomogenized subsample from core 4, segment 4, was analyzed for bulk density, centrifuged solids density, centrifuged supernate density, volume percent centrifuged solids, and weight percent centrifuged solids.

B2.6.2 Weight Percent Solids

Homogenized segments and core composites were analyzed for weight percent solids per PNL-ALO-504. Homogenization test analyses were performed on most of the samples.

B2.6.3 pH

Homogenized segments and core composites were water digested per PNL-ALO-103 and the pH measured according to procedure WHC-053-1. Time-phased analyses for the holding time study (phases I and II) were performed on the core 4 segments.

B2.6.4 Particle Size

Prehomogenized segments were analyzed for particle size according to procedure 2-50.2 or 2-50.3.

B2.6.5 Penetration Resistance

The penetration resistance of prehomogenized segments was measured according to procedure PNL-O-06. For all segments, the penetration resistance was less than 2 pounds per square inch.

B2.6.6 Rheology

Core composites were analyzed for rheological characteristics according to procedure WHC-053-1 to determine the shear stress as a function of shear rate. The data were fit to a yield-pseudoplastic model. No rheological analysis was performed on the core 4 composite.

The rheological parameters along with density data were input into a computer model to determine the critical Reynolds number, velocity, and flowrate for transport of the slurry through 2.0-in., 3.0-in., and 4.0-in. diameter pipes.

B2.7 THERMODYNAMIC ANALYSES

B2.7.1 Thermogravimetric Analysis

Thermogravimetric analysis measures the mass of a sample while its temperature is increased at a constant rate. A carrier gas (nitrogen) is passed over the sample during heating to remove any released gases. Any decrease in the weight of a sample during analysis represents a loss of gaseous matter from the sample through evaporation or through a reaction that forms gas phase products. The moisture content is estimated by assuming that all sample weight loss up to a certain temperature (typically 150 to 200 °C) is caused by water evaporation. The temperature limit for moisture loss is chosen by the operator at an inflection point on the TGA plot. Other volatile matter fractions can often be differentiated by inflection points as well. The core composites were analyzed by TGA according to procedure RDS-TA-1.

B2.7.2 Differential Scanning Calorimetry

Differential scanning calorimetry analysis measures the heat absorbed or emitted by a sample while it is heated at a constant rate. Nitrogen is passed over the sample material to remove any gases being released. The onset temperature for an endothermic or exothermic event is determined graphically.

The core composites were analyzed by DSC per procedure RDS-TA-1. No exothermic reactions were observed. The samples exhibited two to three endothermic transitions which were attributed to water evaporation and the melting of salts.

B2.8 VAPOR PHASE MEASUREMENTS

Vapor phase measurements were taken from tank 241-B-110 on April 26, 1996, to support the safety screening DQO (Dukelow et al. 1995). The measurements were taken through riser 7 in the headspace of the tank. The results were obtained in the field (that is, no gas sample was sent to the laboratory for analysis) and indicate that the headspace vapor concentration is at 0 percent of the LFL. The safety screening DQO states that tank headspace gases should be ≤ 25 percent of the LFL.

Analytical data are presented in Tables B2-2 through B2-86.

Table B2-2. Tank 241-B-110 Analytical Results: Aluminum. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	< 210
90-0640	2	< 15
89-0977	3	< 103
90-0716	4	18
90-1257	9	6.5
90-1279	10	14.5
90-4180	18	12.5
Solids Composites: fusion digest		µg/g
90-2949	1	1,384
90-1125		1,168
90-1126		1,130
89-1251	2	1,840
89-1252		1,880
89-0971	3	< 673
89-0972		734
89-0973		779
89-0974		1,270
89-0975		1,280
89-0976		< 678
90-0714	4	1,200
90-0715		1,240
90-1255	9	<392
90-1256		<347
90-1277	10	1,320

Table B2-2. Tank 241-B-110 Analytical Results: Aluminum. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: fusion digest		μg/g
90-1278	18	1,210
90-4178		1,470
90-4179		1,500
Solids Composites: acid digest		μg/g
89-0621	1	1,160
90-0640	2	1,760
89-0977	3	757
90-0716	4	1,250
90-1257	9	<330
90-1279	10	1,200
90-4180	18	1,480

Table B2-3. Tank 241-B-110 Analytical Results: Barium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	4
90-0640	2	< 1
89-0977	3	< 2
90-0716	4	< 0.249
90-1257	9	< 1
90-1279	10	< 1
90-4180	18	< 1
Solids Composites: fusion digest		µg/g
90-2949	1	23.5
90-1125		26.0
90-1126		13.0
89-1251	2	19.0
89-1252		16.0
89-0971	3	22.0
89-0972		25.5
89-0973		22.5
89-0974		25.5
89-0975		27.0
89-0976		17.5
90-0714	4	< 17
90-0715		< 17
90-1255	9	32
90-1256		31
90-1277	10	26.5
90-1278		24.5
90-4178	18	< 17
90-4179		57.5

Table B2-3. Tank 241-B-110 Analytical Results: Barium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		µg/g
89-0621	1	13.0
90-0640	2	13.0
89-0977	3	14.0
90-0716	4	14.5
90-1257	9	12
90-1279	10	16
90-4180	18	16.5

Table B2-4. Tank 241-B-110 Analytical Results: Bismuth.

Sample Number	Core Number	Mean
Solids Composites: water digest		$\mu g/g$
90-0640	2	171
89-0977	3	2.5
Solids Composites: fusion digest		$\mu g/g$
90-2949	1	21,800
90-1125		17,900
90-1126		17,300
89-1251	2	20,500
89-1252		21,300
89-0971	3	21,700
89-0972		22,500
89-0973		23,000
89-0974		21,700
89-0975		21,000
89-0976		22,500
90-0714	4	18,100
90-0715		17,900
90-1255	9	14,900
90-1256		14,800
90-1277	10	14,400
90-1278		17,100
90-4178	18	19,200
90-4179		19,600
Solids Composites: acid digest		$\mu g/g$
89-0621	1	6,800
90-0640	2	21,300
89-0977	3	21,900
90-0716	4	19,100
90-1257	9	16,200
90-1279	10	18,200
90-4180	18	21,600

Table B2-5. Tank 241-B-110 Analytical Results: Boron. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	< 92
90-0640	2	< 14
89-0977	3	< 112
90-0716	4	15
90-1257	9	15
90-1279	10	< 13
90-4180	18	< 12
Solids Composites: fusion digest		µg/g
90-2949	1	< 230
90-1125		< 302
90-1126		< 308
89-1251	2	< 518
89-1252		< 518
89-0971	3	< 283
89-0972		< 283
89-0973		< 293
89-0974		< 293
89-0975		< 285
89-0976		< 285
90-0714	4	< 391
90-0715		< 391
90-1255	9	< 559
90-1256		< 559
90-1277	10	< 217
90-1278		< 217
90-4178	18	< 296
90-4179		< 296

Table B2-5. Tank 241-B-110 Analytical Results: Boron. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	87.0
90-0640	2	40.0
89-0977	3	36.5
90-0716	4	61.5
90-1257	9	39.5
90-1279	10	84.5
90-4180	18	44.5

Table B2-6. Tank 241-B-110 Analytical Results: Cadmium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	< 9
90-0640	2	< 1
89-0977	3	25.0
90-0716	4	< 1
90-1257	9	< 1
90-1279	10	< 1
90-4180	18	< 1
Solids Composites: fusion digest		μg/g
90-2949	1	< 26
90-1125		< 25
90-1126		< 25
89-1251	2	59
89-1252		< 37
89-0971	3	86
89-0972		56
89-0973		34.5
89-0974		37.5
89-0975		43.5
89-0976	3	28.5
90-0714	4	< 39
90-0715		< 39
90-1255	9	< 49
90-1256		< 49
90-1277	10	< 37
90-1278		< 37
90-4178	18	< 29
90-4179		< 29

Table B2-6. Tank 241-B-110 Analytical Results: Cadmium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	< 7
90-0640	2	5
89-0977	3	3.5
90-0716	4	4.5
90-1257	9	< 29
90-1279	10	4.5
90-4180	18	7.5

Table B2-7. Tank 241-B-110 Analytical Results: Calcium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	79
90-0640	2	7
89-0977	3	37.5
90-0716	4	9.5
90-1257	9	13.5
90-1279	10	13
90-4180	18	8
Solids Composites: fusion digest		μg/g
90-2949	1	996
90-1125		945
90-1126		793
89-1251	2	758
89-1252		628
89-0971	3	1,040
89-0972		1,030
89-0973		984
89-0974		1,000
89-0975		1,010
89-0976		1,030
90-0714	4	980
90-0715		1,130
90-1255	9	609
90-1256		606
90-1277	10	844
90-1278		1,050
90-4178	18	719
90-4179		850

Table B2-7. Tank 241-B-110 Analytical Results: Calcium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		µg/g
89-0621	1	863
90-0640	2	655
89-0977	3	990
90-0716	4	839
90-1257	9	615
90-1279	10	984
90-4180	18	722

Table B2-8. Tank 241-B-110 Analytical Results: Cerium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	263
90-0640	2	< 35
89-0977	3	< 79
90-0716	4	< 20
90-1257	9	< 51
90-1279	10	< 50
90-4180	18	< 40
Solids Composites: fusion digest		µg/g
90-2949	1	< 832
90-1125		< 716
90-1126		< 730
89-1251	2	< 322
89-1252		< 322
89-0971	3	< 846
89-0972		< 846
89-0973		< 876
89-0974		< 876
89-0975		< 852
89-0976		< 852
90-0714	4	< 1,100
90-0715		< 1,100
90-1255	9	< 1,570
90-1256		< 1,570
90-1277	10	< 754
90-1278		< 754
90-4178	18	< 994
90-4179		< 994

Table B2-8. Tank 241-B-110 Analytical Results: Cerium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	< 252
90-0640	2	68.0
89-0977	3	< 19
90-0716	4	66.5
90-1257	9	< 22
90-1279	10	< 66
90-4180	18	< 46

Table B2-9. Tank 241-B-110 Analytical Results: Chromium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	65
90-0640	2	77
89-0977	3	71
90-0716	4	69
90-1257	9	50
90-1279	10	70
90-4180	18	59
Solids Composites: fusion digest		µg/g
90-2949	1	972
90-1125		808
90-1126		798
89-1251	2	843
89-1252		861
89-0971	3	784
89-0972		808
89-0973		778
89-0974		824
89-0975		840
89-0976		766
90-0714	4	863
90-0715		859
90-1255	9	738
90-1256		745
90-1277	10	759
90-1278		765
90-4178	18	794
90-4179		783

Table B2-9. Tank 241-B-110 Analytical Results: Chromium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	824
90-0640	2	822
89-0977	3	836
90-0716	4	1,390
90-1257	9	712
90-1279	10	795
90-4180	18	820

Table B2-10. Tank 241-B-110 Analytical Results: Copper. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	36.5
90-0640	2	< 2
89-0977	3	75.5
90-0716	4	< 1
90-1257	9	< 4
90-1279	10	< 4
90-4180	18	< 3
Solids Composites: fusion digest		µg/g
90-2949	1	61.5
90-1125		84.5
90-1126		56.0
89-1251	2	59.5
89-1252		52.5
89-0971	3	62.5
89-0972		86.5
89-0973		60.5
89-0974		100
89-0975		572
89-0976		59
90-0714	4	< 81
90-0715		< 81
90-1255	9	258
90-1256		169
90-1277	10	234
90-1278		47.5
90-4178	18	350
90-4179		232

Table B2-10. Tank 241-B-110 Analytical Results: Copper. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		$\mu g/g$
89-0621	1	21
90-0640	2	36
89-0977	3	80
90-0716	4	30
90-1257	9	43
90-1279	10	24
90-4180	18	74.5

Table B2-11. Tank 241-B-110 Analytical Results: Iron. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		$\mu g/g$
89-0621	1	162
90-0640	2	79.5
89-0977	3	59.5
90-0716	4	175
90-1257	9	36.5
90-1279	10	141
90-4180	18	90.5
Solids Composites: fusion digest		$\mu g/g$
90-2949	1	21,900
90-1125		23,200
90-1126		18,300
89-1251	2	18,700
89-1252		18,800
89-0971	3	17,400
89-0972		18,300
89-0973		17,600
89-0974		18,300
Solids Composites: fusion digest		$\mu g/g$
89-0975	3	18,400
89-0976		17,900
90-0714	4	18,700
90-0715		19,400
90-1255	9	14,500
90-1256		14,400
90-1277	10	17,600
90-1278		18,100
90-4178	18	18,500
90-4179		18,200

Table B2-11. Tank 241-B-110 Analytical Results: Iron. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		µg/g
89-0621	1	19,400
90-0640	2	18,200
89-0977	3	18,700
90-0716	4	20,400
90-1257	9	14,500
90-1279	10	18,300
90-4180	18	18,400

Table B2-12. Tank 241-B-110 Analytical Results: Lanthanum. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	< 21
90-0640	2	< 3
89-0977	3	< 9
90-0716	4	< 2
90-1257	9	< 5
90-1279	10	< 5
90-4180	18	< 4
Solids Composites: fusion digest		µg/g
90-2949	1	78.5
90-1125		83.0
90-1126		< 62
89-1251	2	< 30
89-1252		< 30
89-0971	3	< 72
89-0972		< 72
89-0973		< 74
89-0974		< 74
89-0975		< 72
89-0976		< 72
90-0714	4	< 93
90-0715		< 93
90-1255	9	< 120
90-1256		< 120
90-1277	10	< 67
90-1278		< 67
90-4178	18	< 88
90-4179		< 88

Table B2-12. Tank 241-B-110 Analytical Results: Lanthanum. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	63.5
90-0640	2	28.5
89-0977	3	17
90-0716	4	53
90-1257	9	15
90-1279	10	30
90-4180	18	6.5

Table B2-13. Tank 241-B-110 Analytical Results: Lead. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest (ICP)		µg/g
89-0621	1	< 104
90-0640	2	< 6
89-0977	3	< 19
90-0716	4	< 5
90-1257	9	< 15
90-1279	10	< 15
90-4180	18	< 13
Solids Composites: fusion digest (ICP)		µg/g
90-2949	1	1308
90-1125		1,110
90-1126		949
89-1251	2	307
89-1252		284
89-0971	3	< 481
89-0972		< 481
89-0973		< 498
89-0974	3	830
89-0975		530
89-0976		< 484
90-0714	4	571
90-0715		748
90-1255	9	< 513
90-1256		< 513
90-1277	10	513
90-1278		522
90-4178	18	< 313
90-4179		< 313

Table B2-13. Tank 241-B-110 Analytical Results: Lead. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest (ICP)		µg/g
89-0621	1	1,130
90-0640	2	466
89-0977	3	372
90-0716	4	629
90-1257	9	275
90-1279	10	531
90-4180	18	283
Solids Composites: acid digest (GFAA)		µg/g
90-0640	2	460
90-0716	4	516
89-1257	9	259
90-1279	10	407
90-4180	18	185

Table B2-14. Tank 241-B-110 Analytical Results: Lithium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		$\mu g/g$
89-0621	1	< 15
90-0640	2	< 2
89-0977	3	37
90-0716	4	< 1
90-1257	9	< 2
90-1279	10	< 2
90-4180	18	< 2
Solids Composites: fusion digest		$\mu g/g$
90-2949	1	< 51
90-1125		< 37
90-1126		< 38
89-1251	2	154
89-1252		157
89-0971	3	< 53
89-0972		< 53
89-0973		< 55
89-0974		< 55
89-0975		< 54
89-0976		< 54
90-0714	4	< 65
90-0715		< 65
90-1255	9	< 104
90-1256		< 104
90-1277	10	< 35
90-1278		< 35
90-4178	18	< 51
90-4179		< 51

Table B2-14. Tank 241-B-110 Analytical Results: Lithium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	< 17
90-0640	2	< 7
89-0977	3	< 2
90-0716	4	< 1
90-1257	9	< 1
90-1279	10	< 3
90-4180	18	< 2

Table B2-15. Tank 241-B-110 Analytical Results: Magnesium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	10.5
90-0640	2	2.0
89-0977	3	< 2
90-0716	4	2.5
90-1257	9	3.5
90-1279	10	4
90-4180	18	3
Solids Composites: fusion digest		μg/g
90-2949	1	196
90-1125		163
90-1126		147
89-1251	2	144
89-1252		137
89-0971	3	136
89-0972		136
89-0973		139
89-0974	3	150
89-0975		146
89-0976		139
90-0714	4	186
90-0715		187
90-1255	9	139
90-1256		136
90-1277	10	172
90-1278		191
90-4178	18	155
90-4179		117

Table B2-15. Tank 241-B-110 Analytical Results: Magnesium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	193
90-0640	2	163
89-0977	3	174
90-0716	4	196
90-1257	9	157
90-1279	10	228
90-4180	18	164

Table B2-16. Tank 241-B-110 Analytical Results: Manganese. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	< 3
90-0640	2	< 0.249
89-0977	3	< 2
90-0716	4	1.5
90-1257	9	< 0.33
90-1279	10	< 2
90-4180	18	< 0.27
Solids Composites: fusion digest		µg/g
90-2949	1	95
90-1125		125
90-1126		78.5
89-1251	2	65.5
89-1252		70.5
89-0971	3	82.5
89-0972		94.0
89-0973		59.0
89-0974		76.0
89-0975		91.0
89-0976		105
90-0714	4	97.5
90-0715		108
90-1255	9	89.5
90-1256	9	95
90-1277	10	129
90-1278		114
90-4178	18	95.5
90-4179		158

Table B2-16. Tank 241-B-110 Analytical Results: Manganese. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	72.5
90-0640	2	55
89-0977	3	55.5
90-0716	4	137
90-1257	9	49.5
90-1279	10	103
90-4180	18	54

Table B2-17. Tank 241-B-110 Analytical Results: Molybdenum. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	< 87
90-0640	2	5.0
89-0977	3	< 118
90-0716	4	5.5
90-1257	9	3
90-1279	10	4
90-4180	18	5.5
Solids Composites: fusion digest		μg/g
90-2949	1	< 36
90-1125		< 50
90-1126		< 51
89-1251	2	< 63
89-1252		< 63
89-0971	3	< 43
89-0972		< 43
89-0973		71
89-0974		48
Solids Composites: fusion digest (Continued)		μg/g
89-0975	3	60.5
89-0976		< 43
90-0714	4	< 44
90-0715		< 44
90-1255	9	< 177
90-1256		< 177
90-1277	10	< 44
90-1278		< 44
90-4178	18	< 60
90-4179		< 60

Table B2-17. Tank 241-B-110 Analytical Results: Molybdenum. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		µg/g
89-0621	1	< 87
90-0640	2	10
89-0977	3	18.5
90-0716	4	22
90-1257	9	3.5
90-1279	10	5.5
90-4180	18	7.5

Table B2-18. Tank 241-B-110 Analytical Results: Neodymium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	< 135
90-0640	2	< 17
89-0977	3	< 28
90-0716	4	< 6
90-1257	9	< 22
90-1279	10	< 22
90-4180	18	< 18
Solids Composites: fusion digest		μg/g
90-2949	1	< 353
90-1125		< 310
90-1126		< 316
89-1251	2	< 131
89-1252		< 131
89-0971	3	< 309
89-0972		< 309
89-0973		< 320
89-0974		< 320
89-0975		< 311
89-0976		< 311
90-0714	4	< 500
90-0715		< 500
90-1255	9	< 541
90-1256		< 541
90-1277	10	< 323
90-1278		< 323
90-4178	18	< 437
90-4179		< 437

Table B2-18. Tank 241-B-110 Analytical Results: Neodymium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		µg/g
89-0621	1	< 128
90-0640	2	26
89-0977	3	< 8
90-0716	4	29.5
90-1257	9	< 10
90-1279	10	< 28
90-4180	18	< 20

Table B2-19. Tank 241-B-110 Analytical Results: Nickel. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	< 32
90-0640	2	< 3
89-0977	3	< 11
90-0716	4	< 2
90-1257	9	< 5
90-1279	10	< 5
90-4180	18	< 4
Solids Composites: fusion digest[1]		µg/g
90-2949	1	1,880
90-1125		4,370
90-1126		3,040
89-1251	2	1,930
89-1252		4,230
89-0971	3	2,860
89-0972		10,500
89-0973		2,460
89-0974		5,110
89-0975		12,900
89-0976		11,500
90-0714	4	5,080
90-0715		4,180
90-1255	9	3,750
90-1256		2,320
90-1277	10	4,260
90-1278		1,460
90-4178	18	7,110
90-4179		9,370

Table B2-19. Tank 241-B-110 Analytical Results: Nickel. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		$\mu g/g$
89-0621	1	< 21
90-0640	2	20
89-0977	3	20
90-1257	9	16.5
90-1279	10	20.5
90-4180	18	19.5

Note:

[1]Results for the ICP fusion analyses for nickel are meaningless because the samples were fused with potassium hydroxide in a nickel crucible.

Table B2-20. Tank 241-B-110 Analytical Results: Phosphorus. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	7,730
90-0640	2	7,760
89-0977	3	7,640
90-0716	4	8,140
90-1257	9	7,660
90-1279	10	7,300
90-4180	18	7,940
Solids Composites: fusion digest		μg/g
90-2949	1	21,400
90-1125		17,100
90-1126		16,700
89-1251	2	14,500
89-1252		13,900
89-0971	3	16,600
89-0972		17,900
89-0973		17,200
89-0974		19,200
89-0975		19,900
89-0976		16,400
90-0714	4	17,200
90-0715		16,700
90-1255	9	15,400
90-1256	9	15,700
90-1277	10	13,200
90-1278		14,200
90-4178	18	15,600
90-4179		14,900

Table B2-20. Tank 241-B-110 Analytical Results: Phosphorus. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	16,500
90-0640	2	16,500
89-0977	3	17,500
90-0716	4	16,100
90-1257	9	14,600
90-1279	10	15,400
90-4180	18	16,200

Table B2-21. Tank 241-B-110 Analytical Results: Potassium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	< 364
90-0640	2	210
89-0977	3	774
90-0716	4	255
90-1257	9	227
90-1279	10	238
90-4180	18	196
Solids Composites: fusion digest[1]		µg/g
90-2949	1	3.28E + 06
90-1125		2.61E + 06
90-1126		2.63E + 06
89-1251	2	2.42E + 06
89-1252		2.33E + 06
89-0971	3	2.47E + 06
89-0972		2.25E + 06
89-0973		2.63E + 06
89-0974		2.98E + 06
Solids Composites: fusion digest (Continued)		µg/g
89-0975	3	2.49E + 06
89-0976		2.64E + 06
90-0714	4	2.62E + 06
90-0715		2.49E + 06
90-1255	9	2.55E + 06
90-1256		2.55E + 06
90-1277	10	2.48E + 06
90-1278		2.54E + 06
90-4178	18	2.58E + 06
90-4179		1.98E + 06

Table B2-21. Tank 241-B-110 Analytical Results: Potassium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		$\mu g/g$
89-0621	1	< 549
90-0640	2	378
89-0977	3	278
90-0716	4	716
90-1257	9	268
90-1279	10	338
90-4180	18	323

Note:

[1]Results for the ICP fusion analyses for potassium are meaningless because the samples were fused with potassium hydroxide in a nickel crucible.

Table B2-22. Tank 241-B-110 Analytical Results: Rhenium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	< 36
90-0640	2	< 4
89-0977	3	< 12
90-0716	4	< 2
90-1257	9	< 4
90-1279	10	< 4
90-4180	18	< 3
Solids Composites: fusion digest		μg/g
90-2949	1	< 55
90-1125		< 58
90-1126		< 59
89-1251	2	< 71
89-1252		< 71
89-0971	3	< 72
89-0972		< 72
89-0973		< 75
89-0974		< 75
89-0975		< 73
89-0976		< 73
90-0714	4	< 99
90-0715		< 99
90-1255	9	< 121
90-1256		< 121
90-1277	10	< 65
90-1278		< 65
90-4178	18	< 73
90-4179		< 73

Table B2-22. Tank 241-B-110 Analytical Results: Rhenium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	< 20
90-0640	2	8.5
89-0977	3	5.5
90-0716	4	6.5
90-1257	9	6.0
90-1279	10	6.5
90-4180	18	6.5

Table B2-23. Tank 241-B-110 Analytical Results: Ruthenium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	< 62
90-0640	2	< 8
89-0977	3	< 20
90-0716	4	< 5
90-1257	9	< 13
90-1279	10	< 13
90-4180	18	< 13
Solids Composites: fusion digest		µg/g
90-2949	1	< 172
90-1125		< 133
90-1126		< 136
89-1251	2	< 298
89-1252		< 298
89-0971	3	< 207
89-0972		< 207
89-0973		< 214
89-0974		< 214
89-0975		< 208
89-0976		< 208
90-0714	4	< 186
90-0715		< 186
90-1255	9	< 399
90-1256		< 399
90-1277	10	< 143
90-1278		< 143
90-4178	18	< 330
90-4179		< 330

Table B2-23. Tank 241-B-110 Analytical Results: Ruthenium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	52
90-0640	2	173
89-0977	3	29.5
90-0716	4	28.5
90-1257	9	137
90-1279	10	175
90-4180	18	185

Table B2-24. Tank 241-B-110 Analytical Results: Silicon. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	389
90-0640	2	371
89-0977	3	424
90-0716	4	322
90-1257	9	459
90-1279	10	447
90-4180	18	460
Solids Composites: fusion digest		µg/g
90-2949	1	11,500
90-1125		9,420
90-1126		9,410
89-1251	2	9,870
89-1252		9,920
89-0971	3	9,050
89-0972		9,550
89-0973		9,000
89-0974		9,360
89-0975		9,620
89-0976		8,980
90-0714	4	9,290
90-0715		9,120
90-1255	9	8,200
90-1256		8,100
90-1277	10	8,780
90-1278		9,000
90-4178	18	10,100
90-4179		10,100

Table B2-24. Tank 241-B-110 Analytical Results: Silicon. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	572
90-0640	2	694
89-0977	3	929
90-0716	4	565
90-1257	9	519
90-1279	10	690
90-4180	18	420

Table B2-25. Tank 241-B-110 Analytical Results: Silver. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	< 31
90-0640	2	6.5
89-0977	3	14
90-0716	4	10
90-1257	9	4
90-1279	10	10.5
90-4180	18	< 3
Solids Composites: fusion digest		μg/g
90-2949	1	98
90-1125		53.5
90-1126		< 51.0
89-1251	2	44
89-1252		< 43
89-0971	3	< 44
89-0972		< 44
89-0973		< 46
89-0974		< 46
89-0975		< 44
89-0976		< 44
90-0714	4	262
90-0715		303
90-1255	9	161
90-1256		140
90-1277	10	132
90-1278		142
90-4178	18	< 73
90-4179		< 73

Table B2-25. Tank 241-B-110 Analytical Results: Silver. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	21.5
90-0640	2	22
89-0977	3	10
90-0716	4	116
90-1257	9	30.5
90-1279	10	48
90-4180	18	12.5

Table B2-26. Tank 241-B-110 Analytical Results: Sodium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	86,600
90-0640	2	88,100
89-0977	3	84,400
90-0716	4	1.04E+05
90-1257	9	93,400
90-1279	10	97,800
90-4180	18	84,700
Solids Composites: fusion digest		µg/g
90-2949	1	1.22E+05
90-1125		98,700
90-1126		97,100
89-1251	2	94,700
89-1252		96,200
89-0971	3	90,200
89-0972		94,900
89-0973		91,100
89-0974		92,800
89-0975		94,900
89-0976		92,500
90-0714	4	1.08E+05
90-0715		1.05E+05
90-1255	9	91,500
90-1256		90,600
90-1277	10	90,900
90-1278		94,400
90-4178	18	96,200
90-4179		92,700

Table B2-26. Tank 241-B-110 Analytical Results: Sodium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	97,000
90-0640	2	97,700
89-0977	3	94,900
90-0716	4	1.07E+05
90-1257	9	92,900
90-1279	10	96,100
90-4180	18	93,500

Table B2-27. Tank 241-B-110 Analytical Results: Strontium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		$\mu g/g$
89-0621	1	< 2
90-0640	2	0.5
89-0977	3	0.5
90-0716	4	0.5
90-1257	9	< 0.274
90-1279	10	1
90-4180	18	1
Solids Composites: fusion digest		$\mu g/g$
90-2949	1	245
90-1125		205
90-1126		202
89-1251	2	212
89-1252		213
89-0971	3	243
89-0972		256
89-0973		245
89-0974		251
89-0975		258
89-0976	3	245
90-0714	4	180
90-0715		180
90-1255	9	172
90-1256		171
90-1277	10	186
90-1278		194
90-4178	18	263
90-4179		257

Table B2-27. Tank 241-B-110 Analytical Results: Strontium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	208
90-0640	2	212
89-0977	3	269
90-0716	4	181
90-1257	9	173
90-1279	10	197
90-4180	18	267

Table B2-28. Tank 241-B-110 Analytical Results: Tellurium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	< 101
90-0640	2	< 10
89-0977	3	< 72
90-0716	4	< 9
90-1257	9	< 12
90-1279	10	< 12
90-4180	18	< 12
Solids Composites: fusion digest		µg/g
90-2949	1	< 267
90-1125		< 216
90-1126		< 220
89-1251	2	< 139
89-1252		< 139
89-0971	3	< 356
89-0972		< 356
89-0973		< 368
89-0974		< 368
89-0975		< 358
89-0976		< 358
90-0714	4	< 457
90-0715		< 457
90-1255	9	< 492
90-1256		< 492
90-1277	10	< 309
90-1278		< 309
90-4178	18	< 302
90-4179		< 302

Table B2-28. Tank 241-B-110 Analytical Results: Tellurium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		µg/g
89-0621	1	< 98
90-0640	2	23.5
89-0977	3	< 13
90-0716	4	18
90-1257	9	13
90-1279	10	14.5
90-4180	18	17

Table B2-29. Tank 241-B-110 Analytical Results: Thorium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	219
90-0640	2	< 25
89-0977	3	< 72
90-0716	4	< 12
90-1257	9	< 37
90-1279	10	< 37
90-4180	18	< 31
Solids Composites: fusion digest		µg/g
90-2949	1	< 602
90-1125		< 495
90-1126		< 505
89-1251	2	< 453
89-1252		< 453
89-0971	3	< 703
89-0972		< 703
89-0973		< 728
89-0974		< 728
89-0975	3	< 708
89-0976		< 708
90-0714	4	< 773
90-0715		< 773
90-1255	9	< 854
90-1256		< 854
90-1277	10	< 507
90-1278		< 507
90-4178	18	< 769
90-4179		< 769

Table B2-29. Tank 241-B-110 Analytical Results: Thorium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		µg/g
89-0621	1	< 223
90-0640	2	< 31
89-0977	3	29
90-0716	4	< 15
90-1257	9	< 19
90-1279	10	< 48
90-4180	18	< 36

Table B2-30. Tank 241-B-110 Analytical Results: Titanium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	12.5
90-0640	2	1
89-0977	3	< 4
90-0716	4	< 1
90-1257	9	< 2
90-1279	10	< 2
90-4180	18	< 2
Solids Composites: fusion digest		µg/g
90-2949	1	29
90-1125		< 33
90-1126		< 33
89-1251	2	24.0
89-1252		< 20
89-0971	3	< 48
89-0972		< 48
89-0973		< 50
89-0974		< 50
89-0975		< 49
89-0976		< 49
90-0714	4	< 47
90-0715		< 47
90-1255	9	< 66
90-1256		< 66
90-1277	10	< 37
90-1278		< 37
90-4178	18	< 56
90-4179		< 56

Table B2-30. Tank 241-B-110 Analytical Results: Titanium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	< 11
90-0640	2	7
89-0977	3	7
90-0716	4	11.5
90-1257	9	7
90-1279	10	14.5
90-4180	18	5

Table B2-31. Tank 241-B-110 Analytical Results: Uranium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest (ICP)		μg/g
89-0621	1	2,050
90-0640	2	< 256
89-0977	3	< 634
90-0716	4	< 131
90-1257	9	< 322
90-1279	10	< 320
90-4180	18	< 247
Solids Composites: water digest (LF)		μg/g
89-0621	1	0.89
90-0640	2	2.5
89-0977	3	1.0
90-0716	4	0.52
90-1257	9	0.52
90-1279	10	1.5
90-4180	18	0.60
Solids Composites: fusion digest (ICP)		μg/g
90-2949	1	< 5,650
90-1125		< 5,360
90-1126		< 5,460
89-1251	2	< 5,340
89-1252		< 5,340
89-0971	3	< 6,610
89-0972		< 6,610
89-0973		< 6,840
89-0974		< 6,840
89-0975		< 6,660
89-0976		< 6,660
90-0714	4	< 7,480
90-0715		< 7,480

Table B2-31. Tank 241-B-110 Analytical Results: Uranium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: fusion digest (ICP) (Continued)		µg/g
90-1255	9	< 7,870
90-1256		< 7,870
90-1277	10	< 4,580
90-1278		< 4,580
90-4178	18	< 6,150
90-4179		< 6,150
Solids Composites: fusion digest (LF)		µg/g
89-0622	1	238
89-0623		232
89-1251	2	232
89-1252		225
89-0971	3	178
89-0972		181
90-0714	4	209
90-0715		223
90-1255	9	179
90-1256		185
90-1277	10	262
90-1278		283
90-4178	18	142
Solids Composites: acid digest (ICP)		µg/g
89-0621	1	< 2,130
90-0640	2	971
89-0977	3	900
90-0716	4	716
90-1257	9	603
90-1279	10	951
90-4180	18	948

Table B2-32. Tank 241-B-110 Analytical Results: Vanadium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	11.5
90-0640	2	< 1
89-0977	3	< 2
90-0716	4	< 1
90-1257	9	< 2
90-1279	10	< 2
90-4180	18	< 2
Solids Composites: fusion digest		μg/g
90-2949	1	< 35
90-1125		< 34
90-1126		< 34
89-1251	2	< 24
89-1252		< 24
89-0971	3	< 43
89-0972		< 43
89-0973		< 44
89-0974		< 44
89-0975		< 43
89-0976		< 43
90-0714	4	< 53
90-0715		< 53
90-1255	9	< 84
90-1256		< 84
90-1277	10	< 44
90-1278		< 40
90-4178	18	< 50
90-4179		< 50

Table B2-32. Tank 241-B-110 Analytical Results: Vanadium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	< 10
90-0640	2	4
89-0977	3	< 1
90-0716	4	5
90-1257	9	2
90-1279	10	4
90-4180	18	4

Table B2-33. Tank 241-B-110 Analytical Results: Zinc. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	7.5
90-0640	2	< 0.498
89-0977	3	80.5
90-0716	4	1
90-1257	9	< 1
90-1279	10	1
90-4180	18	< 1
Solids Composites: fusion digest		µg/g
90-2949	1	128
90-1125		1,370
90-1126		114
89-1251	2	149
89-1252		141
89-0971	3	184
89-0972		210
89-0973		167
89-0974		186
89-0975		217
89-0976	3	200
90-0714	4	118
90-0715		108
90-1255	9	148
90-1256		118
90-1277	10	174
90-1278		89
90-4178	18	229
90-4179		248

Table B2-33. Tank 241-B-110 Analytical Results: Zinc. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		$\mu g/g$
89-0621	1	91.5
90-0640	2	95
89-0977	3	76
90-0716	4	85
90-1257	9	52
90-1279	10	80.5
90-4180	18	82

Table B2-34. Tank 241-B-110 Analytical Results: Zirconium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	< 13
90-0640	2	< 2
89-0977	3	< 7
90-0716	4	< 1
90-1257	9	< 2
90-1279	10	< 2
90-4180	18	< 2
Solids Composites: fusion digest		µg/g
90-2949	1	< 36
90-1125		412
90-1126		417
89-1251	2	232
89-1252		268
89-0971	3	< 51
89-0972		< 51
89-0973		< 53
89-0974		< 53
89-0975		< 51
89-0976		< 51
90-0714	4	< 531
90-0715		< 531
90-1255	9	< 70
90-1256		< 70
90-1277	10	< 33
90-1278		< 33
90-4178	18	< 47
90-4179		< 47

Table B2-34. Tank 241-B-110 Analytical Results: Zirconium. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	14.5
90-0640	2	7
89-0977	3	5
90-0716	4	8.5
90-1257	9	4
90-1279	10	8
90-4180	18	5

Table B2-35. Tank 241-B-110 Analytes Detected Less than Detection Value.

Analyte	Maximum of Less Than Detected Value (µg/g)	Analyte	Maximum of Less Than Detected Value (µg/g)
Antimony	< 1,940	Dysprosium	< 88
Arsenic	< 655	Rhodium	< 750
Beryllium	< 2	Selenium	< 1,130
Cobalt	< 2,430	Thallium	< 14,600

Table B2-36. Tank 241-B-110 Analytical Results: Chloride.

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	1,020
90-0640	2	1,070
89-0977	3	1,050
90-0716	4	1,480
90-1257	9	1,260
90-1279	10	1,280
90-4180	18	1,440

Table B2-37. Tank 241-B-110 Analytical Results: Fluoride.

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	1,650
90-0640	2	1,740
89-0977	3	1,480
90-0716	4	2,260
90-1257	9	2,010
90-1279	10	2,020
90-4180	18	1,980

Table B2-38. Tank 241-B-110 Analytical Results: Nitrate.

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	1.62E+05
90-0640	2	1.70E+05
89-0977	3	1.63E+05
90-0716	4	2.31E+05
90-1257	9	1.88E+05
90-1279	10	1.86E+05
90-4180	18	1.69E+05

Table B2-39. Tank 241-B-110 Analytical Results: Nitrite.

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	9,860
90-0640	2	10,700
89-0977	3	9,210
90-0716	4	11,950
90-1257	9	8,950
90-1279	10	11,100
90-4180	18	10,300

Table B2-40. Tank 241-B-110 Analytical Results: Phosphate.

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	25,400
90-0640	2	24,800
89-0977	3	22,700
90-0716	4	28,100
90-1257	9	25,200
90-1279	10	24,400
90-4180	18	24,000

Table B2-41. Tank 241-B-110 Analytical Results: Sulfate.

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	10,500
90-0640	2	10,600
89-0977	3	10,200
90-0716	4	13,800
90-1257	9	11,100
90-1279	10	11,500
90-4180	18	11,200

Table B2-42. Tank 241-B-110 Analytical Results: Mercury.

Sample Number	Core Number	Mean
Solids Composites: acid digest		μg/g
89-0621	1	1.02
90-0640	2	1.43
89-0977	3	0.915
90-1257	9	0.70
89-1279	10	1.86
90-4180	18	0.60

Table B2-43. Tank 241-B-110 Analytical Results: Ammonia.

Sample Number	Core Number	Mean
Solids Composites: water digest		μg/g
89-0621	1	259
90-0640	2	222
89-0977	3	319
90-1257	9	268
90-1279	10	148
90-4180	18	364

Table B2-44. Tank 241-B-110 Analytical Results: Chromium (VI).

Sample Number	Core Number	Mean
Solids Composites: water digest		µg/g
89-0621	1	67.0
90-0640	2	32.7
89-0977	3	28.6
90-1257	9	36.6
90-1279	10	52.9
90-4180	18	31.4

Table B2-45. Tank 241-B-110 Analytical Results: Volatile Organics.

Analyte	Result µg/g	Analyte	Result µg/g
Chloromethane	ND	Trichloroethane	ND
Bromomethane	ND	Dibromochloromethane	ND
Vinyl Chloride	ND	1,1,2-Trichloroethane	ND
Chloroethane	ND	Benzene	ND
Methylene Chloride	ND	trans-1,3-Dichloropropene	ND
Acetone	ND	Bromoform	ND
Carbon Disulfide	ND	4-Methyl-2-Pentanone	ND
1,1-Dichloroethene	ND	2-Hexanone	ND
1,1-Dichloroethane	ND	Tetrachloroethene	ND
Bromodichloromethane	ND	1,1,2,2-Tetrachloroethane	ND
cis-1,2-Dichloroethene	ND	Toluene	ND
Chloroform	ND	Chlorobenzene	ND
1,2-Dichloroethane	ND	Ethylbenzene	ND
2-Butanone	ND	Styrene	ND
1,1,1-Trichloroethane	ND	Xylene (total)	ND
Carbon Tetrachloride	ND	cis-1,3-Dichloropropene	ND
Vinyl Acetate	ND	1,2-Dichloropropane	ND

Note:
ND = not detected

Table B2-46. Tank 241-B-110 Analytical Results: Semivolatile Organics. (2 sheets)

Analyte	Result µg/g	Analyte	Result µg/g
2,6-Dinitrotoluene	ND	3-Nitroaniline	ND
Phenol	ND	Acenaphthene	ND
bis(2-Chloroethyl)ether	ND	2,4-Dinitrophenol	ND
2-Chlorophenol	ND	4-Nitrophenol	ND
1,3-Dichlorobenzene	ND	Dibenzofuran	ND
1,4-Dichlorobenzene	ND	2,4-Dinitrotoluene	ND
Benzyl alcohol	ND	Diethylphthalate	ND
1,2-Dichlorobenzene	ND	4-Chlorophenyl-phenylether	ND
2-Methylphenol	ND	Fluorene	ND
bis(2-Chloroisopropyl)ether	ND	4-Nitroaniline	ND
4-Methylphenol	ND	4,6-Dinitro-2-methylphenol	ND
N-Nitroso-di-n-propylamine	ND	N-Nitrosodiphenylamine (1)	ND
Hexachloroethane	ND	Benzo(g,h,i)perylene	ND
Nitrobenzene	ND	4-Bromophenyl-phenylether	ND
Isophorone	ND	Hexachlorobenzene	ND
2-Nitrophenol	ND	Pentachlorophenol	ND
2,4-Dimethylphenol	ND	Phenanthrene	ND
Benzoic acid	ND	Anthracene	ND
bis(2-Chloroethoxy)methane	ND	Di-n-butylphthalate	ND
2,4-Dichlorophenol	ND	Fluoranthene	ND
1,2,4-Trichlorobenzene	ND	Pyrene	ND
Naphthalene	ND	Butylbenzylphthalate	ND
4-Chloroaniline	ND	3,3'-Dichlorobenzidine	ND
Hexachlorobutadiene	ND	Benzo(a)anthracene	ND
4-Chloro-3-methylphenol	ND	Chrysene	ND
2-Methylnaphthalene	ND	bis-(2-Ethylexyl)phthalate	ND
Hexachlorocyclopentadiene	ND	Di-n-octylphthalate	ND

Table B2-46. Tank 241-B-110 Analytical Results: Semivolatile Organics. (2 sheets)

Analyte	Result µg/g	Analyte	Result µg/g
2,4,6-Trichlorophenol	ND	Benzo(b)fluoranthene	ND
2,4,5-Trichlorophenol	ND	Benzo(k)fluoranthene	ND
2-Chloronaphthalene	ND	Benzo(a)pyrene	ND
2-Nitroaniline	ND	Indeno(1,2,3-cd)pyrene	ND
Dimethylphthalate	ND	Dibenz(a,h)anthracene	ND
Acenaphthylene	ND		

Note:
ND = not detected

Table B2-47. Tank 241-B-110 Analytical Results: Total Inorganic Carbon.

Sample Number	Core Number	Mean
Solids Composites: water digest		µg C/g
89-0621	1	1,140
90-0640	2	910
89-0977	3	969
90-0716	4	965
90-1257	9	623
90-1279	10	909
90-4180	18	785

Table B2-48. Tank 241-B-110 Analytical Results: Total Organic Carbon.

Sample Number	Core Number	Mean
Solids Composites: water digest		μg C/g
89-0621	1	419
90-0640	2	320
89-0977	3	329
90-0716	4	426
90-1257	9	301
90-1279	10	442
90-4180	18	432

Table B2-49. Tank 241-B-110 Analytical Results: Cerium-144.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		μCi/g
89-0622	1	0.252
89-0623		0.221
90-0715	4	0.0399
90-4178	18	0.0646
90-4179		0.0911

Table B2-50. Tank 241-B-110 Analytical Results: Cesium-134.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		μCi/g
89-0981	1	0.0192
89-0971	3	0.0051
89-0974		0.0115
Solids Composites: water digest		μCi/g
89-0621	1	0.00445
90-4180	18	0.0007

Table B2-51. Tank 241-B-110 Analytical Results: Cesium-137.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		μCi/g
89-0622	1	14.5
89-0623		14.8
89-0980		14.4
89-0981		14.7
90-1125		9.2
90-1126		14.6
89-1251	2	15.0
89-1252		15.1
89-0971	3	13.9
89-0972		14.0
89-0973		13.5
89-0974		13.6
89-0975		13.1
89-0976		14.2
90-0714	4	16.1
90-0715		15.7
90-1255	9	13.6
90-1256		14.5
90-1277	10	15.0
90-1278	10	14.7
90-4178	18	14.2
90-4179		14.2
Solids Composites: water digest		μCi/g
89-0621	1	8.43
89-0640	2	7.85
89-0977	3	7.61
90-0716	4	9.80
90-1257	9	8.80
90-1279	10	8.64
90-4180	18	7.52

Table B2-52. Tank 241-B-110 Analytical Results: Cobalt-60.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		µCi/g
89-0980	1	0.00713
89-0981		0.00864
90-1126		0.0013
89-1251	2	0.121
89-1252		0.00332
89-0971	3	0.00217
89-0972		0.00243
89-0973		0.00382
89-0974		0.0527
89-0975		0.00228
89-0976		0.0118
90-0714	4	0.0051
90-0715		0.0049
90-0716		0.0004
90-4178	18	0.0124
90-4179		0.163

Table B2-53. Tank 241-B-110 Analytical Results: Europium-152.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		µCi/g
89-1251	2	0.0963
89-1252		0.0838
90-1255	9	0.0375

Table B2-54. Tank 241-B-110 Analytical Results: Europium-154.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		μCi/g
89-0622	1	0.388
89-0623		0.392
89-0980		0.415
89-0981		0.272
90-1125		0.219
90-1126		0.324
89-1251	2	0.316
89-1252		0.257
89-0971	3	0.0476
89-0972		0.0497
89-0973		0.0497
89-0974		0.0601
89-0975		0.0428
89-0976		0.0447
90-0714	4	0.195
90-0715		0.152
90-1255	9	0.113
90-1256		0.117
90-1277	10	0.145
90-1278		0.158
90-4178	18	0.0164
90-4179		0.0297
Solids Composites: water digest		μCi/g
89-0621	1	0.0102
90-0716	4	0.00521
90-1279	10	0.00334

Table B2-55. Tank 241-B-110 Analytical Results: Europium-155.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		µCi/g
89-0622	1	0.609
89-0623		0.609
89-0980		0.231
89-0981		0.234
90-1125		0.323
90-1126		0.539
89-1251	2	0.251
89-1252		0.248
89-0971	3	0.0796
89-0972		0.0689
89-0973		0.0633
89-0974		0.0852
89-0975		0.0691
89-0976		0.0696
90-0714	4	0.318
90-0715		0.390
90-1255	9	0.171
90-1256		0.172
90-1277	10	0.206
90-1278		0.219
90-4178	18	0.0128
Solids Composites: water digest		µCi/g
89-0621	1	0.0250
90-0716	4	0.00840
90-1279	10	0.00441

Table B2-56. Tank 241-B-110 Analytical Results: Gadolinium-153.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		µCi/g
89-0980	1	0.571
89-0981		0.267
89-1251	2	0.258
89-1252		0.189
89-0974	3	0.0149
89-0975		0.0130

Table B2-57. Tank 241-B-110 Analytical Results: Ruthenium-106.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		µCi/g
89-0623	1	0.121
89-1252	2	0.270
89-0976	3	0.0231

Table B2-58. Tank 241-B-110 Analytical results: Selenium-75.

Sample Number	Core Number	Mean
Solids Composites: fusion digest (GEA)		µCi/g
89-0973	3	0.0346

Table B2-59. Tank 241-B-110 Analytical Results: Americium-241. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: fusion digest (GEA)		μCi/g
89-0622	1	0.138
89-0623		0.140
89-0980		0.0716
89-0981		0.0803
90-1125		0.129
90-1126		0.212
89-1251	2	0.0666
89-1252		0.0738
89-0971	3	0.0389
89-0972		0.0327
89-0973		0.0379
89-0974		0.0382
89-0975		0.0315
89-0976		0.0345
90-0714	4	0.116
90-0715		0.0989
90-1255	9	0.0492
90-1256		0.0388
90-1277	10	0.0855
90-1278		0.0853
90-4178	18	0.0188
90-4179		0.0175
Solids Composites: fusion digest (AEA)		μg/g
89-0622	1	0.135
89-0623		0.136
89-0971	3	0.0203
89-0972		0.0232
90-0714	4	0.0856
90-0715		0.0932

Table B2-59. Tank 241-B-110 Analytical Results: Americium-241. (2 sheets)

Sample Number	Core Number	Mean
Solids Composites: fusion digest (AEA) (Continued)		$\mu g/g$
90-1255	9	0.0362
90-1256		0.0361
90-1277	10	0.0561
90-1278		0.0592
90-4178	18	0.0168
Solids Composites: water digest (AEA)		$\mu Ci/g$
89-0621	1	0.00453
89-0640	2	0.0005
90-0716	4	0.00239
90-1257	9	0.0004
90-1279	10	0.00215
90-4180	18	9.69E-05

Table B2-60. Tank 241-B-110 Analytical Results: Curium-243/244.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		µCi/g
89-0622	1	0.0033
89-0971	3	0.0008
89-0972		0.0006
90-0714	4	0.0006
90-0715		0.0008
90-1277	10	0.0003
90-1278		0.0002
90-4178	18	0.0015
Solids Composites: water digest		µCi/g
89-0621	1	7.66E-05
89-0640	2	1.5E-06
90-0716	4	5.1E-06

Table B2-61. Tank 241-B-110 Analytical Results: Carbon-14.

Sample Number	Core Number	Mean
Solids Composites: water digest		µCi/g
89-0977	3	0.00360
90-1279	10	7.46E-05
90-4180	18	1.02E-09

Table B2-62. Tank 241-B-110 Analytical Results: Iodine-129.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		µCi/g
89-0623	1	3.00E-05
90-1277	10	7.46E-05
90-1278		7.46E-05
90-4178	18	0.00011
Solids Composites: water digest		µCi/g
89-0640	2	3.13E-06
90-1279	10	6.53E-06

Table B2-63. Tank 241-B-110 Analytical Results: Neptunium-237.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		µCi/g
89-0622	1	1.01E-04
89-0623		3.99E-04
89-0971	3	7.89E-05
89-0972		8.11E-05
90-0714	4	1.39E-04
90-0715		1.08E-04
90-1255	9	8.40E-05
90-1256		7.56E-05
90-1277	10	9.57E-05
90-1278		8.04E-05
90-4178	18	3.02E-05
Solids Composites: water digest		µCi/g
89-0640	2	2.41E-04
90-0716	4	1.89E-04
90-1257	9	2.37E-06
90-1279	10	1.74E-05
90-4180	18	7.00E-06

Table B2-64. Tank 241-B-110 Analytical Results: Plutonium-238.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		μCi/g
89-0622	1	0.00351
89-0623		0.00369
89-0971	3	0.00277
89-0972		0.00182
90-0714	4	0.00244
90-0715		0.00307
90-1255	9	0.00143
90-1256		0.00247
90-1277	10	0.00148
90-1278		0.00208
90-4178	18	0.00703
Solids Composites: water digest		μCi/g
89-0621	1	0.0001
89-0640	2	5.03E-05
89-0977	3	3.00E-05
90-0716	4	6.65E-05
90-1257	9	1.24E-05
90-1279	10	3.91E-05
90-4180	18	4.10E-05

Table B2-65. Tank 241-B-110 Analytical Results: Plutonium-239/240.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		μCi/g
89-0622	1	0.111
89-0623		0.106
89-0971	3	0.149
89-0972		0.124
90-0714	4	0.114
90-0715		0.120
90-1255	9	0.0926
90-1256		0.0962
90-1277	10	0.0700
90-1278		0.114
90-4178	18	0.121
Solids Composites: water digest		μCi/g
89-0621	1	0.00173
89-0640	2	0.00134
89-0977	3	0.00191
90-0716	4	0.00159
90-1257	9	0.0007
90-1279	10	0.00131
90-4180	18	0.00154

Table B2-66. Tank 241-B-110 Analytical Results: Plutonium Isotopics.

Sample Number	Core Number	Pu-238/Pu-239	Pu-240/Pu-239	Pu-241/Pu-239	Pu-242/Pu-239
Solids Composites: fusion digest					
89-0622	1	5.49E-04	0.0294	5.71E-04	2.81E-04
89-0623		6.42E-04	0.0299	6.03E-04	2.90E-04
90-0715	4	0.00487	0.0368	9.19E-04	4.48E-04

Table B2-67. Tank 241-B-110 Analytical Results: Uranium Isotopics.

Sample Number	Core Number	U-234/U-238	U-235/U-238	U-236/U-238
Solids Composites: fusion digest				
89-0622	1	6.9E-05	0.00674	1.20E-04
89-0623		5.9E-05	0.00674	1.12E-04
90-0715	4	6.3E-05	0.00678	1.12E-04

Table B2-68. Tank 241-B-110 Analytical Results: Strontium-90.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		µCi/g
89-0622	1	224
89-0623		210
89-0971	3	26.9
89-0972		26.0
90-0714	4	121
90-0715		149
90-1255	9	50.0
90-1256		47.1
90-1277	10	62.4
90-1278		73.4
90-4178	18	6.78
Solids Composites: water digest		µCi/g
89-0621	1	0.220
89-0640	2	0.302
89-0977	3	0.0813
90-0716	4	0.0714
90-1257	9	0.0103
90-1279	10	0.0486
90-4180	18	0.0037

Table B2-69. Tank 241-B-110 Analytical Results: Technetium-99.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		μCi/g
89-0622	1	0.0207
89-0623		0.0208
89-0971	3	0.00777
89-0972		0.00609
90-0714	4	0.0214
90-0715		0.0173
90-1255	9	0.0154
90-1256		0.0148
90-1277	10	0.0127
90-1278		0.0119
90-4178	18	0.0113
Solids Composites: water digest		μCi/g
89-0621	1	0.0181
89-0640	2	0.0225
90-0716	4	0.018
90-1257	9	0.0156
90-1279	10	0.0159
90-4180	18	0.0158

Table B2-70. Tank 241-B-110 Analytical Results: Tritium.

Sample Number	Core Number	Mean
Solids Composites: water digest		μCi/g
89-0621	1	0.00143
89-0640	2	0.0006
89-0977	3	0.00228
90-0716	4	0.00130
90-1257	9	0.00364
90-1279	10	< 3.58E-06
90-4180	18	0.0060

Table B2-71. Tank 241-B-110 Analytical Results: Total Alpha Activity (Composite).[1]

Sample Number	Core Number	Mean
Solids Composites: fusion digest		μCi/g
89-0622	1	0.228
89-0623		0.219
89-1251	2	0.134
89-1252		0.127
89-0971	3	0.137
89-0972		0.144
90-0714	4	0.162
90-0715		0.174
90-1255	9	0.113
90-1256		0.117
90-1277	10	0.150
90-1278		0.159
Solids Composites: water digest		μCi/g
89-0621	1	0.00581
89-0640	2	0.00190
89-0977	3	0.00171
90-0716	4	0.00445
90-1257	9	0.00093
90-1279	10	0.00249

Note:

[1]Total alpha activity on segment level - see Table C1-1 (Appendix C)

Table B2-72. Tank 241-B-110 Analytical Results: Total Beta Activity.

Sample Number	Core Number	Mean
Solids Composites: fusion digest		µCi/g
89-0622	1	507
89-0623		511
89-1251	2	151
89-1252		147
89-0971	3	61.0
89-0972		66.7
90-0714	4	255
90-0715		313
90-1255	9	107
90-1256		108
90-1277	10	158
90-1278		153
90-4178	18	29.6
Solids Composites: water digest		µCi/g
89-0621	1	14.1
89-0640	2	8.58
89-0977	3	7.45
90-0716	4	12.0
90-1257	9	9.12
90-1279	10	10.6
90-4180	18	7.86

Table B2-73. Tank 241-B-110 Analytical Results: Bulk Density.

Sample Number	Core Number	Mean
Solids Composites: direct		g/mL
None	1	1.36
None	2	1.33
None	3	1.36
None	4	1.42
None	9	1.32
None	10	1.34
None	18	1.37

Table B2-74. Tank 241-B-110 Analytical Results: Centrifuged Solids Density.

Sample Number	Core Number	Mean
Solids Composites: direct		g/mL
None	1	1.55
None	2	1.46
None	3	1.57
None	9	1.44
None	10	1.47
None	18	1.51

Table B2-75. Tank 241-B-110 Analytical Results: Centrifuged Supernatant Density.

Sample Number	Core Number	Mean
Solids Composites: direct		g/mL
None	1	1.25
None	2	1.21
None	3	1.24
None	9	1.24
None	10	1.24
None	18	1.24

Table B2-76. Tank 241-B-110 Analytical Results: Weight Percent Centrifuged Solids.

Sample Number	Core Number	Mean
Solids Composites: direct		volume %
None	1	46.9
None	2	48.6
None	3	44.8
None	9	40.7
None	10	46.6
None	18	53.8

Table B2-77. Tank 241-B-110 Analytical Results: Volume Percent Centrifuged Solids.

Sample Number	Core Number	Mean
Solids Composites		volume %
None	1	41.6
None	2	44.4
None	3	38.1
None	9	37.2
None	10	42.4
None	18	48.7

Table B2-78. Tank 241-B-110 Analytical Results: Weight Percent Dissolved Solids.

Sample Number	Core Number	Mean
Solids Composites		weight %
None	1	19.7
None	2	17.2
None	3	13.4
None	9	20.6
None	10	21.5
None	18	17.2

Table B2-79. Tank 241-B-110 Analytical Results: Weight Percent Solids (Gravimetric).

Sample Number	Core Number	Mean
Solids Composites		weight %
89-0622	1	41.2
89-0623		41.0
89-1251	2	42.2
89-1252		42.1
90-0640		43.5
89-0971	3	40.9
89-0972		41.5
89-0973		40.9
89-0974		40.7
89-0975		40.8
89-0976		40.9
89-0977		40.7
90-0714	4	45.6
90-0715		45.6
90-1255	9	40.2
90-1256		40.0
90-1257		40.4
90-1277	10	41.0
90-1278		40.9
90-1279		40.8
90-4178	18	43.3
90-4180		42.7

Table B2-80. Tank 241-B-110 Analytical Results: pH.

Sample Number	Core Number	Mean
Solids Composites: water digest		
89-0621	1	8.23
90-0640	2	8.94
89-0977	3	7.73
90-1257	9	7.91
90-1279	10	8.11
90-4180	18	8.10

Table B2-81. Tank 241-B-110 Rheological Parameters.[1]

Core	Run	τ_o	K	n
1	1	4.83	0.0448	0.8817
	2	3.80	0.0258	0.9851
2	1	4.65	0.01749	1.05
	2	3.46	0.043	0.8817
3	1	2.58	0.0436	0.8619
	2	2.90	0.01505	1.0266
9	1	2.47	0.0628	0.740
	2	2.08	0.0504	0.780
10	1	2.47	0.1051	0.710
	2	4.14	0.0294	0.892
18	1	7.08	0.0214	0.985
		6.16	0.0636	0.819
	2	6.96	0.0041	1.254
		5.48	0.0454	0.880

Note:

[1] $\tau = \tau_o + K \gamma^n$, where τ = shear stress (Pa) and γ = shear rate (sec^{-1}).

Table B2-82. Tank 241-B-110 Rheological Data.

Core	Pipe Diameter in.	Critical Reynolds Number	Critical Velocity ft/sec	Critical Flowrate gpm
1	2.0	4,300 to 4,600	4.7 to 5.1	50 to 54
	3.0	5,500 to 5,700	4.1 to 4.5	95 to 105
	4.0	6,600	3.8 to 4.2	150 to 166
2	2.0	4,200 to 4,700	4.6 to 5.0	48 to 52
	3.0	5,200 to 6,200	4.1 to 4.4	94 to 100
	4.0	6,000 to 7,600	3.8 to 4.0	150 to 159
3	2.0	4,000 to 4,600	4.1	43
	3.0	4,900 to 6,000	3.6	83
	4.0	5,600 to 7,300	3.3	132
9	2.0	4,300 to 4,500	3.5 to 3.7	37 to 39
	3.0	5,100 to 5,300	3.2 to 3.4	73 to 77
10	2.0	3,800 to 5,400	4.3	45
	3.0	4,300 to 6,800	3.8 to 3.9	88 to 89
18	2.0	4,800 to 7,200	5.0 to 5.5	53 to 57
	3.0	5,900 to 10,700	4.4 to 4.9	101 to 113

Table B2-83. Tank 241-B-110 Analytical Results: Weight Percent Solids by TGA.

Sample Number	Core Number	Mean
Solids Composites		Weight %
None	1	48.1
None	2	49.3
None	3	45.1
None	4	47.8
None	9	41.5
None	10	42.6
None	18	46.2

Table B2-84. Tank 241-B-110 Analytical Results: Differential Scanning Calorimetry.

Sample Number	Core Number		Transition 1		Transition 2		Transition 3	
Solids Composites		Run	Temp. Range (°C)	ΔH (J/g)	Temp. Range (°C)	ΔH (J/g)	Temp. Range (°C)	ΔH (J/g)
None	1	1	25 to 83	837	108 to 165	377	268 to 316	46
None		2	25 to 120	385	95 to 220	544	275 to 310	25
None	2	1	30 to 130	1,042	284 to 308	8	---	---
None		2	30 to 130	1,109	279 to 312	8	---	---
None	3	1	30 to 85	753	104 to 139	406	282 to 309	21
None		2	30 to 92	not available	94 to 134	259	282 to 307	21
None	4	1	30 to 200	1,255	257 to 315	42	---	---
None		2	30 to 140	962	279 to 312	42	---	---
None	9	1	30 to 110	874	95 to 130	264	276 to 312	33
None		2	30 to 105	912	90 to 120	272	273 to 310	37
None	10	1	32 to 95	795	80 to 140	347	280 to 310	25
None		2	32 to 100	854	90 to 139	335	280 to 310	21
None	18	1	32 to 100	661	90 to 160	377	280 to 310	17
None		2	32 to 115	715	105 to 160	477	280 to 310	21

Table B2-85. Tank 241-B-110 Analytical Results: Vapor Phase Measurements.

Measurement	Result
Total organic carbon (TOC)	5.5 ppm
Flammability	0% of LFL
Oxygen	20.9%
Ammonia	50 ppm

Table B2-86. Tank 241-B-110 Projected Heat Load.

Radionuclide	Total Inventory (Ci)	Heat Load (Watts)
^{241}Am	90.7	2.99
^{60}Co	19	0.29
^{152}Eu	84.5	0.64
^{129}I	0.045	2.11E-05
^{238}Pu	4.00	0.130
^{99}Tc	20.65	0.010
^{137}Cs	18,600	87.8
^{90}Sr	136,000	911
$^{243/244}Cm$	1.60	0.055
^{3}H	2.72	0.00009
^{237}Np	0.14	0.0033
Total	154,823	1,003

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

The purpose of this section is to discuss the overall quality and consistency of the current sampling results for tank 241-B-110 and to show the results of the analytical-based inventory calculation.

This section also evaluates sampling and analysis factors that may impact data interpretation. These factors are used to assess the overall data quality and consistency and to identify limitations in data use.

B3.1 FIELD OBSERVATIONS

Sample recovery from segment 1 of the core samples from tank 241-B-110 was generally poor. Segment 1 from cores 3 and 9 contained no sample, and segment 1 from cores 1, 4, and 10 had lower than expected sample recovery. Segment 1 may be under-represented in the core composites, and this may lead to unknown biases in the sample-based mean concentration and inventory estimates.

B3.2 QUALITY CONTROL ASSESSMENT

The quality control requirements outlined in the 222-S and 325 Laboratory quality assurance project plans (WHC 1989, Salter 1990) were followed. Laboratory quality control requirements based on requirements of the EPA Contract Laboratory Program procedure (EPA 1990) and SW-846 (EPA 1986) were also followed.

B3.3 DATA CONSISTENCY CHECKS

Comparing different analytical methods can help to assess data consistency and quality. Several correlations were possible with the data set provided by the core samples, including comparisons of phosphorous as analyzed by ICP with phosphate as analyzed by IC, total beta activity with the sum of beta emitters, and total alpha activity with the sum of alpha emitters. In addition, mass and charge balances were calculated to help assess the overall data consistency.

B3.3.1 Comparison of Results from Different Analytical Methods

The following data consistency checks compare the results from two analytical methods. An agreement between the two methods strengthens the credibility of both results, but a poor agreement brings the reliability of the data into question.

Phosphorus is determined by ICP, and phosphate is determined by IC. Assuming that all phosphorus is present as phosphate and converting the phosphorus concentration of 16,100 μg/g accordingly yielded a mean phosphate concentration of 49,300 μg/g for the fusion-digested sample. This value is about twice the IC value for phosphate (25,300 μg/g average). This indicates that approximately half of the phosphate is water-soluble.

A comparison was made between the gross beta result and the sum of the individual beta emitters. The activity of ^{90}Sr was multiplied by 2 to account for the activity of ^{90}Y, which exists in secular equilibrium with ^{90}Sr and would have been counted in the total beta measurement and not counted in the ^{90}Sr measurement. The activity of the individual beta emitters is summed in the following equation:

$$2(^{90}Sr) + {}^{137}Cs$$

Total beta activity was 183 μCi/g. The sum of the activities of beta emitters was 231 μCi/g. The ratio of total beta to the sum of activities of the beta emitters was 0.79. Table B3-1 shows the results.

Table B3-1. Total Beta Activity Comparison.

Analyte	Laboratory Result (μCi/g)
^{90}Sr	108
^{137}Cs	14.9
Beta sum[1]	231
Gross beta result	183

Note:

[1]beta sum = 2 (^{90}Sr) + ^{137}Cs

B3.3.2 Mass and Charge Balance

The principal objective in performing mass and charge balances is to determine whether the measurements are consistent. In calculating the balances, only analytes detected at a concentration of 1,000 μg/g or greater were considered (see Table B3-12).

Except for sodium, all analytes were assumed to be present in their most common hydroxide, oxide, or phosphate forms. For example, aluminum hydroxide ($Al(OH)_3$) was the assumed species for aluminum because endothermic reactions were observed in the DSC results at approximately 300 °C. Although smaller concentrations of other forms of aluminum such as aluminosilicate are probably also present in the waste, they were not included in order to keep the mass-charge balance calculations simple and consistent. Because precipitates are neutral species, all positive charge was attributed to the sodium cation. The concentrations of cationic species in Table B3-2, the anionic species in Table B3-3, and the percent water were used to calculate the mass balance.

Phosphorus was determined by ICP, and phosphate was determined by IC. Assuming that all the phosphorus was present as phosphate and converting the phosphorus concentration accordingly yielded a mean concentration of 49,300 μg/g for the fusion-digested sample. This value is approximately twice the IC value for phosphate (25,300 μg/g average). Using information from the bismuth phosphate process flowsheet, it was assumed the insoluble phosphate (24,000 μg/g) exists as precipitates of bismuth and iron (see Table B3-3). This assumption is supported by comparing bismuth (water digest) to bismuth (fusion or acid digest).

The concentration of the cations listed in Table B3-2, the anions listed in Table B3-3, and the weight percent water results were used to calculate the mass balance. The mass balance can be calculated from the formula below. The factor 0.0001 is the conversion factor from μg/g to weight percent.

Table B3-2. Cation Mass and Charge Data.

Analyte	Concentration (µg/g)	Assumed Species	Concentration of Assumed Species (µg/g)	Charge (µeq/g)
Aluminum	1,133	$Al(OH)_3$	3,270	0
Bismuth	18,520	$BiPO_4$	26,940	0
Iron	8,910	FeO(OH)	14,180	0
	9,150	$FePO_4$	24,730	0
Sodium	97,730	Na^+	97,730	4,250
Silicon	9,358	SiO_2	20,050	0
Total			186,900	4,250

Table B3-3. Anion Mass and Charge Data.

Analyte	Concentration (µg/g)	Assumed Species	Concentration of Assumed Species (µg/g)	Charge (µeq/g)
Chloride	1,234	Cl^-	1,234	35
Fluoride	1,895	F^-	1,895	100
Nitrate	187,100	NO_3^-	187,100	3,020
Nitrite	10,290	NO_2^-	10,290	224
Phosphate	25,250	PO_4^{3-}	25,250	797
Sulfate	11,530	SO_4^{2-}	11,530	240
Total			237,299	4,416

Mass balance = % Water + 0.0001 x {Total Analyte Concentration}

= % Water + 0.0001 x $\{Al(OH)_3 + BiPO_4 + FeO(OH) + FePO_4 + Na^+ + SiO_2 + Cl^- + F^- + NO_2^- + NO_3^- + PO_4^{3-} + SO_4^{2-}\}$

The total analyte concentration calculated from the above equation is 424,000 µg/g. The weight percent water mean was calculated using the TGA information. The mean value of weight percent solids by TGA was 45.8. This value was subtracted from 100 to give a weight percent water of 54.2. The mass balance resulting from adding the percent water to the total analyte concentration is 96.6 percent (see Table B3-5).

Table B3-4. Mass Balance Totals.

Totals	Concentrations (μg/g)
Total from Table B3-2	186,900
Total from Table B3-3	237,000
Water %	542,000
Grand Total	965,900

The following equations demonstrate the derivation of total cations and total anions; the charge balance is the ratio of total cations to total anions.

Total cations (μeq/g) = $[Na^+]/23.0 = 4{,}250\ \mu eq/g$

Total anions (μeq/g) = $[Cl^-]/35.5 + [F^-]/19.0 + [NO_3^-]/62.0 + [NO_2^-]/46.0 + [PO_4^{3-}]/31.7\ [SO_4^{2-}]/48.0 = 4{,}416\ \mu eq/g$

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 0.96 with a net negative charge of 66 μeq/g.

In summary, the above calculations yield reasonable mass and charge balance values (close to 1.00 for charge balance and 100 percent for mass balance) indicating that the analytical results are generally consistent.

B3.4 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

The following evaluation was performed on the analytical data from the tank 241-B-110 samples.

Because an inventory estimate is needed without comparing it to a threshold value, two-sided 95 percent confidence intervals on the mean inventory are computed. This was done with composite-level data only.

The lower and upper limits (LL and UL) to a two-sided 95 percent confidence interval for the mean are as follows:

$$\hat{\mu} \pm t_{(df,0.025)} \times \hat{\sigma}_{\hat{\mu}}.$$

In these equations, $\hat{\mu}$ is the estimate of the mean concentration, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean concentration, and $t_{(df,0.025)}$ is the quantile from Student's t distribution with df degrees of freedom for a two-sided 95 percent confidence interval.

The mean, $\hat{\mu}$, and the standard deviation, $\hat{\sigma}_{\hat{\mu}}$, were estimated using restricted maximum likelihood estimation methods. The degrees of freedom (df) for tank 241-B-110, is the number of risers sampled minus one.

B3.4.1 Composite Means

The statistics in this section were based on analytical data from the most recent sampling event of tank 241-B-110. Analysis of variance (ANOVA) techniques were used to estimate the mean and to calculate confidence limits on the mean for all analytes that had at least 85 percent of reported values above the detection limit. If at least 85 percent of the reported values were above the detection limit, all data was used in the computations. The detection limit was used as the value for nondetected results. No ANOVA estimates were computed for analytes with less than 85 percent detected values.

The results below are ANOVA estimates based on core composite data from tank 241-B-110. Table B3-5 provides estimates for the mean concentration and confidence interval on the mean concentration. The LL, to a 95 percent confidence interval can be negative. Because an actual concentration of less than zero is not possible, the LL is reported as zero, when it occurred.

Table B3-5. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Composite Sample Data. (3 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.a.Ag	μg/g	4.67E+01	2.34E+01	3	0.00E+00	1.21E+02
ICP.a.Al	μg/g	1.13E+03	1.70E+02	3	5.92E+02	1.67E+03
ICP.a.B	μg/g	4.94E+01	6.43E+00	3	2.90E+01	6.99E+01
ICP.a.Ba	μg/g	1.41E+01	5.66E-01	3	1.23E+01	1.59E+01
ICP.f.Bi	μg/g	1.85E+04	1.30E+03	3	1.44E+04	2.26E+04
ICP.a.Ca	μg/g	8.10E+02	5.67E+01	3	6.30E+02	9.90E+02
ICP.a.Cd	μg/g	5.29E+00	6.88E-01	3	3.10E+00	7.48E+00
ICP.a.Ce	μg/g	3.71E+01	1.04E+01	3	4.05E+00	7.02E+01
IC.w.Cl	μg/g	1.23E+03	8.64E+01	3	9.59E+02	1.51E+03
ICP.a.Cr	μg/g	8.10E+02	2.43E+01	3	7.33E+02	8.87E+02
ICP.a.Cu	μg/g	4.25E+01	1.19E+01	3	4.64E+00	8.04E+01
ICP.f.Fe	μg/g	1.81E+04	7.22E+01	3	1.78E+04	1.83E+04
IC.w.F	μg/g	1.90E+03	1.33E+02	3	1.47E+03	2.32E+03
ICP.a.K	μg/g	3.12E+02	1.56E+01	3	2.62E+02	3.62E+02
ICP.a.La	μg/g	3.18E+01	9.54E+00	3	1.44E+00	6.22E+01
ICP.a.Mg	μg/g	1.79E+02	7.16E+00	3	1.56E+02	2.02E+02
ICP.a.Mn	μg/g	6.68E+01	7.35E+00	3	4.34E+01	9.02E+01
ICP.a.Mo	μg/g	1.35E+01	5.42E+00	3	0.00E+00	3.08E+01
IC.w.NO_2	μg/g	1.03E+04	4.12E+02	3	8.98E+03	1.16E+04
IC.w.NO_3	μg/g	1.87E+05	1.50E+04	3	1.39E+05	2.35E+05
ICP.f.Na	μg/g	9.77E+04	3.91E+03	3	8.53E+04	1.10E+05
ICP.a.Nd	μg/g	1.59E+01	4.76E+00	3	7.20E-01	3.10E+01
ICP.a.Ni	μg/g	1.86E+01	7.45E-01	3	1.63E+01	2.10E+01
ICP.f.P	μg/g	1.61E+04	6.42E+02	3	1.40E+04	1.81E+04
IC.w.PO_4	μg/g	2.53E+04	1.01E+03	3	2.20E+04	2.85E+04
ICP.a.Pb	μg/g	5.28E+02	1.21E+02	3	1.42E+02	9.14E+02
ICP.a.Re	μg/g	6.50E+00	3.90E-01	3	5.26E+00	7.74E+00
ICP.a.Ru	μg/g	1.11E+02	2.66E+01	3	2.62E+01	1.96E+02
IC.w.SO_4	μg/g	1.15E+04	6.92E+02	3	9.33E+03	1.37E+04
ICP.f.Si	μg/g	9.36E+03	3.74E+02	3	8.17E+03	1.05E+04

Table B3-5. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Composite Sample Data. (3 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.a.Sr	μg/g	2.11E+02	2.11E+01	3	1.44E+02	2.78E+02
TIC	μg/g	9.00E+02	6.30E+01	3	7.00E+02	1.10E+03
TOC	μg/g	3.81E+02	2.29E+01	3	3.08E+02	4.54E+02
ICP.a.Te	μg/g	1.93E+01	4.24E+00	3	5.78E+00	3.27E+01
ICP.a.Ti	μg/g	8.41E+00	1.35E+00	3	4.13E+00	1.27E+01
Uranium	μg/g	2.08E+02	1.87E+01	3	1.48E+02	2.68E+02
ICP.a.V	μg/g	2.79E+00	5.02E-01	3	1.19E+00	4.39E+00
ICP.a.Zn	μg/g	8.05E+01	6.44E+00	3	6.00E+01	1.01E+02
ICP.a.Zr	μg/g	6.25E+00	7.50E-01	3	3.86E+00	8.64E+00
ICP.a.As	μg/g	4.32E+02	n/a	n/a	n/a	n/a
ICP.a.Be	μg/g	1.10E-01	n/a	n/a	n/a	n/a
ICP.a.Ce	μg/g	7.71E+01	n/a	n/a	n/a	n/a
ICP.a.Co	μg/g	1.22E+02	n/a	n/a	n/a	n/a
ICP.a.Dy	μg/g	4.79E+00	n/a	n/a	n/a	n/a
ICP.a.Li	μg/g	4.93E+00	n/a	n/a	n/a	n/a
ICP.a.Rh	μg/g	7.48E+01	n/a	n/a	n/a	n/a
ICP.a.Sb	μg/g	1.56E+02	n/a	n/a	n/a	n/a
ICP.a.Th	μg/g	5.74E+01	n/a	n/a	n/a	n/a
ICP.a.Tl	μg/g	9.24E+02	n/a	n/a	n/a	n/a
Am-241	μCi/g	7.25E-02	2.47E-02	3	0.00E+00	1.51E-01
Cm-243/244	μCi/g	1.28E-03	6.40E-04	3	0.00E+00	3.31E-03
Co-60	μCi/g	1.53E-02	6.87E-03	3	0.00E+00	3.71E-02
Cs-137	μCi/g	1.49E+01	5.96E-01	3	1.30E+01	1.68E+01
Eu-152	μCi/g	6.75E-02	2.63E-02	3	0.00E+00	1.51E-01
H-3	μCi/g	2.17E-03	7.58E-04	3	0.00E+00	4.58E-03
I-129	μCi/g	3.60E-05	1.37E-05	3	0.00E+00	7.95E-05
Np-237	μCi/g	1.10E-04	2.75E-05	3	2.25E-05	1.98E-04
Pu-238	μCi/g	3.21E-03	8.03E-04	3	6.57E-04	5.77E-03
Sr-90	μCi/g	1.08E+02	4.43E+01	3	0.00E+00	2.49E+02
Tc-99	μCi/g	1.65E-02	2.31E-03	3	9.14E-03	2.38E-02

Table B3-5. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Composite Sample Data. (3 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Total Alpha	μCi/g	1.56E-01	1.56E-02	3	1.06E-01	2.05E-01
Total Beta	μCi/g	1.83E+02	6.77E+01	3	0.00E+00	3.98E+02
^{238}Pu/^{239}Pu	----	2.73E-03	2.13E-03	3	0.00E+00	9.50E-03
^{240}Pu/^{239}Pu	----	3.32E-02	3.65E-03	3	2.16E-02	4.48E-02
^{241}Pu/^{239}Pu	----	7.50E-04	1.65E-04	3	2.25E-04	1.28E-03
^{242}Pu/^{239}Pu	----	3.60E-04	7.92E-05	3	1.08E-04	6.12E-04
^{234}U/^{238}U	----	6.40E-04	3.20E-05	3	5.38E-04	7.42E-04
^{235}U/^{238}U	----	6.76E-03	2.03E-05	3	6.69E-03	6.82E-03
^{236}U/^{238}U	----	1.10E-04	2.20E-06	3	1.03E-04	1.17E-04

Note:
n/a = Not applicable.

B3.4.2 Analysis of Variance Models

A statistical model is needed to account for the spatial and measurement variability in $\hat{\sigma}_{\hat{\mu}}$. This cannot be done using an ordinary standard deviation of the data (Snedecor and Cochran 1980).

The statistical model fit to the composite sample data is

$$Y_{ijkm} = \mu + R_i + C_{ij} + H_{ijk} + A_{ijkm},$$

$$i=1,\ldots,a,\ j=1,\ldots,b_i,\ k=1,\ldots,c_{ij},\ m=1,\ldots,d_{ijk},$$

where

Y_{ijkm}	=	laboratory result from the m^{th} duplicate in the k^{th} homogenized sample in the j^{th} core in the i^{th} riser in the tank,
μ	=	the grand mean
R_i	=	the effect of the i^{th} riser
C_{ij}	=	the effect of the j^{th} core from the i^{th} riser
H_{ijk}	=	the effect of the k^{th} homogenized sample in the j^{th} core in the i^{th} riser
A_{ijkm}	=	the effect of the m^{th} analytical result from the k^{th} homogenized sample in the j^{th} core in the i^{th} riser
a	=	the number of risers
b_i	=	the number of cores in the i^{th} riser
c_{ij}	=	the number of homogenized samples from the j^{th} core in the i^{th} riser
d_{ijk}	=	the number of analytical results from the k^{th} homogenized sample in the j^{th} core in the i^{th} riser

The variable R_i, C_{ij}, and H_{ijk} are assumed to be random effects. These variables and A_{ijkm} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(R)$, $\sigma^2(C)$, $\sigma^2(H)$, and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(R)$, $\sigma^2(C)$, $\sigma^2(H)$, and $\sigma^2(A)$ were obtained using restricted maximum likelihood estimation techniques. This method, applied to variance component estimation, is described in Harville (1977). The statistical results were obtained using a statistical analysis package.

B3.4.3 Inventory

After the sample means are calculated for the tank for each analyte, the sample- based inventory may be calculated. Because the analyte concentrations above are in terms of a mass basis concentration, the total mass of waste in the tank is needed to estimate inventories. The total mass of waste is derived from the tank volume (from surveillance) and the estimated tank solids density (from the HTCE model). The tank volume is 927 kL (Hanlon 1996). The density used for this estimate is 1.35 g/mL. Table B3-7 provides the inventory for each analyte for composite sample data.

Table B3-6. Analytical-Based Inventory for Composite Sample Data for Tank 241-B-110. (2 sheets)

Analyte	Inventory (kg or Ci)	LL	UL
ICP.a.Ag	5.85E+01	0.00E+00	1.52E+02
ICP.a.Al	1.42E+03	7.41E+02	2.09E+03
ICP.a.B	6.19E+01	3.63E+01	8.74E+01
ICP.a.Ba	1.77E+01	1.54E+01	1.99E+01
ICP.f.Bi	2.32E+04	1.80E+04	2.83E+04
ICP.a.Ca	1.01E+03	7.88E+02	1.24E+03
ICP.a.Cd	6.62E+00	3.88E+00	9.36E+00
ICP.a.Ce	4.65E+01	5.07E+00	8.79E+01
IC.w.Cl	1.54E+03	1.20E+03	1.89E+03
ICP.a.Cr	1.01E+03	9.17E+02	1.11E+03
ICP.a.Cu	5.32E+01	5.80E+00	1.01E+02
ICP.f.Fe	2.26E+04	2.23E+04	2.29E+04
IC.w.F	2.37E+03	1.84E+03	2.90E+03
ICP.a.K	3.90E+02	3.28E+02	4.53E+02
ICP.a.La	3.98E+01	1.81E+00	7.78E+01
ICP.a.Mg	2.24E+02	1.95E+02	2.53E+02
ICP.a.Mn	8.36E+01	5.43E+01	1.13E+02
ICP.a.Mo	1.69E+01	0.00E+00	3.85E+01
IC.w.NO_2	1.29E+04	1.12E+04	1.45E+04
IC.w.NO_3	2.34E+05	1.75E+05	2.94E+05
ICP.f.Na	1.22E+05	1.07E+05	1.38E+05
ICP.a.Nd	1.98E+01	9.01E-01	3.88E+01
ICP.a.Ni	2.33E+01	2.03E+01	2.63E+01
ICP.f.P	2.01E+04	1.75E+04	2.27E+04
IC.w.PO_4	3.16E+04	2.76E+04	3.56E+04
ICP.a.Pb	6.61E+02	1.77E+02	1.14E+03
ICP.a.Re	8.13E+00	6.58E+00	9.69E+00
ICP.a.Ru	1.39E+02	3.28E+01	2.45E+02
IC.w.SO_4	1.44E+04	1.17E+04	1.72E+04
ICP.f.Si	1.17E+04	1.02E+04	1.32E+04
ICP.a.Sr	2.64E+02	1.80E+02	3.48E+02

Table B3-6. Analytical-Based Inventory for Composite Sample Data for Tank 241-B-110. (2 sheets)

Analyte	Inventory (kg or Ci)	LL	UL
TIC	1.13E+03	8.75E+02	1.38E+03
TOC	4.77E+02	3.86E+02	5.68E+02
ICP.a.Te	2.41E+01	7.23E+00	4.10E+01
ICP.a.Ti	1.05E+01	5.17E+00	1.59E+01
Uranium	2.60E+02	1.86E+02	3.35E+02
ICP.a.V	3.49E+00	1.49E+00	5.49E+00
ICP.a.Zn	1.01E+02	7.51E+01	1.26E+02
ICP.a.Zr	7.82E+00	4.83E+00	1.08E+01
ICP.a.As	5.41E+02	n/a	n/a
ICP.a.Be	1.38E-01	n/a	n/a
ICP.a.Ce	9.64E+01	n/a	n/a
ICP.a.Co	1.52E+02	n/a	n/a
ICP.a.Dy	5.99E+00	n/a	n/a
ICP.a.Li	6.17E+00	n/a	n/a
ICP.a.Rh	9.36E+01	n/a	n/a
ICP.a.Sb	1.96E+02	n/a	n/a
ICP.a.Th	7.18E+01	n/a	n/a
ICP.a.Tl	1.16E+03	n/a	n/a
Am-241	9.08E+01	0.00E+00	1.89E+02
Cm-243/244	1.60E+00	0.00E+00	4.15E+00
Co-60	1.91E+01	0.00E+00	4.65E+01
Cs-137	1.86E+04	1.63E+04	2.10E+04
Eu-152	8.44E+01	0.00E+00	1.89E+02
H-3	2.71E+00	0.00E+00	5.73E+00
I-129	4.51E-02	0.00E+00	9.95E-02
Np-237	1.38E-01	2.82E-02	2.47E-01
Pu-238	4.02E+00	8.22E-01	7.22E+00
Sr-90	1.35E+05	0.00E+00	3.11E+05
Tc-99	2.06E+01	1.14E+01	2.98E+01
Total Alpha	1.95E+02	1.33E+02	2.57E+02
Total Beta	2.29E+05	0.00E+00	4.99E+05

APPENDIX B REFERENCES

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

The safety screening DQO (Dukelow et al. 1995) defines acceptable decision confidence limits in terms of one-sided 95 percent confidence intervals. In this appendix, one-sided confidence limits supporting the safety screening DQO are calculated for tank 241-B-110.

Confidence intervals were computed for each sample number from tank 241-B-110 analytical segment-level data. Table C1-1 provides the sample numbers and confidence intervals for alpha. Confidence intervals were not calculated for DSC because no exotherms were observed.

The upper limit (UL) of a one-sided 95 percent confidence interval on the mean is as follows:

$$\hat{\mu} + t_{(df,0.05)} * \hat{\sigma}_{\hat{\mu}}.$$

In this equation, $\hat{\mu}$ is the arithmetic mean of the data, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean, and $t_{(df,0.05)}$ is the quantile from Student's t distribution with df degrees of freedom for a one-sided 95 percent confidence interval.

For tank 241-B-110 data (by sample number), df equals the number of observations minus one.

Table C1-1 lists the UL of the 95 percent confidence interval for each sample number based on alpha data. Each confidence interval can be used to make the following statement. If the UL is less than 41 μCi/g, reject the null hypothesis that the alpha is greater than or equal to 41 μCi/g at the 0.05 level of significance.

Table C1-1. 95 Percent Confidence Interval Upper Limits for Alpha for Tank 241-B-110 (Units are μCi/g).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
89-0331	Core 1, segment 2, homogenized sample 1	3.32E-01	2.14E-02	4.67E-01
89-0332	Core 1, segment 2, homogenized sample 2	3.39E-01	1.87E-02	4.57E-01
89-0648	Core 1, segment 2, homogenized sample 2	3.52E-01	5.18E-03	3.85E-01
89-0333	Core 1, segment 3, homogenized sample 1	1.42E-01	8.56E-03	1.96E-01
89-0334	Core 1, segment 3, homogenized sample 2	1.59E-01	1.80E-03	1.70E-01
89-0335	Core 1, segment 4, homogenized sample 1	5.79E-02	5.18E-03	9.06E-02
89-0336	Core 1, segment 4, homogenized sample 2	5.34E-02	4.73E-03	8.32E-02
89-0337	Core 1, segment 5, homogenized sample 1	8.81E-02	2.03E-03	1.01E-01
89-0338	Core 1, segment 5, homogenized sample 2	9.32E-02	2.25E-03	1.07E-01
89-0465	Core 2, segment 1, homogenized sample 1	5.38E-01	2.93E-02	7.23E-01
89-0466	Core 2, segment 1, homogenized sample 2	6.28E-01	6.76E-03	6.71E-01
90-0636	Core 2, segment 2, homogenized sample 1	1.05E-01	4.73E-03	1.35E-01
89-0727	Core 2, segment 3, homogenized sample 1	7.86E-02	1.58E-03	8.86E-02
89-0728	Core 2, segment 3, homogenized sample 2	8.47E-02	4.50E-04	8.75E-02
90-0638	Core 2, segment 4, homogenized sample 1	7.05E-02	1.58E-03	8.05E-02
89-0729	Core 2, segment 5, homogenized sample 1	7.07E-02	9.01E-04	7.64E-02
89-0730	Core 2, segment 5, homogenized sample 2	7.79E-02	4.50E-03	1.06E-01
89-0668	Core 3, segment 3, homogenized sample 1	2.35E-01	1.24E-02	3.13E-01
89-0669	Core 3, segment 3, homogenized sample 2	2.25E-01	1.13E-03	2.32E-01
89-1109	Core 3, segment 5, homogenized sample 1	8.24E-02	2.70E-03	9.95E-02
90-0300	Core 9, segment 1, homogenized sample 1	7.64E-02	6.76E-04	8.06E-02
90-0301	Core 9, segment 1, homogenized sample 2	8.29E-02	1.80E-03	9.43E-02
90-0304	Core 9, segment 5, homogenized sample 1	8.00E-02	2.48E-03	9.56E-02
90-0305	Core 9, segment 5, homogenized sample 2	7.61E-02	3.15E-03	9.60E-02
90-0708	Core 10, segment 3, homogenized sample 1	9.93E-02	3.38E-03	1.21E-01
90-0709	Core 10, segment 3, homogenized sample 2	8.85E-02	1.58E-03	9.85E-02
90-0712	Core 10, segment 5, homogenized sample 1	7.09E-02	6.98E-03	1.15E-01
90-0713	Core 10, segment 5, homogenized sample 2	8.11E-02	9.01E-04	8.68E-02

C1.0 APPENDIX C REFERENCES

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-B-110

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-B-110

The following evaluation provides a best-basis inventory estimate for chemical and radionuclide components in tank 241-B-110.

D1.0 IDENTIFY/COMPILE INVENTORY SOURCES

The report by Heasler et al. (1993) provides a statistical evaluation of the sample results from the 1989 sampling event of tank 241-B-110. Of the eight core samples obtained, seven were chemically analyzed. A sample-based inventory was prepared based on the core sample analytical results, a waste density of 1.35 g/mL, and a waste solids volume of 927 kL (245 kgal). The HDW model (Agnew et al. 1996) provides tank contents estimates derived from process flowsheets and waste volume records. Hanlon (1996) gives a total waste volume of 931 kL (246 kgal); this includes 4 kL (1 kgal) of supernate.

D2.0 COMPARE COMPONENT INVENTORY VALUES AND NOTE SIGNIFICANT DIFFERENCES

Tables D2-1 and D2-2 show the sample-based inventory estimate from 1989 analytical data and the inventory estimate from HDW model (Agnew et al. 1996) for tank 241-B-110. The sample-based inventory in Table D2-1 is based on values reported by Heasler et al. (1993). The waste solids volume used to generate the sample-based inventory is 927 kL (245 kgal), and the waste solids volume in the HDW model is 931 kL (246 kgal). The estimates use different waste densities. The sample-based inventory used a bulk density of 1.35 g/mL. The measured bulk densities of several core sample segments ranged from 1.32 to 1.37 g/mL. The HDW model uses a lower waste density of 1.20 g/mL. The density difference results in an RPD for analytes with the same concentration of 11.8 percent. Significant differences between the sample-based and HDW model inventories are apparent, for example, Al, Bi, Ca, Cl, Cr, K, Na, NH_4, Ni, NO_2, NO_3, Pb, Si, S, U, and Zr vary by a factor of two or more.

Table D2-1. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-B-110. (2 sheets)

Analyte	Sampling Inventory Estimate (kg)	HDW Model Inventory Estimate (kg)	Analyte	Sampling Inventory Estimate (kg)	HDW Model Inventory Estimate (kg)
Al	1,420	0	Ni	23.3	112
Ag	58.5		NO_2	12,900	382
As	n/a	n/a	NO_3	2.34E+05	47,900
B	62	n/a	OH	n/a	33,200
Ba	17.7	n/a	oxalate	n/a	n/a
Be	n/a	n/a	Pb	661	0
Bi	23,200	13,700	Pd	n/a	n/a
Ca	1,010	7,420	P as PO_4	61,600	57,200
Ce	46.5	n/a	Pt	n/a	n/a
Cd	6.62	n/a	Re	8.1	n/a
Cl	1,540	675	Rh	n/a	n/a
Co	n/a	n/a	Ru	139	n/a
Cr	1,014	197	Sb	n/a	n/a
Cr^{+3}	n/a	197	Se	n/a	n/a
Cr^{+6}	n/a	n/a	Si	11,700	1,870
Cs	n/a	n/a	S as SO_4	14,400	3,080
Cu	53.2	n/a	Sn	n/a	n/a
F	2,370	2,560	Sr	264	0
Fe	22,600	35,400	Te	24.1	n/a
FeCN/CN	n/a	n/a	TIC as CO_3	5,630	11,100
formate	n/a	n/a	Th	n/a	n/a
Hg	n/a	0	Ti	10.5	n/a
K	390	162	TOC	477	n/a
La	39.8	0	U_{TOTAL}	260	488

Table D2-1. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-B-110. (2 sheets)

Analyte	Sampling Inventory Estimate (kg)	HDW Model Inventory Estimate (kg)	Analyte	Sampling Inventory Estimate (kg)	HDW Model Inventory Estimate (kg)
Li	n/a	n/a	V	3.49	n/a
Mg	223	n/a	W	n/a	n/a
Mn	83.6	n/a	Zn	101	n/a
Mo	16.9	n/a	Zr	7.82	0
Na	1.22E+05	63,400	H_2O(wt %)	58.1	75.1
Nd	19.9		Density (kg/L)	1.35	1.20
NH_4		49.4			

Table D2-2. Sample- and HDW Model-Based Inventory Estimates for Radioactive Components in Tank 241-B-110.

Analyte	Sampling Inventory Estimate (Ci)	HDW Model Inventory Estimate (Ci)	Analyte	Sampling Inventory Estimate (Ci)	HDW Model Inventory Estimate (Ci)
^{14}C	n/a	n/a	^{237}Np	0.14	n/a
^{90}Sr	1.35E+05	1.55E+05	$^{239/240}Pu$	n/a	30
^{99}Tc	21	n/a	^{241}Am	91	n/a
^{129}I	0.045	n/a	Total α	195	n/a
^{137}Cs	18,600	6,560	Total β	2.30E+05	n/a
^{154}Eu	n/a	n/a			

D3.0 REVIEW AND EVALUATION OF COMPONENT INVENTORIES

The following evaluation of tank contents is performed to identify potential errors and/or missing information that could influence the sample-based and HDW model component inventories.

D3.1 CONTRIBUTING WASTE TYPES

Tank 241-B-110 was put into service in May 1945 as the first tank in the 241-B-110, 241-B-111, and 241-B-112 cascade. The cascade received 2C waste from B Plant. Waste began overflowing to tank 241-B-111 in December 1945, and tank 241-B-111 overflowed to tank 241-B-112 in April 1946. Tank 241-B-112 was filled in August 1946, and the 2C waste was diverted to the cascade made up of tanks 241-B-104, 241-B-105, and 241-B-106. After tanks 241-B-104, 241-B-105, and 241-B-106 were filled, the supernatant from tanks 241-B-110, 241-B-111, and 241-B-112 was pumped to cribs. The 241-B-110 tank cascade began receiving 2C waste again from B Plant in July 1950 and continued receiving waste until B Plant was shut down in June 1952. Tank 241-B-112 began overflowing to a crib in the second quarter of 1951 (Anderson 1990). After B Plant was shut down in June 1952, the tank 241-B-110 cascade began receiving a concentrated flush waste from B Plant. In 1963, tank 241-B-110 began receiving fission product waste from B Plant.

Table D3-1 shows the current waste volumes for the tanks in the 241-B-110 tank cascade (Hanlon 1996).

Table D3-1. Waste Inventory of the 241-B-110, 241-B-111, and 241-B-112 Tank Cascade.

Waste Volume (kL)	Tank 241-B-110	Tank 241-B-111	Tank 241-B-112
Sludge	927	893	114
Saltcake	0	0	0
Supernatant	4	4	11
Drainable liquid	87	79	0

Table D3-2 lists the documented quantities of waste discharged to tank 241-B-110 from the HDW model waste transaction database. These records indicate that bismuth phosphate 2C waste should be the major constituent of the waste in this tank.

Table D3-2. Waste Transaction Information for Tank 241-B-110.[1]

	Waste Type	Waste Volume (kL)
Waste throughput	2C1	7,960
	2C2	16,450
	DW	556
	P2	2,551
	B	511
	CSR	753
Total waste throughput		28,781
Current inventory		931

Note:
CSR = Waste from cesium recovery from supernates
B = Waste from PUREX acidified waste processed for Sr extraction

[1]Agnew et al. (1996)

Table D3-3 compiles the types of solids in tank 241-B-110 as reported by various authors. All sources indicate that second cycle bismuth phosphate waste should be the principal contributor to tank waste solids.

Table D3-3. Expected Solids for Tank 241-B-110.

Reference	Type
Anderson (1990)	2C, 5-6, FP, FP-EB, BL-EB, BL-IX, IX
HTCE (Brevick et al. 1994)	2C, P2
SORWT model (Hill et al. 1995)	2C, 5-6, FP, IX
WSTRS (Agnew 1996)	2C1, P2, BY saltcake
HDW model (Agnew et al. 1996)	2C1, 2C2, DW, P2, CSR

Note:

BL = B Plant low-level waste
SORWT = sort on radioactive waste type

D3.2 EVALUATION OF TECHNICAL FLOWSHEET INFORMATION

Table D3-4 summarizes the estimate of bismuth phosphate waste discharged to the 241-B-110 tank cascade made in the tank farm process history and the reconstructed fuel processing history.

Table D3-4. B Plant Fuel Processing and 2C Waste Disposition.

Cascade	Period	Fuel Processed (MTU)
Tanks 241-B-110/241-B-111/241-B-112	May 1945 to August 1946	631
Tanks 241-B-104/241-B-105/241-B-106	September 1946 to June 1950	1,312
Tanks 241-B-110/241-B-111/241-B-112	July 1950 to August 1952	823

Note:
MTU = metric tons of uranium

It is possible to estimate of the amount of 2C waste discharged to each cascade from the fuel process history and the flowsheet information. The technical manual flowsheet applies to the first period, and the Schneider (1951) flowsheet applies to the last two periods. The technical manual issued in 1994 is considered to represent early B Plant operations, and the Schneider (1951) flowsheet is considered to represent later years. Table D3-5 shows the results of this calculation.

Table D3-5. Disposition of B Plant 2C Waste.

Period	May 1945 to August 1946	September 1946 to June 1950	July 1950 to August 1952	Total
Cascade	241-B-110	241-B-104	241-B-110	B Plant
Fuel processed (MTU)	631	1,312	823	2,766
Waste Component (kg)				
Bi	8,990	23,900	15,000	47,900
Cr	421	1,190	748	2,360
F	19,900	54,100	33,900	1.08E+05
Fe	8,610	31,000	19,400	59,000
Na	2.83E+05	6.75E+05	4.23E+05	1.38E+06
NO_3	3.64E+05	1.13E+06	7.08E+05	2.20E+06
Si	4,970	13,100	8,200	26,300
PO_4	2.35E+05	4.23E+05	2.65E+05	9.23E+05
SO_4	29,500	1.07E+05	66,800	2.03E+05

Table D3-6 compares the calculated discharge to the 241-B-110 cascade to the sample-based inventory for tanks 241-B-110 and 241-B-111. Table D3-1 shows nearly equal accumulations of sludge in tanks 241-B-110 and 241-B-111. Table D3-7 compares the tank 241-B-110 sample-based estimate and HDW model estimate to the projected receipts of the tank 241-B-110 cascade. The waste transaction records state both inventories are 2C waste. Better agreement exists between the flowsheet-based estimate and the sample-based estimate for the species most likely to precipitate (Bi, Cr, Fe, and Si) than any other combination.

The sample-based data for tank 241-B-110 almost fully account for the 2C waste discharged to the 241-B-110 cascade. Although this is the expected result for the first tank in a cascade, it is at odds with the large inventory of bismuth bearing sludge found in tank 241-B-111.

Heasler et al. (1993) provides a statistical evaluation of the sample results for the seven core samples. Little vertical variability or horizontal stratification exist except for a crust over the sludge. The crust is quite different chemically from the waste below it. This is consistent with the later addition of 5-6 and FP waste. Photographs of the tank interior show an orange or brown dark waste surface. Some of the surface has the appearance of mud from a dried lake bottom. Other areas appear to be covered with a thin layer of liquid.

Table D3-6. Comparison of Tanks 241-B-110 and 241-B-111 Inventory Estimates to the 241-B-110 Cascade Receipts.

Waste Component (kg)	Tank 241-B-110 Sample-Based Inventory Estimate (kg)	Tank 241-B-111 Sample-Based Inventory Estimate (kg)	Calculated Inventory Discharged to Cascade (kg)
Bi	23,200	21,500	24,000
Cr	1,010	1,180	1,170
F	2,370	1,660	53,800
Fe	22,600	18,900	28,000
Na	1.22E+05	1.02E+05	7.06E+05
NO_3	2.34E+05	87,400	1.07E+06
Si	11,700	11,100	13,200
PO_4	61,600	51,800	5.00E+05
SO_4	14,400	12,400	96,300

Table D3-7. Comparison of Tank 241-B-110 Inventory Estimates to the Total Cascade Receipts.

Waste Component (kg)	Sample Based Inventory Estimate (kg)	HDW Model Inventory Estimate (kg)	Total Calculated Inventory Discharged to Cascade (kg)	HDW Cascade B-110, B-111, B-112, Retained (kg)
Bi	23,200	13,700	24,000	21,000
Cr	1,010	197	1,170	792
F	2,370	2,560	53,800	4,400
Fe	22,600	35,400	28,000	89,600
Na	1.22E+05	36,400	7.06E+05	1.21E+05
NO_3	2.34E+05	47,900	1.07E+06	1.08E+05
Si	11,700	690	13,200	6,660
PO_4	61,600	57,000	5.00E+05	69,000
SO_4	14,400	3,080	96,300	7,930

Document Element Basis. In the flowsheet analysis, Bi, Cr, Fe, Si, PO_4, and sulfate analysis are assumed to fully precipitate. The flowsheet analysis for the Bi, Cr, Fe, and Si reconciles best with the sample-based estimate. The HDW model reconciles better with the sample-based estimate for PO_4 and SO_4.

Fluoride, Na, NO_2, and NO_3 inventories cannot be reconciled because these components are relatively soluble, and most would have exited the tank by the cascade system. The best source of information with respect to these compounds is the sample-based estimate.

Significant differences exist between sample-based and HDW model inventories, for example, Al, Bi, Ca, Cl, Cr, K, Na, NH_4, Ni, NO_2, NO_3, Pb, Si, S, U, and Zr vary by a factor of two or more.

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

The results from this evaluation are based on sampling data for tank 241-B-110 for the following reasons:

1. Analytical results from composite cores samples from four different risers were used to estimate the component inventories.

2. The sample-based inventory agrees with composition of bismuth phosphate 2C waste, provided it is assumed that the primary source of sludge is bismuth phosphate 2C waste.

These results are subject to future review because of lack of reconciliation to the flowsheet projected inventory. Tables D4-1 and D4-2 show the best-basis inventory estimates for tank 241-B-110.

Table D4-1. Sample-Based Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-B-110 (September 30, 1996).

Analyte	Total Inventory (kg)	Percent Mean RSD
Al	1,420	15.6
Bi	23,200	6.8
Ca	1,010	7
Cl	1,540	6.4
TIC as CO_3	5,630	6.9
Cr	1,010	2.5
F	2,370	6.3
Fe	22,600	4.1
Hg	Not reported	
K	390	4.8
La	39.8	29.7
Mn	83.6	10.8
Na	1.22E+05	3.3
Ni	23.3	4.1
NO_2	12,900	3.9
NO_3	2.34E+05	8.1
OH	Not reported	
Pb	661	22.5
P as PO_4	61,600	4.4
Si	11,700	3.6
S as SO_4	14,400	6.4
Sr	264	9.5
TOC	477	6.1
U_{TOTAL}	260	8.7
Zr	7.82	12

Table D4-2. Sample-Based Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-110 (September 30, 1996). (2 sheets)

Analyte	Total Inventory	Percent Mean RSD
^{3}H	Not reported	
^{14}C	Not reported	
^{59}Ni	Not reported	
^{60}Co	Not reported	
^{63}Ni	Not reported	
^{79}Se	Not reported	
^{90}Sr	1.36E+05	40.8
^{90}Y	Not reported	
^{93}Zr	Not reported	
^{93m}Nb	Not reported	
^{99}Tc	20.7	14
^{106}Ru	Not reported	
^{113m}Cd	Not reported	
^{125}Sb	Not reported	
^{126}Sn	Not reported	
^{129}I	0.045	38.5
^{134}Cs	Not reported	
^{137}Cs	18,600	3.8
^{137m}Ba	Not reported	
^{151}Sm	Not reported	
^{152}Eu	Not reported	
^{154}Eu	Not reported	
^{155}Eu	Not reported	
^{226}Ra	Not reported	
^{227}Ac	Not reported	
^{228}Ra	Not reported	
^{229}Th	Not reported	
^{231}Pa	Not reported	
^{232}Th	Not reported	
^{232}U	Not reported	

Table D4-2. Sample-Based Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-110 (September 30, 1996). (2 sheets)

Analyte	Total Inventory	Percent Mean RSD
^{233}U	Not reported	
^{234}U	Not reported	
^{235}U	Not reported	
^{236}U	Not reported	
^{237}Np	0.14	24.8
^{238}Pu	Not reported	
^{238}U	Not reported	
^{239}Pu	Not reported	
^{240}Pu	Not reported	
^{241}Am	90.7	0.347
^{241}Pu	Not reported	
^{242}Cm	Not reported	
^{242}Pu	Not reported	
^{243}Am	Not reported	
$^{243/244}Cm$	1.60	50

D5.0 APPENDIX D REFERENCES

Agnew, S. F., J. Boyer, R. Corbin, T. Duran, J. Fitzpatrick, K. Jurgensen, T. Ortiz, and B. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, Draft, March 5, 1996, Los Alamos National Laboratory, Los Alamos, New Mexico.

Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Brevick, C. H., L. A. Gaddis, W. W. Pickett, 1994, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*, WHC-SD-WM-ER-349, Rev. 0, ICF Kaiser Hanford Company, Richland, Washington.

Brevick, C. H., 1996, *Waste Status and Transaction Record Summary for the Northwest Quadrant of the Hanford 200 Areas*, WHC-SD-WM-TI-699, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-B-110

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-B-110

Appendix E is a bibliography that supports the characterization of tank 241-B-110. This bibliography represents an in-depth literature search of known information sources that provide sampling, analysis, surveillance, and modeling information, as well as processing occurrences associated with tank 241-B-110 and its respective waste types.

The references in this bibliography are separated into three broad categories containing references broken down into subgroups. These categories and their subgroups are listed below.

I. NON-ANALYTICAL DATA

- Ia. Models/Waste Type Inventories/Campaign Information
- Ib. Fill History/Waste Transfer Records
- Ic. Surveillance/Tank Configuration
- Id. Sample Planning/Tank Prioritization
- Ie. Data Quality Objectives/Customers of Characterization Data

II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

- IIa. Sampling of tank 241-B-110
- IIb. Sampling and analysis of similar waste types

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

- IIIa. Inventories using both campaign and analytical information
- IIIb. Compendium of existing physical and chemical documented data sources

The bibliography is broken down into appropriate sections of material and has an annotation at the end of each reference describing the information source. Where possible, a reference is provided for information sources. Most information can be found in the Lockheed Martin Hanford Corporation Tank Characterization Resource Center.

I. NON-ANALYTICAL DATA

Ia. Models/Waste Type Inventories/Campaign Information

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev.3,* LA-UR-96-858, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains estimates for the chemical and radionuclide compositions of the 177 Hanford high-level waste storage tanks. Develops the Hanford Defined Waste Model.

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

- Contains single-shell tank fill history and primary campaign/waste information up to 1981.

Jungfleisch, F. M. and B. C. Simpson, 1993, *Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980*, WHC-SD-WM-TI-057, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- A model based on process knowledge and radioactive decay estimations using ORIGEN for different compositions of process waste streams assembled for total, solution, and solids compositions by tank. Gives assumptions about waste/waste types and solubility parameters/constraints.

Schneider, K. J., 1951, *Flow Sheet and Flow Diagrams of Precipitation Separations Process*, HW-23043, General Electric Company, Richland, Washington.

- Contains compositions of first concentration cycle waste before transfer to 200E Area waste tanks.

Ib. Fill History/Waste Transfer Records

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Waste Status and Transaction Record Summary for the Northeast Quadrant of the Hanford 200 East Area*, WHC-SD-WM-TI-615, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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Ic. Surveillance/Tank Configuration

Alstad, A. T., 1993, *Riser Configuration Document for Single-Shell Waste Tanks*, WHC-SD-RE-TI-053, Rev. 9, Westinghouse Hanford Company, Richland, Washington.

- Shows tank riser locations in relation to tank aerial view and a description of the risers and their contents.

Bergmann, L. M., 1991, *Single-Shell Tank Isolation Safety Analysis Report*, WHC-SD-WM-SAR-006, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Contains safety analysis report on isolation of single-shell tanks.

Dasgupta, A., 1995, *Interim Stabilization Status of SSTs B-104, B-110, B-111, T-102, T-112, and U110*, WHC-SD-WM-RE-516, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Discusses the result of an investigation conducted to determine whether the six single-shell tanks (B-104, B-110, B-111, T-102, T-112, and U-110) previously declared interim stabilized are meeting the current interim stabilization criteria. It concluded tank 241-B-111, 241-B-110, and 241-U-110 meet the criteria.

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- Assesses riser locations for each tank; however, not all tanks are included/completed. Also estimates the risers that are available for sampling.

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- Based on a review of the historical data, the team found that tank 241-B-110 should be classified as a confirmed leaker.

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Id. Sample Planning/Tank Prioritization

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Grimes, G. W., 1977, *Hanford Long-Term Defense High-Level Waste Management Program Waste Sampling and Characterization Plan*, RHO-CD-137, Rev. 0, Rockwell Hanford Operations, Richland, Washington.

- Early characterization planning document.

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- Contains Tri-Party Agreement requirement-driven TWRS Characterization Program information and a list of tanks addressed in Fiscal Year 1996.

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Ie. Data Quality Objectives/Customers of Characterization Data

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II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

IIa. Sampling of tank 241-B-110

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- Data package and validation summary report.

Winters, W. I., 1991, *Preliminary Lessons Learned Report from Phase 1A/1B SST Sampling and Analysis* (internal memorandum 28200-91-056, dated July 1991), Westinghouse Hanford Company, Richland, Washington.

- Summarizes the experience gained during the first analysis of single-shell tank wastes at Pacific Northwest and Westinghouse Hanford laboratories.

Winters, W. I., 1990, *Preliminary Results for Toxicity Tests on Samples from Tanks B-110 and U-110*, (internal memorandum 12715-ASL90-084 to V. W. Hall, June 21), Westinghouse Hanford Company, Richland, Washington.

IIb. Sampling and Analysis of Similar Waste Type

Remund, K. M., J. M. Tingey, P. G. Heasler, J. J. Toth, F. M. Ryan, S. A. Hartley, and C. J. Benar, 1996, *Tank Characterization Report for Single-Shell Tank 241-B-111*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Provides characterization information and interprets data from the sampling events of tank 241-B-111.

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

IIIa. Inventories from Campaign and Analytical Information

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Rev. 3*, LA-UR-96-858, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains waste type summaries and primary chemical compound/analyte and radionuclide estimates for sludge, supernatant, and solids.

Allen, G. K., 1976, *Estimated Inventory of Chemicals Added to Underground Waste Tanks, 1944 - 1975*, ARH-CD-601B, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

- Contains major components for waste types and some assumptions. Purchase records are used to estimate chemical inventories.

Allen, G. K., 1975, *Hanford Liquid Waste Inventory As Of September 30, 1974*, ARH-CD-229, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

- Contains major components for waste types and some assumptions.

Brevick, C. H., R. L. Newell, and J. W. Funk, 1996, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 Areas*, WHC-SD-MW-ER-349, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Contains summary information from the supporting document and in-tank photo montages and the solid composite inventory estimates for Revisions 0 and 0A.

IIIb. Compendium of Existing Physical and Chemical Documented Data Sources.

Agnew, S. F., and J. G. Watkin, 1994, *Estimation of Limiting Solubilities for Ionic Species in Hanford Waste Tank Supernates*, LA-UR-94-3590, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Provides solubility ranges used for key chemical and radionuclide components based on supernatant sample analyses.

Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1995, *Tank Waste Source Term Inventory Validation, Vol I & II.*, WHC-SD-WM-ER-400, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains a quick reference to sampling information in spreadsheet or graphical form for 23 chemicals and 11 radionuclides for all tanks.

Brevick, C. H., R. L. Newell, and J. W. Funk, 1996, *Supporting Document for the Historical Tank Content Estimate for B Tank Farm*, WHC-SD-WM-ER-310, Rev. 1A, Westinghouse Hanford Company, Richland, Washington.

- Contains summary tank farm and tank write-ups on historical data and solid inventory estimates and appendices for the data. The appendices contain the following information: Appendix C, Level History AutoCAD sketch; Appendix D, Temperature Graphs; Appendix E, Surface Level Graph; Appendix F, Riser Configuration Drawing and Table; and Appendix G, In-Tank Photogrphs.

De Lorenzo, D. S., J. H. Rutherford, D. J. Smith, D. B. Hiller, and K. W. Johnson, 1994, *Tank Characterization Reference Guide*, WHC-SD-WM-TI-648, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Provides a broad background of information relating to the characterization of Hanford Site tank wastes.

Colton, N. G., 1996, *Status Report: Pretreatment Chemistry Evaluation-Wash and Leach Factors for the Single-Shell Tank Waste Inventory*, PNNL-1129, Pacific Northwest National Laboratory, Richland, Washington.

- Contains sludge wash data for all single-shell tanks evaluated since 1986.

Dukelow, G. T., 1974, *Symptoms Of Leakage As Indicated By Increasing Dry Well Radiation Levels At Waste Tanks 110B*, OR-74-112, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

- Contains information about increased radiation in dry well 20-10-07 located approximately six feet southwest of tank 241-B-110.

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending September 30, 1996*, WHC-EP-0182-102, Westinghouse Hanford Company, Richland, Washington.

- Contains a monthly summary of the following: fill volumes, Watch List tanks, occurrences, integrity information, equipment readings, equipment status, tank location, and other miscellaneous tank information.

Hartley, S. A., G. Chen, C. A. Lopresti, T. A. Ferryman, A. M. Liebetrau, K. M. Remund, and S. A. Allen, 1996, *A Comparison of Historical Tank Contents Estimates (HTCE) Model*, Rev. 3, PNNL-11429, Pacific Northwest National Laboratory, Richland, Washington.

Husa, E. I., 1993, *Hanford Site Waste Storage Tank Information Notebook*, WHC-EP-0625, Westinghouse Hanford Company, Richland, Washington.

- Contains in-tank photographss and summaries of the tank description, leak detection system, and tank status.

Remund, K. M., B. C. Simpson, 1996, *Hanford Waste Tank Grouping Study*, PNNL-11433, Pacific Northwest National Laboratory, Richland, Washington.

Shelton, L. W., 1996, *Chemical and Radionuclide Inventory for Single- and Double-Shell Tanks*, (internal memorandum 74A20-96-30, to D. J. Washenfelder, February 28), Westinghouse Hanford Company, Richland, Washington.

- Contains a tank inventory estimate based on analytical information.

Shelton, L. W., 1995, *Chemical and Radionuclide Inventory for Single- and Double-Shell Tanks*, (internal memorandum 75520-95-007, to R. M. Orme, August 8), Westinghouse Hanford Company, Richland, Washington.

- Contains a tank inventory estimate based on analytical information.

Shelton, L. W., 1995, *Radionuclide Inventories for Single- and Double-Shell Tanks*, (internal memorandum to F. M. Cooney, 71320-95-002, February 14), Westinghouse Hanford Company, Richland, Washington.

- Contains a tank inventory estimate based on analytical information.

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